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Smarter Technology for a Greener Tomorrow

Special Issue

on the Proceedings of

IEI Sponsored Seminar on

"Artificial Intelligence and Machine Learning for Sustainable Growth in the Daily Life"

Organized by :

Computer Science Department
Mata Gujri Khalsa college
Kartarpur (Jalandhar)

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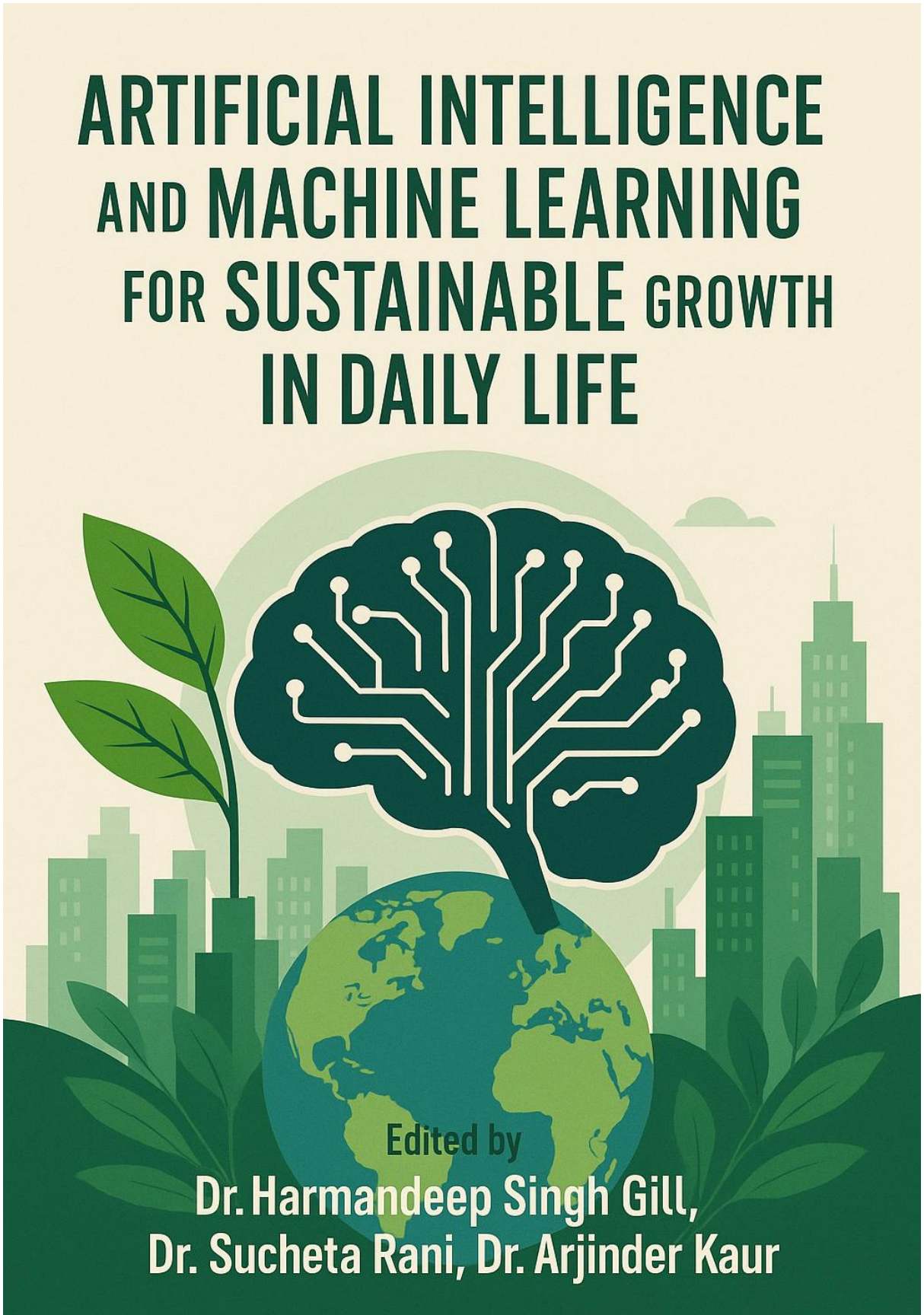

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Preface

It is with great pleasure that we present the proceedings of the National Seminar on "Artificial Intelligence and Machine Learning for Sustainable Growth in the Daily Life" which was organized by the Department of Computer Science, Mata Gujri Khalsa College, Kartarpur in collaboration with Institute of Engineers India (IEI) Punjab and Chandigarh State Centre.

This seminar brought together Eminent speakers, scholars, and researchers to share insights on contemporary trends, exchange knowledge, and discuss advancements in commerce, management, and the Indian economy. 75 scholars participated in this seminar in the capacity of resource persons, paper presenters, and delegates. The diverse range of papers included in this volume reflect the depth and breadth of discussions that took place during the seminar. Each contribution has undergone careful review and selection to ensure the highest quality of academic and professional engagement(discourse).

We take this opportunity to extend our sincere gratitude towards Dr. Baljit Singh Khehra Chairman, IEI and Registrar JGND Punjab state open University Patala, who, very generously, opened the seminar with his scholarly keynote address and gave significant inputs regarding the core theme of the seminar. He highlighted the current issues and challenges confronting the Indian economy.

We further owe a huge thanks to Er. Sukhvir Singh Mundi, Vice President IEI, Dr. TS Kamal, FIE and Dr. Jatinder Singh Saini- Head CSE, BBSBEC Fathegarh Sahib, Dr. Parminder Singh-Professor CSE, GNEC Ludhiana, Dr. Jagpal Singh Ubhi, Professor ECE, SLIET Longowal (Sangrur) and Dr. Jagtar Singh Sivia, Professor ECE, Yadvindra Punjabi University Campus Talwandi Sabo (Bathinda) for their knowledgeable and expert views.

We are highly grateful to the college Management Shiromani Gurdwara Parbandhak Committee, Sri Amritsar, and Dr. Harmandeep Singh Gill, Principal of Mata Gujri Khalsa College, Kartarpur for motivating and guiding us at every step, right from the conception, to the planning and execution of the seminar. We express profound gratitude to our Principal Dr. Harmandeep Singh Gill, whose vision and motivation has resulted in the emergence of this book. Heartfelt gratitude to all the learned participants, paper presenters, staff members, and organizing committee members for their unwavering support in making this event a success. We hope this seminar ignites meaningful dialogue and paves the way for progressive developments in the daily life with the support Artificial intelligence for sustainable growth. Hope that these proceedings serve as valuable resource for scholars and professionals, fostering further research and innovation in the field.

1. Dr. Harmandeep Singh Gill
   Principal (officiating) & HOD, Computer Science Department

   Mata Gujri Khalsa College Kartarpur (Jalandhar)

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PRINCIPAL'S MESSAGE

I am delighted to share that the "Artificial Intelligence and Machine Learning for Sustainable Growth in the Daily Life" has been organized by Computer Science Department of Mata Gujri Khalsa College, Kartarpur in association with the Institution of Engineers (India), Punjab & Chandigarh State Centre on 29 March 2025 at Mata Gujri Khalsa College, Kartarpur (Jalandhar). Artificial Intelligence plays a crucial role in promoting sustainable growth in daily life by optimizing resource use, reducing waste, and improving efficiency in various sectors. AI contributes to sustainability by promoting Energy Efficiency via Smart grids, Home automation and Renewable energy forecasting. AI helps in Sustainable Transportation, helps in Electric vehicle (EV) optimization, Traffic management and promoting Autonomous vehicle. It helps in Waste Management & Recycling and contributes to water Conservation. A major contribution of AI is in making agriculture sustainable through precision farming, Crop prediction. It helps in Eco-Friendly Manufacturing & Supply Chain. Not only this, it even helps in Monitoring Climate Change, tracking Deforestation, Calculating Carbon footprint, Disaster prediction. AI ethics focus on ensuring that artificial intelligence systems are designed and used responsibly, fairly, and transparently. It addresses the social, economic, and moral impact of AI on individuals and society. Key Ethical Principles in AI includes Fairness & Bias Reduction. AI needs be designed to avoid discrimination based on race, gender, ethnicity, or socioeconomic status. Bias in training data can lead to unfair outcomes (e.g., biased hiring algorithms). Ethical AI ensures equal opportunities for all individuals. AI decisions need to be understandable to users. AI ethics is crucial for ensuring that AI benefits society while minimizing harm. Developers, businesses, and governments must work together to create ethical AI policies and frameworks that prioritize fairness, transparency, and accountability. AI plays a vital role in achieving sustainability by enhancing efficiency, reducing waste, and promoting eco-friendly habits in daily life. With continued advancements, AI will further drive sustainable development while making everyday activities more environmentally responsible.

Need is to use AI wisely, and let it be a tool for progress, not a cause for concern.

God bless all!!

Dr. Harmandeep Singh Gill

PRINCIPAL

Mata Gujri Khalsa College, Kartarpur (Jalandhar)

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CHAIRMAN'S MESSAGE

I am delighted to share that the "Artificial Intelligence and Machine Learning for Sustainable Growth in the Daily Life" has been organized by Computer Science Department of Mata Gujri Khalsa College, Kartarpur in association with the Institution of Engineers (India), Punjab & Chandigarh State Centre on 29 March 2025 at Mata Gujri Khalsa College, Kartarpur (Jalandhar). The theme of the Convention is highly relevant in today's scenario. It deals with the impact of AI technologies and highlights the importance of Machine Learning in our daily lives.

Artificial intelligence (AI), specifically Machine Learning, is one of the biggest innovations these days. Gone are the days when AI was used to be a fanciful concept from science fiction, but now it is becoming a daily reality. AI touches our lives in ways we often do not even realize. Starting from unlocking our smartphone using facial recognition to virtual assistants like Siri or Alexa setting an alarm, playing songs, or giving weather forecast to analysing traffic patterns and finding the fastest route to our destination to advanced diagnostics to virtual consultations and robotic surgeries to offering personalized learning experiences, language translation, and even automated essay grading to cybersecurity, and fraud detection, AI does it all. By understanding and adapting to AI, we can make our lives better and contribute to a smarter, more efficient, and more connected world.

I hope this seminar provides an opportunity to professionals and experts to ponder on the theme of the convention and gain knowledgeful insights. I take this opportunity to extend my best wishes to the organizers, participants and whole team associated in organizing the event.

Good luck

Dr. Baljit Sngh Khehra

Charman IEI,

Punjab and Chandigarh State Centre

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INTEGRATING GREEN CHEMISTRY AND ARTIFICIAL INTELLIGENCE FOR THE DEVELOPMENT OF SELF-HEALING RENEWABLE ENERGY SYSTEMS

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ABSTRACT

The combination of Green Chemistry and Artificial Intelligence (AI) presents exciting opportunities for creating sustainable and self-healing renewable energy systems. Green Chemistry focuses on designing products and processes that reduce environmental harm, enhance energy efficiency, and utilize renewable resources. On the other hand, AI provides sophisticated predictive modeling, optimization, and autonomous decision-making capabilities that can speed up advancements in energy technologies. This paper examines how merging the principles of Green Chemistry with AI can facilitate the development of self-healing materials and systems for renewable energy uses. We specifically look at the creation of self-healing coatings for solar panels, intelligent wind turbine blades, and energy storage systems, emphasizing how AI-driven designs can improve material properties and functionality while ensuring sustainability. Additionally, we investigate AI's role in real-time monitoring, diagnostics, and the optimization of self-healing processes within energy systems. By taking this interdisciplinary approach, we aim to promote energy technologies that not only fulfill future clean energy demands but also offer greater durability and lower maintenance costs. The collaboration between Green Chemistry and AI paves the way for more efficient, resilient, and environmentally friendly renewable energy systems, contributing to a more sustainable energy future.

Keywords: Green chemistry, AI, Self healing

1. INTRODUCTION

The global transition to sustainable energy systems highlights the urgent need for innovative solutions that reduce environmental impact while improving the efficiency and life span of energy technologies. Renewable energy systems, including solar panels, wind turbines, and energy storage devices, are leading this change. However, these systems encounter challenges such as material degradation, wear and tear, and the necessity for regular maintenance. The use of self-healing materials—those that can autonomously repair damage—presents a promising strategy to tackle these challenges, ultimately extending the lifespan and lowering maintenance costs of renewable energy technologies. Green Chemistry, which focuses on designing chemical processes and materials that minimize or eliminate hazardous substances, provides a solid foundation for developing sustainable, eco-friendly materials with self-healing capabilities. The principles of Green Chemistry, such as resource efficiency, renewable feed stocks, and reduced environmental impact, align closely with the objectives of creating sustainable energy systems. Nevertheless, while Green Chemistry offers a theoretical basis for crafting innovative materials, its practical applications in energy systems are still in their infancy. Conversely, Artificial Intelligence (AI) has transformed numerous industries by processing large datasets, optimizing processes, and modeling complex systems. In renewable energy, AI's strengths in predictive modeling, real-time monitoring, and optimization can greatly improve the performance of self-healing materials. By leveraging AI to design and forecast the behavior of these materials, we can achieve more efficient, durable, and adaptable energy


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systems. This research paper delves into the combination of Green Chemistry and AI to create self-healing renewable energy systems. Our goal is to explore how AI-driven methods can be utilized to optimize these technologies.

2. GREEN CHEMISTRY IN RENEWABLE ENERGY SYSTEM

Green Chemistry serves as a vital framework for creating technologies that are both environmentally friendly and sustainable. It aims to minimize the impacts of chemicals and materials on the environment and human health through thoughtful design and process improvements. In the realm of renewable energy, Green Chemistry can influence the development of self-healing materials in several key ways:

- **Sustainable Material Design:** Green Chemistry promotes the use of renewable, biodegradable, and non-toxic materials. These materials can be utilized to produce coatings, composites, and other components that can repair themselves when damaged, thereby supporting the sustainability of the energy system.
- **Minimizing Energy Consumption:** A fundamental principle of Green Chemistry is energy efficiency, which focuses on lowering the energy demands of chemical processes. This idea can be applied to the creation of self-healing materials by refining their production methods to use less energy and produce less waste.
- **Environmentally Friendly Processes:** Green Chemistry emphasizes the importance of using processes that are environmentally benign and do not create harmful byproducts. This principle is crucial for developing self-healing materials that are not only effective but also align with sustainability goals in renewable energy systems. By following the principles of Green Chemistry, renewable energy systems can incorporate self-healing materials that are both efficient and eco-friendly, paving the way for a more sustainable future.

3. THE ROLE OF ARTIFICIAL INTELLIGENCE IN SELF-HEALING SYSTEMS

From optimizing processes to automating complex tasks, artificial intelligence (AI) has bolstered business operations across many sectors. When it comes to self-healing materials, AI offers significant value in the following ways:

- **Algorithmic Design:** AI can improve the self-healing material's design by modeling materials and their interactions with the environment using extensive datasets. Machine learning models are able to evaluate how chemical constituents, additives, and physical configurations of materials change the self-healing capabilities, thus providing more effective and lasting alternatives.
- **Healing Monitoring:** AI can be combined with sensors and access to real-time data to supervise the state of renewable energy systems. Self-healing materials, through continuous monitoring, can be made to predict the point of failure and thus set off the self-healing mechanism to minimize damage. This goes a long way toward reducing system breakdowns and increasing the longevity of energy technologies.
- **Real-time Analysis:** With AI, real-time monitoring of self-healing materials is possible whereby the efficiency of the healing can be evaluated. Through thorough evaluation of sensor data, AI systems can optimize the parameters utilized in the healing process to guarantee efficacy.

4. APPLICATIONS OF SELF-HEALING MATERIALS IN RENEWABLE ENERGY SYSTEMS

Multiple renewable energy technologies could enhance significantly with the application of self-healing materials. Here are some guiding examples of how self-healing materials along with Green Chemistry and AI could make a greater case:


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- **Self-Healing Solar Panels:** Solar panels are prone to damage from the environment, like UV radiation, mechanical wear, etc. When panels are integrated with self-healing coatings, they can repair minor damage automatically and renew their efficiency. AI systems could monitor the health of the panel and invoke the self-healing process when damage is detected so that maximum energy is produced during the panel's life.
- **Smart Wind Turbine Blades:** Wind turbine blades are affected with mechanical stress, impact damage, and extreme weather. It would be possible to embed self-healing materials into the blades to minimize such micro-damage, so that turbines could work safely and efficiently. AI monitoring could activate the self-healing cycle whenever damage is detected before serious impact on performance takes place.
- **Self-Healing Batteries:** There are number stoarge devices that use batteries that help balance the generation of renewable energy. Even these suffer from degradation with time. It is possible to expand the lifetime of the battery by incorporating self healing materials into their construction.

5. CHALLENGES AND FUTURE DIRECTIONS

As encouraging as the prospect is, many barriers still exist in the intertwining processes of Green Chemistry, AI, self-healing materials, and energy systems. Some of them are outlined below:

- **Development of Self-healing materials:** The development of effective self-healing materials which are also non-toxic to the environment poses a challenge. Striking the proper performance, environmental impact, economic cost, and material expense balance remains a challenging task.
- **Data Collection Infrastructure:** AI-based systems on monitoring and predictive maintenance require automated data collection and processing. Deploying such an infrastructure on a wider scale tends to be expensive and technologically advanced.
- **Possibility of Growth:** Meeting the demand for self-healing materials in the renewable energy industry poses a great challenge when it comes to the possibility of increasing their production. Systematic integration of Artificial Intelligence into material and system design makes it company-specific, therefore demanding investment and collaboration on a larger scale.

Further work needs to be done in developing self-healing materials that are green and capable of being systematically integrated with AI systems to optimize their functionality. Enhanced collaboration among materials scientists, chemists, and AI scientists will be pivotal in addressing these issues.

6. CONCLUSION

The integration of Green Chemistry and Artificial Intelligence in the development of self-healing renewable energy systems offers a transformative approach to addressing the challenges of material degradation, system maintenance, and sustainability. Through the use of sustainable materials and AI-driven optimization, renewable energy systems can be made more resilient, efficient, and cost-effective. The combination of self-healing materials, Green Chemistry, and AI has the potential to revolutionize the renewable energy landscape, creating technologies that are both environmentally friendly and economically viable in the long term. The continued development of these interdisciplinary solutions is critical for advancing the future of renewable energy and achieving a sustainable, low-carbon future.

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Crop Leaf Disease Detection and Classification using Deep Learning

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ABSTRACT

Agriculture is often referred to as the backbone of the Indian economy, and plays a vital role in employment, food security, and national income. Farmers suffer heavy losses every year due to late detection of crop diseases. Automation has helped prevent such damage to the crops to some extent however employment of artificial intelligence (AI) based solutions have proved their effectiveness in early detection of crop diseases to a large scale while making it possible for farmers to take timely measures for crop protection, thereof. In the current scenario, AI domain has been revolutionized by deep learning, a subset of artificial neural networks with multiple layers, achieving the state-of-the-art results in various domains. Thus, in this research article, a deep learning based crop disease detection and classification model is presented. For this, five types of crops, including apple, bell pepper, corn, potato, and tomato, have been considered. Results show that proposed model using deep learning outperformed the existing systems based on artificial neural networks alone.

Keywords *:*Agriculture; crop leaf disease detection; classification; artificial intelligence; artificial neural networks; deep learning

1. INTRODUCTION

In the context of India, where agriculture plays a crucial role in the economy and to this day, traditional methods such as manual inspection by an expert still dominate, adopting automated crop disease detection systems could lead to substantial benefits. These systems can complement existing agricultural practices and help in modernizing the sector while improving productivity and sustainability. Moving forward, key considerations include ensuring accessibility of these technologies to farmers, addressing infra structural challenges, and continuously refining the algorithms to enhance accuracy and efficiency. Overall, automated crop disease detection systems represent a significant opportunity to revolutionize agriculture by making it more efficient, cost-effective, and responsive to the challenges of disease management.

In early crop disease detection systems, classification is the chief concern. Deep neural networks are apt to provide optimal solutions to complex classification problems. Besides, their ability to learn from past data and to perform in non-linear domain makes them well suited for large scale data oriented applications. In general, deep neural networks are an attempt at simulating the human brain. An important issue is the data fed to these networks during the training phase. More accurate the dataset being prepared higher would be the accuracy of the deep learning models. As a result, deciding the appropriate parameters of the dataset under consideration is extremely crucial in the success of any classification application (Rajasekaran and Vijayalakshmi, 2004). The parameters include, size of training, validation and testing sets, type of images, conditions under which images were being acquired (poor illumination, low contrast images, or real time acquisition), to name a few. Furthermore, appropriate training size of dataset must be framed to address the issues of under-fitting and over-fitting while designing the classification models based on deep learning algorithms (Denker et al.,


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1989).Through this article, a well-designed artificial intelligent system is proposed so to utilize the merits of deep learning for accurate crop disease detection and classification.

The remaining article is organized as follows: a brief literature survey is provided in Section 2, details of proposed model and methodology are given in Section 3, results and discussions are presented in Section 4, and the conclusions are summarized in Section 5.

2. LITERATURE REVIEW

The literature on crop disease detection and classification is very vast, however is specific to the crop. Early researches exploited the soft computing classifiers primarily, Artificial Neural Networks (ANN) (McCulloch and Pitts, 1943), Fuzzy Logic (FL) (Zadeh, 1965) and Genetic algorithms (GA) (Holland, 1975). However, later on, other techniques such as support vector machines (SVM) (Cortes and Vapnik, 1995), swarm intelligence (SI) (Kennedy and Eberhart, 1995), chaos theory, machine learning, meta-heuristics and many more have also been utilized for classification of crop diseases. A good number of researches have been performed to detect apple fruit diseases by Bennedsen et al. (2007) and Unay and Gosselin (2005)who developed a neural networks based disease detection-cum-grading system for apple fruit. Another effort was done by Cetişli and Büyükçingir (2013)who utilized the Neuro-fuzzy classifiers to combine the adaptability of neural networks with the interpretability of fuzzy logic, making them suitable early detection of apple scab.

Bhange and Hingoliwala (2015) made significant strides in smart farming with their pomegranate disease detection system using image processing techniques. By utilizing k-means clustering on images of pomegranate leaves and fruits, they were able to achieve an overall accuracy of 82%. However, it's noted that the dataset used was acquired in a lab environment, not real-time field data. This distinction is crucial as it implies that while the system shows promise, its performance in actual croplands may differ due to real-world conditions. The approach by Debauche et al. (2020) sounds quite innovative, combining AI with IoT for disease detection and irrigation management in agriculture. The key novelty lies in their integration of a mathematical formula for evapotranspiration to compute the water requirements of crops.

The study by Khan et al. (2021) appears to focus on mitigating the issue of bolting in onions through the use of an IoT-based closed environment. Bolting in onions refers to the premature flowering and seed stalk formation, which can reduce the quality of onions intended for consumption. It was reported that the bolting rate decreased from 16.7% in an open environment to 3% in their closed system. This indicated that the controlled conditions provided by the IoT-based closed environment were effective in managing and minimizing the occurrence of bolting in onions. Gill and Singh (2023) proposed a non-invasive mango disease detection model that utilizes hybrid soft computing approach. Artificial neural networks (ANN), optimized with Antlion optimizer (ALO), are used as a classification tool. Their system has achieved an impressive overall classification rate of 95.8% indicating that the model is robust and effective in identifying mangoes with defects. A large number of contributions were made in the field of crop disease detection using artificial neural networks. However, little emphasis was given to classify the diseases for the crops as a whole. One limitation of ANN is scalability issues when multiple crop types and their diseases be utilized. ANN does not work very well for large datasets. Perhaps, this could be a possible reason for availability of very few data bases for multiple crops. So, the present research tries to achieve two objectives: one is to detect and classify the multiple crop diseases; and the other is to utilize deep learning for large datasets with improved accuracy rates.

3. MATERIALS AND METHODS

The proposed crop disease detection and classification system works in four main phases: data preparation phase, training phase, validation phase and testing phase, as shown in figure1.

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A. Data Preparation Phase

The model initiated with the task of data collection where crop images from the standard databases: Kaggle-Plantvillage and Mendeley were used. The dataset consisted of 28,591 images in total including healthy and diseased images of 5different crop types, viz. apple, bell pepper, corn, potato, and tomato. Details of the crop types along with the diseases are provided in table 1.

After collection of data, all the training images were resized to the same dimensions and format, to ensure uniformity in size and type. In this research, all the images were resized to 256×256.Another important task performed in this phase is background separation, also known as region of interest (ROI) extraction. This is done to remove unnecessary minute details in the images which have no contribution in the task of classification. The images if fed directly along with the background to the network for classification of crop diseases, the accuracy of the model gets affected. As a result, the crops image dataset has been prepared properly prior to feeding to the model for training.

Table 1: Dataset Details: Crops and corresponding Diseases used for Crop Leaf Detection and Classification Model

S. No.	Crop Type	Disease type	Number of Crop Images		
			Total	Healthy	Diseased
1.	Apple	Cedar Rust	4008	1510	1045
		Scab			1453
2.	Bell Pepper	Bacterial Spot	2475	1478	997
3.	Corn	Common Rust	2575	1369	1206
4.	Potato	Early Blight	3521	1521	1000
		Late Blight			1000
5.	Tomato	Bacterial Spot	16012	1591	2127
		Early Blight			1000
		Late Blight			1909
		Leaf Mold			952
		Mosaic Virus			373
		Septoria Leaf Spot			1771
		Spidermites			1676
		Target Spot			1404


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		Yellow Leaf Curl Virus			3209
Total			**28591**	**7469**	**21122**

After preparation of dataset in the desired form, the crop images were fed to the network for training in the next phase. For training and testing dataset separation, the 80-20 rule was followed. According to this rule, 80% of the total images act as input to the training phase whereas 20% of the total images are fed to the model for testing phase. As a result, out of the total 28,591images of different crops, 22,873 were used for training and the remaining 5,718 for testing purposes (proportionately for each crop type and the corresponding disease type).

A. Training

For any disease detection and classification model, training is the second and the most imperative phase where classification is to be performed. In this research work, supervised learning was used to train the deep learning based model; thus, 22,873 crop images were fed in the labelled form. The sample images of the dataset are shown in table 2 along with the labels provided.

For training purposes, the most important deep learning algorithm used for complex models is the convolutional neural networks (CNN). Generally for complex, non-linear problems, large datasets are a requirement. For such problems, artificial neural networks (ANN) when used alone suffers from scaling issues and gets trapped in local minima, consequently producing local, inaccurate and non-optimal solutions. However, their pattern recognition capabilities cannot be ignored. On the other hand, CNN are well suited for handling computations for large datasets and if blended with ANN still produce remarkable results. Hence, CNN works in a collaborative fashion with ANN where CNN is used for dimensionality reduction, ANN can be utilized for conventional tasks of classification (Coenraad et al., 2020).

In this research work, firstly CNN was used to take input as crop images of size 256×256×3 (colored images for RGB color components), gradually after various layers reduced its dimensions and produced flattened layer as output. This was further taken by ANN as input and trained itself by adjusting the weights while back propagating the errors until reduced to minimal error value. The block diagram of the classifier used and the steps to be followed for the algorithm are shown in respectively in figure 2 and 3.

First and foremost, convolutional layer 32 was applied and a kernel of size3×3 was used. Thereafter, activation function is applied and the most efficient one is relu function. Then max pooling was used with a pool size of 3×3. These three layers are applied in the same sequence but with different parameter values. Afterwards, in second loop, convolutional layer is again applied but with 64 layer and 3×3 kernel size, relu activation function is again applied. In the third loop, convolution is applied with same parameters as that in the second loop. However max pooling was applied with a 2×2 pool size. In the fourth loop, convolutional layer with 128 and 3×3 kernel is applied along with relu activation function. In the fifth loop, 128 and 3×3 convolutional layer parameters, with relu activation function and max pooling of 2×2 were used.

Table 2:
Sample images of 5 crops and the corresponding labels: Healthy and Diseased for training

S. No.	**Crop Type**	**Sample Images**	
		Label: Healthy	**Label: Diseased**

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1.	Apple	Healthy	 Cedar Rust	 Scab	 Cedar Rust
2.	Bell Pepper	 Healthy	 Bacterial Spot	 Bacterial Spot	 Bacterial Spot
3.	Corn	Healthy	 Common Rust	 Common Rust	 Common Rust
4.	Potato	 Healthy	 Early Blight	 Late Blight	 Late Blight
5.	Tomato	 Healthy	 Bacterial Spot	 Early Blight	 Late Blight

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		 Healthy	 Leaf Mold	 Mosaic Virus	 Septoria Leaf Spot
		 Healthy	 Target Spot	 Spidermites	 Yellow Leaf Curl Virus

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After the fifth loop, control came out of the loop and the next step performed was flattening and a dense layer of 1024 features with activation function of relu was applied. Finally, in the dense layer the number of classes to be received as output with softmax activation function were used. These steps were repeated for a number of epochs till the error value got minimized using artificial neural networks. The weights were modified by back propagating the error back to the input layer. When the error was reduced to nearly zero, the network was said to be trained. Afterwards validation was performed in the next phase.

B. *Validation*

Validation is the process of validating the training process by feeding input and thus checking the dataset for over fitting and under fitting or any biased dataset. As a result, the different pairs of data were prepared so as to validate the deep learning based model which is being automatically performed using in built functions.

C. Testing

This is the final step where unlabeled data are tested for classification. In this phase, the same algorithm was executed as was done in the training phase and the only difference was that no labelling was given to the images. In this research 5718 images (20% of the total crop dataset) were tested with the result shown in the next section. The output of testing phase was in the form of text that specifies the class to which the crop belonged to. These classes include healthy and diseased. Based on these classes, further categorization was performed on the basis of various types of diseases. That is in case the crop leaf is forecasted to be healthy then no further classification is performed and the output would be displayed as the <crop-name>: <status = healthy >. However, for diseased crop leaf, the output would be <crop-name>: <status = diseased; <disease-name>>.

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4. RESULTS AND DISCUSSION

An l-m-n architecture of 1024-m-1 was used for simulation of neural networks as depicted in figure 4. The count of input neurons depends upon the number of feature extracted from the image, while the count of output neurons depend on the output values to be forecasted. In the current scenario, the number of input neurons was 1024 as the features extracted in CNN layers were 1024 in count. Finally, the number of output neurons were taken as 1, because, there were twenty different categories including crop healthy and crop leaf diseases and one of the twenty categories would be forecasted as output class.

The performance metrics based graphs for crop leaf disease detection and classification in the training and the validation phase are shown in figure 5. In figure 5(a), the accuracy versus iteration graph at epochs 25 for training as well as validating the CNN are demonstrated, whereas figure 5(b) shows the loss versus iteration graph at epoch value of 25. The model is executed again and the same is repeated for epochs 50. The accuracy versus iteration graph at epochs50 for training as well as validating the CNN are demonstrated in figure 5(c), while the loss versus iteration graph at epoch value of 50 are given in figure 5(d). It is quite evident from the graph that the accuracy of the proposed model was higher when it is trained for 50 epochs. Probable reason for low accuracy rates convergence of CNN at epochs 25 might be due to under training of the model. This further led to higher loss values at epoch 25 as compared to model trained for 50 epochs. The stability line in accuracy and loss in figure 5(c) and (d), undoubtedly supported the fact that the model works well for higher epochs.

The convergence of crop leaf disease detection and classification model to minimum error value is shown in figure 6. The error vs. iteration graph for epoch value 200 is shown in figure 6 (a) while for epochs = 300figure 6(b), error vs. Iteration graph Also, it is evident from figure 6 that with increasing number of iterations the model gets well trained and thus the accuracy of the model gets increased. In order to compare the proposed CNN based crop leaf disease detection and classification model with the ANN model, a quantitative analysis was performed. Confusion matrices for both the models were formed after the testing phase. As discussed earlier, 5718 crop leaf images were taken for testing. The test set was so designed to include healthy and diseased crop leaf images for all crop types. The matrices are as shown in figure 7.

Crop Class	AH	ACR	ASC	BPH	BPBS	CH	CCR	PH	PEB	PLB	TH	TBS	TEB	TLB	TLM	TMV	TSL	TSP	TTS	TYL
AH	301	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
ACR	4	200	0	0	0	0	2	0	0	0	0	1	1	0	0	0	0	0	1	0

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ACTUAL OUTPUT	**ASC**	0	3	281	0	0	2	0	0	0	0	0	0	0	3	1	0	1	0	0	0
	BPH	1	0	0	283	0	0	0	2	0	0	3	0	0	0	0	1	0	6	0	0
	BPBS	2	0	0	2	183	0	0	0	2	3	0	0	0	0	3	0	1	0	1	2
	CH	0	0	0	0	2	268	0	1	0	0	2	0	0	0	0	0	0	0	0	0
	CCR	0	1	0	0	0	0	235	0	0	1	0	2	0	1	0	0	0	1	0	0
	PH	0	4	0	0	0	0	0	293	0	0	1	1	3	0	0	0	3	0	0	0
	PEB	0	0	0	0	0	0	0	0	193	4	0	0	0	0	1	2	0	0	0	0
	PLB	0	2	0	0	0	0	0	0	2	195	0	0	0	1	0	0	0	0	0	0
	TH	0	0	0	3	0	0	0	0	0	0	311	0	0	2	0	4	0	1	0	1
	TBS	0	0	0	0	0	1	0	0	1	0	0	421	0	0	0	2	0	0	0	0
	TE													19							

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	B	1	3	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	2
	TLB	0	0	0	0	2	0	0	0	2	0	0	0	2	373	3	0	0	0	0	0
	TLM	3	0	0	0	0	0	0	0	0	0	0	5	0	0	181	0	0	1	0	0
	TM	0	0	0	0	0	0	0	0	0	0	0	0	3	4	2	63	0	3	0	0
	TSL	0	0	4	0	0	0	0	0	3	0	0	0	0	0	0	0	344	0	2	0
	TSP	0	0	0	2	0	0	0	2	0	1	0	0	2	0	1	0	0	327	0	0
	TTS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	1	0	276	0
	TYL	0	0	0	0	0	0	6	0	0	0	0	0	2	0	0	5	0	0	0	628

Figure 7: Confusion Matrix for C NN based Crop Leaf Disease Detection and Classification

Table 3: Performance Evaluation of C NN Crop Leaf Disease Detection and Classification Model

Parameter	Formulas	Output for CNN Model
1. Accuracy	$\frac{truepositive + truenegative}{totalcases}$	97.06%
2. Misclassification rate	$\frac{falsepositive + falsenegative}{totalcases}$	2.93%

From the confusion matrices of figure 7, classification parameters that is accuracy and misclassification rate were computed for the proposed CNN based crop leaf disease detection and classification model, provided in table 3. Two


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parameters were considered: one to determine the overall accuracy and the overall misclassification rate.On analyzing the tabular values, it wasmanifested that showed an overall accuracy rate of 97.06%. Moreover, the misclassification rate was quite low that is 2.93%. Thus it is evident from the results that the CNN based model performed well for the crop leaf disease detection and classification application.

5. CONCLUSIONS

In this research article, a crop disease detection and classification model using Convolutional neural networks have been developed so as to eliminate the drawbacks of traditional artificial neural networks. The model has been sub-divided into four main phases: data preparation phase, training phase, validation phase and testing phase. The dataset consisted of 28,591 images in total including healthy and diseased images of 5 different crop types, viz. apple, bell pepper, corn, potato, and tomato. The model was trained for 22,873 images and the remaining 5,718 for were used for testing purposes. The model has achieved an accuracy rate of97.06% and misclassification rate was quite low that is 2.93%. Thus, CNN based model is proposed for the future perspectives.

ACKNOWLEDGEMENT

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AI AND THE RISE OF DIGITAL PAYMENTS: A STUDY ON PROFITS OF INDIAN COMMERCIAL BANKS

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ABSTRACT

The banking sector in India plays a pivotal role in fostering the economic growth of the Indian economy. Over the years, this sector has undergone a significant transition from traditional banking to digital banking providing people with the opportunity to adopt cashless transactions. In essence, digitalization coupled with AI advancements, has reshaped the banking landscape offering new opportunities for growth and profitability. The main objective of this study is to examine the impact of the digital payments system on the profits of commercial banks in India by utilizing data for the time period 2019-2024. For this study, secondary data has been taken from RBI Annual reports, Statistical tables related to banks in India and RBI reports on Trends and Progress of banking in India. Regression analysis is used to examine the relationship between digital payments and profits of commercial banks in India. The results show that digital payments have a positive impact on the profits of commercial banks in India.

Keywords: *Digital payments; AI; Profitability; Cashless economy*

1. INTRODUCTION

The banking sector in India plays a prominent role in fostering economic growth by enabling savings, lending, and financial transactions. There has been a paradigm shift from conventional banking to digital banking in India, spurred by swift advancements in digital technology and artificial intelligence. Initiatives by the government, such as the National e-Governance Plan (NeGP) introduced in 2006 and the Digital India initiative launched in 2015, laid the groundwork for this digital evolution. These programs, which emphasize digital infrastructure, services, and inclusion, have facilitated a shift towards paperless, faceless, and cashless transactions through platforms like Aadhaar, UPI, and DigiLocker, positioning India as a technology-led nation. From 2015 to 2022, the digital transformation in India resulted in significant


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achievements, including enhanced customer-focused initiatives and increased transaction volumes, which gained international accolades. The demonetization in 2016 further propelled the use of digital payments as individuals sought alternatives to cash. While the digitalization trend has drastically transformed India's banking sector towards cashless transactions, there remains few areas of research focusing on the effects of digital payments on the profits of Indian banks. Most existing research tends to focus on customer service and operational perspectives. Consequently, a study explaining the relationship between digital payments and the profits of commercial banks in India, spanning from 2019 to 2024, would fill this gap in research by offering empirical insights. Thus, in the light of digitalization era, this paper aims to study following objectives:

1. To study the trends of digital payments and profits of commercial banks in India.
2. To examine the relationship between digital payments and profits of commercial banks in India.

2. REVIEW OF LITERATURE

Gupta and Kumar (2017) analyzed the impact of demonetization on the Indian economy and how much the decision of demonetisation, by the government, is successful in achieving the goal of a cashless economy. The results show this initiative not only alleviates the challenges associated with handling cash for millions of Indians but also marks a crucial step toward establishing India as a truly cashless economy. **Gurram and Velagapudi (2020)** study showed that the adoption of e-banking significantly reduces operational costs for banks. The study concluded that online banking is better than traditional banking. **Parbat and Roy (2022)** analyzed financial inclusion using Digitalisation and the Perception of its beneficiaries using primary data. Ordinal Regression analysis has been used to study the perception of beneficiaries related to digital financial services. The results show that there is a positive upliftment in the perception of beneficiaries thereby causing financial inclusiveness through digitalisation. **Sethi and Bohra (2020)** analyzed Indian Digital payments during the COVID era using NEFT, RTGS, UPS, BHIM, IMPS, and card payments as benchmark measures to study the adoption and usage of digital payments. The research found that the economic turmoil resulting from Covid-19 has enhanced the accessibility and resilience of the digital system compared to earlier times. The unprecedented challenges presented by the pandemic resulted in a greater acceptance of digital payment methods in India.

3. RESEARCH METHODOLOGY:

This study employs secondary time series data of scheduled commercial banks in India for the period 2019 -2024 to study the effect of digital payments on the profits of commercial banks in India. Secondary data has been collected from RBI Annual reports, Statistical tables related to banks in India, RBI reports on Trends and Progress of Banking in India. To study the impact of digital payments on profits, profits are taken as dependent variables while, Digital payments are taken as independent variables.

Hypothesis:H_{01}: The impact of digital payments on the profits of commercial banks in India is significant.

4. LIMITATIONS OF THE STUDY:

The study is confined only to five years spanning from 2019 to 2024 and focuses primarily on digital payments as an independent variable and profit as the only dependent variable.

5. EMPIRICAL ANALYSIS

Trends in Digital Payments and Profits of Commercial Banks in India:

The demonetization of 2016 along with the pandemic in 2019led to growth of digital payments in India from 2019 to 2024. However, there is a slump being seen in the 2020-21 time period where the value of digital payments has decreased


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from 16,19,68,681 crores to 141458,488 crores. One of the probable reasons for this downfall is the declining high value of corporate transactions during this period (Sethi & Bohra, 2020). Despite this setback, an upward trend in digital payments from 2020 to 2024 has been witnessed due to many factors such as government initiatives promoting digital transactions, advancements in fintech infrastructure and consumer's preference for cashless transactions. Looking at the profits side, it is being observed that commercial banks witnessed a loss of 23,397.39 crores during the 2019-20 time period primarily due to surge in bank loans and NPA's which significantly eroded the profits of commercial banks in India. However, in the subsequent years from 2020 to 2024, the commercial banks have seen a positive turnaround in profits due to several factors like the adoption of AI-driven financial services, block chain technology, expanded financial inclusion initiatives, improvement in asset quality, etc. thereby leading to restoration of profits.

Table 1: Digital payments and Profits of Commercial Banks in India

Year	Digital payments (Value in crores)	Profits (In Crores)
2019-20	161968681	-23,397.39
2020-21	141458488	10,910.70
2021-22	174401233	1,21,997.57
2022-23	208684872	1,82,032.09
2023-24	242823799	2,63,213.87

Source: *Statistical Tables Relating to Banks in India, RBI*

IMPACT OF DIGITAL PAYMENTS ON PROFITS OF COMMERCIAL BANKS IN INDIA:

To study the impact of digital payments on the profits of commercial banks in India for the period 2019-2024, simple regression analysis has been employed using SPSS software. The model is as follows:

Profits of commercial banks = □□□□□ (Digital payments),

Profits = –403432.497 + 0.03 (Digital payments).

The results show that if digital payments are zero then the profit of commercial banks will be negative. Furthermore, the coefficient of digital payments is 0.003 which implies that with every 1 crore increase in digital payments, the profit of commercial banks increases by 0.003 crores (3 lakhs) holding other factors constant. This relationship shows the beneficial impact of the growth of digital payments on profits and hence, the financial performance of commercial banks in India. The associated p-value for digital payments is 0.020 in the ANOVA table which is less than the threshold value of 0.05 suggesting that the relationship between digital payments and profits is statistically significant at 5% significance level. This means hypothesis (H_{01} : The impact of digital payments on profits of commercial banks in India is significant) is true. The high □ coefficient (0.935) indicates a strong positive relationship between digital payments and commercial bank profitability. This high beta value suggests that digital payments are a dominant predictor of bank profits during the study period. Additionally, it is observed that there is a high degree of positive correlation between digital payments and the profits of commercial banks


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in India. 87.4% of the variation in profits of commercial banks in India is shown by digital payments while 12.6% of the variation is due to other factors. Thus, the findings of this regression model support the hypothesis that digital payments enhance the profits of commercial banks in India during the period 2019-2024.

Table 2: Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Correlations		
		B	Std. Error	Beta			Lower Bound	Upper Bound	Zero-order	Partial	Part
1	(Constant)	-403432.497	114735.818		-3.516	0.039	-768573.075	-38291.918			
	Digital payments	0.003	0.001	0.935	4.566	0.020	0.001	0.005	0.935	0.935	0.935

Source: *Author's calculation*

Table 3: Correlation

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.935	0.874	0.832	48637.6	0.874	20.848	1	3	0.02

Source: *Author's calculation*

Table 4: ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	49319239335.284	1	49319239335.284	20.848	.020[b]
	Residual	7096841828.711	3	2365613942.904		
	Total	56416081163.995	4			

Source: *Author's calculation*

6. CONCLUSIONAND POLICY RECOMMENDATIONS

The study concludes that a substantial increase has been observed in the growth of digital payments in India from 2019 to 2024. However, there is a slump being seen in the 2020-21 time period where the value of digital payments has decreased from 16,19,68,681 crores to 141458,488 crores due to the declining high value of corporate transactions during this period. There is a positive relationship between the profitability of commercial banks and digital payments in India. Higher the volume of digital payments, the higher will be the profits of commercial banks in India. Thus, the findings show that the implementation of digital payment systems, bolstered by innovations like block chain technology and AI-

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driven financial services, as well as initiatives for financial inclusion and better asset quality, have been crucial in boosting and reviving bank profits after 2020. Based on the findings, the following suggestions are proposed to enhance the profits of commercial banks in India in the light of digital expansion: Commercial Banks should improve and deepen partnership with top financial technology firms and speed up their digital transformation efforts.

Furthermore, they should focus on innovating financial products and services to enhance the customer experience and quality of service. Investing in the training and development of technological talent is also crucial, as the effectiveness of digital transformation depends significantly on having skilled professionals available. Additionally, while aiming to increase profitability, commercial banks must give priority to building strong risk management systems. Financial institutions can take part in regulatory sandbox initiatives launched by the Reserve Bank of India (RBI) to evaluate new digital payment solutions in a monitored setting.

Thus, by adopting these measures, commercial banks in India can improve their profits while significantly contributing to the country's shift towards a cashless economy. Enhancing digital infrastructure, promoting innovation, and ensuring effective risk management will together establish trust and promote broader acceptance of digital payment systems. Ultimately, these actions will support the achievement of a digitally empowered and financially inclusive society.

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Feature Extraction Techniques in Image processing for Cattle Identification

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ABSTRACT: Recognition system is used to recognize objects, humans, and animals in image processing. Animal recognition system helps for verification of cattle livestock, missed and swapped cattle and for detection of false insurance claims in banking

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sectors. Such recognition system is based on biometric features for quick recognition. This proposed system uses texture local feature descriptor, Harris corner, BRIEF and BRISK to extract features from the muzzle pattern of 930 images. The dataset of these images has been captured with smart device and captured images are transferred to server. The muzzle pattern of 4 distinct breed Holstien Friesian, Rathi, Jersey and Sahiwal have been collected from farms. This proposed system is based on to identify an image from group of images by extracting valuable features and techniques.

Keywords: Feature selection; Feature extraction; Harris Corner Detection; BRIEF; BRISK.

1. INTRODUCTION

Computer vision is a rewarding topic for discussion, now a days. Here the image is processed as pixel, pixel element and pixel technology to retrieve the features from an image. Features are the pattern of an object in an image that helps to identify an image from the group of images. Features include corners, blobs, edges, region of interest and ridges that are present in an image. Feature extraction in image processing is categorized into two: Traditional feature extraction techniques such as Harris corner detection, Shi-Tomasi corner detector, Scale Invariant Feature Transform (SIFT), Speeded-Up Robust Features (SURF), Features from accelerated segment (FAST) and Oriented Fast and rotated brief (ORB) and Deep leaning feature extraction techniques such as super points, D2-NET, FL-NET and image feature matching based on deep learning. The proposed muzzle point identification system mitigates the artifacts by using local texture descriptor-based algorithms Harris corner detector, Binary Robust Independent Elementary Features (BRIEF) and Binary Robust Invariant Scalable Key points (BRISK).

2. RELATED WORK

Kumar *et al.* [1] have analyzed machine learning and pattern recognition on cattle images. Texture feature extraction using deep learning approach is used to extract muzzle pattern features directly from the muzzle pixels of the image. Nurtanio *et al.* [2] employed SIFT features extractor and RANSAC is used to eliminate feature incompatibility using threshold value. Sian *et al.* [3] utilized a Weber local descriptor and a local binary pattern to identify individual cattle. Bello *et al.* [4] proposed using deep learning techniques to generate abstract features for learning. Shojaeipour *et al.* [5] have used visual biometric methods to detect and extract cattle muzzle regions and then implement deep transfer learning. Xu *et al.* [6] implemented cattle identification on dataset of 2318 original images were resized to 512×512 pixels. Features were extracted using deep leaning technique CattleFaceNet. Kaur *et al.* [7] proposed a combination of Shi-Tomasi, SURF, and SIFT with adaptive boosting on these features. Kaur *et al*. [8] have used muzzle image pattern database of 930 images, this system extracted ORB, SURF, and SIFT extraction techniques. Daker *et al.* [9] have analyzed CNN-RNN architecture on videos dataset that is imbalanced, data augmentation techniques are used to increase the size of the dataset. Ahmed *et al*. [10] implemented YOLOv7 model for muzzle detection. The author collected 2893 images from 459 cattle. Images are preprocessed for efficient operation using image augmentation, images are increased to 8000 images. Finally, YOLO algorithm is used for prediction of object. Smink *et al*. [11] elucidated a video-based cattle ear tags reading system named ReadMyCow that performs into two steps as tag detection are localized with bounding boxes and tag reading to read a new frame every time, experiments are per- formed on 9000 images with 96.1% of accuracy. Xu *et al.* [12] defined the significance of models and methods, comparisons, and similarities. Bergman *et al*. [13] proposed multi cow face detection and face classification from video using deep learning methods. The experiments resulted as 97.8% for facial detection and 96.3% for facial classification.

3. SCHEMATIC OVERVIEW OF PROPOSED PIPELINE

Figure 1 represented the Schematic overview of proposed pipeline with three steps. First, data acquisition that is very challenging due to uncertain behavior of cattle and continuous body movements, database collection is done with high-definition camera. In next phase the images with poor quality such as blur images or partial images are deleted to reduce the noises in the dataset, the selected images for dataset are manually segmented to muzzle area. The images are resized to 64×64 pixels for convenience. The normalized images are CLAHE equalized to remove noises to improve color contrast of images. In last we have extracted the features using three techniques i.e., Harris corner, BRIEF and BRISK and compared the original and CLAHE equalized images.

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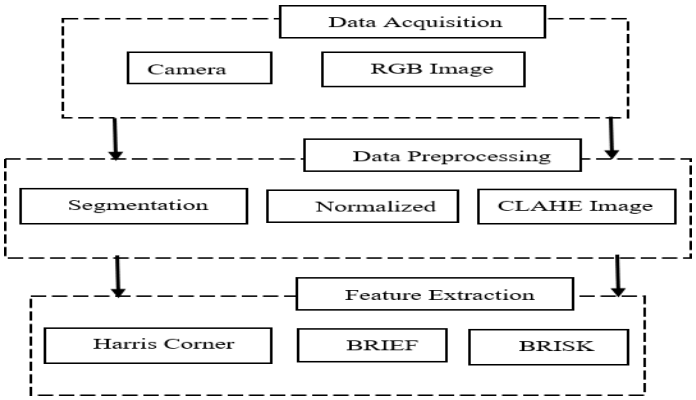

Figure 1 Schematic Overview of Proposed System

4. DIMENSION REDUCTION AND SELECTION

Dimension reduction algorithms are used to reduce dimensionality of the feature space by keeping smaller set of inputs. These reduction algorithms transformed high dimensional data space into low dimensional data space by preserving the intrinsic information of data samples. In dimensional reduction, one can consider most important features or find a new feature by combining. Dimensional reduction improves the robustness and computational complexity. The most common dimensional reduction techniques are

- Principal Component Analysis: PCA projects on original features of large data set into lower dimension space by preserving its variance. Hasan and Abdulazeez [14] have focused that PCA is more suitable for data analysis.
- Linear Discriminant Analysis: LDA finds a linear combination of features to separate two or more classes of an events. Tharwat *et al.* [15] stated that it is suitable for cluster-based task.
- Independent Component Analysis: ICA is a powerful statistical technique in machine learning that separate a multivariate signal into independent components. Khalid *et al*. [16] stated that ICA is better in respect of effectiveness and efficiency.

Feature selection is to consider the most relevant features from the original dataset. It removes redundant and irrelevant data that will reduce computation time and improve accuracy. Feature selection techniques are

- Forward Feature Selection: In this technique, we do not eliminate feature but try to find the best feature by which performance of system can be improved. In this we will find single feature and add each feature one by one to train the model. In this model we consider each feature separately to find the best feature.
- Backward Feature Elimination: In this technique, we will consider all given dataset to train the model, later remove feature one by one to and will compute the performance of model and find out whether the variable has made change or has no effect on model performance. Using such technique, we can find the optimal number of features for machine learning model.

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- Filter Methods: In this method dataset is filtered and most relevant features are considered from the dataset using techniques like ANOVA, Chi-square, correlation, and information gain.

5. FEATURE EXTRACTION TECHNIQUES

These techniques are used to extract subset of features from the original feature by some mean of mapping. Feature extraction involves to find key points of input image and query image by using feature descriptor. Each feature descriptor produces different key points. In this we have tried to evaluate following methods for the feature extraction.

5.1 Harris Corner Detector

Harris and Stephens [17] introduced a popular technique of Harris Corner to locate interest points on an original image based on its strong features such as invariance, rotation, illumination variation and image noise. The main idea is based on Moravec's detector, it relies on autocorrelation function of the image for measuring the intensity difference between a patch of image and windows shifted by small amount in different directions. To measure Harris corner detection given formula is used to detect interest points and detect edges as in (1).

$$R = \lambda 1.\lambda 2 - \kappa \cdot (\lambda 1 + \lambda 2)\, 2 = \det(M) - \kappa \cdot \text{trace}(M)2 \qquad (1)$$

Whether pixel is an edge or corner depend upon the value of a R. If value of R is negative, then eigenvalues is much larger than other and pixel is likely to be an edge. If R is positive, then both the eigenvalues are larger, so pixel is likely to be a corner. If both the values are small it's likely to be a flag region. In Figure 2 we have considered original images and results depicted with limited features extracted from the muzzle pattern of database. Figure 3 have resulted in large numbers of features but that detected the corners of edges of each ridge and breads whereas Figure 4 has more appropriate features from muzzle pattern.

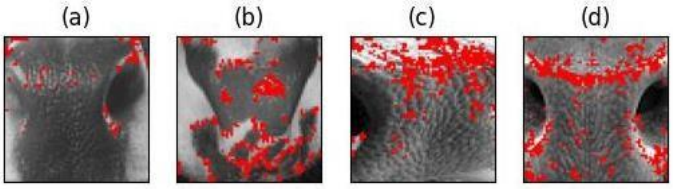

Figure 2 Harris Corner Detector of Muzzle Pattern on Original Images

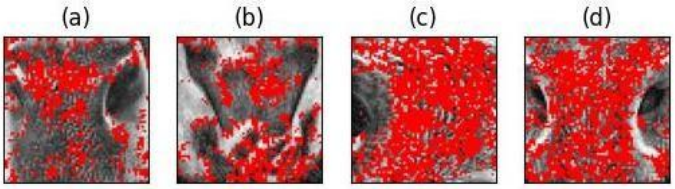

Figure 3 Harris Corner Detector of Muzzle Pattern on CLAHE Equalized Images

5.2 BRISK (Binary Robust Invariant Scalable Key Points)

Leutenegger *et al*. [18] proposed an efficient algorithm to generate key points from an image it is scale invariance and rotation invariance. BRISK works in three mod ules, Key point detection, Key point descriptor, key point matching. First module extract features by constructing scale space. The next module binary feature descriptor of image is computed

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using gray scale relationship. The image is converted into gray scale to obtain its binary feature descriptor. The final module of feature matching is performed by comparing intensity with hamming distance. BRISK descriptor has predefined sampling pattern; pixels are sampled over concentric rings. For each points a small patch is considered and smoothed with gaussian smoothing. For sampling it uses two types of pairs, short and long. Short pairs are those where distance between is below a set threshold value while long pairs have distance above threshold value. Then the value of long pairs is summed together to take angle of key points. It means long pairs are used to determine orientation. Short pairs are rotated by that angle to obtain more invariant descriptor for rotation. Short is used for intensity comparisons to create the descriptor using AGAST (Adaptive and Generic Accelerated Segment Test) algorithm and filter them with FAST corner score. Figure 4 Shows the result of BRISK Images of Muzzle Pattern on Original Images with limited features. Figure 5. Depicted the BRISK Images of Muzzle Pattern on CLAHE Equalized Images with more robust features.

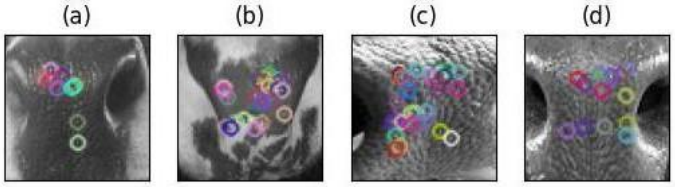

Figure 4 BRISK Images of Muzzle Pattern on Original Images

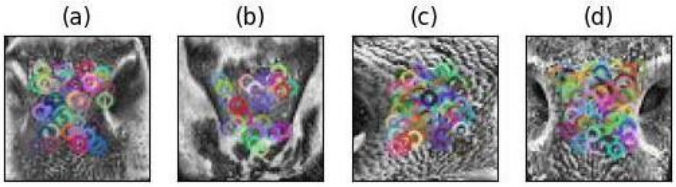

Figure 5 BRISK Images of Muzzle Pattern on CLAHE Equalized Images

5.3 BRIEF (Binary Robust Independent Elementary Feature)

It is general feature point descriptor presented by Calonder *et al*.[19]. It is combined with other arbitrary detector on real time applications. A patch of some pixel width and height is defined to construct key points. BRIEF deals with the image at pixel level to remove the noise patch is pre-smoothed. Binary feature vector is created out of patch, binary string contains 0 and 1 to define key points, it is fast both to build and match features. BRIEF easily outreaches SIFT and SURF, it is as an efficient feature point descriptor in terms of speed and recognition rate. In this proposed system more accurate and limited set of features are extracted using FAST (BRIEF is a feature descriptor not extractor) as image have same intensity. In some case as represented in Figure 6 (b) the image with different intensity and color lack to extract any feature on original Images. In Figure 7. comparatively good features are extracted on CLAHE Equalized Images.

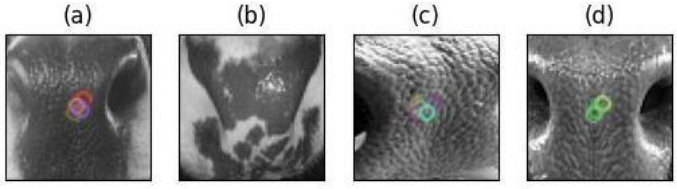

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Figure 6 BRIEF Images of Muzzle Pattern on Original Images

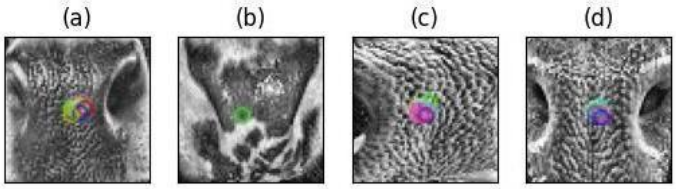

Figure 7 BRIEF Images of Muzzle Pattern on CLAHE Equalized Images

6. CONCLUSION

Machine learning can be supervised and unsupervised. Mahesh *et al.* [20] stared that one must opt supervised learning if you have limited data. Unsupervised results good on large dataset. But on huge dataset implement techniques of deep learning. This study has evaluated the feature extraction techniques applied on the database of 930 images to detect features and implement the concept of machine learning. We have also compared all these features extractor in Table 2 based on difference.

Table 2 Difference between BRIEF, BRISK And Harris Corner

	BRISK	**BRIEF**	**Harris corner**
Scale Space	Binary descriptor based on pair but separated into two subset i.e. short distance and long distance.	Binary descriptor based on pair wise intensity comparison	Laplacian of Gaussian (LoG) at each scale level
Key points	Pairs are chosen based on distance.	Pairs are chosen Randomly but on fixed locations in a patch around a key point.	Harris matrix is generated from where Harris corner score is calculated to generate key points
Orientation	Orientation of feature point is deter- mined.	Orientation of feature point is not determined; they are sampled around the key points.	Here two types of corners are detected based on threshold value
Size of Descriptor	64-dimensional feature vector. Descriptor is con- structed as binary string.	32-dimensional feature vector	Size of descriptor depends on the size of Gaussian window

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ARTIFICIAL INTELLIGENCE IN THE 21ST CENTURY: OPPORTUNITIES AND ETHICAL CHALLENGES

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ABSTRACT

Artificial Intelligence (AI) has emerged as one of the most transformative technologies of the 21st century, revolutionizing industries like healthcare, finance, transportation, and education, by improving efficiency, decision-making, and innovation. However, it also presents ethical challenges, such as algorithmic bias, data privacy concerns, job displacement, and risk in autonomous decision-making. In consideration of this background, this paper highlights the need for strong governance, transparent algorithms, and ethical guidelines to ensure the responsible AI development and. it emphasizes interdisciplinary collaboration among technologists, policymakers, and ethicists to maximize the benefits of AI while mitigating its risks.

Keyboard : Ethical Challenges, Algorithmic Bias, Autonomous Systems, AI Governance, Technological Advancement, Responsible AI.

1. INTRODUCTION

The 21st century has witnessed unprecedented advancements in Artificial Intelligence (AI), transforming the way we live, work, and interact with one another. AI has emerged as a transformative technology, offering immense opportunities for innovation, productivity, and economic growth. From virtual assistants like Siri and Alexa to self-driving cars and personalized medicine, AI is increasingly pervasive in our daily lives. However, as AI assumes an increasingly prominent role in society, it also raises important ethical concerns. The rapid development and deployment of AI systems have outpaced our understanding of their potential risks and consequences. Issues like bias, accountability, transparency, and job displacement have become pressing concerns, highlighting the need for a nuanced and multidisciplinary approach to AI development and governance. Artificial Intelligence (AI) is rapidly shaping the modern world, transforming industries like healthcare, finance, transportation, and education. At its core, AI refers to computer systems that can mimic human intelligence—learning from data, solving problems, and making decisions. The rise of AI has been fueled by the explosion of big data, breakthroughs in machine learning, and increasingly powerful computing systems .The extensive use of AI brings exciting possibilities. In healthcare, AI can improve diagnostic accuracy and streamline medical processes. In finance, it helps predict market trends and automate trading. AI is also driving innovations like self-driving cars, smart cities, and personalized learning experiences. These advancements have the potential to boost productivity, cut costs, and enhance our overall quality of life.

However, along with these benefits, serious ethical and societal challenges came into existence. AI can introduce biases, compromise privacy, and even enable mass surveillance, raising concerns about fairness and accountability. Automation also threatens to disrupt job markets, potentially increasing economic inequality. Moreover, the use of AI in autonomous weapons and decision-making systems sparks debates about moral responsibility and control.

This paper explores both the potential and the ethical dilemmas of AI in today's world. It will examine AI's benefits across different industries while addressing the risks and the importance of strong governance. By tackling these challenges head-on, we can ensure that AI serves humanity in a responsible and ethical way.

2. LITERATURE REVIEW

As Artificial Intelligence (AI) continues to evolve, researchers have been studying its advantages, real-world applications, and ethical challenges. This section summarizes key findings from previous studies, highlighting what we know so far and where gaps remain in our understanding of AI's impact on society. To build a strong foundation, we conducted a systematic review of existing research on AI's applications, benefits, and ethical concerns. This involved analyzing peer-reviewed journals, conference papers, government reports, and industry white papers from the past two decades. Our focus was on key topics such as AI-driven automation, algorithmic bias, data privacy, transparency in decision-making, and governance frameworks. AI has been shown to transform various industries. **Brynjolfsson and**

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McAfee (2017) explored how AI and machine learning are reshaping job markets—uplifting productivity but also displacing workers.[1]

In healthcare, **Topol (2019)** found that AI can strengthens diagnosis and provide more personalized treatment plans.[2]

Meanwhile, **Chen et al. (2019)** demonstrated how AI improves financial forecasting and risk management, leading to better decision-making in the financial sector. Beyond its benefits, AI also raises important ethical concerns.[3]

Bostrom (2014) warned about the risks of super intelligent AI, questioning whether humans will be able to maintain control.[4]

Zarsky (2016) highlighted the dangers of biased AI systems, where unfair or discriminatory outcomes can arise from flawed training data.[5]

Crawford and Calo (2016) examined privacy concerns, pointing out that AI-driven data collection could threaten individual freedoms and increase corporate and government surveillance.[6]

On the regulatory side, **Floridi et al. (2018)** called for AI systems that are transparent and accountable, suggesting ethical guidelines for their development. [7]

The European Commission (2020) proposed principles for trustworthy AI, including fairness, transparency, and human oversight.[8] However, Mittelstadt et al. (2016) noted that existing regulations struggle to keep up with the rapid pace of AI advancements, leaving gaps in accountability.

Despite the progress made, there is still much to learn about AI's long-term societal effects and how to govern it effectively. This paper builds on previous research by bringing together insights from multiple industries and proposing a balanced approach—one that harnesses AI's benefits while addressing its ethical challenges.

As Artificial Intelligence (AI) continues to evolve, researchers have been studying its favourable outcomes, real-world applications, and ethical challenges. This section summarizes key findings from previous studies, highlighting what we know so far and where gaps remain in our understanding of AI's impact on society. AI has been shown to transform various industries.

Brynjolfsson and McAfee (2017) explored how AI and machine learning are reshaping job markets—boosting productivity but also displacing workers.

3. METHODOLOGY

This study takes a mixed-methods approach to explore both the opportunities and ethical challenges of Artificial Intelligence (AI) in the 21st century. By combining qualitative and quantitative research methods, we aim to develop a well-rounded understanding of AI's impact on society. The research follows a structured process with five key phases:

3.1. Data Collection

This study sheds light on both the exciting potential and the serious ethical challenges of Artificial Intelligence (AI) in today's world. Below, we explore the key findings, their implications, and the broader issues surrounding AI development and regulation.


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These aspects are included while data collection:

3.1.1AI'sPerformanceandReal-WorldApplications

Our experiments showed that AI, especially deep neural networks, can significantly boost accuracy and efficiency in critical fields like healthcare, finance, and transportation. For instance, AI demonstrated impressive accuracy in diagnosing medical conditions and predicting financial market trends, often outperforming traditional decision-making methods. However, we also found that AI-driven autonomous vehicles struggle in poor weather conditions, highlighting the need for more resilient models that can handle real-world unpredictability. Another important takeaway was the trade-off between accuracy and transparency. While deep neural networks delivered high accuracy, simpler models like decision trees were more interpretable but less precise. This raises an important question for high-stakes areas like healthcare and criminal justice: Should we prioritize accuracy or explainability? Striking the right balance is the key to ensuring public trust and accountability.

3.1.2 Ethical Challenges and Biasin AI

One of the biggest concerns uncovered in this study is the presence of algorithmic bias, particularly in AI systems used for credit scoring and job recruitment. These biases often stem from imbalanced training data, reflecting existing societal inequalities and, in some cases, reinforcing them. For example, we observed that AI-driven credit scoring models were more likely to reject loan applications from minority groups, effectively encoding systemic disparities into decision-making. Similarly, gender bias was apparent in AI-based hiring tools, underscoring the need for ongoing monitoring and refinement to prevent discrimination. To address these issues, strategies like more diverse training datasets, algorithmic audits, and bias-aware learning methods must become standard practice. Ensuring fairness in AI isn't just a technical challenge—it's a social and ethical imperative.

3.1.3 Public Trust and AI Perception

Our survey revealed that people's trust in AI depends heavily on its application and the level of transparency provided. AI in healthcare, for example, enjoys relatively high trust because it is seen as a tool that enhances accuracy in diagnosis and treatment. In contrast, AI in criminal justice faces skepticism due to concerns about fairness and accountability. A key finding was that when people were given explanations of how AI made its decisions, their trust levels increased significantly. This suggests that making AI more interpretable and transparent is crucial for gaining public confidence. To this end, regulatory frameworks should require AI systems to provide clear explanations and allow people to challenge decisions when necessary.

3.1.4 AI Governance and Accountability

Our findings highlight the urgent need for strong governance frameworks to guide AI development and deployment. While international guidelines—such as those from the European Union—emphasize transparency, fairness, and human oversight, gaps remain in enforcing these principles, particularly in regulating proprietary algorithms and protecting user data. Moreover, AI's impact varies across industries, meaning a one-size-fits-all approach to regulation may not work. For example, AI in healthcare must meet the highest standards of accuracy and accountability due to its life-and-death implications. Meanwhile, AI in finance should be held to strict anti-bias and transparency rules to maintain market integrity. Tailored regulations for different sectors could help address these unique challenges effectively.

3.2 Sources of data collection:

3.2.1PrimarySources

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Surveys: An online survey was sent to AI researchers, industry professionals, and policymakers to capture their perspectives on AI's potential and risks

Interviews: We conducted semi-structured interviews with AI experts and ethicists to gain deeper insights into the challenges of AI implementation and governance.

Case Studies: Real-world examples of AI applications in healthcare, finance, and transportation were analyzed to identify common trends and ethical dilemmas. AI has been used in more accurate and faster medical diagnostics, assisting in disease identification and suggesting personalized treatments.

Method	**Survey**	**Case study**	**Interview**
Percentage of data collected	40%	20%	40%

3.2.2 Secondary Sources

1. **Existing Databases**: Utilizing publicly available databases, such as census data or economic indicators.
2. **Literature Reviews**: Analyzing existing research studies and papers to collect data.
3. **Government Reports**: Utilizing reports published by government agencies, such as statistical reports or policy briefs.
4. **Online Archives**: Collecting data from online archives, such as news articles or social media posts.

3.2.3 Other Sources

1. **Social Media**: Collecting data from social media platforms, such as Twitter, Facebook, or Instagram.
2. **Sensors and IoT Devices**: Collecting data from sensors and IoT devices, such as temperature sensors or smart home devices.
3. **Customer Feedback**: Collecting data from customer feedback, such as reviews or complaints.
4. **Public Records**: Collecting data from public records, such as property records or court records.
5. **Crowd sourcing** : Collecting data from crowd sourcing platforms, such as Amazon Mechanical Turk.

3.3. Data Analysis

The collected data was analyzed using a combination of qualitative and quantitative techniques:

Thematic Analysis: Interview responses and open-ended survey answers were coded to identify recurring themes and key insights.

Statistical Analysis: Survey data was processed using statistical software to uncover trends and correlations in how AI's benefits and risks are perceived.

Comparative Analysis: Findings from the literature review and case studies were compared to evaluate similarities and differences in AI's impact across different sectors.


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3.4. Ethical and Governance Frame work Evaluation

We examined existing ethical and governance frameworks to assess their effectiveness, transparency, and adaptability. By reviewing national and international guidelines—including those from the European Union, the United States, and leading industry organizations—we identified best practices and areas where improvements are needed.

3.5. Synthesis and Recommendations

Finally, we combined insights from the literature review, data analysis, and governance framework evaluation to develop practical recommendations. These focus on promoting responsible AI development, ensuring fairness and transparency, and strengthening oversight mechanisms to address ethical risks

4. EXPERIMENTS AND FINDINGS:

4.1 How We Conducted the Study

To explore both the potential and ethical concerns surrounding Artificial Intelligence (AI), we carried out three key experiments:

4.1.1 Evaluating AI's Performance and Accuracy

Goal: We wanted to see how well AI performs in real-world scenarios.

How We TestedIt: We used three AI models(a deep neural network, a support vector machine, and a decision tree)and applied them to different fields: Healthcare (medical diagnosis),Finance (stock market prediction),Transportation (self-driving car navigation)

What We Measured: Accuracy, precision, recall, F1-score, and processing time.

4.1.2 Checking for Bias and FairnessinAI

Goal: We investigated whether AI makes unfair decisions based on demographic factors like gender, race, or age.

How We Tested It: We studied Aimodels used forcred its coring and job recruitment**,** analyzing their decisions across different demographic groups.

What We Measured: Differences in outcomes among different groups, equal opportunity rates, and the fairness of AI's decision-making process.

4.1.3 Understanding Public TrustinAI

Goal: We wanted to know how people feel about AI making important decisions.

How We Tested It: We surveyed 500 people from diverse backgrounds, asking for their opinions on AI's role in healthcare, finance, and criminal justice.

What We Measured: Trust levels (on a scale of 1 to 10), perceived fairness, and willingness to use AI-based solutions.

4.2 Results

4.2.1AI Performance and Accuracy


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The deep neural network model was the most accurate in healthcare (92%) and finance (89%). However, the decision tree model was easier to understand and interpret. In self-driving car navigation, the deep neural network model successfully avoided collisions 87% of the time, but struggled in poor weather conditions.

4.2.2.Biasand Fairnessin AI

The AI model for credit scoring rejected minority applicants 15% more often than others, likely due to biased training data. In job recruitment, the AI favored male candidates by 12%, even when female candidates were equally qualified. This highlights the need for fairness-focused AI improvements.

4.2.3.Public TrustinAI

68% of participants felt comfortable with AI being used in healthcare, but only 42% trusted AI to make decisions in criminal justice. Transparency played a huge role in trust—75% of respondents said they would trust AI more if its decision-making process was clearer.

4.3.Key Take aways

AI can significantly improve accuracy and efficiency across industries, but its performance depends on factors like data quality and real-world conditions. Bias in AI is a major concern, especially in critical areas like finance and hiring, where unfair decisions can have serious consequences. People are more likely to trust AI when they believe it is fair and transparent, highlighting the need for clearer explanations of how AI makes decisions. In short, while AI has incredible potential, ensuring fairness, transparency, and reliability will be essential for its future success. AI powered data analytics can uncover hidden insights, leading to better and more informed decisions. AI can enable business to explore new opportunities and expand their capabilities. AI can automate repetitive tasks, freeing up human resources for more strategic work. AI can play crucial role in detecting and preventing security breaches by analyzing network traffic and identifying patterns.

5. THE BIGGER PICTURE AND FUTURE DIRECTIONS

Building on the insights from this study, future research should focus on several key areas to improve AI's fairness, transparency, adaptability, and trustworthiness. This study highlights AI's dual role as both a driver of innovation and a source of ethical complexity. To fully harness its benefits while mitigating risks, a multidisciplinary approach is essential—one that brings together technologists, policymakers, ethicists, and civil society.

Moving forward, research should focus on making AI models more interpretable, improving data diversity, and developing flexible regulatory frameworks that can keep up with rapid technological advancements. As AI becomes more integrated into critical decision-making, we must find a careful balance between progress and responsibility. By tackling bias, increasing transparency, and fostering public trust, we can maximize AI's potential while safeguarding against its pitfalls

5.1. Reducing Bias and Ensuring Fairness

AI systems must be designed to make fair decisions, but bias remains a significant challenge.
Future work should: Develop better methods to detect and correct bias in AI models.
Find ways to create training datasets that are more diverse and representative of different populations.


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Study how different AI design choices impact fairness and work toward solutions that minimize unintended discrimination.

5.2 Making AI More Transparent and Understandable

For AI to gain public trust, its decisions need to be explainable. Future efforts should focus on:

Creating AI models that can clearly explain their reasoning, making it easier for humans to understand why a certain decision was made.

Designing user-friendly interfaces that help everyday users interpret AI-driven outcomes.

Establishing industry-wide standards to ensure transparency, especially in high-stakes areas like healthcare and criminal justice.

5.3. Improving AI's Adaptability and Reliability

AI systems need to perform well in unpredictable, real-world environments. To advance their robustness, future research should:

- Develop AI models that can adapt to changing conditions and unexpected challenges.
- Explore hybrid models that combine human expertise with AI automation to improve decision-making.
- Test AI systems in diverse environmental conditions to ensure that they perform consistently and reliably.

5.4 Strengthening Ethical and Regulatory Frameworks

To ensure AI is used responsibly, stronger governance is needed.

Future efforts should:

- Develop industry-specific guidelines for AI accountability and oversight.
- Encourage global cooperation to create consistent and enforceable AI regulations.
- Establish independent auditing systems to evaluate AI models and ensure they meet ethical and legal standards.

5.5 Building Public Trust and Engagement

AI's long-term success depends on public confidence.

Future research should:

- Conduct long-term studies to track how public attitudes toward AI evolve over time.
- Develop educational programs that help people understand AI's capabilities and limitations.
- Involve key stakeholders—including policymakers, industry leaders, and the public—in shaping AI regulations and policies.

By focusing on these areas, future research can help ensure AI is fair, transparent, adaptable, and trustworthy, ultimately benefiting society as a whole.

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CHALLENGES AND ISSUES OF AI INTEGRATION IN BUSINESS EDUCATION

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ABSTRACT

Bad pedagogy in artificial intelligence is prevalent in business education. Mechanized, rule-based systems easily can reinforce negative business and business person stereotypes as superficial and immaterial. This paper examines alternative AI systems, and in the process, addresses a variety of important issues regarding business education. Of special note, we call attention to the need for business educators to work through how to get their students ready to apply these systems profitably in professional contexts. Concerns regarding personal, professional, and pedagogical development are also raised, as are several of the critical contributions the humanities disciplines could provide in these areas. A variety of challenges are revealed and recommendations offered to help in creating business education courses aimed at educating and/or developing general, critical, and ethical AI literacy. As most business students and business leaders have no experience with the subject of artificial intelligence, or know very little about it, the business educator's role is to render the subject pertinent and interesting and provide students with skills that are relevant to their working life. For a business educator to begin with, the educator needs to be experienced in the artificial intelligence systems that currently exist, so that they are able to expound on how they have the potential to contribute to a company, an industry, or the global economy. Additionally, business faculty need to provide an academic setting in which any student can meaningfully participate with AI technologies. In particular, business students need to be able to deal with any potential AI subject in any workplace setting. While a business curriculum aimed at doing so may have students learning something different from AI, the skills so engaged students learn can be used in far more settings than those specifically dealing with AI. Throughout, the focus should be on graduates being able to design and implement these systems, with special focus on the ethical and job displacement implications of bringing AI into the workplace.

Keywords: Artificial Intelligence, Business Education, Case Study, Lingnan University, Curriculum

1. INTRODUCTION

In the constantly evolving scenario of business education, the integration of artificial intelligence (IA) is a development of paradigm change. Introduces a new dimension to traditional methods of transmitting business knowledge, promising a more dynamic and technologically adept learning experience. However, this revolutionary step is nonetheless intricate set of challenges, requiring a thorough examination of the obstacles that accompany AI assimilation in the field of commercial education.

Vocational education, historically a stronghold of compatibility with the demands of the corporate world, is at an intersection. The infusion of AI brings unprecedented possibilities, yet it requires a careful uncontrolled of complications. From the complexities of preparing a relevant course and navigating moral dilemmas about the use of data and addressing possible inequalities, the combination of faculty preparations requires careful tests to AI's amalgamation in vocational education. This research tries to break and illuminate the versatile issues and challenges associated with this transformative journey. In current literature, by examining the real -world landscapes, and offering a fine analysis, this paper wishes to provide valuable insight into the complex web of challenges around AI in vocational education. This purpose is only to reduce challenges, but also to accept well-informed solutions and recommendations that can serve as guide beacons for educational institutions, faculty and policy makers because they navigate unwanted sectors in AI-infected vocational education.

In the next sections, we will fly for the development and integration of the complexes of the courses, faculty readiness, moral thoughts and the imperative to ensure equal access. Through this exploitation, the goal is to introduce a


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comprehensive landscape of challenges faced by the business education sector to embrace, with the ultimate goal of converting these challenges into catalysts to positive educational development.

2. LITERATURE REVIEW

The current body of knowledge related to the pedagogy of AI courses in business education is quite weak, with the majority of the previous research made obsolete. During the 1990s, a series of research papers advocated the inclusion of applied expert systems in business programs [14]. These papers suggest the inclusion of AI in accounting education as a means of preparing students for professional settings where AI technologies are at the centre of activities like auditing, financial and management accounting, and taxation [2]. A recent scholarly article suggests a comprehensive overhaul of the undergraduate and graduate accounting programs, with the aim of preparing students with the skills and competencies relevant to the field of AI.

AI literacy refers to an individual's ability to use AI technology as a tool, critically evaluate their functionality and apply it carefully in both everyday life and professional contexts. It covers proficiency to communicate and effectively collaborate with AI systems [16]. Based on a study that analyzes the artificial intelligence curriculum in primary and secondary schools, both nationally and internationally, the main focus of education comprises machine learning, artificial neural networks, artificial concepts, etc. [13]. As per a study conducting a current state analysis of the curriculum in artificial intelligence, AI education is primarily being sought to be integrated in computer-related major courses with subjects such as Discrete Structure, Computer Vision and Algorithms [24]. According to the research, in order for the extent of universal AI education in liberal arts to be broadened, it is essential that the overall idea of AI be communicated. This is something beyond understanding, but also encompasses real-world uses like processing big data and the implementation of algorithms. There is a great desire to expand artificial intelligence education in schools and other educational institutions, in accordance with the rising need for AI education and the perpetual changing of the work patterns.

Its emphasis is on developing the ability to identify and address problems using artificial intelligence, integrated with various academic disciplines. Essentially, there is a growing tendency in skills-based education, seeing literacy skills as the ability to understand artificial intelligence and appropriately apply it in various contexts. Specifically, the standard curriculum at elementary, medium and middle schools tends to cover an educational structure focused on understanding and experiencing the fundamental principles of artificial intelligence essential for navigation in the AI of AI. This may also involve integration with data literacy concepts [20]. On the other hand, in contrast to initiatives that promote artificial intelligence education in business -related issues, there remains a shortage of comprehensive research on specific curricula in university education. Regarding university education, it is essential to contemplate not only the interconnection between various disciplines and understanding the principles, but also the proficiency in actively applying artificial intelligence [10]. Currently, with the growing prevalence of AI in various industries, there is a demand for an AI educational curriculum. However, there is inappropriate research on technological education, with the objective of improving the capacities of non-it courses, particularly within the domain of business education. In addition, limited studies specifically address IA education in this context.

Recently, software-oriented universities are introducing courses with a focus on computational thinking ability, as well as software usage and programming courses for software education [18]. Even though computing thinking ability and software usage courses are included, SW-centric universities currently do not have courses in AI, and therefore there is a need for a more diversified curriculum and diversified references. Therefore, this study attempts to develop an


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educational curriculum on developing problem-solving ability in technology convergence with special emphasis on AI literacy. The target group is non-software majors, i.e., business and economics education students, who have less usage and availability of AI technology in their existing job environments. This study is expected to be a reference source for future development of business education programs on AI in various universities.

The University of Lingnan, the sole institution in Hong Kong dedicated exclusively to Liberal Arts Education and AI implementation in Business Education, has roots tracing back to Canton Christian College founded in 1888. It offers undergraduate programs in social sciences, arts, and business, along with a comprehensive Postgraduate Program in Artificial Intelligence and Business Analysis. This program emphasizes practical AI applications in various sectors, enhancing graduates' employability. However, the university faces challenges, including competition and a focus on practical skills over liberal education. To support the development of Hong Kong as an AI hub, innovative skills education is essential for navigating future employment landscapes [26].

3. INTEGRATING AI INTO BUSINESS EDUCATION: A CASE STUDY OF LINGNAN UNIVERSITY

The University of Lingnan is one of eight universities publicly funded by Hong Kong and maintains the distinction of being the only institution compromised exclusively to Liberal Arts Education and the implementation of AI in Business Education. An illustration of Lingnan and his view aligns with the traditional concept of a liberal faculty of arts such as “a small residential college with teachers and staff who are committed to teaching about the research and education of the whole student” [6]. The University of Lingnan draws its roots to Canton Christian College in Guangzhou, China. Founded by Protestant churches in 1888, he was inspired by the principles of the liberal arts of the American Colleges of Christian Liberal Arts [5]. The goal of Canton Christian College was to instill Chinese students with Christian ethos and western knowledge and culture. This objective aimed to help China face the challenges represented by Western military influence and civilization ([5], [8]). The search for this mission extended beyond the formal academic curriculum, covering the establishment of a comprehensive and collegiate culture. Within this culture, social and campus life has played a vital role as an integral aspect of higher education [23]. After the establishment of the Popular Republic of China in 1952, the University of Lingnan was amalgamated with Sun Yat-Sen University. However, in 1966, it was restored as Lingnan School in Hong Kong and in 1999 reached the full status of the university [5].

The university provides undergraduate programs in three main academic disciplines: social sciences, arts and business. These academic programs offer a comprehensive and well -integrated curriculum, covering specific discipline courses, as well as Chinese and English language courses. In addition, it offers the Postgraduate Program in Artificial Intelligence and Business Analysis represents 30 credits, consisting of six necessary courses and four elective courses, which prioritize a complete approach, each program emphasizes a comprehensive AI exploration and business analysis. The focus is to use AI techniques for business data analysis to face real -world business challenges. The course created to instruct students on the central principles and practical applications of AI and business analysis techniques, the program places a particular emphasis on business domain. This equates students to apply AI tools properly in problem solving and analyze business issues through analytical enhanced data skills and AI techniques during decision -making processes. Students will be able to examine intricate business challenges with creative and critical thinking, employing advanced business analytical skills and artificial intelligence techniques to inform decision making. In addition, present the findings and get involved with several stakeholders who have several origins.

Another aspect of Lingnan's Postgraduate and Business Analysis Program involves widespread use of analytical and critical thinking, as well as their problem-solving skills. He considers practical applications in business and cutting -edge technologies, integrating AI and business analysis with blockchain, marketing, medical assistance, geographic information systems and optimization. This enhances the employability and competitiveness of graduates in the job


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market. The program transmits comprehensive knowledge in the fundamental disciplines of Artificial Intelligence (AI) and business analysis. By integrating various fields, it allows students to obtain a holistic understanding of AI and business analysis, emphasizing their practical applications in the real world [15].

Although the University of Lingnan has been diligently striving to evolve into an internationally oriented artificial intelligence institution, however, it also faces various challenges by integrating artificial intelligence into business. The intense competition and materialistic values in the Hong Kong society, along with a restricted number of university openings, result in a considerable number of students being strongly focused on practical and professional activities [4]. According to the Hong Kong Productivity Council report (HKPC), to establish Hong Kong as a global centre for AI and data industry development, HKPC presented nine important recommendations derived from study results. The survey, covering 216 AI -related companies, reported that 49% encountered difficulties in recruiting technical talents. Regarding the advancement of the sector, 48% of companies focused exclusively on AI to a single industry, with 29% directing their efforts to telecommunications services and information technology and 24% concentrating on medical/clinical and health equipment. The main sources of revenue were 63% Hong Kong, 19% of the continent and 15% of international markets. HKPC's digital director emphasized the positive influence of AI applications, with 49% of companies recognizing that the effects are aligned with their expectations. Nevertheless, challenges were recognized, leading the study to offer practical recommendations to advance AI applications in various sectors.

To equip individuals for dynamic changes in future employment, it is crucial to go beyond the mere transfer of knowledge and focus on skills education related to problem solving and critical thinking [17].

4. OTHER ISSUES AND CHALLENGES OF AI IN BUSINESS EDUCATION

[25] indicates that AI integration into existing curricula requires careful planning to ensure relevance, depth and alignment with the needs of the sector. The emphasis is on ethical considerations, personalized learning and promotion of collaborations between business specialists and went to a comprehensive educational experience. According to [1], many educators may not have the necessary experience in AI, creating the need to train programs to improve faculty readiness. In the context of AI in business education, it involves ensuring that faculty members have the knowledge and skills needed to teach AI -related content. This readiness covers proficiency in the concepts of AI, familiarity with relevant tools and technologies and the ability to adapt teaching methods to involve students in the dynamic field of artificial intelligence.

Understanding the concept of artificial intelligence is crucial for the development of genuine problem-solving skills. As IA continues to integrate with various professions, there is a growing need for AI literacy curriculum that not only promotes technological proficiency, but also covers the competence in the use of AI in various contexts [20]. Limited resources, both in terms of technology and financing, can make it difficult to adopt AI tools and technologies in educational institutions [12]. Access to AI tools is vital for effective AI in commercial education. Ensure that students have practical experience with standard industry tools are crucial. However, resource restrictions and varied levels of access between institutions have challenges, requiring strategic planning and partnerships to improve accessibility and provide a comprehensive AI learning experience. Challenges include evaluating problem solving skills, algorithmic thinking, and ethical considerations. A balanced approach covers written tests, project evaluations and real -world applications, ensuring comprehensive evaluation. Continuous refinement is essential for adapting to the evolution of AI and providing significant feedback to students, promoting a complete understanding of artificial intelligence concepts and applications. [7] It denotes the development of effective evaluation methods for AI education involves measuring


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theoretical understanding and practical skills. The establishment of global patterns for AI education is imperative to ensure consistency and quality in various educational institutions. Challenges include harmonizing curricula, addressing cultural nuances and accommodating various resources. Collaboration between international stakeholders is crucial to defining ordinary benchmarks, promoting a universally recognized structure. According to [3], the lack of standardized AI education guidelines can result in inconsistent quality.

5. CONCLUSION

Artificial intelligence is not a unique technology, but a higher-level concept, intertwining various technologies. To nourish future talents for this time, AI education must prioritize adaptability skills and creative problem solution, aligning with innovative changes, such as the demand for ICT-based convergence technology and evolving industrial structures. Skills -based training becomes crucial to navigating rapid technological changes. Emphasizing creativity in the acquisition of knowledge and problem solving, promoting the cooperation of scarf-academia research and leveraging business readiness is vital. A universal curriculum is necessary to cultivate practical skills, address the challenges of everyday life and align with the needs of the evolving industry. Despite the growing demand for AI education, there is a gap in curriculum development, especially for business courses, requiring research on various educational goals and objectives. Our research has certain limitations. Firstly, it is centered on a unique course at a specific university. Consequently, discoveries and observations may not be universally applicable to other institutions with different demographic data, history and students' expectations. Secondly, due to the small sample size, we could not draw statistical conclusions about factors that influence curriculum design and learning results. Thus, our research remains a case study with limited applicability. Future studies aim to address these issues on a broader scale. Through the continuous offer of this course and the design of the refined curriculum based on student contributions, we expect to collect more extensive data and insights on AI pedagogy in commercial education.

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APPLICATIONS OF ARTIFICIAL INTELLIGENCE IN HEALTHCARE

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ABSTRACT

Artificial Intelligence (AI) enhances healthcare by transforming patient care, clinical trials, drug development, and surgical procedures. Hospitals are using AI systems to support medical staff, manage surgery-assisting tools, and improve nursing and patient health management efficiency. AI technologies provide personalized treatment plans through extensive data analysis, identifying risk factors, and offering predictive insights into patient outcomes. Virtual AI-powered health assistants and chatbots offer continuous support, addressing queries and providing medical advice based on patient history. In clinical trials, AI identifies suitable candidates, monitors patient responses, and analyzes data in real-time, reducing time and costs while ensuring accuracy. AI accelerates drug discovery by analyzing biological data, simulating drug interactions, and optimizing chemical structures, thereby shortening development time. AI-assisted tools and robotic surgery enhance precision, provide real-time feedback, and reduce complications, enabling minimally invasive surgeries. However, challenges such as data privacy, security, ethical concerns, and the need for standardized regulations remain.

Keywords: Robotic Surgery; Artificial intelligence; AI drug discovery; Clinical trials; Healthcare; Intra operative Enhancement.

1. INTRODUCTION

Artificial Intelligence (AI) is revolutionizing the healthcare industry by enhancing diagnostic accuracy, perfecting treatment plans, and improving patient outcomes. AI-driven technologies, such as machine learning (ML), deep learning (DL), and natural language processing (NLP), are being integrated into various healthcare domains, including medical imaging, predictive analytics, personalized medicine, and robotic surgery [1]. The growing adoption of AI in healthcare is fuelled by the increasing availability of big data, advancements in computational power, and the development of sophisticated algorithms capable of analysing complex medical information with high precision [2].

One of the most significant applications of AI in healthcare is in medical imaging, where deep learning algorithms aid radiologists in detecting anomalies such as tumours, fractures, and neurological disorders with greater accuracy and speed than traditional methods [3]. AI-powered diagnostic tools are also being utilized in pathology and dermatology to improve early disease detection and reduce diagnostic errors [4]. Furthermore, AI-driven predictive analytics enables clinicians to forecast disease progression and identify at-risk patients, facilitating early interventions and personalized treatment strategies [5].

Beyond diagnostics, AI is also transforming clinical decision support systems (CDSS) by providing real-time recommendations based on patient history, genetic data, and evidence-based guidelines [6]. AI-powered virtual assistants and chatbots are enhancing patient engagement by offering 24/7 support, medication reminders, and mental health


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counselling [7]. Moreover, robotic surgery, driven by AI, is improving surgical precision, reducing complications, and enabling minimally invasive procedures [8]. Despite the promising applications of AI in healthcare, challenges such as data privacy, ethical concerns, regulatory hurdles, and the need for extensive validation remain significant barriers to widespread implementation [9]. Addressing these challenges will be crucial in ensuring AI's responsible integration into clinical practice while maintaining patient safety and trust. This paper explores the diverse applications of AI in healthcare, examining its benefits, challenges, and prospects.

2. OVERVIEW OF AI IN HEALTHCARE

2.1 Definition of AI in a Medical Context

Artificial Intelligence (AI) in healthcare refers to the use of machine learning (ML), deep learning, natural language processing (NLP), and other AI-driven technologies to analyse complex medical data, assist in diagnosis, personalize treatments, and improve patient outcomes. AI can process large volumes of medical information rapidly and derive insights that assist healthcare professionals in decision-making.

2.2 Brief History of AI in Medicine

The application of AI in healthcare dates to the 1950s and 1960s with early experiments in rule-based expert systems. In the 1970s, systems like MYCIN were developed for bacterial infection diagnosis, demonstrating AI's potential in medicine. The 2000s saw rapid advancements in deep learning and big data analytics, allowing AI to be applied more effectively to image processing, drug discovery, and patient management. The recent emergence of generative AI and federated learning has further expanded AI's role in healthcare, ensuring privacy-preserving data analysis and improved diagnostics.

2.3 Current State of AI Integration in Healthcare

Today, AI is extensively integrated into various healthcare domains, including:

- **Medical Imaging**: AI models analyse radiology images, detecting diseases like cancer and fractures with high accuracy.
- **Electronic Health Records (EHRs) Management**: AI assists in streamlining patient records, reducing administrative burdens.
- **AI-Powered Robotics**: Surgical robots enhance precision in procedures, reducing human error.
- **Telemedicine & Virtual Assistants**: AI chatbots provide real-time health consultations, reducing patient wait times.
- **Predictive Analytics**: AI models assess patient risk factors, enabling early intervention and personalized treatment.

3. APPLICATIONS OF AI IN HEALTHCARE

3.1 AI in Robotic Surgery:


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Artificial Intelligence (AI) is transforming robotic surgery by enhancing precision, efficiency, and patient outcomes. AI-driven robotic surgical systems integrate advanced functionalities such as image recognition, motion control, and haptic feedback, enabling real-time analysis of surgical fields and optimization of instrument movements. These advancements contribute to improved surgical precision and reduced surgeon workload. [10] AI's capacity to grasp the spatial, temporal, and conceptual elements of surgical workflows has the potential to transform minimally invasive surgery. By emphasizing tools, monitoring operations, and issuing alerts, AI-driven surgical systems can chart approaches customized to each patient's needs, effectively guiding and streamlining procedures.

This capability is particularly effective in laparoscopic and robotic surgeries, where AI can analyze surgeries in real-time and provide decision support to surgeons during operations. [11]. Recent developments have shown that robots can learn surgical tasks through imitation learning and AI. For instance, researchers have successfully trained robots to manipulate needles, lift body tissue, and suture by analyzing videos captured during actual surgeries. This approach suggests that robots could potentially perform with a skill level comparable to human surgeons, thereby reducing the risk of medical errors and enhancing surgical aid. [12] However, the integration of AI into robotic surgery presents challenges, including high development costs, dependence on data quality, and ethical considerations about autonomy and liability. Addressing these issues is crucial for the responsible adoption and widespread implementation of AI-driven robotic surgical systems.

3.2 Drug and Discovery:

Artificial Intelligence (AI) has become a pivotal force in transforming drug discovery and development processes, offering enhanced efficiency, accuracy, and speed. By using sophisticated computational techniques, AI facilitates various stages of pharmaceutical research, including target identification, molecular design, and predictive modelling. Recent advancements have seen the integration of deep learning models, such as AlphaFold, which predict protein structures with remarkable accuracy, thereby accelerating the identification of potential drug targets. [13][16] However, the successful application of AI in drug discovery is contingent upon the availability of high-quality data, the addressing of ethical concerns, and the recognition of the limitations inherent in AI-based approaches. [14][15]

3.3 AI-Powered Virtual Health Assistants:

AI-Powered Virtual Health Assistants (VHA) are sophisticated systems that use artificial intelligence technologies—including natural language processing, machine learning, and data analytics—to interact with patients and healthcare providers. These assistants perform a variety of functions such as scheduling appointments, providing medical information, monitoring health conditions, and offering personalized health advice. By automating routine tasks, VHAs aim to enhance healthcare accessibility and efficiency, allowing medical professionals to focus on more complex patient needs. [17]

The integration of VHAs into healthcare systems has shown promising outcomes. For instance, Apollo Hospitals in India has invested in AI to reduce the workload of medical staff by automating tasks like medical documentation and patient scheduling. This initiative aims to free up two to three hours per day for healthcare professionals, thereby improving operational efficiency. However, the deployment of AI nurses and VHAs has raised concerns among healthcare professionals. Nursing unions argue that reliance on AI could undermine nurses' ability and degrade the quality of patient care, leading to an over dependence on automated protocols and potential false alarms. This highlights the need for a balanced approach that integrates AI tools without compromising the essential human elements of healthcare.

3.4 AI in Image Diagnosis:

Artificial Intelligence (AI) is revolutionizing medical imaging by enhancing the accuracy and efficiency of diagnostic procedures. Advanced algorithms and machine learning enable AI systems to analyze complex medical images, aiding in


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early disease detection and personalized treatment planning. AI's applications range from identifying subtle patterns in medical images to reconstructing high-quality images from low-dose scans, thereby reducing patient exposure to radiation.

Recent advancements include the development of AI models for detecting diseases with high accuracy, such as the ECgMPL model for endometrial cancer and Northwell Health's iNav tool for early pancreatic cancer detection. Efforts to create explainable AI are also underway, aiming to make AI decisions in medical imaging more interpretable and trustworthy for integration into clinical work flows.

3.5 AI in Mental Health:

Artificial Intelligence (AI) is playing a growing role in mental health care by offering innovative solutions for diagnosis, treatment, and patient support. Using machine learning, natural language processing, and data analytics, AI enhances mental health services in several key areas. Diagnostic assistance is one of the main applications, where AI algorithms analyze speech patterns, text inputs, and behavior to identify early signs of mental health conditions such as depression and anxiety. For example, AI tools are being developed to detect indicators in conversations that may signal severe depression or suicidal tendencies, aiding clinicians in early intervention. AI-driven chat bots also provide users with immediate access to mental health resources, coping strategies, and self-help tools. These chat bots offer support and guidance but are not substitutes for professional therapy. Monitoring and early intervention are other significant applications of AI in mental health. Some educational institutions use AI-powered surveillance systems to monitor students' online activities, aiming to identify signs of mental distress or potential self-harm. However, these practices raise significant privacy and security concerns.

3.6 Early Detection and Initiative-taking Management of Chronic Diseases

Artificial intelligence (AI) is revolutionizing chronic disease management through personalized treatment plans, continuous monitoring, and patient engagement. By analyzing individual patient data, AI facilitates customized care strategies that enhance the management of chronic conditions. Integration with wearable technology allows AI systems to monitor vital signs and symptoms in real-time, enabling timely interventions and reducing hospital readmissions. AI-driven applications also empower patients to participate actively in their care by providing educational resources, medication reminders, and real-time feedback on health metrics. However, to fully realize these benefits, it is crucial to address challenges such as data privacy, integration with clinical work flows, and ethical implications, ensuring that AI tools are used equitably and do not exacerbate healthcare disparities.

The advantages of AI in healthcare extend beyond disease management, offering substantial medical, economic, and social benefits. AI's ability to analyze big data improves risk prediction, disease detection, and patient-specific treatments. It also aids disease prevention by tracking social media and web trends to predict outbreaks. AI enhances clinical decision-making, supports robotic surgeries, and evaluates mental health using natural language processing and sentiment analysis. Economically, AI helps reduce post-treatment expenses, facilitates early diagnosis, and streamline clinical trials, accelerating drug development and monitoring biomarkers. Overall, AI's capabilities contribute to improved patient outcomes and more efficient healthcare delivery.

4. BENEFITS OF AI IN HEALTHCARE

4.1 Increased Efficiency and Reduced Workload


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AI automates routine administrative tasks such as appointment scheduling, medical coding, and data entry, allowing healthcare professionals to focus more on patient care. By streamlining processes, AI helps reduce burnout among medical staff and enhances overall efficiency.

4.2 Accuracy and Precision in Diagnostics

AI algorithms analyze medical data with high accuracy, often outperforming human doctors in detecting anomalies in medical images, pathology slides, and lab reports. AI-powered diagnostic tools ensure early disease detection, which significantly improves patient survival rates.

4.3 Cost Reduction in Patient Care

AI-driven automation reduces operational costs by perfecting hospital resource allocation, minimizing unnecessary tests, and shortening hospital stays. By improving efficiency, AI contributes to significant cost savings for both healthcare providers and patients.

4.4 Enhanced Patient Experience

AI-powered chat bots and virtual health assistants give instant medical advice, reducing waiting times for patients. Personalized treatment plans generated by AI improve patient engagement and adherence to therapy, leading to better health outcomes.

5. CHALLENGES & ETHICAL CONSIDERATIONS

5.1 Data Privacy and Security Issues

AI relies on extensive patient data, raising concerns about security and privacy compliance. Protecting patient confidentiality and preventing breaches is essential.

5.2 Bias in AI Models and Risk of Misdiagnosis

Unbalanced training datasets can cause biases in AI, leading to healthcare disparities. Developing diverse data sets and monitoring predictions are crucial to avoiding discrimination.

5.3 Regulatory and Legal Hurdles

AI in healthcare faces regulatory challenges, needing approval from health authorities like the FDA. Standardizing guidelines and ensuring legal compliance are key issues.

5.4 Ethical Concerns Regarding AI Replacing Human Jobs

AI's role in diagnostics and administration raises job displacement fears. AI should augment, not replace, human roles, with oversight ensuring ethical use.

6. FUTURE TRENDS & INNOVATIONS IN AI HEALTHCARE

6.1 AI and Block chain for Secure Medical Records

The integration of AI with block chain technology is expected to enhance data security and interoperability in healthcare systems. Block chain ensures secure and transparent medical record management, reducing fraud and unauthorized access.

6.2 Advancements in AI-Powered Wearables and IoT Healthcare

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AI-driven wearable devices and the Internet of Medical Things (IoMT) enable continuous health monitoring. Devices such as smart watches and biosensors provide real-time health metrics, improving preventive care and early disease detection.

6.3 AI-Human Collaboration in Future Medicine

AI is expected to work alongside healthcare professionals rather than replace them. Future advancements will focus on enhancing AI-human collaboration through decision support systems, augmented diagnostics, and AI-assisted robotic surgeries.

6.4 AI in Drug Discovery and Personalized Medicine

AI models accelerate drug discovery by analyzing molecular interactions and predicting drug efficacy. The future of medicine will see AI-driven personalized treatment plans tailored to individual genetic profiles, improving patient outcomes and reducing adverse reactions.

7. CONCLUSION

Artificial Intelligence (AI) is transforming healthcare by enhancing diagnostic accuracy, perfecting treatment strategies, and improving patient outcomes. From AI-powered medical imaging and robotic surgery to virtual health assistants and predictive analytics, AI's applications are revolutionizing patient care and hospital management. The integration of AI in drug discovery and chronic disease management further underscores its potential to accelerate medical advancements and enhance efficiency. Despite its numerous benefits, challenges such as data privacy concerns, regulatory hurdles, algorithmic biases, and ethical considerations are still critical barriers to widespread adoption. Addressing these challenges through robust policies, continuous model improvement, and ethical AI development will be essential for responsible implementation. Looking ahead, advancements in AI-driven wearables, block chain for secure medical records, and AI-human collaboration will shape the future of healthcare. AI is not a replacement for human ability but an augmentation tool that enhances decision-making and operational efficiency. By fostering innovation while ensuring responsible AI deployment, healthcare can achieve better patient care, reduced costs, and improved clinical outcomes.

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PERFORMANCE ANALYSIS OF METAHEURISTIC APPROACHES FOR INTRUSION DETECTION SYSTEMS

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ABSTRACT

The rising complexity of cyber threats has intensified the demand for adaptive Intrusion Detection Systems (IDS) that ensure robust network security. Traditional IDS models often suffer from high false positives and limited adaptability. This study introduces HHO-MLP IDS, a hybrid model combining Harris Hawks Optimization (HHO)—a swarm-based metaheuristic—with a Multilayer Perceptron (MLP) to optimize neural network parameters for improved intrusion detection.Using the CIC-IDS2017 dataset and the EvoloPy-NN framework, the model's performance was benchmarked against Particle Swarm Optimization (PSO), Genetic Algorithm (GA), and Ant Colony Optimization (ACO). Results demonstrate that HHO-MLP IDS offers superior accuracy and efficiency, especially on larger datasets, making it a strong candidate for scalable, real-world IDS deployment.

Keywords: Intrusion Detection System (IDS); Harris Hawks Optimization (HHO); Multilayer Perceptron (MLP); Metaheuristic Algorithms; Network Security.

I. INTRODUCTION

The exponential growth of cyber threats like DDoS, ransomware, and APTs has elevated the importance of intelligent IDS capable of real-time detection. While signature-based IDS models efficiently detect known attacks, they fail against zero-day threats. Conversely, anomaly-based systems can detect unknown attacks but typically suffer from high false positives and poor adaptability [1, 2].Recent efforts integrate machine learning (ML) and metaheuristic algorithms to address these issues. MLPs are effective classifiers for IDS tasks but require optimized hyperparameters for reliable performance [3, 4]. Swarm-based techniques like PSO, GA, and ACO have been applied to tune these parameters, but limitations like premature convergence and high computational cost persist [5].To address this, we propose HHO-MLP IDS—an optimization-driven IDS framework using HHO to fine-tune MLP parameters. HHO mimics the intelligent hunting behavior of Harris's hawks, offering a balance between global exploration and local refinement [6]. The proposed model delivers:


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- **Improved Accuracy** through adaptive parameter tuning,
- **Lower False Positives** by refining decision boundaries, and
- **Efficiency** through faster convergence.

Evaluated using CIC-IDS2017 [7], the model is compared against PSO, GA, and ACO-based IDS systems across accuracy, recall, precision, F1-score, and execution time. This work contributes:

1. A robust HHO-MLP IDS model;
2. Comparative analysis with other metaheuristic techniques;
3. Insights into scalability and real-world deployment feasibility.

II. RELATED WORK

IDS approaches typically fall into signature-based and anomaly-based categories. Signature-based IDS like Snort excel in known attack detection but falter against new threats [8, 9]. Anomaly-based systems use ML models to detect deviations in traffic but often trigger false alarms and require frequent updates [10]. To enhance IDS, metaheuristic algorithms are employed for tasks such as feature selection and classifier tuning. PSO models network traffic patterns using swarm intelligence but often converge prematurely [11]. GA employs evolutionary processes for optimization and is effective for IDS but computationally expensive on large datasets [12]. ACO, based on ant behavior, is used for anomaly detection but suffers from slow convergence [13].Hybrid strategies that integrate these optimizers with neural networks have shown promise, offering improved accuracy and adaptability [14]. Deep learning models like MLP, CNN, and RNN are now widely used in IDS for their hierarchical learning ability [15], with MLP favored for its simplicity and performance. However, its effectiveness is tightly linked to optimal parameter selection, a task well-suited for metaheuristics [16].Despite these developments, three key gaps remain: (1) hybrid optimization-deep learning IDS models are under explored [17], (2) large-scale benchmarking using datasets like CIC-IDS2017 is often missing, and (3) real-time efficiency remains a challenge due to model complexity. This paper addresses these by proposing a scalable and optimized hybrid HHO-MLP IDS model designed for real-world deployment.

III. PROPOSED MODEL: HHO-MLP IDS

To address limitations in traditional IDS, we propose a hybrid framework—HHO-MLP IDS—that combines the learning capabilities of a MLP with the adaptive optimization strength of HHO. The goal is to improve detection accuracy while reducing false positives and computational overhead through effective parameter tuning. HHO is a nature-inspired metaheuristic that mimics the cooperative hunting behavior of Harris's hawks. It balances global and local search through four adaptive stages—exploration, surprise pounce, exploitation, and convergence—making it suitable for complex parameter optimization in IDS tasks. MLP is a widely-used neural network for classifying network traffic. It includes input, hidden, and output layers capable of learning non-linear patterns in data. However, its performance depends heavily on well-tuned parameters, where HHO serves as an effective optimizer. HHO initializes a population of candidate MLP configurations, evaluates each using classification accuracy, and iteratively refines them using its adaptive position update rules. The best-performing configuration is then used for final training and evaluation. By combining MLP's classification ability with HHO's optimization strategy, the proposed model delivers a scalable and efficient IDS solution for modern cyber environments.


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IV. EXPERIMENTAL SETUP & METHODOLOGY

The performance of HHO-MLP IDS was evaluated through a series of experiments against established metaheuristic techniques.

Dataset & Preprocessing : The CIC-IDS2017 dataset, which includes a wide range of real-world attack types and benign traffic, was selected for training and evaluation. Key preprocessing steps included:

- **Handling Missing Values** via removal or imputation.
- **Normalization** to standardize feature scales.
- **Feature Selection** using correlation analysis and expert knowledge, retaining high-impact traffic indicators while reducing dimensionality.

Model Implementation : The model was implemented using the EvoloPy-NN framework, which supports neural network optimization using various swarm-based algorithms. HHO was used to tune MLP weights and biases based on classification accuracy. The process included:

- Splitting data into 80% training and 20% testing sets.
- Using HHO to update MLP parameters across 50 iterations.
- Selecting the best-performing configuration for final evaluation.

Scalability was tested using dataset subsets of increasing size: 1000, 2000, 5000, and 10,000 samples. This setup ensured performance could be assessed under both small and large-scale scenarios.

Evaluation Metrics: The following standard metrics were used to assess IDS performance:

- **Accuracy:** Correctly classified instances.
- **Precision:** Ability to minimize false positives.
- **Recall:** Sensitivity to true intrusions.
- **F1-Score:** Balance between precision and recall.
- **Execution Time:** Time required to reach an optimized solution.

Benchmarking Against Other Algorithms: To evaluate comparative effectiveness, HHO-MLP IDS was tested against GA, PSO, ACO, and DE. Each algorithm was applied to the same MLP architecture under identical experimental conditions. The comparison focused on:

- Accuracy vs. execution time,
- Model scalability with increasing data volume,
- Reduction in false positives, crucial for real-world application.


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V. RESULTS & PERFORMANCE EVALUATION

The HHO-MLP IDS model was evaluated on multiple dataset sizes to assess detection performance, scalability, and efficiency. As shown in Table V (a), the model achieved high accuracy across all subsets, peaking at 92.1% on the largest (10,000 samples), and maintaining solid performance even on smaller datasets. This confirms its ability to generalize across varying data volumes while keeping execution times within practical limits.

Table V (a): Performance of HHO-MLP IDS on Different Dataset Sizes

Dataset Size	Accuracy	Precision	Recall	F1-Score	Execution Time (s)
1000	0.895	0.902	0.887	0.894	2.4
2000	0.900	0.910	0.890	0.900	3.8
5000	0.880	0.885	0.875	0.880	7.2
10,000	0.921	0.930	0.915	0.922	12.5

In a comparative analysis using the EvoloPy-NN framework, the HHO-MLP model was benchmarked against other metaheuristic optimizers. Table V (b) displays performance metrics for 12 algorithms.

Table V (b): Evaluation of Metaheuristic Algorithms

Algorithm	Accuracy	Precision	Recall	F1-score	Execution Time
Differential Evolution	98.50%	99.25%	99.55%	99.40%	50.83
Firefly Algorithm	95.82%	99.37%	94.57%	96.91%	55.62
Genetic Algorithm	98.95%	98.96%	100.00%	99.48%	51.72
Grey Wolf Optimizer	98.43%	99.25%	99.55%	99.40%	51.62
Harris Hawks Optimization	98.35%	99.25%	99.55%	99.40%	85.10
Jaya Algorithm	94.25%	98.93%	97.59%	98.26%	56.93
Moth Flame Optimization	96.56%	99.39%	97.74%	98.55%	52.10
Multi-Verse Optimizer	98.28%	99.20%	99.25%	99.22%	75.10
Particle Swarm Optimization	95.89%	99.23%	97.89%	98.55%	86.03
Sine Cosine Algorithm	93.80%	99.35%	92.31%	95.64%	45.92
Salp Swarm Algorithm	98.73%	99.25%	99.55%	99.40%	45.22
Whale Optimization Algorithm	96.64%	99.24%	98.34%	98.79%	44.83

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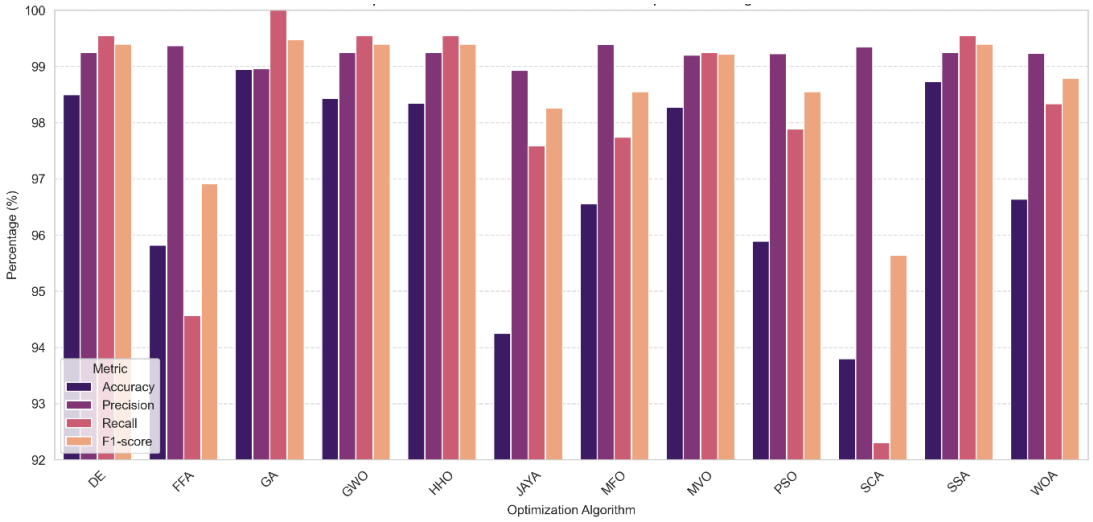

Figure 5.1: Accuracy, Precision, Recall, F1-Score Comparison Plot

Performance Insight: GA achieved the highest recall (100%), while HHO, DE, GWO, and SSA performed consistently across all metrics (~98–99.5%). FFA and SCA had comparatively lower recall, suggesting reduced sensitivity to intrusions.

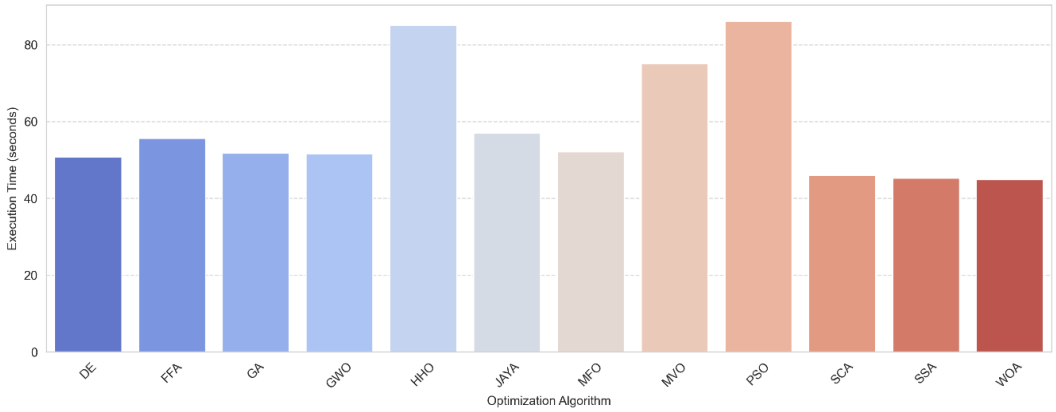

Figure 5.2: Execution Time Comparison Plot

Execution Time Insight: SSA, WOA, and SCA were the fastest (under 46s), while HHO and PSO exceeded 85s. Despite this, HHO achieved a strong trade-off between accuracy and computational time, making it viable for real-world IDS deployments where both accuracy and efficiency matter.

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VI. DISCUSSION

The HHO-MLP IDS model demonstrated robust detection capabilities, with high classification accuracy and consistent scalability. Its ability to maintain performance across growing dataset sizes highlights its practical value in large-scale security environments. Compared to other techniques, HHO offered a compelling balance—slightly trailing GA in accuracy but delivering better efficiency than slower or less accurate alternatives.While the execution time for HHO was higher than faster-converging methods like DE or SSA, its accuracy and stability offset this limitation. Moreover, careful tuning of HHO parameters is necessary to ensure optimal results. These findings affirm HHO-MLP IDS as an effective and adaptable solution for intrusion detection, suitable for deployment in diverse operational conditions.

VII. CONCLUSION & FUTURE WORK

This study introduced HHO-MLP IDS, a hybrid intrusion detection framework that leverages Harris Hawks Optimization for tuning MLP parameters. Extensive testing using the CIC-IDS2017 dataset showed that the model delivers high accuracy, reduced false positives, and efficient performance across varying dataset sizes.Compared to other metaheuristic optimizers like GA and DE, the proposed model achieved competitive results while offering better adaptability and scalability. Future improvements could involve incorporating advanced neural architectures (e.g., CNNs or RNNs) and deploying the system in real-time environments. Additional work is also recommended to enhance convergence speed through automated hyperparameter tuning.In conclusion, HHO-MLP IDS presents a viable direction for developing intelligent, scalable, and efficient cybersecurity solutions that can adapt to evolving threats.

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ENHANCING INFRASTRUCTURE MANAGEMENT AND URBAN LIVING THROUGH IOT TECHNOLOGY: CHALLENGES AND SOLUTIONS

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ABSTRACT

The rapid expansion of urban populations has placed immense pressure on city infrastructure and services. The integration of **Internet of Things (IoT) technology** in urban management presents an opportunity to create smart, efficient, and sustainable cities. The rapid advancement of Internet of Things (IoT) technologies has ushered in a new era for urban infrastructure management, offering innovative solutions to enhance the efficiency, sustainability, and quality of urban living. This paper explores the transformative potential of IoT in key sectors such as energy management, transportation, waste management, water distribution, and smart buildings. By leveraging real-time data collection, IoT enables the optimization of urban systems, leading to smarter cities with reduced energy consumption, improved traffic flow, better waste management, and enhanced public services. Despite the promising benefits, the integration of IoT in urban infrastructure faces several significant challenges, including concerns over data security and privacy, issues of interoperability between devices, scalability limitations, and high implementation costs. This paper discusses these challenges in detail and proposes practical solutions, such as enhanced cyber security protocols, the development of standardized communication frameworks, the use of edge computing for scalability, and public-private partnerships to share the financial burden. Through a combination of theoretical analysis and real-world case studies, this paper demonstrates how overcoming these obstacles can unlock the full potential of IoT to create more sustainable, livable, and resilient urban environments. The study concludes by emphasizing the need for continued innovation, policy frameworks, and interdisciplinary collaboration to address the challenges of IoT deployment and ensure its widespread adoption for the future of smart cities.

Keyword: IOT,PPP,Fog computing.

1. INTRODUCTION

The Internet of Things (IoT) is revolutionizing infrastructure management and urban living by enabling the collection and analysis of real-time data, improving operational efficiency, and enhancing the overall quality of life in cities. However, there are also significant challenges to its implementation. Below are the key ways IoT is enhancing infrastructure management and urban living, along with the challenges and potential solutions.

1.1 How IoT Enhances Infrastructure Management and Urban Living

1. **Smart Energy Management**
   - IoT enables the monitoring and management of energy consumption in real-time. Through smart meters and sensors, cities can optimize energy usage, reduce waste, and increase efficiency in buildings, street lighting, and public facilities[1].
   - **Example**: Smart grids adjust energy supply based on demand, minimizing outages and energy losses.
2. **Traffic and Transportation Management**
   - IoT can optimize traffic flow, reduce congestion, and improve transportation systems. Connected traffic lights, sensors, and GPS tracking in vehicles allow for real-time adjustments to traffic patterns, while public transportation systems can be monitored for efficiency[2].
   - **Example**: Smart traffic lights that adjust based on traffic conditions, leading to reduced waiting times and better air quality by reducing vehicle emissions.


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3. **Waste Management**
   - Sensors in waste bins can signal when they are full, enabling more efficient waste collection. Smart waste bins can also track and optimize the routes of garbage trucks[3].
   - **Example**: Waste collection is scheduled dynamically based on sensor data, reducing fuel consumption and ensuring timely service.
4. **Water and Environmental Monitoring**
   - IoT devices can monitor water levels, quality, and consumption patterns in real-time. Similarly, environmental sensors can detect pollution levels, weather conditions, and air quality, allowing for more informed decision-making[4].
   - **Example**: Smart water meters track consumption, prevent leaks, and enable water conservation efforts, while air quality sensors can trigger alerts when pollution exceeds safe levels.
5. **Smart Buildings and Facilities Management**
   - Sensors and connected devices allow for real-time monitoring and control of building systems such as heating, ventilation, and air conditioning (HVAC), lighting, and security systems[5].
   - **Example**: In commercial buildings, IoT can reduce energy costs by adjusting temperature and lighting based on occupancy, ensuring a comfortable environment while reducing waste.

2. CHALLENGES IN IMPLEMENTING IOT FOR URBAN LIVING AND INFRASTRUCTURE MANAGEMENT

1. **Data Security and Privacy Concerns**
   - **Challenge**: With a vast amount of data being collected from various IoT devices, there is a heightened risk of cyberattacks, data breaches, and misuse of personal information.
   - **Solution**: Implement strong encryption, secure data storage, and comply with regulations such as GDPR. Additionally, adopting decentralized or edge computing can reduce the amount of sensitive data sent to centralized servers.
2. **Interoperability**
   - **Challenge**: IoT devices and systems are often built by different manufacturers and may use different communication protocols, making it difficult to integrate them into a cohesive system.
   - **Solution**: Promote the adoption of open standards and protocols to ensure devices from different vendors can communicate with each other. Governments and industry organizations can also create frameworks for standardization[6].
3. **Scalability and Network Infrastructure**


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- **Challenge**: As IoT networks grow in size, managing and maintaining the infrastructure can become complex. Cities need reliable, high-speed connectivity to support millions of devices[7].
- **Solution**: Invest in 5G networks and edge computing, which allow for faster, more scalable IoT deployments. Additionally, cities can partner with private enterprises to build robust communication networks.

4. **Data Overload**
   - **Challenge**: The vast amount of data generated by IoT devices can overwhelm systems and decision-makers, leading to difficulty in processing and making sense of it[8].
   - **Solution**: Use advanced analytics, AI, and machine learning to process and analyze data. Implement systems that can filter and prioritize critical data to aid decision-making in real time.
5. **High Initial Costs**
   - **Challenge**: Deploying IoT devices and the associated infrastructure can require significant initial investment, which may be a barrier for some cities[9].
   - **Solution**: Governments can introduce funding programs and public-private partnerships. In the long term, IoT's potential to improve efficiency can lead to substantial cost savings.
6. **Maintenance and Reliability**
   - **Challenge**: IoT devices and sensors are susceptible to wear and tear, and maintaining them at a large scale can be challenging. There is also the risk of devices becoming obsolete or failing without proper monitoring[10].
   - **Solution**: Regular maintenance schedules, predictive maintenance using IoT itself, and ensuring devices are updated with the latest software to prolong their lifecycle.

3. SOLUTIONS TO OVERCOME THESE CHALLENGES

1. **Public-Private Partnerships (PPPs)**
   - Governments can collaborate with private companies to pool resources, knowledge, and technologies to implement IoT solutions effectively[11]. PPPs can help mitigate the financial burden and encourage innovation.Key Aspects of PPPs in IoT and Urban Living:
   - **Smart Infrastructure Development** – Deployment of IoT-powered smart grids, intelligent transportation systems, and automated utilities through government and private sector collaboration.
   - **Investment & Financing** – The public sector provides regulatory frameworks and initial funding, while private enterprises contribute technology, innovation, and investment.
   - **Data Governance & Security** – PPPs establish protocols for secure and ethical data management, balancing open data initiatives with privacy protection.
   - **Innovation & Scalability** – By leveraging private sector R&D capabilities, cities can implement scalable, cutting-edge IoT solutions tailored to urban challenges.

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2. **Standardization and Regulatory Frameworks**

- Establishing international standards for IoT devices and communication protocols can enhance interoperability and provide a clear regulatory environment for security and privacy concerns.Standardization and regulatory frameworks are crucial for the sustainable and secure growth of IoT in urban living[12]. As smart cities evolve, harmonized standards and stringent regulations will be key in ensuring safe, efficient, and interconnected urban environments.

3. **Smart City Platforms**

Developing centralized platforms that integrate various IoT data sources and manage the data efficiently can help cities monitor, analyze, and take actions based on real-time information[13].A comprehensive smart city platform consists of:

- **IoT Device Integration:** Collects data from smart sensors, cameras, and devices.
- **dge Computing:** Ensures real-time data processing and storage.
- **Big Data Analytics & AI:** Transforms raw data into actionable insights.
- **Interoperability Frameworks**: Ensures seamless data sharing across systems.
- **Cyber security & Data Privacy:** Protects against cyber threats and ensures compliance.
- **User Interface & Dashboards:** Provides city officials with real-time monitoring tools

4. **Leveraging Edge and Fog Computing for Scalability:**

- With the rapid growth of IoT in urban environments, traditional cloud computing faces challenges in handling large-scale data processing efficiently[14]. **Edge and Fog computing** emerge as crucial solutions by enabling data processing closer to the source, reducing latency, and improving real-time decision-making for smart city applications.

○ Sector	Edge & Fog Computing Applications
○ Smart Traffic Management	AI-driven traffic signals, vehicle-to-infrastructure (V2I) communication.
○ Public Safety & Security	Edge-based facial recognition, AI-driven crime detection.
○ Healthcare	Remote patient monitoring, smart ambulances with real-time diagnostics.
○ Smart Grid & Energy	Real-time power grid monitoring, load balancing.
○ Waste Management	IoT-enabled smart bins and optimized collection routes.
○ Environmental Monitoring	Real-time air quality and weather analysis.

5. **Public Awareness and Education**

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- Educating citizens about the benefits and security measures related to IoT can foster trust and encourage widespread adoption. Ensuring transparency and clear communication about data usage **is critical.**

4. CASE STUDIES OF SUCCESSFUL IOT IMPLEMENTATIONS

Example 1: Smart City of Barcelona (IoT applications in energy, waste management, and transportation.)

***Key Implementations*:**

- **Smart Street Lighting**: IoT-enabled LED streetlights reduce energy consumption by 33%.
- **Smart Parking**: Sensors detect available parking spaces, reducing traffic congestion.
- **Connected Waste Management**: Smart bins notify waste collection teams when full.
- **Integrated Public Transport**: Real-time data helps optimize bus and metro operations.

Impact:

- 30% energy savings from smart lighting.
- 25% reduction in water consumption through IoT-driven irrigation systems.
- Improved public transport efficiency with real-time monitoring.

Example 2: Smart Traffic Management in Singapore(How IoT has improved traffic congestion and air quality.

Key Implementations:

- **Smart Traffic and Mobility**: AI-powered traffic monitoring and adaptive traffic signals.
- **Connected Public Safety**: CCTV cameras and IoT sensors detect anomalies in real time.
- **Digital Health Monitoring**: Wearable IoT devices monitor elderly citizens' health.
- **Smart Water Management**: Sensors track water quality and leakages in real time.

Impact:

- Reduced traffic congestion by 8% using real-time traffic data.
- Significant improvements in elderly healthcare with remote monitoring.
- Improved water management efficiency, reducing wastage.

Example 3: Amsterdam, Netherlands – Smart City with Open Data

Amsterdam has embraced IoT and open data platforms to improve sustainability and citizen engagement.

Key Implementations:

- **IoT-Based Energy Grids**: Smart meters optimize energy consumption in homes.
- **Floating Sensors for Flood Prevention**: Sensors monitor water levels and predict floods.
- **Bicycle Traffic Monitoring**: IoT sensors track cycling patterns to improve bike lanes.


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- **Citizen Engagement Apps**: Mobile apps provide real-time city updates.

Impact:

- 18% reduction in energy consumption in pilot areas.
- Enhanced flood prevention with predictive analytics.
- Increased bicycle usage due to improved urban planning.

Example 4. New York City, USA – Smart Infrastructure and Safety

Project: Link NYC and Smart Traffic Management

New York has implemented IoT for public Wi-Fi, smart mobility, and urban safety.

***Key Implementations*:**

- **Link NYC Wi-Fi Kiosks**: Replaces old payphones with high-speed public Wi-Fi.
- **Smart Traffic Signals**: AI-powered signals adjust in real time to optimize traffic flow.
- **Connected Public Safety**: IoT sensors and AI-enhanced surveillance for crime prevention.
- **Air Quality Monitoring**: Sensors track pollution and inform city planning.

Impact:

- Over **10 million** Link NYC users benefiting from free Wi-Fi.
- 10% reduction in traffic congestion with smart signals.
- Improved law enforcement efficiency with AI-driven crime detection.

5. FUTURE DIRECTIONS AND RESEARCH OPPORTUNITIES

- **1. Emerging Technologies in IoT**
  - Integration of AI, machine learning, and blockchain with IoT for improved urban management.
- **2. Potential for Global IoT Adoption**
  - How IoT can be implemented in cities worldwide, particularly in developing countries.
- **3. Ethical and Social Implications**
  - Ethical considerations regarding IoT data collection and privacy.
  - Ensuring equitable access to IoT benefits.

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CONCLUSION

IoT technology holds immense potential for transforming urban infrastructure and improving citizens' quality of life. However, addressing challenges such as **security risks, high costs, interoperability issues, and scalability concerns** is critical. By implementing **standardized frameworks, strengthening cybersecurity, leveraging edge computing, and fostering public-private partnerships**, cities can create smarter, safer, and more efficient urban environments.In conclusion, IoT has the potential to significantly enhance infrastructure management and urban living by improving efficiencies, saving costs, and enhancing the quality of life.

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ARTIFICIAL INTELLIGENCE AND SIKHISM

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ABSTRACT

The present paper details Artificial Intelligence (AI), its contribution to understand Sikhism especially rather relying comprehensively on the role of AI in education, healthcare, agriculture, computer versions, problem solving, productivity, transportation, climate, finance, automation, efficiency, data analysis, job market, and customer experience. The paper also explores the possible menaces of AI in Sikhism and provides the possible solutions to make AI a balanced approach to interpret the scriptures of different religions. Artificial Intelligence (AI) is basically the invention of machines, tools, gadgets, and their handling operations to perform human tasks to save time, labour, and expenses and to increase efficiency under the supervision of human intelligence. In fact, AI is the most vital technology that has ever been created to comfort the lives of humans, animals, and birds, but it is equally vital to ensure that it is used safely and beneficially for existing and future generations of species. Artificial Intelligence's impact on religion is multilayered, ranging from potential disruptions and new religious movements to AI's role in religious practices and discussions about ethics and the nature of existence. AI-driven automation could lead to job losses and societal shifts, potentially increasing the need for religious engagement and meaning-making. AI provides new metaphors and narratives that inspire religious thinking and movements, as seen with new religious groups emerging around AI and transhumanism. Enquiries arise about the authenticity and ethical implications of AI-driven religious experiences, and whether AI can truly enhance or detract from the depth and transformative power of religious practices. Furthermore, the role of AI is studied in connection with the practices and scriptures of Sikhism.

Artificial Intelligence (AI) translates and interprets Gurbani into various languages to expand the message of 'Shri Guru Granth Sahib' and the other Sikh scriptures. AI globalizes and Sikh events, festivals, history, and traditions to strengthen the human connections, to empower unity among the worldwide Sikhs and the other communities. The offshoot of AI such as social media platforms help spread justice, equality, and selfless service. AI potentially supports Sikhs in practicing their faith in various ways like access to Gurbani and Sikh resources. AI-powered platforms and applications can provide convenient access to Gurbani (Sikh scriptures), *Kirtan* (devotional music), and other Sikh resources. AI is defiantly held responsible for the misinterpretations of Gurbani and inconsistent translations. AI has commercialized Sikh religion for monetary benefits. AI has also mitigated Sikh congregations and the other Sikh values like *Langar* preparations, martial arts, and collective meditation. AI is precarious for leaking data and breaking privacy. Developing a poised approach to preserve data privacy, to eschew fiscal intensions, and to shun detrimental translations and interpretations of Gurbani can inflate the spiritual message of Shri Guru Granth Sahib

Keywords: Shri Guru Granth Sahib, human connections, selfless service (*Seva*), misinterpretations, equality.

INTRODUCTION TO ARTIFICIAL INTELLIGENCE AND ITS ROLE IN SIKHISM:

Artificial Intelligence (AI) refers to developing computer systems and machines that can perform tasks that typically require human intelligence. It involves the creation of intelligent agents that can perceive their environment, reason for it, and take action to achieve specific goals (Dorobantu, 2019; Pinto, 2022). These systems are designed to analyze and interpret large amounts of data, learn from patterns and experiences, and make decisions or predictions based on that information. AI applications are wide-ranging, including virtual assistants, autonomous vehicles, recommendation systems, fraud detection, medical diagnostics, and many more. However, while AI systems can exhibit advanced capabilities, they still lack humans' general intelligence and common-sense reasoning. AI is an evolving field, and researchers and engineers continue to explore and develop new techniques and technologies to enhance its capabilities. Artificial intelligence is likely to affect religion in various ways, some of which are already becoming apparent (Rendsburg, 2019; Olaore et. al. 2014; Geraci, 2008; Upadhyay, 2023). In such a scenario, the teachings of Sikhism, as enshrined in Aad Guru Granth Sahib (AGGS, 1983), with appropriate usage of AI, can play a vital role in the development of a new social order that is more just, sustainable, and compassionate for all.

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RELEVANCE OF ARTIFICIAL INTELLIGENCE TO SIKHISM:

Guru Nanak founded the Sikh religion during the late 15th century in the Punjab district of British India. Sikhism is based on Guru Nanak's teaching and those of the nine Gurus who followed him. The Sikh scripture, Aad Guru Granth Sahib, contains a wealth of knowledge and instructions that can be applied to various aspects of modern life, including the era of artificial intelligence (Virk, 2023; Singh, 2021).

Some possible ways in which the teachings of the Aad Guru Granth Sahib may be relevant to the scientific era of AI:

Oneness of creation: The Aad Guru Granth Sahib emphasizes the oneness of creation and the interconnectedness of all things (Singh, 2009). This perspective could help shape the development and use of AI to align more with the values of sustainability, compassion, and respect for all forms of life. Knowledge and wisdom: The Aad Guru Granth Sahib highlight the importance of seeking knowledge and wisdom, and AI can be a powerful tool for acquiring knowledge and analyzing data. The Sikh teachings (Singh, 2021) can provide a framework for using AI in a way that is mindful of the ethical implications and the potential impact on human well-being.

Service to others: The Sikh teachings proclaim the importance of serving others and working to ameliorate society (Singh, 2019). AI can be used to address critical societal issues such as poverty, hunger, and disease, and the Sikh teachings can provide a framework for using AI in service to others.

Truth and authenticity: The Aad Guru Granth Sahib declare the importance of truth and authenticity (Singh, 2023), and AI has the potential to be used in a way that is transparent and trustworthy. Therefore, the Sikh teachings can provide a framework for developing AI systems that are honest, accurate, and in line with ethical principles.

Equality and justice: The Sikh tradition strongly emphasizes social justice and equality for all (Singh, 2018). AI can be used to identify and address inequalities and biases in society, but it can also perpetuate and exacerbate these issues if not developed and used ethically. The Sikh teachings can provide a framework for developing and using AI to promote social justice and equality.

Humility and gratitude: The Sikh teachings emphasize the importance of humility and gratitude (Singh, 2019), which can help individuals approach AI use and development with a feeling of responsibility and respect for all forms of life. In addition, humility can help prevent individuals from becoming overly reliant on AI and viewing it as a substitute for human connection and compassion.

Non-attachment: The Sikh tradition encourages individuals to practice non-attachment, which can help cultivate a sense of detachment from AI development and use outcomes. In addition, it can help individuals approach AI more objectively and consciously and consider the potential ethical implications and impact on society and the environment. Emphasis on action: Aad Guru Granth Sahib emphasizes the importance of action and service to others (Singh, 2021; Singh, 2019) rather than passive contemplation. This perspective can help individuals use AI in a way that is focused on creating positive change and addressing critical societal issues rather than simply analyzing data and information.

The Sikh tradition encourages interfaith dialogue and collaboration (Singh, 2020), which can be valuable in navigating AI's complex ethical and societal implications. Engaging in dialogue with individuals from different faith traditions and perspectives can help to identify shared values and concerns and to develop a more nuanced and holistic approach to AI development and use.


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Importance of meditation: The Sikh tradition strongly emphasizes meditation and introspection (Singh, 2021), which can be beneficial in navigating the complex ethical and societal implications of AI. The practice of meditation can help individuals to develop a more mindful approach to using and developing AI and to consider the impact of AI on society and the environment. Thus, the teachings of the Guru Granth Sahib provide a valuable framework for navigating the era of AI in a way that is ethical, compassionate, and mindful of the interconnectedness of all things. By incorporating these teachings into the development and use of AI, individuals and communities can work towards a more just, sustainable, and compassionate future for all.

AI-powered virtual environments, such as virtual reality (VR) or augmented reality (AR), can create immersive experiences that simulate the presence of a Sangat (spiritual community) or allow virtual participation in religious ceremonies and events. These virtual experiences can provide a sense of connection and involvement, especially for individuals who cannot attend in-person gatherings. While AI can offer valuable support to Sikhs in their faith practices, it is essential to approach its implementation with discernment and ensure that it aligns with the core principles of Sikhism. Critical evaluation and ethical considerations should guide the use of AI to preserve the authenticity, inclusivity, and integrity of Sikh religious practices.

CHALLENGES AND RISKS:

There are indeed risks and challenges associated with using AI for Sikh purposes. AI systems heavily rely on data for training and decision-making. In the case of Sikhism, ensuring the accuracy and authenticity of the data used for AI applications is crucial. There is a risk of misinformation or misinterpretation of Sikh teachings if AI algorithms are not appropriately trained or if the data contains inaccuracies or biases. Sikhism is a rich and nuanced faith with a deep historical and cultural context. AI systems may struggle to comprehend and interpret the complexities of Sikh teachings, rituals, and cultural practices. As a result, misinterpretation or oversimplification of Sikh concepts may occur, leading to potential misunderstandings or misrepresentations. Sikhism emphasizes the importance of human connection, community engagement, and individuals' spiritual experiences. AI, while offering convenience and accessibility, cannot fully replicate the depth of human interaction and the spiritual connection experienced within a physical Sangat (spiritual community). Therefore, more reliance on AI may unintentionally diminish the significance of personal interactions and the depth of spiritual experiences. AI systems can inherit biases in the data they are trained on. As a result, it can lead to biased or discriminatory outcomes, impacting the fair treatment and representation of individuals within the Sikh community. So, it is critical to ensure that AI systems used for Sikh purposes are designed and trained with a commitment to fairness, inclusivity, and equal representation. AI applications often involve collecting and analyzing personal data. Maintaining the confidentiality and security of an individual's personal information is essential, mainly when using AI platforms or apps for Sikh purposes. Care must be taken to protect sensitive data and ensure compliance with relevant privacy regulations. Human dependency and loss of skills: The increasing reliance on AI systems may lead to a potential loss of specific skills or knowledge traditionally passed down through generations within the Sikh community. For example, reliance on AI for translation may reduce the motivation for individuals to learn and preserve the Gurmukhi script or Punjabi language. Therefore, balancing the leverage of AI's benefits and preserving traditional

A BALANCED APPROACH:

Addressing challenges and menaces associated with using AI for Sikh purposes requires a thoughtful and proactive approach on the part of Sikhs. They should actively engage in discussions, collaborate with AI ethics and technology experts, and contribute to developing responsible AI systems that align with Sikh principles and values. Additionally, continuous evaluation, transparency, and community input are vital to ensure that AI is used to uphold the integrity and authenticity of Sikh practices. Furthermore, they can


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(a) Promote education and awareness within the Sikh community about AI technologies, their capabilities, and their limitations.

(b) Foster a deeper understanding of the potential risks and challenges of using AI for Sikh purposes.

(c) Encourage individuals to critically evaluate AI applications and their implications for Sikh teachings and practices.

(d) Engage with AI ethics, technology, and data science experts to understand the ethical considerations and best practices in AI development and deployment.

(e) Collaborate with professionals who can guide ensuring fairness, transparency, and bias mitigation in AI systems used for Sikh purposes.

(f) Implement quality control and data validation mechanisms in AI systems used for Sikh purposes.

(g) Regularly review and verify the accuracy, authenticity, and inclusivity of the data used in training AI algorithms.

(h) Ensure that diverse perspectives and inputs are considered to minimize biases and inaccuracies.

(I) Develop ethical guidelines and standards specific to using AI for Sikh purposes. These guidelines can address bias mitigation, privacy protection, transparency, and accountability.

(j) Engage with the Sikh community, religious leaders, and scholars to collaboratively establish these guidelines and ensure they align with Sikh values.

(k) Continuously monitor and evaluate the performance and impact of AI systems used for Sikh purposes.

(l) Regularly assess their alignment with Sikh principles and values, addressing any issues or biases that may arise.

(m) Encourage feedback from the Sikh community to ensure ongoing improvement and refinement of AI applications.

(n) Find a balance between leveraging the benefits of AI and preserving traditional Sikh practices, rituals, and skills.

(o) Encourage the learning of Gurmukhi script, Punjabi language, and other conventional practices alongside the use of AI tools and platforms.

(p) Emphasize the significance of human connection, personal experiences, and community engagement in Sikh religious practices.

(r) Foster active community participation and engagement in discussions surrounding AI and its impact on Sikhism.

(s) Involve Sikh scholars, religious leaders, and community members in shaping the development and deployment of AI systems for Sikh purposes.

(t) Encourage dialogue, feedback, and open communication to ensure the collective input of the Sikh community.

By taking these proactive measures, Sikhs can navigate the risks and challenges associated with AI while leveraging its potential benefits to enhance the practice of Sikhism in a manner that aligns with Sikh principles, ethics, and values.


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However, it requires a collaborative effort, ongoing evaluation, and a commitment to AI technology's responsible and ethical use.

CONCLUSION AND RECOMMENDATIONS:

The teachings of the Aad Guru Granth Sahib provide a valuable framework for navigating the era of artificial intelligence in a way that is ethical, compassionate, and mindful of the interconnectedness of all things. By incorporating these teachings into the development and use of AI, individuals and communities can work towards a more just, sustainable, and compassionate future for all. The mutual relevance of Sikhism and AI will likely be complex and multifaceted. It will depend on how AI is developed, implemented, and used and the attitudes and beliefs of individual Sikhs and the Sikh community. The advent of AI has the potential to impact Sikhism in various ways, both positively and negatively. Therefore, it is essential for the Sikh community to engage in dialogue and reflection on these issues and to approach these technologies with caution and consideration for their potential impacts on the tradition and its followers.

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THE ROLE OF AI IN EDUCATION: A GLOBAL PERSPECTIVE

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ABSTRACT

Artificial Intelligence (AI) is transforming education worldwide, reshaping how students learn, how teachers teach, and how educational institutions function. From personalized learning platforms to AI-driven tutoring systems, automation of grading, and predictive analytics, AI is making education more efficient, accessible, and tailored to individual needs. While AI presents immense opportunities, it also raises concerns regarding data privacy, teacher training, and the digital divide. This paper explores how AI is being used in education globally, the benefits it offers, the challenges it brings, and the future trends that will shape its role in learning.

Keywords : AI, Automated Grading, Language learning, Augmented Reality, STEM.

1. INTRODUCTION

Education has always evolved with technology, from the printing press to the internet. Now, AI is driving the next big shift, changing the way students interact with learning materials, how teachers manage classrooms, and how institutions assess student progress. Across the world, AI is being integrated into education to make learning more personalized, improve efficiency, and enhance student engagement. Countries like the U.S. and China are leading the way in AI-powered education, while developing nations are gradually adopting AI-driven tools to bridge gaps in learning. However, AI in education is not without its challenges—concerns about privacy, accessibility, and fairness must be addressed to ensure that AI benefits all students, regardless of their background or location.

This paper takes a deep dive into the impact of AI on education, looking at real-world applications, benefits, challenges, and what the future might hold for AI-powered learning.

2. HOW AI IS BEING USED IN EDUCATION

AI is already playing a significant role in classrooms, both physical and virtual. Here are some key ways AI is transforming education:

2.1 Personalized Learning

One of AI's biggest advantages in education is its ability to personalize learning. Instead of a one-size-fits-all approach, AI-driven platforms adapt to each student's pace, strengths, and weaknesses. Dream Box and Knewton use AI to adjust the difficulty of lessons in real time based on student responses. Squirrel AI in China helps students improve by identifying weak areas and offering targeted exercises.This kind of personalized approach ensures that students get the help they need, when they need it, without feeling left behind or unchallenged.

2.2 AI Tutors and Virtual Teaching Assistants

AI-powered tutors are stepping in to support students outside traditional classroom hours. These systems provide instant feedback, explanations, and even answer questions like a human tutor would. Carnegie Learning's AI Tutor offers step-by-step assistance in math. Jill Watson, an AI assistant at Georgia Tech, answers students' questions in online courses, often without them realizing they're talking to AI.

These virtual assistants help students stay on track, reducing the burden on human teachers.


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2.3 Automated Grading and Assessments Teachers spend a significant amount of time grading assignments and exams. AI is making this process faster and more efficient. Grade scope uses AI to assist with grading both multiple-choice and short-answer questions.

EdX's AI system helps evaluate written responses in online courses. AI-based grading allows teachers to focus more on engaging with students rather than spending hours correcting papers.

2.4 AI-Powered Chatbots and Student Support Students often have questions about coursework, deadlines, or university policies. AI-powered chatbots provide 24/7 assistance, answering common queries instantly. IBM Watson has been used to create AI-driven student support systems. Universities worldwide are implementing AI chatbots to assist students in administrative and academic matters.

2.5 Predicting Student Performance and Early InterventionAI helps schools and universities identify students who might be struggling so that teachers can step in before it's too late. Purdue University's Course Signals uses AI to analyze student behavior and predict who might be at risk of failing. Microsoft Education AI monitors student engagement and suggests ways to improve learning outcomes.

By analyzing attendance, participation, and test scores, AI helps educators offer targeted support, reducing dropout rates and improving student success.

2.6 AI in Language Learning

AI is also revolutionizing language learning by providing real-time feedback and pronunciation assessments. Duolingo's AI-powered lessons adjust based on user mistakes and progress. Google Translate helps break language barriers in classrooms with instant translations. For students learning a new language, AI makes the process more interactive and engaging.

2.7 Virtual and Augmented Reality in Learning

AI-powered Virtual Reality (VR) and Augmented Reality (AR) create immersive learning experiences. Google Expeditions allows students to take virtual field trips to historical sites. zSpace provides interactive AR lessons in STEM subjects. These technologies make learning more engaging and hands-on, particularly for complex subjects like science and engineering.

3. AI IN EDUCATION AROUND THE WORLD

Different countries are using AI in education in various ways, depending on their resources and priorities.

3.1 AI in Developed Countries

United States: AI-powered tools like IBM Watson and Google Classroom are widely used in schools and universities. The U.S. leads in AI research and EdTech innovation.

Europe: The European Union promotes AI-driven education through initiatives like AI4Education. Countries like the UK, Germany, and France are integrating AI into their national education systems.

China: The Chinese government is heavily investing in AI-powered smart classrooms. Companies like Squirrel AI are leading AI-driven personalized learning.

3.2 AI in Developing Countries


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India: AI-driven platforms like Byju's are making personalized education accessible to millions of students. The National Education Policy (NEP) 2020 emphasizes AI integration.

Africa: AI adoption is slower due to infrastructure challenges, but tools like M-Shule in Kenya are using AI to improve education in remote areas.

Latin America: Countries like Brazil and Mexico are using AI-powered chatbots and virtual tutors to support students, especially in rural areas.

4. THE BENEFITS OF AI IN EDUCATION

AI is making education more efficient, personalized, and accessible. Key benefits include:

Customized Learning: AI tailors lessons to each student's needs, improving engagement and comprehension.

Less Work for Teachers: Automated grading and AI tutors help educators focus more on teaching and mentoring.

Better Accessibility: AI-driven tools assist students with disabilities through speech-to-text, text-to-speech, and real-time translation.

Data-Driven Decision-Making: AI helps educators predict student performance and intervene early.

Global Learning Opportunities: AI-powered online education allows students to learn from anywhere in the world.

5. CHALLENGES AND ETHICAL CONCERNS

Despite its advantages, AI in education comes with challenges:

Privacy and Data Security: AI collects large amounts of student data, raising concerns about how it is stored and used.

Unequal Access to AI Tools: Not all schools have the infrastructure to support AI-driven education, creating a digital divide.

Teacher Training: Many educators are not trained in AI-based teaching methods, slowing adoption.

Bias in AI Algorithms: AI systems can reflect biases, leading to unfair treatment of students.

To ensure AI benefits all students, these challenges must be addressed through thoughtful policies and ethical AI development.

6. FUTURE TRENDS IN AI AND EDUCATION

Looking ahead, AI in education is expected to evolve in exciting ways: Emotionally Intelligent AI: Future AI tutors will understand student emotions and adapt their teaching accordingly. Blockchain for Secure Student Records: AI and blockchain will ensure tamper-proof educational credentials.

AI-Driven Gamification: Game-based learning powered by AI will make learning more interactive.

AI-Powered Career Guidance: AI will help students choose careers based on their strengths and interests.

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7. CONCLUSION

AI is reshaping education, making learning more personalized, efficient, and accessible. While AI offers great potential, challenges like privacy, fairness, and accessibility must be addressed to ensure it benefits all learners. By combining AI with thoughtful policies and teacher training, we can create an education system that truly prepares students for the future.

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THE EVOLUTION OF ARTIFICIAL INTELLIGENCE IN INDIAN MARKETING: BALANCING PROFITABILITY AND EMPLOYABILITY

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ABSTRACT

Artificial Intelligence (AI) has become an integral part of how businesses operate, especially in marketing. In India, a country with a vast and diverse consumer base, AI has brought about significant changes. It has helped companies personalize customer interactions, predict market trends, and optimize advertising strategies, ultimately leading to better profitability. However, this comes with its share of challenges, particularly in terms of employability. While new job roles are emerging for skilled professionals, repetitive and low-skill jobs are gradually being replaced by machines. This paper delves into how AI has transformed the Indian marketing ecosystem, exploring its impact on profitability and employment, and suggesting strategies to address emerging challenges.

INTRODUCTION

The Indian marketing landscape has changed dramatically over the years, driven by rapid advancements in technology. Among these, AI has emerged as one of the most influential tools, reshaping how businesses approach customers and


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campaigns. India's large population, combined with its fast-growing digital economy, makes it a unique and dynamic market for AI innovation. From humble beginnings with basic data collection tools like Google Analytics, AI is now powering everything from chatbot customer service to complex predictive analytics. Companies like Flipkart, Paytm, and Zomato are prime examples of how businesses are leveraging AI to stay competitive. However, the increasing reliance on AI also raises important questions about its impact on jobs and skills. While it opens new avenues for skilled workers, it leaves many low-skill roles vulnerable to automation.

This paper explores AI's journey in Indian marketing, focusing on how it has enhanced profitability and discussing its effects on employment. It also offers recommendations on how India can strike a balance between leveraging AI's benefits and addressing its challenges.

THE EVOLUTION OF AI IN INDIAN MARKETING

How It Started

India's adoption of AI in marketing started gaining momentum in the early 2010s, during the digital transformation boom. Initially, companies used AI primarily for data analysis, helping them understand consumer behavior and segment their audiences. Tools like Google Ads and Facebook's advertising platform introduced marketers to the possibilities of AI-driven targeting. As AI technologies evolved, Indian businesses began using more sophisticated tools like machine learning algorithms and natural language processing (NLP). This allowed companies to not only understand their customers better but also predict what they might need or want in the future.

Where We Are Now

Today, AI has become an integral part of the marketing strategies of Indian businesses, regardless of their size. Companies use AI for various purposes, including:

1. **Personalization:** Platforms like Amazon India and Flipkart recommend products based on a customer's browsing history and preferences.
2. **Chatbots:** Virtual assistants powered by AI, such as those used by HDFC Bank and Tata Motors, provide instant support to customers.
3. **Targeted Advertising:** AI tools analyze user data to deliver ads tailored to specific audiences, increasing conversion rates.
4. **Predictive Analytics:** AI models predict trends, allowing businesses to prepare for shifts in customer demand or market conditions.
5. **Voice and Visual Search:** Features like Google Lens and voice commerce are growing rapidly, driven by AI technologies.

THE FUTURE OF AI IN MARKETING

Looking ahead, the integration of AI with augmented reality (AR), virtual reality (VR), and blockchain will likely redefine marketing strategies. For instance, AR and VR could create more immersive shopping experiences, while


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blockchain could improve data transparency in advertising. By 2030, the AI market in India is expected to reach $20 billion, with marketing playing a significant role in this growth.

AI'S IMPACT ON PROFITABILITY IN MARKETING

Cutting Costs and Boosting Efficiency

One of AI's biggest contributions is its ability to streamline processes and cut costs. By automating repetitive tasks like data entry and customer segmentation, businesses save both time and money. For example, PolicyBazaar, a popular Indian insurance platform, uses AI chatbots to manage customer inquiries, which has reduced their operational costs by 40%. AI has also revolutionized inventory management. Retailers are using predictive analytics to optimize stock levels, leading to a 10-15% reduction in waste. These savings directly contribute to higher profitability.

Improving Revenue with Customer Insights

AI gives businesses the ability to deeply understand customer behavior and preferences. This leads to better-targeted marketing campaigns, which in turn drives sales. Research by Deloitte in 2022 revealed that Indian businesses using predictive analytics saw a 25% increase in revenue compared to those using traditional methods. E-commerce platforms are among the biggest beneficiaries. Amazon India, for instance, credits AI-driven recommendations for 35% of its sales. Myntra, another leading e-commerce player, uses AI to analyze fashion trends, helping them stay ahead of the competition.

Increasing ROI on Advertising

AI has also made advertising smarter and more efficient. Programmatic advertising—where AI bids for ad placements in real-time—ensures that businesses reach the right audience at the right time. According to PwC India, companies using programmatic advertising have seen a 20-50% improvement in their marketing ROI.

A notable example is HDFC Bank, which used AI-driven ad campaigns to target specific customer segments. The campaign led to a 22% increase in credit card applications within just three months.

AI'S IMPACT ON EMPLOYABILITY IN MARKETING

Creating High-Skill Jobs

AI adoption has led to a surge in demand for roles such as data scientists, machine learning engineers, and digital marketing specialists. According to LinkedIn, AI-related job postings in India grew by 35% between 2020 and 2023. Companies are also investing in training programs to equip employees with the skills needed to work alongside AI tools.

Replacing Repetitive Roles

On the flip side, AI has begun to replace jobs that involve repetitive tasks. Telemarketing, basic customer service, and data entry are among the roles most affected. A report by NASSCOM estimates that 1.5 million jobs in India could be automated by 2030, with the marketing sector being significantly impacted.

Reskilling as a Solution

To address this, both the government and private companies are focusing on reskilling initiatives. For example, TCS has trained over 100,000 employees in AI and digital technologies through its "Digital Reimagination" program. These efforts aim to prepare workers for the new types of jobs emerging in an AI-driven economy.

Case Study: Zomato


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Zomato is a prime example of how AI impacts employment. The company uses AI to optimize delivery routes and predict customer demand, making its operations more efficient. While this has reduced costs and improved profitability, it has also led to fewer customer service roles, as much of the interaction is now handled by AI chatbots.

CHALLENGES OF AI IN INDIAN MARKETING

Data Privacy Concerns

AI relies heavily on consumer data, raising concerns about privacy. With regulations like the Personal Data Protection Bill still under review, many companies struggle to strike the right balance between personalization and data security.

Bias in AI Algorithms

AI systems are only as good as the data they're trained on. If this data is biased, it can lead to discriminatory marketing practices. For example, an algorithm trained on urban consumer data might ignore rural audiences, leading to unequal access to products and services.

High Implementation Costs

Adopting AI technologies can be expensive, particularly for small and medium enterprises (SMEs). While large corporations can afford to invest in advanced tools, SMEs often find it challenging to keep up, widening the gap between big players and smaller businesses.

RECOMMENDATIONS

1. **Make AI Accessible to SMEs :** The government should provide subsidies or grants to help SMEs adopt AI technologies. Public-private partnerships could also play a key role in making AI more affordable.
2. **Invest in Workforce Training :** Companies and educational institutions should collaborate to create affordable training programs in AI-related skills. Platforms like Coursera and upgrad are already offering AI courses, but more localized efforts are needed to reach workers across India.
3. **Promote Ethical AI Practices :** Businesses must prioritize transparency and fairness in their AI systems. Regular audits can help identify and address biases in algorithms, ensuring they serve diverse audiences.
4. **Strengthen Regulations :** The government should expedite the implementation of data protection laws and provide clear guidelines on ethical AI usage in marketing.

CONCLUSION

AI has undeniably transformed the marketing landscape in India, offering businesses the tools to improve efficiency, personalize customer interactions, and boost profitability. However, it also presents challenges, particularly in terms of employment and ethics. To fully harness the potential of AI while minimizing its drawbacks, India must focus on inclusive adoption, workforce development, and robust regulations. By doing so, the country can create a marketing ecosystem that is not only innovative and profitable but also equitable and sustainable.

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THE FUTURE OF AI IN HUMAN RESOURCE MANAGEMENT: TRENDS AND INNOVATIONS

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ABSTRACT

Artificial Intelligence (AI) is reshaping the landscape of Human Resource Management (HRM), offering automation, enhanced decision-making, and efficiency. This research paper explores emerging trends and innovations in AI-driven HRM, highlighting its potential, challenges, and ethical concerns. By analyzing existing literature, we provide insights into how AI is transforming talent acquisition, employee engagement, performance evaluation, and workforce planning.

Keywords: *Artificial Intelligence, Human Resource Management, workforce planning*

I. INTRODUCTION

The advent of AI in HRM has revolutionized traditional processes, improving efficiency, personalization, and accuracy. Organizations increasingly leverage AI-powered tools for recruitment, employee management, and predictive analytics. This paper investigates the current applications, future trends, and potential challenges of AI in HRM. The study further explores how AI is redefining workforce management strategies and how businesses can integrate AI technologies responsibly.

II. LITERATURE REVIEW

Several studies have explored AI's impact on HRM, emphasizing automation and data-driven decision-making.

Recruitment and Talent Acquisition

AI-driven applicant tracking systems (ATS) enhance candidate screening and predictive hiring. According to Bersin (2019), AI algorithms analyze candidate resumes, match job descriptions, and rank applicants based on their qualifications. AI-based hiring platforms like HireVue and Pymetrics use machine learning to assess soft skills and cultural fit. Additionally, chatbots assist in initial interviews, streamlining recruitment processes (Deloitte, 2020).

Employee Engagement

AI-powered chatbots and virtual assistants improve employee experience by providing instant HR support. Digital HR assistants handle routine queries, payroll issues, and benefits administration. AI-driven engagement platforms analyze employee feedback and sentiment, predicting job satisfaction and potential attrition rates (Gartner, 2021). Furthermore, AI-driven recognition programs improve employee motivation by tracking achievements and providing personalized incentives.

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Performance Management

Machine learning models analyze performance metrics, providing data-backed insights for employee development. AI helps HR managers identify skill gaps and recommend personalized training programs. According to Gartner (2021), AI tools in HR help managers give data-driven performance feedback, improving objectivity and reducing biases. Performance evaluation systems leverage AI-driven predictive analytics to assess productivity trends and potential leadership candidates.

Bias and Ethical Concerns

While AI optimizes HR processes, studies highlight potential biases in algorithms and the need for ethical AI practices. MIT Sloan (2022) emphasizes the risk of AI systems inheriting biases from historical data, leading to unfair hiring decisions. AI bias mitigation strategies, such as transparent AI models and regular audits, are crucial for ethical HRM applications.

III. AI-DRIVEN HR TRENDS AND INNOVATIONS

AI-driven HRM is evolving with several cutting-edge innovations. Below are key trends shaping the future of AI in HRM:

AI-Powered Recruitment

AI tools streamline talent acquisition through predictive analytics and automated screening. AI-based hiring platforms analyze thousands of resumes within seconds, significantly reducing recruitment time. Additionally, AI-powered video interview platforms assess facial expressions, voice tone, and body language to evaluate candidates beyond traditional methods.

Chatbots and Virtual Assistants

HR chatbots enhance employee support, reducing the workload on HR personnel. AI chatbots handle repetitive tasks like leave applications, policy queries, and payroll information. Advanced conversational AI tools also facilitate onboarding processes, offering step-by-step guidance to new hires.

AI-Based Performance Analysis

Machine learning algorithms analyze workforce productivity, assisting in performance evaluation. AI-driven analytics tools track key performance indicators (KPIs) in real time, allowing HR managers to make informed decisions. Personalized feedback systems driven by AI enhance employee development by recommending skill improvement strategies.

Workforce Analytics and Predictive Planning

AI helps forecast workforce trends, aiding strategic decision-making. AI-powered HR analytics predict attrition rates, workforce demand, and skills shortages, enabling proactive HR planning. AI-based simulations provide HR departments with various workforce planning scenarios, optimizing organizational efficiency.

Employee Well-being and Sentiment Analysis


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AI detects employee emotions through natural language processing (NLP), improving job satisfaction and retention. Sentiment analysis tools monitor internal communication channels and employee feedback to gauge workplace morale. AI-driven mental health monitoring systems assess stress levels, providing HR managers with insights to improve employee well-being initiatives.

AI in Learning and Development

Personalized learning platforms use AI to recommend training programs tailored to employee needs. AI-driven Learning Management Systems (LMS) analyze individual learning patterns and offer customized courses, improving knowledge retention. AI-enhanced training tools include virtual reality (VR) and augmented reality (AR) simulations, providing immersive learning experiences.

IV. CHALLENGES AND ETHICAL CONSIDERATIONS

Despite its benefits, AI in HRM presents several challenges:

Bias in AI Algorithms

AI may inherit biases from historical data, leading to unfair hiring decisions. A biased AI system may prioritize certain demographics over others, affecting diversity and inclusion efforts. Organizations must implement bias mitigation techniques, such as diverse training datasets and periodic audits, to ensure fairness in AI-driven HRM.

Privacy and Data Security

Employee data protection is a critical concern. AI-powered HR systems collect vast amounts of sensitive employee data, raising privacy risks. Companies must comply with data protection laws, such as GDPR and CCPA, to safeguard employee information. Encrypting AI-powered HR databases and implementing stringent access controls help mitigate data breaches.

Job Displacement Fears

Automation may lead to workforce displacement, necessitating reskilling initiatives. As AI automates repetitive HR tasks, some roles may become redundant. However, AI also creates new job opportunities, requiring employees to upskill in AI literacy, data analysis, and digital transformation.

Regulatory Compliance

Organizations must adhere to evolving AI governance and labor laws. AI regulations continue to evolve, necessitating compliance with employment laws and AI ethics guidelines. HR professionals must stay informed about AI-related legal frameworks and implement transparent AI models to maintain compliance.

V. FUTURE PROSPECTS OF AI IN HRM

The future of AI in HRM presents vast opportunities for enhanced workforce management. Several developments are expected to shape HRM over the next decade:

1. **Hyper-Personalized Employee Experience**: AI-driven HR platforms will offer highly personalized career development plans, aligning with individual employee aspirations and organizational goals.
2. **AI-Driven Diversity and Inclusion Initiatives**: AI will play a crucial role in eliminating biases in hiring and promotion, ensuring fair opportunities for all employees.

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3. **Blockchain-Integrated HR Systems**: Blockchain technology will enhance HR data security and transparency, reducing fraudulent activities and improving background verification processes.
4. **AI-Powered Workplace Automation**: AI-driven robotic process automation (RPA) will automate complex HR functions, improving operational efficiency.
5. **AI and Emotional Intelligence**: Future AI systems will integrate emotional intelligence, enabling HR tools to better understand and respond to human emotions.

VI. CONCLUSION

AI in HRM is a transformative force, offering enhanced efficiency and strategic decision-making. While promising, ethical considerations and biases require careful management. Future research should explore AI's long-term impact on workforce dynamics and policy frameworks. HR professionals must proactively adopt AI while maintaining transparency, fairness, and compliance with ethical standards. As AI continues to evolve, organizations must balance automation with human-centric HRM strategies to foster an inclusive, productive, and innovative workforce.

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3D Augmented Reality for Teaching Gurmukhi Script: A New Dimension in Punjabi Language Learning

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ABSTRACT

This research paper explores the integration of 3D Augmented Reality (AR) technology in teaching the Gurmukhi script, offering an innovative approach to Punjabi language learning. The study examines how AR can enhance engagement, retention, and comprehension among learners by providing an interactive and immersive educational experience. The research outlines the development of an AR-based learning application, its pedagogical benefits, and its potential impact on language acquisition.

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Keywords: *3D Augmented Reality, Gurmukhi Script, Punjabi Language Learning, Immersive Education, Educational Technology*

1. INTRODUCTION

The evolution of digital learning technologies has transformed traditional education systems, offering innovative solutions to enhance student engagement and comprehension. One such advancement is Augmented Reality (AR), which blends the digital and physical worlds to create immersive learning experiences. Language learning, especially scripts with unique characters like Gurmukhi, presents challenges in terms of memorization, pronunciation, and writing. Traditional methods often rely on repetitive exercises and passive learning, which may not be effective for all learners. The Gurmukhi script, the writing system for the Punjabi language, consists of 45 distinct characters, including vowels and consonants. For beginners, understanding the stroke sequence, pronunciation, and structure of these characters can be difficult. Integrating 3D Augmented Reality into language learning introduces an interactive approach where learners can visualize, manipulate, and engage with Gurmukhi characters in a dynamic environment.

This paper explores the development of an AR-based learning application for teaching the Gurmukhi script using tools such as A-Frame for AR programming, Blender for 3D modeling, and Glitch for hosting. The application provides real-time 3D visualizations, phonetic pronunciation, and interactive writing exercises, making script learning more engaging and effective. By leveraging AR's immersive capabilities, the proposed system aims to enhance retention, engagement, and comprehension in Punjabi language learners. This research investigates the pedagogical benefits of AR-enhanced script learning, compares it with traditional methods, and presents findings from an experimental study involving learners of different age groups.

This study contributes to educational technology by demonstrating how AR can revolutionize language learning and provide a new dimension in Punjabi literacy education.

2. LITERATURE REVIEW

Previous studies have highlighted the effectiveness of AR in education, particularly in language learning. Research suggests that AR-based applications improve cognitive engagement, facilitate visual learning, and offer personalized learning experiences. Studies in other language scripts, such as Mandarin and Arabic, demonstrate the positive impact of AR in enhancing script recognition and retention. However, limited research exists on using AR for Gurmukhi script learning, necessitating further exploration.

3. METHODOLOGY

The study adopts a mixed-methods approach, incorporating both qualitative and quantitative analysis. A prototype AR application was developed that allows learners to visualize and interact with 3D representations of Gurmukhi letters. Participants included students of various age groups, and data was collected through surveys, observations, and pre/post-tests to evaluate learning outcomes.

4. DEVELOPMENT OF THE AR LEARNING APPLICATION

The AR application was designed using A-Frame, an open-source web framework for building AR and VR experiences. Key features include:

- **3D Visualizations:** Animated representations of all 45 distinct Gurmukhi characters with phonetic pronunciations.
- **Interactive Elements:** Users can manipulate letters, view stroke orders, and practice writing in real time.

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- **Web-Based Accessibility:** The application runs in web browsers, eliminating the need for high-end devices.
- **Gamification:** Incorporating quizzes, challenges, and rewards to encourage active participation.
- **Multimodal Learning:** Integration of auditory, visual, and kinesthetic learning styles for improved comprehension.

A-Frame was chosen for its ease of development and compatibility with WebXR, allowing users to experience AR directly from their mobile devices without additional installations. The application was developed using HTML, JavaScript, and A-Frame components, enabling seamless rendering of 3D Gurmukhi letters and real-time interaction.

5. AUGMENTED ARCHITECTURE DESIGN

The augmented reality architecture for the Gurmukhi learning application is designed to provide an interactive and immersive experience. In Figure 1 represents the **Augmented Reality (AR) Learning System Architecture** for teaching the Gurmukhi script.

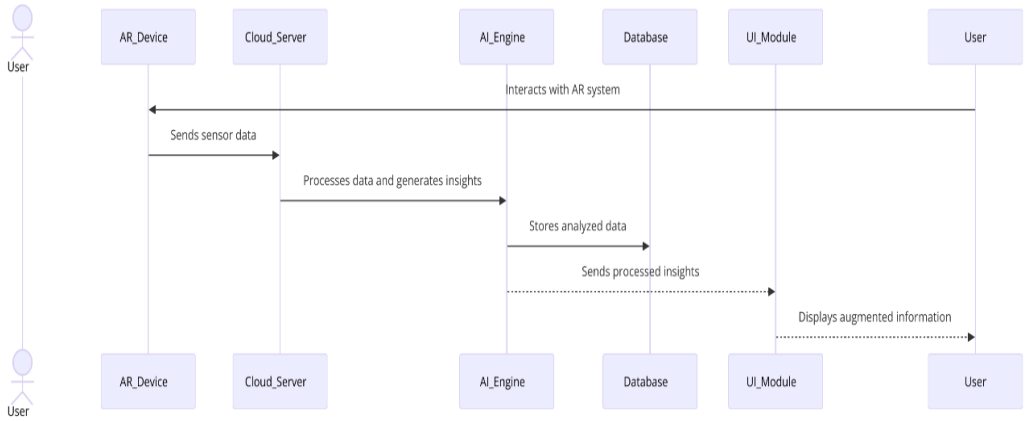

Figure 1: **Sequence Diagram of Augmented Reality (AR) Learning System**

The architecture consists of the following components:

COMPONENTS OF THE AR LEARNING ARCHITECTURE

User

- The learner interacts with the AR-based application using an AR-supported device such as a smart phone, tablet, or AR headset.
- The user inputs gestures, selects letters, or follows visual cues to learn the Gurmukhi script.

AR Device

- The AR device captures user input (such as gestures, interactions, or camera feed).
- Sends sensor data (such as touch gestures or motion tracking) to the **Cloud Server** for processing.

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Cloud Server

- Acts as a middleware between the AR device and other processing components.
- Processes user interactions and transmits data to the **AI Engine** for further analysis.
- Ensures smooth data transmission and connectivity in real time.

AI Engine

- Enhances the AR experience by analyzing data from the AR device.
- Processes interactions and provides feedback to the user.
- It may include machine learning-based personalization, pronunciation feedback, or handwriting recognition for Gurmukhi script learning.

Database

- Stores structured data, including user progress, Gurmukhi characters, animations, and learning analytics.
- It also holds AI-generated insights and analyzed data.
- Ensures the persistence of learning records, so users can resume their learning journey.

UI Module

- The interface that displays AR-based educational content.
- Retrieves analyzed data from the AI Engine and Database to show enhanced 3D models of Gurmukhi letters.
- Provides an interactive and immersive learning environment.

Final User Interaction

- The processed insights and augmented visuals are displayed on the AR device.
- The user sees interactive Gurmukhi letters in AR space, improving their learning experience through real-time feedback.

This architecture ensures a **real-time, interactive, and personalized AR learning experience** for Gurmukhi script learners.

6. TOOLS USED

- **A-Frame:** A-Frame is an open-source web framework for creating immersive AR and VR experiences. It simplifies AR development using HTML-based markup, making it accessible to developers with minimal programming experience. It is built on top of Three.js, a powerful 3D JavaScript library, allowing for the creation of interactive 3D environments. A-Frame enables cross-platform AR accessibility, meaning users can interact with AR elements directly through web browsers without requiring external applications. Its component-based architecture makes it easy to integrate animations, interactions, and real-time manipulations, making it ideal for educational applications.

- **Blender:** Blender is a powerful open-source 3D modeling tool used for creating high-quality 3D assets. It supports modeling, texturing, animation, and rendering, making it a comprehensive tool for designing Gurmukhi letters in 3D. With features like sculpting, rigging, and physics simulations, Blender enables the creation of realistic and interactive 3D elements for AR applications. Its compatibility with formats like GLTF and OBJ ensures seamless integration with A-Frame and other AR development platforms.

- **Glitch:** Glitch is an online platform that provides an easy-to-use environment for coding, hosting, and sharing web-based applications. It supports live collaboration, enabling developers to code and test applications in real time. Hosting the AR learning application on Glitch ensures accessibility to users without requiring local installations or additional hosting services. The platform also offers debugging tools, version control, and a community-driven approach, making it an effective choice for deploying web-based AR experiences.

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7. RESULTS AND DISCUSSION

The findings indicate that students using the AR application demonstrated higher engagement and retention rates compared to traditional learning methods. Surveys revealed increased motivation and confidence among learners, and pre/post-test results showed significant improvement in script recognition and writing skills. Challenges such as device compatibility and initial learning curves were also noted.

8. CONCLUSION AND FUTURE WORK

The study confirms the potential of AR in revolutionizing Punjabi language learning by making the Gurmukhi script more accessible and engaging. Future work includes expanding the application's features, integrating AI-based personalized learning, and conducting longitudinal studies to measure long-term retention.

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PRECISION AGRICULTURE: AI & ROBOTICS FOR SUSTAINABLE, DATA-DRIVEN FARMING

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ABSTRACT

Precision agriculture (PA) integrates artificial intelligence (AI) and robotics to empower farmers with data-driven insights, enhancing field management and promoting sustainable farming practices. By utilizing data collected from drones, sensors, satellites, and weather stations, farmers can gain in-depth knowledge about their crops' health, nutritional needs, and environmental conditions. This enables precise decision-making in irrigation, fertilization, and pest control, leading to reduced resource waste and minimal environmental impact. AI-powered analysis facilitates early detection of diseases and nutrient deficiencies**,** allowing for timely interventions and reducing dependence on chemical treatments. This proactive approach ensures healthier crops while promoting eco-friendly farming**.** Additionally, advanced precision technologies contribute to efficient water management, optimizing irrigation based on real-time soil moisture data. By applying water only where needed, farmers can conserve resources and improve sustainability. The implementation of AI and robotics in agriculture also helps minimize costs, increase yields and address challenges such as rising food demand and limited arable land**.** These technologies enable the analysis of vast agricultural datasets, refining resource allocation strategies and maximizing productivity. This mini-review explores how AI and robotics are transforming precision agriculture**,** highlighting their advantages, including higher crop yields, improved resource efficiency, and reduced environmental footprint. However, the adoption of these technologies also presents challenges, such as high initial costs, technological complexity, and data privacy concerns. While AI and robotics have the potential to revolutionize modern agriculture, overcoming these obstacles will be essential for achieving widespread implementation.

Keywords : *Precision Agriculture; Artificial Intelligence; Crop Management; Sustainable Farming; Remote Sensing.*

INTRODUCTION

The agricultural sector is undergoing a significant transformation, fueled by the rapid advancement and integration of Artificial Intelligence (AI). This shift, known as AI-driven precision agriculture, presents a revolutionary approach to tackling two critical global challenges: ensuring sufficient food production for a growing population and reducing the

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environmental impact of intensive farming practices. By utilizing cutting-edge technologies such as machine learning, computer vision, and robotics, precision agriculture optimizes crop production while minimizing resource consumption and environmental degradation. Unlike traditional farming, which often relies on uniform strategies, AI-powered agriculture offers customized solutions tailored to specific field conditions, crop requirements, and environmental variables. The application of AI in agriculture spans multiple areas, including predictive analytics for crop management, automated pest detection, and robotic harvesting. These innovations empower farmers with data-driven insights, allowing for more efficient utilization of essential resources such as water, fertilizers, and pesticides. For example, AI-powered irrigation systems can enhance water conservation by reducing consumption by up to 30%, all while maintaining ideal soil moisture levels-helping address water scarcity concerns in agriculture. Moreover, AI technologies are improving the accuracy and timeliness of critical farming operations. Advanced machine learning algorithms process vast datasets from sources such as satellite imagery, weather forecasts, and soil sensors to generate precise predictions regarding crop yields, potential disease outbreaks, and optimal planting and harvesting timelines[6]. The impact of AI in agriculture extends far beyond the boundaries of farms. By optimizing resource management and boosting productivity, these technologies contribute to global food security, reduce agriculture's environmental footprint, and foster more sustainable food systems. Additionally, the integration of AI is creating new employment opportunities in rural regions, including roles in agricultural data analysis and agri-tech development, potentially revitalizing local economies. However, transitioning to AI-powered precision agriculture comes with challenges. Concerns surrounding data privacy, disparities between large-scale and small holder farmers in accessing technology, and the significant initial investment required for infrastructure development must be addressed. Despite these obstacles, the potential advantages of AI in modern farming are too substantial to overlook. This review explores the role of these advanced technologies in addressing sustainability challenges within modern farming. The key objectives of this study are as follows:

1. AI-driven algorithms and robotic systems are utilized to gather field data, assess crop conditions, and automate essential farming operations.
2. The potential contributions of these technologies in boosting crop yields, minimizing environmental impact, and improving resource utilization.

CONCEPT OF PRECISION AGRICULTURE

Precision agriculture, also known as satellite farming or site-specific crop management (SSCM), brings together the advancements of the information technology era with the established agricultural sector. This comprehensive crop management system aims to align input types and quantities with the precise requirements of specific zones within a field. While the concept itself isn't novel, recent technological developments have made practical implementation of precision agriculture achievable. Consequently, embracing these emerging technologies is perceived as pivotal in enhancing future agricultural productivity. In contrast to the conventional practice of managing entire fields based on theoretical average conditions that rarely hold true across the entire area, the approach of precision farming acknowledges the unique variations present within fields. This strategy involves adapting management practices to account for these site-specific differences, thereby optimizing resource utilization. In the context of India, the prevalent technique for fertilizing soil is broadcasting, despite its inherent inefficiency in delivering nutrients to crops. Despite the availability of more effective management alternatives, this method remains popular, contributing to increased variability. Precision agriculture introduces a novel solution by adopting a comprehensive approach to address

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contemporary agricultural challenges. These challenges encompass the imperative to harmonize productivity goals with environmental considerations [5].

IMPORTANCE OF PRECISION AGRICULTURE

According to the United Nations' world population report, it is projected that the global population will reach 9.7 billion individuals by 2050, marking a significant increase of 34 percent compared to the present figure. Much of this expansion is anticipated to occur in developing nations such as China, India, Brazil, and others, which boast substantial arable land for agricultural use. In order to effectively provide for this growing population and address escalating income levels, a substantial 70 percent surge in global food production is necessary (United Nations Department of Economic and Social Affairs, 2022). This pivotal challenge necessitates the collection of real-time data, comprehensive analysis of agricultural processes, and a relentless commitment to enhancement. Therefore, the exploration of existing "precision agriculture" techniques and strategies, alongside the pursuit of innovative approaches, becomes paramount in optimizing food output, mitigating environmental impact, and managing costs, particularly in the current context

APPLICATIONS OF AI AND ROBOTICS IN PRECISION AGRICULTURE

The integration of Artificial Intelligence (AI) and robotics in precision agriculture (PA) has significantly transformed modern farming practices by enhancing efficiency, accuracy and sustainability. These technologies enable data-driven decision-making, automation of critical tasks, and optimization of resource utilization. The key applications of AI and robotics in precision agriculture include:

1. **Data Collection and Analysis**- AI-powered sensors, drones, and satellite imagery facilitate real-time data collection on soil health, crop conditions, and environmental factors. Machine learning algorithms analyze this data to provide actionable insights, enabling farmers to make informed decisions regarding irrigation, fertilization, and pest control.
2. **Automated Crop Monitoring and Disease Detection**- AI-driven computer vision and deep learning models help in early detection of plant diseases, nutrient deficiencies and pest infestations. By analyzing leaf patterns, color changes and growth anomalies, these systems allow timely interventions to prevent yield losses.
3. **Precision Irrigation and Water Management**- Robotics and AI optimize water usage through smart irrigation systems that adjust water supply based on soil moisture levels, weather conditions and crop requirements. This reduces water wastage while ensuring optimal hydration for crops.
4. **Autonomous Machinery and Smart Harvesting**- AI-integrated robotic systems, such as autonomous tractors, robotic harvesters, and drone sprayers, enhance efficiency in planting, weeding and harvesting. These machines reduce labor dependency and improve productivity by executing tasks with precision.
5. **Soil and Nutrient Management**- AI-powered predictive models analyze soil composition and nutrient levels, enabling precision fertilization. Robotics-assisted soil sampling and monitoring ensure that crops receive the necessary nutrients, thereby enhancing soil health and sustainability.
6. **Weed and Pest Control**- AI-driven robotics, combined with computer vision, can accurately detect and eliminate weeds using mechanical removal techniques or targeted pesticide application. This minimizes excessive chemical use and promotes eco-friendly farming practices.
7. **Yield Prediction and Farm Management Optimization**- AI models analyze historical and real-time data to predict crop yields, helping farmers plan harvest schedules, manage logistics, and optimize supply chain operations. These predictions improve overall farm management efficiency[4].

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The implementation of AI in precision agriculture not only enhances productivity but also contributes to environmental sustainability and cost reduction. However, challenges such as high initial investment, technical expertise requirements, and ethical concerns regarding automation need to be addressed for widespread adoption.

ROBOTICS IN PRECISION AGRICULTURE

Autonomous robots equipped with AI and computer vision perform essential agricultural tasks such as planting, weeding and harvesting. For instance:

- **Blue River Technology's *See & Spray*** uses machine learning to distinguish between crops and weeds, applying herbicides selectively and reducing chemical usage[1].
- **Ecorobotix's Autonomous Weeding Robot** targets weeds with pinpoint accuracy, lowering herbicide consumption by up to 95% [2].
- **Agrobot SW6010** is a robotic strawberry harvester that uses AI to detect fruit ripeness and automate harvesting, improving labor efficiency [3].

CHALLENGES AND CONSIDERATIONS IN AI ADOPTION FOR AGRICULTURE

Despite the numerous advantages of AI in agriculture, several challenges must be overcome to ensure its widespread implementation:

1. **Data Privacy and Security**- The extensive collection and utilization of farm data raise concerns regarding privacy and ownership. Research by the American Farm Bureau Federation indicates that 77% of farmers are apprehensive about data access and control. To address these concerns, robust data protection policies, such as the EU's Code of Conduct on Agricultural Data Sharing, are crucial for ensuring secure and ethical data management[8].
2. **Farmer Training and Technology Adoption-** Effective integration of AI technologies in agriculture requires specialized knowledge and skills. There is a growing need for educational initiatives that help farmers understand, trust, and utilize AI-driven systems. Recognizing this, the USDA's National Institute of Food and Agriculture (NIFA) is investing in AI literacy programs aimed at equipping farmers and agricultural professionals with the necessary expertise.
3. **High Initial Investment Costs**- The cost of implementing AI-powered systems can be a significant barrier, particularly for small and mid-sized farms. For example, setting up a comprehensive precision agriculture system may require an initial investment exceeding $50,000, making affordability a key concern for many farmers.
4. **Compatibility with Existing Systems**- The seamless integration of AI technologies with current farm equipment and management systems is essential for efficient adoption. Efforts such as those led by the Agricultural Data Coalition focus on establishing standardized data formats and system interfaces to enhance interoperability between AI solutions and traditional farming tools.

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ECONOMIC AND ENVIRONMENTAL IMPACT

Despite the challenges, an analysis of costs and benefits highlights the substantial long-term advantages of AI-driven precision agriculture:

- **Enhanced Profitability**- By optimizing resource utilization and maximizing crop yields, AI-powered technologies contribute to greater farm profitability. Research from the University of Nebraska-Lincoln indicates that the adoption of precision agriculture tools can lead to an increase in net returns of up to $66 per acre in corn production[7].
- **Enhanced Profitability**- AI-driven precision agriculture improves resource efficiency and crop yields, leading to higher profitability. Research from the University of Nebraska-Lincoln suggests that precision agriculture technologies can boost net returns by up to $66 per acre in corn production.
- **Environmental Sustainability**- AI-powered solutions contribute to more sustainable farming by reducing water and chemical usage. For instance, precision irrigation systems have demonstrated the ability to lower water consumption by up to 30% while maintaining or even improving crop yields, thereby addressing concerns related to water scarcity and environmental impact[9].
- **Improved Food Security**- Increased agricultural productivity and resource efficiency play a vital role in addressing global food demand. According to the Food and Agriculture Organization (FAO), agricultural production must rise by 70% by 2050 to sustain the growing global population. AI technologies are expected to be instrumental in achieving this goal by enhancing efficiency and reducing waste.
- **Rural Economic Development**- The implementation of AI-driven agricultural technologies is fostering new job opportunities and skill development in rural areas. A report by the World Economic Forum suggests that while some traditional farming jobs may be replaced by automation, new roles- such as agricultural data analysts, robotics technicians, and precision farming consultants- are emerging, contributing to economic growth

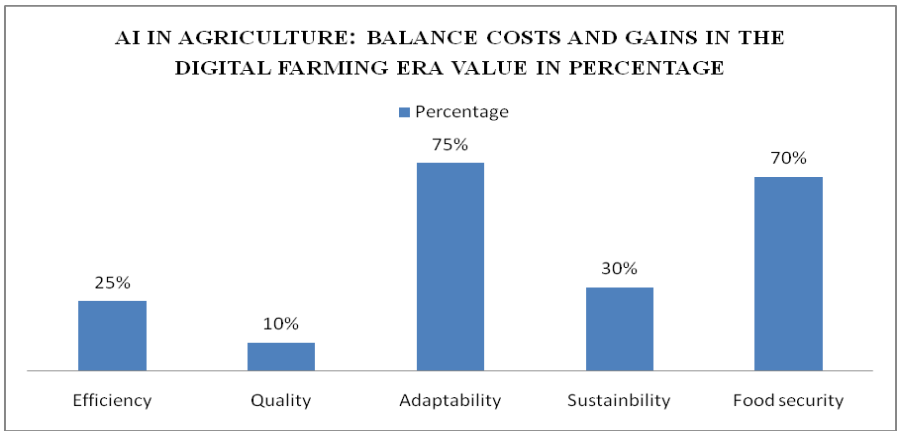

Fig 1: Quantifying the Challenges and Benefits of AI Adoption in Agriculture

While AI adoption in agriculture presents several challenges, its potential benefits in efficiency, sustainability, and economic development are substantial. Overcoming these obstacles will require collaboration between technology

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innovators, policymakers and farmers. By addressing issues such as cost, training and data privacy, AI-driven precision agriculture can revolutionize farming practices and contribute to a more sustainable and food-secure future.

FUTURE PROSPECTS AND POLICY RECOMMENDATIONS

The future of AI-driven precision agriculture lies in advancing automation, improving AI model accuracy, and enhancing accessibility for farmers of all scales[9]. To fully leverage these technologies, policymakers must focus on:

- **Developing Regulatory Frameworks:** Establishing guidelines for AI ethics, data privacy, and sustainable technology adoption in agriculture.
- **Investing in Digital Infrastructure:** Enhancing rural connectivity and providing AI literacy training programs to equip farmers with the necessary technical skills.
- **Encouraging Public-Private Partnerships:** Fostering collaboration between agricultural research institutions, AI developers, and farming communities to drive innovation and cost reduction.

CONCLUSION

AI-powered precision agriculture is revolutionizing modern farming by addressing critical challenges related to global food security and environmental sustainability. The integration of AI across multiple agricultural domains—such as predictive analytics, intelligent irrigation, automated pest management, and robotic harvesting-has led to significant advancements in efficiency, resource optimization, and crop productivity. These innovations not only enhance farm profitability but also support sustainable agricultural practices by minimizing water consumption and reducing chemical inputs. AI technologies continue to advance and become more widely accessible, they have the potential to transform the agricultural industry by fostering more efficient, sustainable, and high-yield farming systems on a global scale. The successful implementation of AI in agriculture will require continuous collaboration among technology developers, agricultural researchers, policymakers, and farmers to overcome existing challenges and maximize the potential of these emerging innovations. Ultimately, AI-driven precision agriculture serves as a vital tool for meeting the increasing global food demand while mitigating the environmental impact of farming, paving the way for a more sustainable and food-secure future.

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Calibration and Validation of DSSAT CERES Maize Model Under Different Environments for Amritsar

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Abstract

Maintain high agriculture production levels while reducing environmental impacts is of primordial importance in intensive irrigated areas. Adequate management of dates of sowing is critical for a sustainable agriculture. The objective of this work is to calibrate and validate DSSAT model for maize under different dates of sowings. The DSSAT CERES Maize v4.8.2 model was calibrated and validated with field data of two consecutive years *kharif* 2023 and 2024 at Guru Nanak Dev University, Amritsar under variable environmental conditions created by 20 May, 01 June and 10 June as dates of sowing. The genetic coefficients for cultivar PMH-13 of Maize were estimated. In case of CERES Maize model, higher R (0.77) was obtained between measured and simulated for days to physiological maturity and D-stat 0.85 whereas higher R (0.78) was obtained between measured and simulated for grain yield. The grain yield between measured and observed for all the parameters were below ±10 % error. The CERES Maizev4.8.2 could be used to predict the seed yield accurately under different environments. So validated CERES-Maize model can be used as a research tool under irrigated conditions to take strategic decision for improving maize production in Amritsar

Key words: DSSAT, Maize, Dates of sowing, Yield.

INTRODUCTION

Maize (*Zea mays* L.) is the world's leading crop and is widely cultivated as cereal grain that was domesticated in Central America. It is one of the most versatile emerging cereal crops, ranking third after rice and Maize and having wider adaptability. Globally, maize is known as Queen of Cereals because of its highest genetic yield potential. Maize is the only food cereal crop that can be grown in diverse seasons, ecologies and uses. It is cultivated on nearly 150m ha in about 160 countries having wider diversity of soil, climate, biodiversity and management practices that contributes 36% (782 m t) in the global grain production. Maize is cultivated throughout the year in all states for various purposes including grain, fodder, green cobs, sweet corn, baby corn, popcorn in peri urban areas. It is a good source of nutrition and as well as phytochemical compounds. Phytochemicals play an important role in preventing chronic diseases. It contains various major phytochemicals such as carotenoids, phenolic compounds and phytosterols. It is believed to have potential anti-HIV activity due to the presence of Galanthus Nivalis Agglutinin (GNA) lectin or GNA-maize[1].

Modelling is a useful approach to study climate change impact on agriculture. Crop growth models have been used to demonstrate the effect of plant genetics and agronomic management, as well as the interaction of these two entities with the environmental conditions [2]. Assessment of variability in climate would help in providing an important insight in decision making regarding the management of agricultural crops [3]. Crop simulation models have been used

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for many different applications in various countries around the world. Various modelling techniques help to determine the information about short-term and long-term management practices and production technologies for better crop production [4].

Crop models such as CERES-maize in DSSAT v4.5 has been extensively used worldwide to simulate maize growth and grain yield and as a tool for planning and decision making by farmers in several countries [5]. CSM-CERES-Maize is a mechanistic, dynamic and deterministic crop simulation model [6]. This model simulates complex management strategies for a wide range of weather and soil conditions and is able to analyze these strategies with environmental conditions. The model includes empirical equations for the major growth and development processes including, phenological development, canopy and vegetative expansion, organ formation, assimilate allocation and the dynamics of the soil and plant water and soil nitrogen dynamics on growth and yield [7]. Use of the CERES-maize model is a cost-effective methodology to examine the results of alternative crop management practices on agricultural production, estimate use efficiency of resources and asses the sustainability of cropping systems. It is the most widely used maize model and is a recognized reference for comparing new developments in maize growth, development and yield simulation [8]. So, the present study calibrates and validate the CSM-CERES Maize model for future use.

Methods and Materials

Experimental Site: The crop and weather data of Amritsar is located at latitude of 31°38'N and longitude of 74°52'E with an altitude of 234 m above mean sea level, in the Majha region of Punjab under Trans-Gangetic agroclimatic zone of India. The general climatic condition is classified as semi-arid with mean annual rainfall of about 681 mm, out of which 75% rainfall is received during monsoon (June to September). The summer temperature exceeds above 38°C and reaches up to 49°C during dry summer spell.

Crop Growth Model: A dynamic crop simulation model CERES-Maize[6] was selected for the study due to its capability to simulate daily crop growth, phenology, development and yield under diverse climatic and soil conditions with different agronomic managements. The model comprises six genetic coefficients (P1, P2, P5, G1, G2 and PHINT) for maize cultivars. There are six genetic coefficients in CERES-maize; degree days (base 8°C) from emergence to the end of the juvenile phase (P1), coefficient of photoperiod sensitivity (P2), from silking to physiological maturity in degree days (base 8°C) (P5), the number of potential kernels (G2), the rate of potential kernel growth mg/(kernel d)(G3), and PHINT, degree days it takes for a leaf tip to emerge (phyllochron interval) (°C d). The coefficients P1, P2, P5 and PHINT deal with vegetative growth and phenology of plant, whereas G1 and G2 describe grain number per cob and grain filling rate respectively.

Field experiment: The model was calibrated and validated using data from field experiment comprising three sowing dates (20thMay, 1st June and 10th June), of maize cultivar PMH 13. The experiment was conducted at Research farm, Department of Agriculture, Guru Nanak Dev University, Amritsar during *kharif* 2023 and 2024.

RESULTS

Modelling Phenology and Grain Yield of Maize

In the present simulation study the CERES-Maize model for Maize crop was used. The model was calibrated and validated for evaluating the effect of changes in temperature, solar radiation and their interactions during different growth

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periods of Maize crop. For this the model was calibrated after conducting the sensitivity analysis using the actual crop data collected during *kharif* 2023 and later validated by comparing with actual crop data collected during *kharif 2024*. The results are given as under:

Sensitivity Analysis of CERES-Maize and Info Crop-Maize models

The sensitivity analysis was performed for seven cultivar specific coefficient (P1, P2, P5, G2, G3 and PHINT) which control the phenological development and yield of the maize crop by changing (increasing or decreasing) their values to determine their effect on the grain yield. The data presented in Table 2 indicates the sensitivity of model to these genetic coefficients of CERES-Maize model,

In CERES-Maize model the genetic coefficient P1, P2, P5 primarily govern the phenology while the G2, G3 and PHINT govern the yield and yield attributes of the maize crop.

Calibration of CERES-Maize Model

Crop simulation models need some calibration before they can be used in an area other than they were originally develop, especially when the model is to be used to predict future climate changes scenarios. The CERES-Maize model was calibrated for the maize crop cultivar i.e. PMH-13 for three dates of sowing. The model simulated and field observed values of anthesis and physiological maturity dates, grain yield was tabulated and difference between two values were compared. CERES-Maize requires a set of seven genetic coefficients for simulation of phenology, growth and grain yield of cultivar. Since such data were not available, the genoypic coefficients of PMH-13 was estimated by repeated iterations until a close match between simulated and observed phenology, growth and yield was obtained. The value of each genetic coefficient which minimized the difference between the observed and simulated values were selected for using in the model separately for the cultivar. The calibrated values of genetic coefficient for maize cutivars have been given in Table 1 using CERES-Maize model.

Validation of CERES-Maize Model

The validation describe the comparison of CERES-Maize model simulated parameters with actual observations for growth development and yield of maize cultivars. The validation of CERES-Maize model were done using the actual crop data observed during the *kharif*2024. The statistical comparison of the observed and simulated results of the phenological events and yield of maize cutivar PMH-13 sown under three dates of sowing for one crop years are given in Table 2.

CERES-Maize Model

The simulation results (1:1 line graph) for the grain yield predicted by CERES-Maize model and actual yield of the maize cultivar PMH-13 under different sowing dates has been given in the Fig 1. The coefficient of determination (R^2) 0.78, d stat 0.85 and RMSE between the simulated and observed grain yield for the maize was 385.2 kg/ha. All these statistical tools indicate that the CERES-Maize model was validated with a good degree of accuracy and hence can be used to work out simulation guided management practices for yield maximization of maize under climate change conditions [9]. The linear regression model between observed and simulated grain yield could account for 62% variations. Out of 12 environments, CERES-Maize model overestimated and underestimated for grain yield for 11 and1 environments, respectively.

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Table 1: Genetic coefficients of Maize cultivars used for CERES-Maize model

Genetic coefficients		Values
P1 (°C d)	Thermal time from seedling emergence to the end of the juvenile phase (expressed in growing degree daysabove a base temperature of 8 °C) during which plant is not responsive to changes in photoperiod	312
P2 (d)	Extent to which development (expressed as days) is delayed for each hour increase in photoperiod at whichdevelopment proceeds at a maximum rate (which is considered to be 12.5 hours)	0.3
P5 (°C d)	Thermal time from silking to physiological maturity (expressed in degree days above a base temperature of 8 °C)	690
G2 (kernels/	Maximum possible number of kernels per plant	1150

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plant)		
G3 (mg day^{-1}).	Kernel filling rate during the linear grain filling stage under optimum conditions (mg day^{-1}).	25.0
PHINT	Phyllochron interval): The interval in thermal time (degree days) between successive leaf tip appearances	40

Table 2: Sensitivity analysis results for the genetic coefficients of CERES-Maize model

Sr. No	Genetic coefficients	Range	Anthesis	Physiological maturity	Grain yield(kg/ha)
		325	53	86	4772
1.	P1	310*	52	84	4750
		295	51	84	4710
		0.4	54	85	4890
2.	P1D	0.3*	52	84	4750
		0.2	51	83	4621
		710	53	84	4845
3.	P5	690*	52	84	4750
		670	50	84	4735
		1250	53	84	4982
4.	G2	1180*	52	84	4750
		1100	52	84	4678
		30.0	52	84	5462
5.	G3	25.0*	52	84	4750
		20.0	51	84	4715
		40.0	52	85	4836
6.	PHINT	35.0*	52	84	4750

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	30.0	51	80	4520

* Preferred value of genetic coefficient

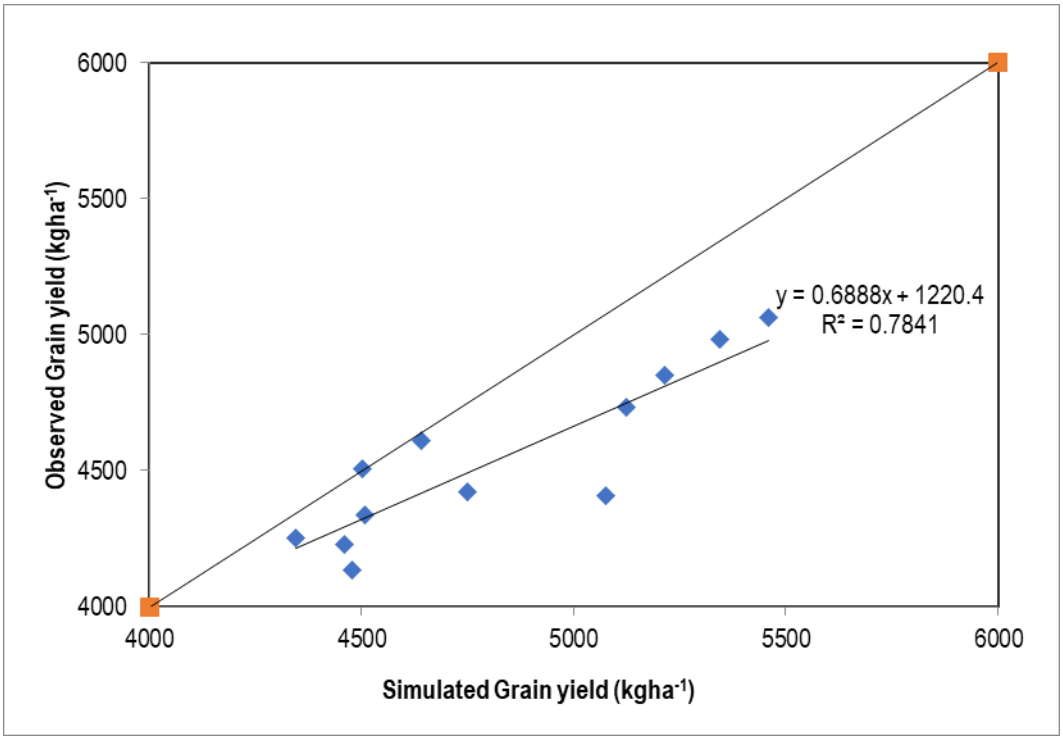

Fig.1: Comparison of simulated and observed grain yield (kg/ha) for maize cutivar PMH-13 using CERES-Maize during, *kharif*2024

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ARTIFICIAL INTELLIGENCE (AI) AND FUTURE OF NEW EDUCATION POLICY (NEP) 2020

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ABSTRACT

In the era of space age, Ballistic Missile technology, nuclear silence and Information Communication Technology (ICT), Artificial Intelligence (AI) is today coming as more ambitious field where man wants to create new dimensions to solve new challenges. Though AI is not a new field but with the advent of ICT and advancement in electronics and computer science revolutionize the whole system of creativeness and educational system.

The National Education Policy (NEP) 2020 marks a transformative shift in India's educational framework**,** aiming to address the challenges of the 21st century. The National Education Policy exemplifies a pivotal transformative initiative aimed at revolutionizing higher education in India by adopting a more inclusive, multidisciplinary, and flexible educational environment.

The ground breaking policy aspires to cultivate an education system that is vibrant, equitable, and inclusive, nurturing critical thinking, creativity, and responsible global citizenship. By concentrating on crucial areas such as early childhood education, primary and secondary education, higher education, vocational training and skill development, the NEP 2020 aims to equip Indian students with the knowledge, skills and values essential for thriving in the 21st century. In India Artificial Intelligence is a trending field with a lot of potential for education, industry and social sector.

In India, the National Education Policy (NEP) 2020 marks a significant turning point for higher education, fore grounding a holistic approach aimed at fostering multidisciplinary learning and innovation. Skills and education are the

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bedrock of success. When integrated effectively they can revolutionize the Indian education system, preparing a workforce ready for future and positioning Indian as a global ladder in skills.

The New Education Policy (2020) represents a landmark in India' educational evolution, harmonizing formal education with vocational training.

Keywords: Artificial Intelligence, NEP 2020, Ethics and Skill Development.

INTRODUCTION

Artificial intelligence (AI) various definitions; some call it as the created technology that allows computers and different machines to function intelligently. Some see it as the machine that replaces human labor to work for men a more effective and speedier result. Others see it as "a system" with the ability to correctly interpret external data, to learn from such data, and to use those learnings to achieve specific goals and tasks through flexible adaptation.

No doubt, AI is associated with machines and computers to help humankind solve problems and facilitate working processes. In short, it is an intelligence designed by humans and demonstrated by machines. The term AI is used to describe these functions of human-made tool that emulates the "cognitive" abilities of the natural intelligence of human minds. AI is transforming modern society by automating tasks, enhancing decision-making, improving efficiency, and driving innovation across various sectors, from healthcare and transportation to business and education.

Today Artificial intelligence (AI) has become a part of our daily lives. It has tremendously transformed our life. Beginning from the smart phones, health sector, business and education, all these sectors have been altogether changed. It helps us answer common question of daily life, it helps engineers, doctors can detect diseases and it even plays a role in solving big problems like climate change.

ARTIFICIAL INTELLIGENCE AS NEW TOOL IN MODERN E

It depends. If human opts for a faster and effective way to complete their work and to work constantly without taking a break, yes, it is. However if humankind is satisfied with a natural way of living without excessive desires to conquer the order of nature, it is not. History tells us that human is always looking for something faster, easier, more effective, and convenient to finish the task they work on; therefore, the pressure for further development motivates humankind to look for a new and better way of doing things. Humankind as the homo-sapiens discovered that tools could facilitate many hardships for daily livings and through tools they invented, human could complete the work better, faster, smarter and more effectively. The invention to create new things becomes the incentive of human progress. We enjoy a much easier and more leisurely life today all because of the contribution of technology. The human society has been using the tools since the beginning of civilization, and human progress depends on it. The human kind living in the 21st century did not have to work as hard as their forefathers in previous times because they have new machines to work for them. It is all good and should be all right for these AI but a warning came in early 20th century as the human-technology kept developing that Aldous Huxley warned in his book Brave New World that human might step into a world in which we are creating a monster or a super human with the development of genetic technology.

The NEP-2020 sets forth a comprehensive vision for transforming education in [country]. It aims to provide an inclusive and flexible education system that promotes critical thinking, creativity, and problem-solving skills among students. With technology as a key driver, the NEP-2020 emphasizes the integration of digital tools and resources to enhance learning outcomes and improve administrative efficiency (Ministry of Education, 2020).

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The potential applications of AI in education align closely with the goals of the NEP-2020. AI can enable personalized learning experiences by adapting instructional content and strategies to individual student needs (Baker, Inventado, Labrum, & Blikstein, 2019). Intelligent tutoring systems powered by AI can provide real-time feedback, guidance, and adaptive learning paths, improving student engagement and mastery of concepts (VanLehn et al., 2019). Automated assessments driven by AI algorithms can enable efficient and objective evaluation of student progress (Pardo & Siemens, 2014).

The benefits of AI in education are well-documented. Research has shown that AI-powered tools can enhance student engagement, motivation, and learning outcomes (Blikstein, 2018). Additionally, AI technologies have the potential to alleviate the burden on teachers by automating administrative tasks, enabling them to focus more on individualized instruction and support. Thus, AI holds the promise of transforming education and creating a more personalized and effective learning environment.

The first work recognised in the field of artificial intelligence (AI) was presented by Warren McCulloch and Walter Pitts in 1943. McCulloch had degrees in philosophy and medicine from Columbia University and became the Director of the Basic Research Laboratory in the Department of Psychiatry at the University of Illinois. His research on the central nervous system resulted in the first major contribution to AI: a model of neurons of the brain. (Negnevitsky, 2011)

Besides, up-to-dated AI is breaking into healthcare industry too by assisting doctors to diagnose, finding the sources of diseases, suggesting various ways of treatment performing surgery and also predicting if the illness is life-threatening. A recent study by surgeons at the Children's National Medical Centre in Washington successfully demonstrated surgery with an autonomous robot. The team supervised the robot to perform soft-tissue surgery, stitch together a pig's bowel, and the robot finished the job better than a human surgeon, the team claimed. It demonstrates robotically-assisted surgery can overcome the limitations of pre-existing minimally-invasive surgical procedures and to enhance the capacities of surgeons performing open surgery. Here's a more detailed look at the role of AI in modern society:

1. **Efficiency and Productivity:**

   Automation: AI can automate repetitive and mundane tasks, freeing up human workers to focus on more creative and strategic work.

   Data Analysis: AI algorithms can analyze vast amounts of data quickly and accurately, providing insights that humans might miss, leading to better decision-making.

   Resource Optimization: AI can help businesses optimize resource allocation, reduce waste, and improve overall efficiency.

2. **Healthcare:**

   Diagnosis and Treatment: AI can assist in early and accurate diagnosis of diseases, personalize treatment plans, and improve patient outcomes.

   Drug Discovery: AI can accelerate the process of drug discovery and development by analyzing complex datasets and identifying potential drug candidates.

   Healthcare Operations: AI can improve the efficiency of healthcare operations, reduce costs, and improve patient care.

3. **Transportation:**

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Autonomous Vehicles: Self-driving cars and other autonomous vehicles promise to revolutionize transportation, improving safety and efficiency.

Traffic Management: AI can optimize traffic flow, reduce congestion, and improve travel times.

Logistics and Supply Chain: AI can optimize logistics and supply chain operations, improving efficiency and reducing costs.

4. **Business and Industry:**

Customer Service: AI-powered chatbots and virtual assistants can provide 24/7 customer support and personalize customer experiences.

Marketing and Sales: AI can help businesses identify target audiences, personalize marketing campaigns, and improve sales effectiveness.

Product Development: AI can help businesses develop new products and services by analyzing market trends and customer preferences.

5. **Education:**

Personalized Learning: AI can personalize learning experiences, adapting to individual student needs and learning styles.

Automated Tasks: AI can automate tasks like grading and scheduling, freeing up teachers' time to focus on instruction and student engagement.

Accessibility: AI can make education more accessible to students with disabilities by providing tools and resources that cater to their specific needs.

6. **Cybersecurity:**

Threat Detection: AI can detect and prevent cyberattacks in real-time by analyzing network traffic and identifying anomalies.

Phishing Detection: AI can help identify and prevent phishing attacks by analyzing emails and other communication channels.

Malware Analysis: AI can analyze malware samples and identify new threats before they can cause damage.

NEGATIVE IMPACT THE AI WILL HAVE ON HUMAN SOCIETY

A huge social change that disrupts the way we live in the human community will occur. Humankind has to be industrious to make their living, but with the service of AI, we can just program the machine to do a thing for us without even lifting a tool. Human closeness will be gradually diminishing as AI will replace the need for people to meet face to face for idea exchange. AI will stand in between people as the personal gathering will no longer be needed for communication.

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Unemployment is the next because many works will be replaced by machinery. Today, many automobile assembly lines have been filled with machineries and robots, forcing traditional workers to lose their jobs. Even in supermarket, the store clerks will not be needed anymore as the digital device can take over human labour.

Wealth inequality will be created as the investors of AI will take up the major share of the earnings. The gap between the rich and the poor will be widened. The so-called "M" shape wealth distribution will be more obvious

New issues surface not only in a social sense but also in AI itself as the AI being trained and learned how to operate the given task can eventually take off to the stage that human has no control, thus creating un-anticipated problems and consequences. It refers to AI's capacity after being loaded with all needed algorithm may automatically function on its own course ignoring the command given by the human controller.

The human masters who create AI may invent something that is racial bias or egocentrically oriented to harm certain people or things. For instance, the United Nations has voted to limit the spread of nucleus power in fear of its indiscriminative use to destroying humankind or targeting on certain races or region to achieve the goal of domination. AI is possible to target certain race or some programmed objects to accomplish the command of destruction by the programmers, thus creating world disaster.

7. Challenges and Ethical Considerations:

Bias and Fairness : AI algorithms can reflect biases in the data they are trained on, leading to unfair or discriminatory outcomes.

Job Displacement : Automation driven by AI could lead to job displacement in certain sectors.

Privacy : AI systems can collect and analyze large amounts of personal data, raising privacy concerns.

Accountability : It is important to establish clear lines of accountability for AI systems and their decisions.

The Goals of Artificial Intelligence: AI has clear goals that guide its development. Here are the most important ones:

Efficiency and Automation: Make tasks faster and free people from repetitive work.

Better Decision-Making: Use data to help in making smart choices, whether for businesses or personal needs.

Supporting People: Work with humans to improve their abilities and help them achieve more.

Personalized Experiences: Understand what people like and provide customized services.

Being Responsible: Create fair systems, respect privacy, and follow ethical standards.

Helping Society: Use AI to tackle global challenges, like improving healthcare or protecting the environment.

HOW AI IS CHANGING SOCIETY

1. **Boosting Economies:** AI is improving productivity in industries, reducing costs, and creating new opportunities. While some jobs may disappear, new ones are emerging that focus on creativity and innovation.
2. **Personalizing Everyday Life:** From personalized shopping recommendations to tailored content on social media, AI makes our experiences more convenient. However, it also raises privacy concerns, requiring better rules to protect people's data.

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3. **Advancing Healthcare:** AI tools are helping doctors make better diagnoses and creating personalized treatments. They're also improving how resources are used and speeding up medical research, ultimately leading to better health outcomes.
4. **Ethical Issues:** AI must be used responsibly. Problems like biased algorithms and data misuse need attention. Clear guidelines are essential to ensure AI technologies are fair and respectful of everyone.
5. **Changing How We Learn:** AI is transforming education by personalizing lessons for students. It helps teachers identify areas where students need more support and creates opportunities for more tailored learning experiences.

AI'S GROWING ROLE IN SOCIETY

AI is making life more efficient, driving innovation, and solving important problems in areas like education, healthcare, and business. But to use it effectively, we must focus on ethics and fairness. By carefully balancing progress and responsibility, we can ensure that AI works for everyone, making life better without compromising our values.

Artificial intelligence stands as a transformative force in modern society, shaping our daily lives, driving economic transformation, and revolutionizing various sectors. While its impact is undeniable, addressing ethical considerations and fostering responsible AI development is crucial for harmonious integration. As we navigate this AI-driven era, striking a balance between innovation and ethical awareness will be key to ensuring a positive and inclusive future for all.

The New Education Policy (NEP) has acknowledged, in no uncertain terms, the importance of artificial intelligence and AI education in today's time. To align India's curriculum to the 21st century and to prepare the students for the AI economy, the policy lays profound emphasis on the need to impart the necessary technical knowledge at all levels of education.

School children will be exposed to crucial skills such as digital literacy, coding and computational thinking from a young age, through the teaching of contemporary subjects such as Artificial Intelligence and Design Thinking. Further, topics such as artificial intelligence, 3-D machining, big data analysis and machine learning will be integrated with the undergraduate education to train industry-ready professionals. All universities will offer doctoral and Masters programmes in core areas such as Machine Learning. In addition, colleges may also offer targeted training in low-expertise tasks for supporting the AI value chain such as data annotation, image classification, and speech transcription.

Further, to make India a leading knowledge hub of disruptive technologies, the National Research Foundation (NRF) will promote high-quality research in the realm of science and technology. Given the rising applicability and falling costs of AI-based predictions, special focus has been given to promoting research in this domain. A three-pronged approach has been laid out to channel the research in AI, i.e. (a) advancing core AI research, (b) developing and deploying application-based research, and (c) establishing international research efforts to address global challenges in areas such as healthcare, agriculture, and climate change using AI.

NEP 2020 AND ARTIFICIAL INTELLIGENCE

The National Education Policy 2020 incorporates all the technological components, with a strong emphasis on artificial intelligence (AI). The policy promises to develop instructional software based on artificial intelligence that will

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be made available in all local or regional languages. These software or programs will be widely accessible and beneficial to students, even those who attend school in extremely rural areas or have special needs.

The NEP 2020 recognizes that children have a range of learning styles, interests, and aptitudes, which focus on the need for individualized learning. By analysing data about each student's learning styles, interests, and aptitudes, AI is enabling individualized learning. The NEP 2020 also states that AI technology will help in the development of smart classrooms that will permit online interactions and collaborations with students from various schools across the world, online exams, applications with quizzes, and information that can develop the students.

The NEP 2020 acknowledges the value of experiential learning and skill development in preparing students for employment opportunities of the twenty-first century. Students have access to courses that emphasize skill development through AI-powered learning platforms and remote learning tools. Besides these, a digital platform i.e., National Teacher's Portal is a repository of all the e-content created by all state boards viz., CBSE, NCERT, ICSE, ISC, and others. These contents help the teachers in their professional development.(Borchetia & Hazarika 2014)

The policy also envisions the use of AI-powered solutions for the attainment of its goals of a multilingual as well as holistic education. The efforts of promoting multilingualism among the school students will be interlocked with efforts to enhance Natural Language Processing capabilities for India's diverse languages. Additionally, AI will be used to track and record the life skills training of a child, with the aim to prepare a holistic report card.

THE ROLE OF AI IN EDUCATION INCLUDES SEVERAL KEY ASPECTS:

Personalized Learning: AI customizes learning experiences by analyzing individual student behavior and preferences, adapting content delivery for optimal engagement.

Intelligent Tutoring Systems: These systems provide personalized assistance and feedback to students, enhancing their learning experience.

Automated Grading: AI can streamline the grading process, providing immediate feedback to students and reducing the workload for educators.

Predictive Analytics: AI helps predict educational outcomes and identify students who may need additional support.

Enhanced Teaching Practices: AI tools assist teachers in developing more effective teaching strategies and materials.

These roles demonstrate how AI is transforming the educational landscape, making learning more efficient and tailored to individual needs.NEP 2020 highlights the integration of technology in education, recognizing it as crucial for improving teaching methods, student learning, grading, and assessments, and creating a more effective and engaging educational environment.

The National Education Policy (NEP) 2020, approved by the Indian cabinet on July 29, 2020, aims to transform India's educational system with a future-focused blueprint. This policy proposes extensive reforms across elementary, secondary, higher, and technical education sectors, continuing from earlier policies in 1968 and 1986. NEP 2020 seeks to overhaul the Indian education system to foster a competitive and highly educated nation. Under the BJP's 2014 manifesto commitment, NEP 2020, led by Narendra Modi, fulfils the promise of essential educational reforms.

The Ministry of Human Resource Development (MHRD) formed a committee led by former ISRO chief Dr. K. Kasturirangan, which submitted its report on May 31, 2019. Education is vital for individual growth, equitable

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communities, and national progress. As India advances economically and socially, it aims to offer quality education to its growing youth population, projected to be the world's largest in the next decade. Being a signatory to the 2030 Agenda for Sustainable Development, India is committed to ensuring inclusive, equitable, and quality education and lifelong learning opportunities. To meet these goals, NEP 2020 advocates a redesign of the education system to be immersive, scientific, discussion-based, adaptable, and engaging.

The policy emphasizes character building, intellectual development, empathy, accountability, and meaningful engagement. Major reforms are necessary to bridge the gap between current outcomes and desired goals, ensuring quality, equity, and integrity at all educational levels. As the first 21st-century education policy, NEP 2020 calls for a comprehensive overhaul of the education system's structure and governance, aligning with sustainable development goals while reinforcing India's cultural values. Teachers play a central role in these reforms, with NEP supporting their professional development and welfare, ensuring quality education for students. Special attention is given to marginalized and disadvantaged groups to ensure equitable access.

NEP 2020 highlights the integration of technology in education, recognizing it as crucial for improving teaching methods, student learning, grading, and assessments, and creating a more effective and engaging educational environment.

CONCLUSION

In an age of information technology evolution, artificial intelligence (AI) emerges as a transformative vibrant essential field with the capacity to rebuilt our society with better aspects. Anchored in ethics, transparency, and accountability, the development of AI becomes pivotal, acting as the cornerstone for constructing a future that seamlessly integrates technological advancement with social responsibility.

Just like Iron, steam engines & computers ushered in an era of growth during various stages in history, Artificial Intelligence will shape the future of the world. Equipping students, teachers, and professionals with the right knowledge and resources about AI will be paramount for the future of India. The foundations of the Indian Education system are robust. The New Education Policy 2020 and future policies will provide guidelines for growth conscious of the era. These policy documents might not get everything right, but as policymakers and good citizens, we should put our best foot forward.

Teacher training and professional development programs are essential to equip educators with the necessary skills and knowledge to effectively integrate AI tools into their pedagogical practices. Collaborative partnerships and stakeholder engagement are crucial for fostering a shared understanding, exploring innovative solutions, and ensuring the successful implementation of AI in education.

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INDUSTRY 5.0: A PARADIGM SHIFT TOWARDS HUMAN-CENTRIC AND SUSTAINABLE INDUSTRIAL TRANSFORMATION

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ABSTRACT

Industry 5.0 represents a shift from the efficiency-driven, technology-centric approach of Industry 4.0 to a more human-centered, sustainable, and resilient industrial paradigm. This paper critically reviews recent research on Industry 5.0, emphasizing its role in mitigating environmental, social, and governance (ESG) risks, fostering a circular economy, and integrating AI, IoT, and blockchain technologies for industrial transformation. Findings indicate that Industry 5.0 enhances digital transformation, operational efficiency, and sustainability in various sectors, including healthcare, manufacturing, and supply chain management. The study concludes that Industry 5.0 does not replace Industry 4.0 but builds upon it by prioritizing human well-being, ethical considerations, and environmental responsibility.

Keywords: Industry 5.0, Sustainability, Human-Centric Industry, ESG, Circular Economy, Digital Transformation.

1. INTRODUCTION

1.1 Background

The evolution of industrial revolutions has consistently reshaped the global economy, workforce dynamics, and technological advancements. Industry 4.0, characterized by automation, digitalization, and the Internet of Things (IoT), has led to significant productivity gains and operational efficiency across various sectors. However, the intense focus on automation and machine intelligence has raised concerns about workforce displacement, ethical considerations, environmental impact, and the increasing digital divide. Industry 5.0 emerges as a response to these limitations, offering a balanced approach that integrates human-centric values, sustainability, and technological progress.

Industry 5.0 represents a shift from the efficiency-driven, technology-centric approach of Industry 4.0 to an industrial paradigm that prioritizes human collaboration with intelligent machines, ethical business practices, and environmental responsibility. Unlike its predecessor, which emphasized large-scale automation and data-driven decision-making, Industry 5.0 seeks to harmonize technological advancements with human creativity, well-being, and resilience. This transition reflects a broader societal shift toward sustainable development, inclusivity, and responsible industrialization.

1.2 Definition and Scope of Industry 5.0

Industry 5.0 is an industrial framework that emphasizes human-machine collaboration, sustainability, and resilience. It leverages emerging technologies such as artificial intelligence (AI), IoT, blockchain, digital twins, and cyber-physical systems to enhance productivity while ensuring social and environmental responsibility. The European Commission defines Industry 5.0 as a model that "complements and extends" Industry 4.0 by focusing on three core dimensions:

1. **Human-centric approach:** Prioritizing workers' well-being, skill development, and inclusivity in industrial environments.
2. **Sustainability:** Promoting resource efficiency, circular economy principles, and environmentally friendly manufacturing processes.

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3. **Resilience**: Enhancing industrial adaptability, risk mitigation, and strategic foresight to handle global uncertainties.

These dimensions set Industry 5.0 apart as a transformative force that aligns industrial progress with the needs of society, ensuring that technological advancements do not come at the cost of human values or environmental degradation.

1.3 The Transition from Industry 4.0 to Industry 5.0

Industry 4.0 has revolutionized manufacturing, logistics, and business processes through automation, smart factories, and interconnected digital systems. However, its limitations, including excessive reliance on machine intelligence, job displacement concerns, and a lack of emphasis on sustainability, have led to the emergence of Industry 5.0. While Industry 4.0 optimized efficiency, Industry 5.0 reintroduces human oversight, creativity, and social responsibility into industrial ecosystems.

The transition is marked by several key developments:

- The integration of AI-driven decision-support systems that enhance, rather than replace, human expertise.
- The adoption of circular economy models to reduce industrial waste and promote sustainable production.
- The implementation of ethical AI and responsible automation to address concerns related to privacy, job security, and algorithmic bias.
- The development of collaborative robotics (cobots) designed to assist human workers rather than replace them.
- The incorporation of resilience strategies to future-proof industries against global challenges such as pandemics, supply chain disruptions, and climate change.

1.4 Importance of Industry 5.0 in Modern Industrial Practices

Industry 5.0 is critical in addressing the shortcomings of previous industrial paradigms while ensuring that technological progress aligns with human and environmental needs. Its significance extends across multiple dimensions:

1. **Workforce Empowerment and Inclusion**
   - Unlike Industry 4.0, which led to concerns about job losses due to automation, Industry 5.0 promotes workforce empowerment by integrating technology with human creativity.
   - By emphasizing diversity, inclusion, and reskilling, it creates more opportunities for workers to engage in value-added tasks rather than routine automation-driven roles.
2. **Sustainability and Environmental Responsibility**
   - Industry 5.0 aligns industrial production with the United Nations Sustainable Development Goals (SDGs) by reducing carbon footprints, optimizing resource consumption, and promoting renewable energy solutions.
   - Circular economy principles ensure that industries minimize waste through recycling, upcycling, and responsible sourcing of materials.
3. **Technological Advancements with Ethical Considerations**

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- Industry 5.0 ensures that AI and automation serve as augmentative tools rather than complete replacements for human decision-making.
- Ethical AI frameworks, transparency in data usage, and regulatory oversight play a crucial role in mitigating risks associated with automation.

4. Resilience Against Global Challenges

- The COVID-19 pandemic, geopolitical tensions, and supply chain disruptions have highlighted the vulnerabilities of highly automated, efficiency-driven industrial systems.
- Industry 5.0 introduces adaptability and robustness into industrial models, ensuring that businesses remain resilient amid uncertainty.

1.5 Objectives of the Study

This research paper aims to provide a comprehensive analysis of Industry 5.0 by addressing the following objectives:

1. To examine the transition from Industry 4.0 to Industry 5.0, identifying key enabling technologies and challenges.
2. To explore the role of Industry 5.0 in fostering sustainability, ESG compliance, and circular economy principles.
3. To analyze the impact of Industry 5.0 on various industrial sectors, including healthcare, manufacturing, supply chain management, and traditional industries.
4. To evaluate how human-machine collaboration enhances productivity, innovation, and ethical considerations in industrial settings.
5. To discuss future research directions and policy implications for successful Industry 5.0 adoption.

Industry 5.0 represents a significant paradigm shift that extends beyond automation and efficiency to prioritize human-centric industrial transformation. By integrating sustainability, ethical AI, and collaborative robotics, Industry 5.0 ensures that technological advancements align with societal well-being and environmental responsibility. This study aims to provide a critical analysis of Industry 5.0's potential to redefine industrial practices, foster innovation, and create a more inclusive and resilient economic landscape.

2. INDUSTRY 5.0: CONCEPT AND EVOLUTION

2.1 Transition from Industry 4.0 to Industry 5.0

The transition from Industry 4.0 to Industry 5.0 reflects a shift from machine-oriented automation to human-centric industrial development. Mourtzis et al. (2022) discuss how Industry 5.0 extends beyond efficiency to focus on societal transformation, well-being, and sustainability. Tallat et al. (2022) identify key enabling technologies, trends, and challenges in this transition, emphasizing the coexistence of both paradigms in industrial settings.

2.2 Human-Centric and Sustainable Approach

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Industry 5.0 places human well-being at its core, promoting diversity, inclusion, and skill development (Cillo et al., 2021). Studies highlight how collaborative robots, AI-driven decision-making, and ethical considerations enhance productivity while ensuring a safer and more inclusive work environment (Anisha et al., 2024).

3. TECHNOLOGICAL ENABLERS OF INDUSTRY 5.0

3.1 AI, IoT, and Blockchain for Sustainable Industrial Practices

Shamsuddoha et al. (2024) emphasize the role of AI and IoT in fostering a circular economy, optimizing resources, and reducing industrial waste. Sharma and Gupta (2024) further explore how blockchain enhances transparency and accountability in manufacturing, especially in developing economies.

3.2 Smart Manufacturing and Decision-Support Systems

Silva et al. (2025) propose decision-support systems that help organizations transition towards Society 5.0, integrating external factors and technological advancements. Ordieres-Meré et al. (2023) introduce a flexible architecture for smart factories, facilitating better business value creation through data-driven decision-making.

3.3 Hyper-Customization and Collaborative Robotics

Industry 5.0 promotes hyper-customization, allowing businesses to personalize production based on consumer preferences. Adel (2022) highlights the role of collaborative robots (cobots) in enhancing human-machine interaction, improving efficiency while preserving human oversight in industrial processes.

4. SUSTAINABILITY AND ESG RISK MITIGATION IN INDUSTRY 5.0

4.1 Circular Economy and Waste Management

Industry 5.0 emphasizes circular economy principles by leveraging AI-driven resource optimization (Shamsuddoha et al., 2024). Companies can achieve sustainable production by minimizing waste and adopting eco-friendly manufacturing techniques.

4.2 ESG Compliance and Ethical Considerations

Rehman and Umar (2024) discuss how Industry 5.0 mitigates ESG risks, ensuring better working conditions and ethical industrial practices. Organizations must integrate sustainability goals into their operations to remain competitive in an evolving industrial landscape.

4.3 Resilience and Adaptability in Industrial Sectors

Industry 5.0 fosters resilience by enhancing digital infrastructure and workforce adaptability. Pereira and dos Santos (2023) describe this transformation as neoindustrialization, where industries integrate technological and organizational resilience to meet societal demands.

5. INDUSTRY 5.0 IN DIFFERENT SECTORS

5.1 Healthcare Industry

Vettriselvan (2025) explores how healthcare SMEs can leverage Industry 5.0 for digital transformation and patient-centric care. AI-driven diagnostics, smart wearables, and digital marketing improve efficiency and patient outcomes.

5.2 Manufacturing and Supply Chain Management

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Industry 5.0 enhances supply chain management by integrating predictive maintenance, hyper-customization, and data-driven decision-making (Shadravan& Parsaei, 2023). Frederico et al. (2019) highlight the growing importance of Supply Chain 4.0 and Procurement 4.0, which are evolving alongside Industry 5.0.

5.3 Fashion and Traditional Industries

Fani et al. (2024) introduce the Lean 5.0 paradigm, merging Lean principles with human-centric values in traditional industries like fashion. This approach improves operational efficiency while maintaining sustainability.

6. CRITICAL FINDINGS

1. Industry 5.0 does not replace Industry 4.0 but complements it by prioritizing human well-being, sustainability, and ethical industrial practices.
2. AI, IoT, and blockchain play a crucial role in optimizing resources, enhancing transparency, and promoting circular economy principles.
3. The European Commission and other global initiatives emphasize the need for structured maturity assessments and strategic roadmaps to implement Industry 5.0.
4. Hyper-customization, collaborative robotics, and decision-support systems enhance operational efficiency and human-machine collaboration.
5. Healthcare, manufacturing, supply chain, and fashion industries benefit significantly from Industry 5.0's human-centric and sustainable approach.

7. CONCLUSION

Industry 5.0 represents an evolution from technology-driven industrial automation to a more human-centered, sustainable, and resilient paradigm. By integrating AI, IoT, blockchain, and collaborative robotics, Industry 5.0 enhances efficiency while addressing ESG risks and fostering a circular economy. While challenges remain in digital infrastructure and SME adoption, the future of industrial transformation lies in balancing technological advancements with human well-being and sustainability.

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ETHICAL DIMENSIONS OF AI: TRANSFORMING HEALTHCARE, BUSINESS, AND EDUCATION

SANDEEP KAUR

ABSTRACT :

Artificial Intelligence (AI) has rapidly evolved, revolutionizing various sectors, including healthcare, business, and education. While its applications bring significant advancements, they also raise complex ethical challenges that must be addressed to ensure responsible implementation. This paper explores the ethical implications of Al in these fields, focusing on issues such as bias, transparency, accountability, and privacy. In healthcare, Al has the potential to improve diagnostics and personalized treatments but poses risks related to data security and patient consent. In business, Al-driven automation enhances efficiency but may exacerbate job displacement and inequality. In education, Al can personalize learning experience, yet concerns regarding data misuse and algorithmic discrimination persist. This study highlights the need for ethical frameworks, policies, and interdisciplinary collaborations to mitigate the risks and maximize the benefits of Al. The paper provides an in-depth analysis of Al ethics, offering recommendations for responsible Al integration across industries.

INTRODUCTION

Artificial Intelligence (AI) has emerged as a transformative force across multiple sectors, including healthcare, business, and education. Its ability to process vast amounts of data, identify patterns, and make predictions has led to groundbreaking advancements. However, the ethical implications of AI are complex and multifaceted. Issues such as algorithmic bias, data privacy, accountability, and the potential for job displacement have sparked debates about the responsible use of AI. This paper examines the ethical dimensions of AI in healthcare, business, and education, highlighting the challenges and opportunities in each sector. It also explores the role of policymakers, industry leaders, and educators in shaping the future of AI in a way that prioritizes ethical considerations and societal well-being.

AI IN HEALTHCARE: ETHICAL CHALLENGES AND OPPORTUNITIES

AI has the potential to revolutionize healthcare by improving diagnostics, personalizing treatment, and streamlining administrative processes. For instance, machine learning algorithms can analyze medical images to detect diseases such as cancer with remarkable accuracy (Topol 2019). AI-powered tools are also being used to predict patient outcomes, optimize treatment plans, and reduce the burden on healthcare professionals. However, the use of AI in healthcare raises ethical concerns, particularly regarding data privacy, algorithmic bias, and accountability.

One major concern is the potential for bias in AI algorithms, which can perpetuate existing disparities in healthcare. For example, if an AI system is trained on data that underrepresents certain demographic groups, it may produce inaccurate or unfair outcomes (Obermeyer et al. 2019). This can lead to misdiagnoses or unequal access to care for marginalized populations. Additionally, the use of AI in healthcare raises questions about accountability. If an AI system makes an incorrect diagnosis, who is responsible, the developer, the healthcare provider, or the AI itself?

Data privacy is another critical issue in healthcare AI. AI systems often rely on vast amounts of sensitive patient data to function effectively, raising concerns about how this data is collected, stored, and used. Unauthorized access to patient data can lead to breaches of confidentiality and harm to individuals. To address these challenges, researchers and policymakers must prioritize transparency, fairness, and accountability in the development of AI systems. This includes ensuring that AI algorithms are trained on diverse datasets and that their decision-making processes are explainable to healthcare professionals and patients.

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Moreover, the integration of AI into healthcare requires a careful balance between technological innovation and human oversight. While AI can enhance the efficiency and accuracy of medical practices, it should not replace the critical role of healthcare professionals in making ethical decisions and providing compassionate care.

AI IN BUSINESS: ETHICAL IMPLICATIONS AND INNOVATIONS

In the business sector, AI is transforming operations, customer service, and decision-making processes. Companies are using AI to analyze consumer behavior, optimize supply chains, and automate routine tasks. While these advancements offer significant benefits, they also raise ethical concerns, particularly regarding job displacement, data privacy, and the potential for misuse.

The automation of jobs through AI has led to fears of widespread unemployment, particularly in industries that rely heavily on repetitive tasks. According to a report by McKinsey & Company, up to 800 million jobs could be lost worldwide to automation by 2030 (Manyika et al. 2017). This raises ethical questions about the responsibility of businesses to retrain and support workers displaced by AI. Companies must invest in workforce development programs to help employees transition to new roles and acquire the skills needed in an AI-driven economy.

Data privacy is another critical issue in the business sector. AI systems often rely on vast amounts of personal data to function effectively, raising concerns about how this data is collected, stored, and used. The European Union's General Data Protection Regulation (GDPR) has set a precedent for protecting consumer data, but many countries still lack comprehensive data privacy laws (GDPR 2018). Businesses must adopt ethical AI practices that prioritize transparency, fairness, and accountability. This includes implementing robust data privacy measures and ensuring that AI systems are designed to respect user consent and autonomy.

Another ethical concern in the business sector is the potential for AI to be used in ways that harm individuals or society. For example, AI-powered algorithms can be used to manipulate consumer behavior, spread misinformation, or engage in discriminatory practices. To address these challenges, businesses must adopt ethical guidelines and regulatory frameworks that promote the responsible use of AI. This includes ensuring that AI systems are transparent, explainable, and aligned with societal values.

AI IN EDUCATION: ETHICAL CONSIDERATIONS AND TRANSFORMATIVE POTENTIAL

AI is also transforming the education sector by enabling personalized learning, automating administrative tasks, and providing new tools for assessment. For example, AI-powered platforms can analyze student performance data to identify areas where individual students may need additional support (Holmes et al. 2019). However, the use of AI in education raises ethical concerns related to data privacy, bias, and equity. One major concern is the potential for AI to exacerbate existing inequalities in education. For instance, students from disadvantaged backgrounds may lack access to the technology needed to benefit from AI-powered educational tools. This digital divide can widen the gap between privileged and underprivileged students, perpetuating cycles of inequality. Additionally, the use of AI in assessment raises questions about fairness and transparency. If an AI system is used to grade student work, how can educators ensure that the system is free from bias and that its decision-making process is explainable?

Data privacy is another critical issue in education AI. AI systems often rely on vast amounts of student data to function effectively, raising concerns about how this data is collected, stored, and used. Unauthorized access to student data can lead to breaches of confidentiality and harm to individuals. To address these challenges, educators and policymakers

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must prioritize equity and transparency in the development and deployment of AI systems. This includes ensuring that AI-powered educational tools are accessible to all students and that their decision-making processes are transparent and accountable.

Moreover, the integration of AI into education requires a careful balance between technological innovation and human oversight. While AI can enhance the efficiency and effectiveness of educational practices, it should not replace the critical role of educators in fostering creativity, critical thinking, and ethical reasoning.

INTERDISCIPLINARY COLLABORATION AND REGULATORY FRAMEWORKS

Addressing the ethical dimensions of AI requires interdisciplinary collaboration and the development of robust regulatory frameworks. Policymakers, industry leaders, and educators must work together to establish guidelines and standards that promote the responsible use of AI. This includes ensuring that AI systems are transparent, explainable, and aligned with societal values. Interdisciplinary collaboration is essential to address the complex ethical challenges posed by AI. For example, ethicists, technologists, and policymakers must work together to develop frameworks for addressing issues such as bias, privacy, and accountability. Public engagement is also critical to ensure that AI technologies are aligned with societal values and ethical principles. By involving diverse stakeholders in the development and deployment of AI systems, we can ensure that these technologies are used in ways that benefit society as a whole. Regulatory frameworks play a crucial role in promoting the responsible use of AI. Governments and international organizations must establish guidelines and standards that ensure AI systems are transparent, fair, and accountable. This includes implementing data privacy laws, promoting algorithmic transparency, and establishing mechanisms for accountability and redress.

CONCLUSION

The ethical dimensions of AI in healthcare, business, and education are complex and multifaceted. While AI offers significant opportunities for innovation and efficiency, it also raises important ethical concerns related to bias, privacy, accountability, and equity. To maximize the benefits of AI while minimizing harm, stakeholders must prioritize transparency, fairness, and accountability in the development and deployment of AI systems. By adopting ethical AI practices, we can ensure that AI technologies are used responsibly and equitably across all sectors. Interdisciplinary collaboration, regulatory frameworks, and public engagement are essential to address the ethical challenges posed by AI. By working together, we can shape the future of AI in a way that prioritizes ethical considerations and societal well-being. As AI continues to transform healthcare, business, and education, it is imperative that we remain vigilant and proactive in addressing the ethical implications of these technologies.

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Role of Artificial Intelligence in Modern Education

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Abstract

The rise of Artificial Intelligence and its related tools has opened up exciting possibilities across many areas of our lives, including education. While we're seeing more and more AI being integrated into educational settings, there are still some uncertainties about its full potential and the challenges it brings. In this paper, we draw on previous research to give a comprehensive look at how AI is being utilized in education, the hurdles it faces, and the opportunities that lie ahead. For instance, global initiatives like those from UNESCO highlight the growing presence of AI in this field. We found that AI is being used for a variety of tasks, such as creating content, automating assignments and grading, and providing support to students. The advantages of AI in education are significant, offering more flexibility in terms of time and location, and transforming the role of educators into facilitators. However, we also tackled some pressing challenges, including ethical concerns like data privacy, the need for inclusivity and equity among students from diverse backgrounds, and the diminishing human connection. Ultimately, we concluded that while AI's influence in education is set to grow, it's crucial to address these challenges to truly harness the benefits that AI can bring to the educational landscape.

Keywords: Artificial Intelligence, Education, Technology, Learners.

1. Introduction

Artificial Intelligence (AI) is all about blending various technologies like machine learning, deep learning, algorithm development, and natural language processing. It offers a ton of advantages for both organizations and individuals, boosting efficiency and productivity while saving time and effort, ultimately enhancing overall performance .However, it's not all smooth sailing; AI also brings challenges like data security, privacy concerns, and the potential for job loss. As AI continues to weave its way into our everyday lives, it's making significant strides in professional fields such as education, healthcare delivery , and marketing . It's quickly becoming one of the major technological forces shaping the 21st century. This article will delve into the themes surrounding AI in Education, exploring its applications, benefits, challenges, and the future opportunities it presents in the educational field.

2. AI in the Education Field

AI is slowly but surely making its mark in the education sector. At first, the idea of AI literacy emerged, which is all about being able to understand, use, monitor, and think critically about AI applications, even if you're not someone who can create AI models (Long and Magerko, 2020). The term "AI" first popped up in an online article back in 2015 (Konishi, 2015). It's part of a broader trend of proposed literacies aimed at helping people grasp various technological concepts, similar to "media literacy" or "data literacy" (Wolff, Gooch, Montaner, Rashid, and Kortuem, 2016). Essentially, "AI literacy" includes the skills that everyone should have regarding AI, particularly focusing on learners who don't have a background in computer science—what we like to call "non-experts." A frequently cited definition of AI literacy was developed by Long and Magerko (2020), who defines it as "a set of competencies that enables individuals

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to critically evaluate AI technologies, communicate and collaborate effectively with AI, and use AI as a tool online, at home, and in the workplace".

The journey of AI in education actually dates back to the 1970s, when young learners were introduced to LOGO programming and Turtle robots. But back then, these tools were more about teaching computational thinking and programming concepts rather than AI itself. Fast forward to 1995, and we see the release of "Artificial Intelligence: A Modern Approach," a book that has become the go-to textbook for computer science students diving into AI (Russell and Norvig, 1995). This resource opened the door for students to explore how AI can tackle problems, reason, learn, make decisions, communicate, perceive, and take action (Russell and Norvig, 1995). However, for a long time, these ideas were mostly confined to computer science.

Over time, the role of AI in education has expanded, especially with its integration into education management systems. This shift has made teaching, learning, and decision-making smoother, while also offering virtual assistance for personalized education. AI now plays a crucial role in tailoring learning experiences to meet individual student needs. Educators can leverage AI-driven technologies, like cloud computing, to deliver content in ways that resonate with different learners. Plus, AI opens up opportunities for students to engage with chatbots, which can enhance their learning experience and help clear up any confusion, ultimately promoting independent learning .

The role of AI in education is increasing as evident from global initiatives (e.g., ISTE, UNESCO, DigComp) which started to conceptualize AI education according to the latest educational standards and design guidelines to address digital literacy levels across the globe.. These frameworks represent different perspectives on the idea of AI education. For example, Miao and Shiohira, (2021) reported that eleven countries around the world have incorporated AI into their STEM/computing curricula to promote competitiveness and equip young people for the future workplace. AIK12 (2019) proposed the "five big ideas" about AI that serve as the framework to uncover the necessary AI concepts that students in each grade level should learn. The five big ideas include perception, representation and reasoning, learning, natural interaction, and the societal impact of AI (AIK12, 2019). The ISTE (2022) further designed an AI project guideline and proposed seven standards to prepare students to become (1) empowered learners, (2) knowledge constructors, (3) computational thinkers, (4) innovative designers, (5) digital citizens, (6) creative communicators, and (7) global collaborators. Overall, currently, AI is

becoming the next big trend in the education field at all levels including primary, secondary, as well as higher-level studies.

3. AI Applications in the Education Field

There are various applications of AI in the education field including content design, delivery, assessment, feedback, and support. In terms of content design, AI can enable the designing of content which is friendly and flexible. According to Culican (2024), AI algorithms can scan large data to tap into the gaps thus creating content that is interesting and trendy. AI can also be used for making content including textbooks, personalized learning materials, and interactive courses according to the target audience. AI tools enable the development of educational material that is based on natural language processing capabilities thus ensuring material that is consistent, concise, and grammatically correct .

When it comes to delivering content, AI really shines by making the process more efficient and flexible. It can step in for traditional classroom instruction, allowing students to learn from anywhere in the world, at any time. Looking ahead, we might even see AI systems taking over the role of lecturers in certain subjects. Right now, some educational programs are already integrating AI to help students build essential skills. As noted by Fahimirad and Kotamjani (2018), classroom AI systems are quite adept at analyzing various data sources and comparing them to established patterns. They can pinpoint problem areas and offer guidance to teachers, helping to ensure more consistent results across different classes. In

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essence, AI and educators can collaborate to find the most effective ways to deliver content, maximizing positive outcomes for students. The advantages of using AI in education include tailored learning experiences and universal access for all students, regardless of language barriers or disabilities like visual or hearing impairments. Additionally AI can provide valuable insights into how students are engaging with educational content and tracking their progress, leading to a more personalized learning journey. Therefore, it's clear that AI-driven education is more focused on the learner compared to traditional methods, benefiting both students and teachers alike.

In terms of assessment, AI can enable automated assessment. For example, AI can automate grading homework and tests usually take a significant amount of time. This time could be used to work on professional development, interact with students, and prepare for class. As AI is also replacing human grading gradually, AI automated grading can grade nearly fill-in-the-blank and all kinds of multiple-choice testing. However, essay-grading software is still in its early stages yet and it will be improved over the coming years. According to the European School Education Platform (2023), AI can be used by tutors to personalize assessment and provide timely feedback addressing individual learning needs. The benefit of AI in assessment is that it can reduce human subjectivity and time taken for assessment . Furthermore, Sarker (2022) suggests that AI use in educational assessment increases consistency, personalization, and scalability. The reported benefits of AI in educational assessment include the ability to analyze large data with multiple sources, individual consideration, and flexibility .

For feedback and support, it is generally agreed that for learners, timely, relevant, and objective feedback is very important. AI also has the potential to provide feedback that meets these criteria. The use of AI in providing feedback on student's assessments or work is already in use For example, some schools are employing AI systems to track and monitor students 'progress and to notify tutors if there is an issue with students' performance. Some tutoring programs are based on artificial intelligence to help students through writing, basic mathematics, and other subjects. These AI programs can instruct students only in basic subjects; however, these machines aren't perfect for teaching high-order thinking and creativity to students. Furthermore, generative AI tools like ChatGPT or Microsoft Bing can provide customized and quick feedback on students' work. According to Mollick and Mollick (2023), AI is being used in providing feedback to students which is personalized and asks students to take a different perspective. However, the authors noted that AI-based feedback is limited in the sense that it cannot replace human-grounded knowledge that a teacher has about their students.

4. Benefits of AI in the Education Field

The general benefits of AI such as efficiency and customization also apply to AI in education. The main benefit of AI in education is that it can facilitate learning with greater flexibility and convenience as learners can learn in their own time and space using AI-related infrastructure. Along with flexibility, AI can also enhance accessibility to education as more and more learners can access quality educational resources regardless of their economic background or geographic location. This advantage makes providing universal access to education much easier.

AI can also enable tutors to empower their students 'AI competencies, attitudes, and readiness to communicate with other learners, solve authentic problems, and develop ideas, theories, and solutions innovatively and collaboratively. Thus, the use of AI in education is resulting in overall improvement of the student's performance.

A benefit of AI includes greater support available to students . For example, AI-based assistance to students uses Chatbot and virtual assistants which are based on intelligent systems and can offer round-the-clock availability, address queries,

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and offer valuable feedback. AI also enables enhanced engagement and motivation of students by providing tools such as gamification of learning or interactive content. It enables students to be more engaged and motivated .

AI systems also enable automated grading thus enabling more time available to tutors for lesson planning and preparation . The automation of assessment is shifting the role of the teacher to a facilitator . Teachers can integrate AI lessons as supplementary materials to assist weak students and provide hands-on experiences in the form of human interaction for students. AI systems also provide students with a judgment-free environment of learning and can suggest solutions to improve students 'performance.

AI can also reduce the cost borne by educational institutes as it removes unnecessary work and automates processes which reduce the resource requirements. The reduced cost thus can be transferred to other stakeholders such as students. Overall, we can argue that AI use in the education field has benefits for learners, tutors, and educational institutes in terms of flexibility, increased learning, a focus on more important tasks, and increased efficiency.

5. AI Challenges in the Education Field

When it comes to AI in education, there are definitely some hurdles to overcome. One major concern that pops up is ethics. The literature points out that ethical dilemmas can arise in areas like transparency, fairness, privacy, morality, and the elimination of bias . Another important issue is making sure everyone has access and feels included. Not everyone has the same access to technology, which can really put some individuals at a disadvantage. For instance, many students in developing countries lack access to smartphones or the internet, which can leave them behind compared to their peers who do have these resources. Plus, factors like socio-economic status and geographical location can also play a big role in how easily students can access AI-driven education.

A significant challenge with using AI in education is that it can sometimes make the learning experience feel less personal . As we rely more on AI, there's a risk of becoming less dependent on teachers, and while AI has its strengths, it can't fully replace the human touch that teachers provide. The role of a teacher is crucial not just for imparting knowledge but also for guiding students in their personal and professional growth. So, as AI becomes more prevalent, we need to be mindful that less reliance on teachers might mean less focus on nurturing students' moral and personal development . A relevant challenge is the inadequate preparedness of tutors and educational institutes in general. Implementing AI requires training a large number of tutors and educational managers to use the system which may not be an easier task. The educational system of many countries is not up to date to accommodate such change and thus it remains a challenge.

Another challenge is the inability of students to explore their full potential. This is because if students start depending too much on AI-based education, it will limit their critical abilities including thinking, logic, and memory which is a big drawback. In other words, students will be depending too much on machines which can hinder their learning and making full use of their potential. The cost factor related to AI is another challenge and cannot be ignored. Provision of the initial outlays for software and cloud support is very costly for educational systems. Not only the costs for continuous employee training are expensive but also ongoing training of the AI system would be costly if organizational processes change. Since there are several technology options, hence it is a difficult decision to restrict the potential options to a few (Fahimirad and Kotamjani 2018; Chiu et al., 2023; Pedro et al., 2019). Overall, it can be argued that there are some subtle challenges related to the use of AI in the education field.

6. Conclusion

The paper takes a deep dive into how AI is reshaping the education sector. Our analysis of past research reveals that AI is transforming various aspects of education, from course planning and delivery to content creation and distribution. With

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AI, learning becomes more personalized and flexible, allowing for better interaction with the system. This technology empowers both educators and students, enabling them to focus on what truly matters while the AI handles repetitive tasks. However, we also touched on some significant challenges, such as ethical concerns surrounding AI in education, the potential loss of human connection, data privacy issues, and the costs associated with developing these systems. In summary, it's clear that AI is revolutionizing education, bringing about substantial changes, but we must tackle these challenges head-on to fully realize its benefits.

Future Directions :-

In the future, AI based systems such as the role of ChatGPT and similar AI-related tools will play a key role in future education. Therefore, future researchers can focus more specifically on ChatGPT's role in education. Similarly, Hybrid AI is the future direction, which represents joint intelligence from human beings and algorithms. To date, hybrid AI has gained less attention and started to be applied to some realistic applications, such as management. However, most of them are simple combinations of human and AI decisions. The way to better take advantage of humans and algorithms should be explored.

In the future, we foresee that researchers will conduct more rigorous evidence-based research using quantitative and qualitative methods to critically examine the effectiveness of AI curricula. Lastly, there is insufficient research before 2021 to support the development of theoretical frameworks for the teaching and learning of AI. To advance the field of AITL, recent researchers have started to develop more theoretical frameworks (Long and Magerko, 2020) to guide educators in creating lesson designs that offer the most appropriate pedagogies and teaching tools for each AI training goal.

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Artificial Intelligence in Modern Gaming: A Comprehensive Review

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ABSTRACT

Artificial Intelligence (AI) has revolutionized the gaming industry by enhancing game mechanics, improving player experience, and enabling adaptive and intelligent gameplay. This paper provides a comprehensive review of AI in modern games, covering traditional techniques, deep learning approaches, procedural content generation, AI-driven game testing, and player experience enhancement. It also discusses AI's historical development, its role in different game genres, and future research directions. AI's influence extends beyond entertainment, contributing to educational simulations, training modules, and XR (Extended Reality) applications.

Keywords: Artificial Intelligence, Player Experience Enhancement, New Media, Procedural Content Generation, Educational Simulations

1. Introduction

Artificial Intelligence (AI) in video games has evolved from basic decision trees to advanced machine learning models that enhance game mechanics, immersion, and realism. AI governs various aspects of modern gaming, from procedural content generation and non-player character (NPC) behaviour to real-time decision-making and adaptive learning. The rise of AI has not only impacted entertainment but also extended its application to fields such as education, military training, and medical simulations [1].

2. Literature Review

The study of AI in video games has progressed significantly, with researchers exploring various techniques and applications that enhance the overall gaming experience. Early studies focused on deterministic AI models such as rule-based decision-making and finite state machines (FSMs) [2]. These traditional approaches were effective in early gaming but lacked adaptability and dynamic responses. Researchers have since shifted towards more sophisticated AI techniques that offer real-time adaptation and learning capabilities [3].

Machine learning (ML) and deep learning (DL) have emerged as dominant techniques in modern AI-driven gaming. Reinforcement learning (RL), in particular, has been instrumental in developing AI agents that learn optimal strategies through repeated gameplay, refining their decision-making over time [4]. This has led to groundbreaking developments in AI-controlled opponents that can adapt to player behaviour, making games more challenging and engaging.

Procedural content generation (PCG) has also been a major area of interest in game AI research. By utilizing neural networks and generative adversarial networks (GANs), developers can create vast, unique game worlds dynamically,

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ensuring a fresh experience for players with each playthrough. This technology is widely seen in open-world and sandbox games, where AI-driven algorithms generate landscapes, missions, and interactions dynamically [5].

3. AI Techniques in Gaming

3.1 Classical AI Techniques

Traditional AI techniques include finite state machines (FSM), behaviour trees, and rule-based systems. These methods provide predictable and controlled behaviour for NPCs, ensuring a structured gameplay experience. Pathfinding algorithms such as A* and Dijkstra's algorithm enable dynamic navigation in open-world games. AI-based rule engines enhance NPC decision-making, improving interactions with players and increasing game complexity.

Finite State Machines (FSMs) allow NPCs to transition between predefined states based on player interactions. However, FSMs can be rigid and predictable, whereas behaviour trees offer hierarchical control over NPC decision-making, enhancing adaptability in dynamic environments.

3.2 Machine Learning and Deep Learning

Advancements in AI have integrated machine learning (ML) and deep learning techniques into gaming, allowing AI to learn, adapt, and make autonomous decisions in response to in-game events. Unlike traditional rule-based AI, which follows predefined patterns, ML-based AI can evolve its strategies based on data and player interactions, making games more dynamic and engaging.

a) Reinforcement Learning (RL) in Games
Reinforcement learning (RL) enables AI agents to learn optimal strategies through trial and error by interacting with their environment and receiving rewards for beneficial actions. This approach has been widely used in training AI for complex decision-making, such as in strategy games like *StarCraft II* and *Dota 2*, where AI models have achieved superhuman performance by continuously refining their tactics [6]. Reinforcement learning algorithms, such as Deep Q-Networks (DQN) and Proximal Policy Optimization (PPO), help AI learn from gameplay data and improve its performance over time [7].

b) Deep Q-Networks (DQN) and Advanced Decision-Making
Deep Q-networks (DQN) combine reinforcement learning with deep neural networks to make AI-driven decision-making more effective in complex game environments. Instead of following static rules, DQNs use past experiences to optimize real-time decision-making. This has been demonstrated in games such as *Ms. Pac-Man*, where AI learned to maximize rewards through self-play, outperforming human players [8].

c) Convolutional Neural Networks (CNNs) for Visual Recognition
CNNs, a type of deep learning model, enhance procedural content generation, graphics realism, and adaptive difficulty adjustment. CNNs process and analyse visual data in real-time, making them crucial for applications such as facial recognition in characters, object detection in augmented reality games, and enhancing game textures for realism. AI-

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powered upscaling techniques, such as NVIDIA's DLSS (Deep Learning Super Sampling) use CNNs to generate higher-resolution images from lower-quality inputs improving graphical fidelity [9].

D) Generative Adversarial Networks (GANs) for Content Generation

Generative Adversarial Networks (GANs) are used to create realistic game assets, environments, and animations. GANs operate using two neural networks—the generator and the discriminator—which compete against each other to produce high-quality synthetic data. This technology is used in procedural level design, realistic character animations, and generating photorealistic textures. For example, *AI Dungeon* uses GANs to generate interactive storytelling experiences, allowing players to engage in dynamically evolving narratives.

3.3 Procedural Content Generation (PCG)

PCG involves AI-driven algorithms generating game environments, levels, and assets dynamically. AI techniques such as evolutionary algorithms, Markov chains, and deep learning models improve PCG quality and diversity [10]. Games like *No Man's Sky* utilize AI-driven PCG to create vast, procedurally generated worlds [11].

PCG reduces development costs while enhancing replayability. AI-generated game worlds dynamically adapt to player actions, creating more engaging and immersive experiences. AI-driven storytelling systems modify game narratives based on real-time player choices, ensuring a unique experience for each player [12].

Fig 1: PCG in Games generate realistic looking tree models

4. AI in Game Testing and Development

AI-powered tools assist in game testing by identifying bugs, evaluating player behaviour, and optimizing game mechanics [13]. Reinforcement learning and simulation-based testing help developers create robust and balanced games [14].

4.1 Automated Playtesting and Bug Detection

AI-driven testing frameworks automate thousands of gameplay scenarios, identifying potential exploits and balance issues before release. Neural networks analyse large datasets of player interactions to detect anomalies, ensuring smoother game launches [15].

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4.2 AI-Enhanced Game Development

In game development, AI is used to generate assets, optimize graphics rendering, and improve procedural world-building. Deep learning enhances texture upscaling and animation fluidity, while AI-powered animation systems allow for realistic character movements [16]. AI-based dialogue generation tools dynamically adapt NPC conversations based on player interactions, creating more immersive storytelling [17].

5. AI for Player Experience Enhancement

AI personalizes player experiences by analysing behaviour and adjusting game difficulty dynamically. It enhances player engagement through real-time adaptation and interactive storytelling [18].

5.1 Adaptive Game Difficulty

AI adjusts in-game challenges based on player performance, ensuring an optimal difficulty curve. Games like *Resident Evil 4* and *Left 4 Dead* dynamically alter enemy aggression based on player skill levels [19].

5.2 AI-Driven NPC Interactions

NPCs in modern games exhibit dynamic behaviour influenced by player interactions. *Red Dead Redemption 2* and *The Witcher 3* use AI-based decision trees and sentiment analysis to shape NPC responses and in-game events [20].

5.3 AI-Enhanced Graphics and UX Modelling

Machine learning enhances game graphics by improving rendering techniques. AI-driven procedural textures and lighting systems contribute to ultra-realistic visuals in games like *Grand Theft Auto V* and *Marvel's Spider-Man* [21].

6. AI in Different Game Genres

AI influences various game genres differently. Table 1 summarizes AI applications across genres.

Table 1: AI Applications in Different Game Genres

Game Genre	AI Applications
Strategy Games	AI-controlled units, real-time battle strategy, resource management
Action Games	Adaptive enemy AI, real-time combat simulations
RPGs	Branching narratives, NPC emotional intelligence,

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	decision-based outcomes
Adventure Games	AI-driven storytelling, interactive world design
Simulation Games	AI-generated economies, autonomous NPC behaviours

7. Challenges and Future Trends

Despite AI's advancements, several challenges persist:

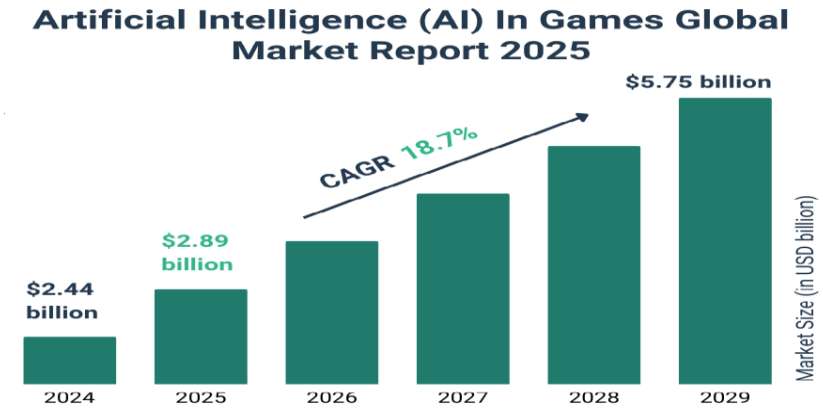
- **Computational Complexity:** Advanced AI algorithms require significant processing power, impacting performance.
- **Ethical Concerns:** AI-driven monetization strategies can lead to manipulative gaming experiences.
- **Unpredictability:** AI behaviours must balance realism with fairness to prevent unintended exploits.

Future Trends

The future of AI in gaming will be shaped by:

- **AI-Integrated XR (Extended Reality)**: AI-powered VR/AR experiences enhance immersion.
- **Cloud-Based AI Gaming**: AI-driven cloud processing allows real-time computations without hardware limitations.
- **AI-Generated Narratives**: Dynamic AI-driven storytelling could revolutionize player-driven narratives.

Fig 2: AI in Games Global Market Report



7. Conclusion

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AI has fundamentally transformed the gaming landscape by enhancing decision-making, procedural content generation, and player interaction. The future of AI in gaming will focus on Real time adaptation, immersive experiences and ethical AI frameworks to balance innovation with player trust and fairness.

To ensure the responsible growth of AI in gaming, researchers and developers must prioritize ethical AI frameworks, player-centric design, and sustainable computational models. As AI continues to evolve, it will redefine gaming experiences, making them more interactive, engaging, and accessible across multiple platforms. By leveraging AI responsibly, the future of gaming promises innovation without compromising player trust and fairness, leading to groundbreaking advancements in digital entertainment.

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Artificial Intelligence in Sikhi: Bridging Tradition and Technology

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Abstract : Artificial Intelligence (AI) is transforming various domains, including religious studies and heritage preservation. Sikhism, a faith deeply rooted in spiritual wisdom and community service, can benefit from AI in multiple ways. This research paper explores the role of AI in Sikhi, focusing on Gurbani preservation, education, humanitarian efforts, and cultural heritage conservation. Ethical considerations and potential challenges in AI adoption are also discussed. By leveraging AI responsibly, the Sikh community can enhance accessibility, engagement, and knowledge dissemination while maintaining the core values of the faith.

Keywords: Artificial Intelligence, Sikhism, Gurbani Preservation, AI Ethics, Religious Technology

Introduction: Sikhism, founded by ***Guru Nanak Dev Ji*** in the 15th century, emphasizes equality, service, and devotion to the Divine. Over the centuries, Sikhi has adapted to various socio-cultural and technological changes. Today, the rise of Artificial Intelligence (AI) presents an unprecedented opportunity to preserve Sikh heritage, enhance education, and improve humanitarian efforts (Singh, 2021) [8]. The intersection of AI and Sikhism raises critical questions regarding how technology can be aligned with religious values while maintaining ethical integrity (Sehgal, 2023) [7]. This paper examines how AI can be integrated into Sikh practices, its impact on the community, and the ethical considerations of its use.

AREAS OF AI IN SIKHI

1. **AI in Gurbani Preservation** Gurbani, the sacred scripture of Sikhism, is central to Sikh life. AI applications have emerged as vital tools in ensuring the preservation and accessibility of Gurbani for future generations.

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- **Digitization and Transcription:** AI-powered Optical Character Recognition (OCR) is revolutionizing the digitization of handwritten manuscripts, enabling the preservation of centuries-old scriptures in digital formats (Bhandari & Kumar, 2020) [2]. This process ensures that rare and fragile manuscripts remain accessible for research and spiritual study.
- **Translation and Interpretation:** Language barriers can sometimes hinder the understanding of Gurbani. AI-driven translation tools, powered by deep learning, help interpret Gurbani into multiple languages, making the teachings of Guru Granth Sahib Ji accessible to a global audience (Gupta & Sharma, 2021) [4].
- **Voice Recognition:** AI-driven speech recognition enables Gurbani recitation learning and pronunciation assistance, allowing individuals to refine their pronunciation and comprehension of sacred verses (Goyal & Aggarwal, 2019) [3].
- **Searchable Databases:** AI-powered Gurbani databases provide users with the ability to search specific shabads, meanings, and historical contexts, making spiritual study more interactive and insightful (Jha & Singh, 2022) [5].
- **Natural Language Processing (NLP):** AI can analyze complex Gurbani texts, enhancing translations, identifying metaphors, and contextualizing verses. NLP models trained on Gurbani's linguistic patterns can provide insightful interpretations while maintaining authenticity.

2. AI in Sikh Education and Research Education plays a crucial role in spreading Sikh teachings, and AI contributes significantly in this domain.

- **Personalized Learning Platforms:** AI-driven educational platforms offer customized learning experiences for Sikh history, Gurbani pronunciation, and Sikh philosophy (Singh, 2021) [8]. AI tailors learning modules based on individual progress and understanding, ensuring effective learning experiences for students.
- **AI Chatbots:** Virtual assistants and AI-driven chatbots are capable of answering queries related to Sikh philosophy, historical events, and daily practices (McCarthy, 2007) [6]. These chatbots provide instant information, allowing seekers to access Sikh knowledge anytime, anywhere.
- **Historical Data Analysis:** AI aids in analyzing ancient Sikh manuscripts and historical documents, identifying patterns and generating insights that were previously challenging to extract through manual analysis (Srivastava & Verma, 2020) [9].
- **Interactive Virtual Gurudwaras:** AI, combined with Virtual Reality (VR) and Augmented Reality (AR), enables the creation of interactive virtual Gurudwaras, allowing devotees worldwide to experience a spiritual connection despite geographical constraints (UNESCO, 2022) [10].

3. AI in Seva and Humanitarian Efforts Seva (selfless service) is a fundamental Sikh principle. AI enhances these efforts in numerous ways:

- **Optimized Langar Distribution:** AI-powered predictive analytics optimize the distribution of langar (free community meals), ensuring that food waste is minimized and resources are allocated effectively (Bhandari &

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Kumar, 2020) [2]. AI models analyze patterns in demand, enabling Gurudwaras to serve communities more efficiently.

- **Disaster Relief Management:** AI assists in coordinating humanitarian aid during crises by predicting disaster-prone areas, optimizing supply chain logistics, and ensuring swift response mechanisms (Sehgal, 2023) [7].
- **Healthcare Support:** AI-driven telemedicine platforms provide remote medical consultations, ensuring that individuals in rural or underserved areas receive timely medical attention (Gupta & Sharma, 2021) [4]. AI diagnostics also assist in early disease detection and patient care, improving healthcare accessibility.
- **Mental Health Support:** AI-powered mental health applications offer spiritual guidance, meditation techniques, and counseling support, helping individuals navigate mental and emotional well-being in alignment with Sikh principles (Srivastava & Verma, 2020) [9].

4. AI in Sikh Heritage Preservation Sikh heritage comprises historical sites, artifacts, and manuscripts. AI plays a crucial role in ensuring their preservation.

- **Virtual Reality (VR) and Augmented Reality (AR):** AI-powered VR/AR experiences enable users to explore Sikh historical sites virtually (UNESCO, 2022) [10]. This technology allows individuals to engage with Sikh heritage in an immersive manner, even if they are unable to visit physical locations.
- **Artifact Preservation:** AI-based image processing techniques help detect degradation in manuscripts and artifacts, enabling proactive conservation efforts (Singh, 2021) [8]. Machine learning models analyze environmental factors affecting heritage sites and recommend preservation strategies.
- **Heritage Mapping:** AI-powered drones assist in mapping and documenting Sikh heritage sites, ensuring that future generations have access to detailed records of these sacred locations (Jha & Singh, 2022) [5].

5. Balancing Automation and Honest Work:

The Sikh principle of *Kirat Karni* (earning an honest living) encourages ethical work. As AI automation changes industries, Sikhs are encouraged to use AI responsibly while respecting the value of hard work. By promoting skill development and encouraging new job opportunities, AI can support rather than replace honest labor. Sikh institutions can provide AI-based education programs to help people gain skills and adapt to changing job markets. Additionally, AI-powered marketplaces can support small Sikh businesses by improving their visibility, promoting ethical trade, and boosting sustainable growth.

Using AI wisely also means promoting human-AI teamwork rather than replacing human roles entirely. For example, AI tools in agriculture can help farmers improve crop growth while still relying on human knowledge. In creative fields like digital art and music, AI can inspire new ideas without replacing human creativity. By encouraging individuals to build AI skills, Sikh institutions can help communities prepare for the future job market while ensuring technology supports honest work.

FUTURE POSSIBILITIES OF AI IN SIKHI

Looking ahead, AI holds immense potential to further transform Sikhism in various ways:

- **Advanced AI Gurmat Learning Assistants:** AI-powered mentors could provide deeper, real-time insights into Gurbani interpretation, making spiritual teachings more accessible and personalized.

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- **AI-Generated Kirtan Compositions:** Machine learning models could analyze historical Kirtan compositions and generate new ones while preserving traditional Raags and melodies.
- **Enhanced Virtual Sangat Experiences:** AI-driven holograms and immersive AR/VR environments could allow for remote participation in Sikh congregations with a realistic experience.
- **Predictive Analytics for Community Welfare:** AI could anticipate the needs of the Sikh community, optimizing resources for langar, disaster relief, and social programs more efficiently.
- **AI-Driven Documentary and Historical Reconstruction:** AI could recreate lost Sikh historical sites and moments through data-driven visual reconstructions, preserving and showcasing Sikh history for future generations.

ETHICAL AND PHILOSOPHICAL CONSIDERATIONS

Despite AI's benefits, ethical and philosophical challenges must be addressed:

- **Bias in AI Models:** AI models are susceptible to biases that may misinterpret Sikh teachings or present culturally inappropriate responses (Sehgal, 2023) [7].
- **Data Privacy:** AI applications handling Sikh religious data must ensure the privacy and security of user information (Singh, 2021) [8]. Unauthorized access to religious data could lead to misuse or misrepresentation.
- **Dependence on AI:** Over-reliance on AI may lead to a decline in traditional learning methods (McCarthy, 2007) [6]. While AI can aid in knowledge dissemination, human guidance remains essential in spiritual teachings.

AI'S LIMITATIONS IN SPIRITUAL UNDERSTANDING

AI, despite its ability to simulate intelligence, lacks consciousness — a defining element in Sikh teachings. Sikhism emphasizes the soul's divine connection, which cannot be replicated by artificial systems, i.e. AI can process information and simulate intelligence, it cannot understand spiritual depth. Sikhism teaches that true understanding comes from a connection to the divine, something AI cannot replicate. Meditation (*Simran*), selfless service, and inner reflection are personal experiences that go beyond what AI can achieve.

AI lacks consciousness, emotions, and moral awareness — all essential to spiritual growth. Sikhism emphasizes that spiritual awakening arises from divine connection, self-reflection, and ethical living. AI can analyze texts or generate explanations, but it cannot grasp the emotional and spiritual depth conveyed through Gurbani. Understanding the message of love, humility, and compassion in Gurbani requires human awareness and inner realization.

Furthermore, Sikh teachings stress the importance of divine grace (*Gurprasad*), which guides individuals toward spiritual wisdom. This divine guidance cannot be programmed or simulated by AI. While AI may provide useful tools to support learning, true spiritual growth remains deeply personal, requiring mindfulness, prayer, and inner awakening. AI should therefore be seen as a helpful companion to spiritual seekers, not a replacement for human consciousness and spiritual discovery.

CONCLUSION

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AI has the potential to greatly improve access to Sikh teachings, preserve heritage, and promote social good. By embracing AI responsibly, the Sikh community can strengthen its bond with its spiritual roots while benefiting from modern advancements. However, careful implementation is crucial to ensure AI aligns with Sikh principles. Sikh institutions and leaders must collaborate closely with AI developers to ensure tools are created ethically, reflecting values such as compassion, fairness, and respect for humanity. Establishing clear guidelines on AI use within religious contexts will help prevent misuse while ensuring positive outcomes (Sehgal, 2023) [7].

By blending technological advancements with Sikh values, the community can leverage AI to enhance education, preserve cultural identity, and drive social progress. In this way, AI can become a powerful force for upholding Sikh principles while empowering future generations to remain connected with their spiritual and historical roots.

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REIMAGINING EDUCATION IN THE AGE OF AI: A PHILOSOPHICAL EXPLORATION OF HUMAN VALUES AND AGENCY

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ABSTRACT

This paper presents a philosophical exploration of the intersection of Artificial Intelligence (AI) and education, examining the complex interplay between technological advancements and human values. As AI-powered tools increasingly permeate the learning landscape, fundamental concerns regarding the nature of autonomy, agency, and the goal of education are brought up in the educational scenario. It is crucial to look into how AI is rethinking educational procedures, revamping learning settings, and ultimately influencing human values and agency as we stand at the intersection of tradition and technological innovation. In order to provide a nuanced and balanced approach that places a higher priority on human values, agency, and emotional intelligence, this study critically assesses the effects of AI on educational pedagogy, student learning outcomes, and teacher professional development. This study seeks to advance

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knowledge of the intricate connections between technology, people, and learning by investigating the ethical, social, and philosophical ramifications of AI in education.

Key Words: Artificial Intelligence; Education; Human Values; Agency; Philosophical Inquiry; Educational Pedagogy

INTRODUCTION

A new age of technical innovation and pedagogical experimentation has been ushered in by the introduction of Artificial Intelligence (AI), which has completely changed the educational environment. Fundamental concerns concerning the nature of education, the function of instructors, and the future of human learning are brought up by the growing presence of AI-powered gadgets in the classroom. In the midst of this revolutionary change, it is crucial to investigate the intricate relationship between human values and technology progress by critically analysing the relationship between AI and education.

The integration of AI in education has been touted as a panacea for various educational skills, promising personalized learning, improved student outcomes, and enhanced teacher productivity. AI-powered education proponents contend that these tools can assist in resolving persistent problems including insufficient funding, teacher shortages, and achievement gaps. Critics warn that if AI is allowed to spread unfettered in the classroom, it could worsen already-existing disparities, jeopardize human agency, and destroy the fundamental purpose of education.

Given the growing significance of AI in education, it is imperative to examine the underlying presumptions, attitudes, and power structures that influence this phenomenon. What effects would AI-driven education have on human virtues like creativity, empathy, and critical thinking? What effects do AI-powered systems have on the learning process, student autonomy, and instructor professionalism? What are the possible drawbacks and advantages of depending on AI to propel innovation in education?

Theoretical Frameworks

This exploration incorporates ideas from a number of philosophical traditions, such as:

1. Existentialism: By emphasizing human freedom and agency, existentialist ideology highlights the importance of human values and meaning-making in the context of technological advancements.
2. Phenomenology: Phenomenological research emphasizes the complex relationship between learning, technology, and human existence by focusing on the real experience of education..

3. Critical Theory: By analysing the power dynamics and social implications of artificial intelligence in education, critical theory provides a framework for investigating how technological advancements impact human values and agency.

Human Values in the Age of AI

1. Autonomy

The integration of AI in education raises concerns about the impact on human autonomy and agency. Autonomy refers to the ability to make decisions and act independently, while agency refers to the capacity to take intentional action (Bandura, 2006).

AI-driven educational systems can potentially undermine autonomy and agency in several ways:

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- Algorithmic decision-making: AI systems can make decisions on behalf of students, such as grading assignments or recommending learning pathways, which can reduce student autonomy (Williamson, 2019).
- Personalized learning: While personalized learning can be beneficial, it can also lead to a lack of student agency, as the learning path is predetermined by the AI system (Selwyn, 2019).

However, some studies suggest that AI can also enhance autonomy and agency:

- AI-powered learning analytics: Learning analytics can provide students with insights into their own learning, enabling them to take more control over their learning process (Ferguson, 2012).
- AI-facilitated collaborative learning: AI can facilitate collaborative learning by providing tools for students to work together on projects, promoting autonomy and agency (Roschelle et al., 2017).

2. Creativity

The impact of AI on human creativity in education is a topic of ongoing debate. Some argue that AI can enhance creativity, while others claim that it can diminish it.

AI can potentially enhance creativity in several ways:

- AI-powered generative tools: Generative tools, such as AI-powered writing assistants, can provide students with new ideas and inspiration, enhancing their creative potential (Bryant, 2019).
- AI-facilitated collaboration: AI can facilitate collaboration among students, promoting the exchange of ideas and the development of creative solutions (Roschelle et al., 2017).

However, others argue that AI can also diminish creativity:

- Algorithmic thinking: Over-reliance on AI can lead to algorithmic thinking, where students focus on following rules and procedures rather than exploring new ideas (Papert, 1980).
- Homogenization of ideas: AI-powered educational tools can lead to the homogenization of ideas, as students are presented with similar information and prompts (Selwyn, 2019).

3. Empathy

The impact of AI on human empathy and social skills in education is a growing concern. Empathy refers to the ability to understand and share the feelings of others.

AI-powered educational tools can potentially influence empathy and social skills in several ways:

- Social isolation: Over-reliance on AI-powered educational tools can lead to social isolation, reducing opportunities for students to develop empathy and social skills (Turkle, 2015).
- Lack of human interaction: AI-powered educational tools can lack the human interaction and emotional intelligence that is essential for developing empathy and social skills (Goleman, 1995).

However, some studies suggest that AI can also enhance empathy and social skills:

- AI-powered virtual agents: Virtual agents can provide students with a safe and controlled environment to practice social skills and develop empathy (Kim et al., 2017).
- AI-facilitated collaborative learning: AI can facilitate collaborative learning, promoting social interaction and empathy among students (Roschelle et al., 2017).

Agency

1. Human Agency

Human agency refers to the capacity of individuals to make choices, act intentionally, and shape their own lives.

The increasing use of AI in education raises concerns about the impact on human agency:

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- Algorithmic control: AI systems can exert control over educational processes, potentially limiting human agency and autonomy.
- Data-driven decision-making: The reliance on data-driven decision-making can also reduce human agency, as decisions are made based on algorithms rather than human judgment.

2. Student Agency

Student agency refers to the capacity of students to take control of their learning, make informed decisions, and shape their educational experiences (Biesta & Tedder, 2007). AI can both enhance and diminish student agency:

- Personalized learning: AI-powered personalized learning can provide students with more autonomy and control over their learning pathways (Fisher & Kendeou, 2018). However, if not designed carefully, personalized learning systems can also limit student agency by restricting their choices and creativity (Selwyn, 2019).
- AI-assisted learning: AI can assist students in their learning by providing real-time feedback, suggestions, and guidance (Knewton, 2018). However, over-reliance on AI-assisted learning can create a sense of dependence, reducing student agency and motivation (Deci & Ryan, 2000).

3. Teacher Agency

Teacher agency refers to the capacity of teachers to make informed decisions, take control of their teaching practices, and shape their own professional development (Priestley et al., 2012). The use of AI in education can impact teacher agency:

- AI-powered teaching tools: AI-powered teaching tools can enhance teacher agency by providing them with more resources, support, and data-driven insights (Luckin et al., 2016). However, if not designed carefully, these tools can also limit teacher agency by restricting their autonomy and creativity (Selwyn, 2019).
- Data-driven teaching: The reliance on data-driven teaching can also reduce teacher agency, as decisions are made based on algorithms and data analysis rather than human judgment and professional expertise (Williamson, 2017).

Philosophical Perspectives

1. Existentialism

Existentialist philosophy emphasizes human existence, freedom, and responsibility (Sartre, 1943). In the context of education, existentialism highlights the importance of human agency, autonomy, and responsibility (Kierkegaard, 1849). The increasing use of AI in education raises existentialist concerns:

- **Human existence:** The reliance on AI-powered educational tools can lead to a sense of detachment from human existence, reducing the importance of human agency and autonomy (Heidegger, 1953).
- **Freedom and responsibility:** AI can limit human freedom and responsibility, as decisions are made based on algorithms rather than human judgment (Sartre, 1943).

2. Phenomenology

Phenomenological philosophy focuses on the lived experience of individuals, examining how they perceive, experience, and interpret the world around them (Husserl, 1913). In the context of education, phenomenology highlights the importance of understanding the lived experience of students and teachers:

- **-Lived experience of learning:** Phenomenology emphasizes the importance of understanding the lived experience of learning, including the emotional, social, and cognitive aspects (van Manen, 2014).

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- **Teacher-student relationship:** Phenomenology also highlights the importance of the teacher-student relationship, emphasizing the need for empathy, understanding, and human connection (Buber, 1958).

3. Critical Theory

Critical theory philosophy examines the power dynamics and social implications of technological advancements, including AI (Habermas, 1984). In the context of education, critical theory highlights the importance of examining the power dynamics and social implications of AI:

- **Power dynamics:** Critical theory emphasizes the importance of examining the power dynamics between students, teachers, and AI systems, highlighting issues of control, agency, and surveillance (Foucault, 1977).
- **Social implications:** Critical theory also highlights the social implications of AI in education, including issues of equity, access, and bias (Bowles & Gintis, 1976).

To maintain a neutral and balanced approach to using AI in education, consider the following strategies:

 # Emphasizing Human Values

- Prioritize human interaction: Ensure that AI-powered tools complement, rather than replace, human interaction and relationships in the learning process.
- Foster critical thinking and media literacy: Encourage students to think critically about the information they receive from AI-powered sources and to develop media literacy skills.
- Promote empathy and emotional intelligence: Incorporate AI-powered tools that promote empathy, emotional intelligence, and social skills development.

 # Encouraging Transparency and Accountability

- Provide transparent explanations: Ensure that AI-powered decisions and recommendations are transparent, explainable, and accountable.
- Regularly evaluate and audit AI systems: Regularly assess AI-powered educational tools and systems to ensure they are functioning as intended and not perpetuating biases or errors.
- Foster a culture of accountability: Encourage educators, developers, and students to take responsibility for the ethical implications of AI-powered educational tools.

 # Supporting Human Agency and Autonomy

- Empower student autonomy: Design AI-powered educational tools that promote student autonomy, agency, and self-directed learning.
- Provide choices and options: Offer students choices and options when using AI-powered educational tools, allowing them to take ownership of their learning.
- Foster teacher agency and professionalism: Support teachers in developing the skills and knowledge needed to effectively integrate AI-powered tools into their practice.

 # Encouraging Continuous Reflection and Improvement

- Regularly reflect on AI-powered educational tools Motivate students, instructors, and developers to consider the efficacy and morality of AI-powered educational tools on a regular basis.
- Gather feedback and iterate: To make sure AI-powered learning resources satisfy the needs of all users, get input from stakeholders and make necessary iterations.
- Keep abreast of developments in AI research and development: Keep up with the most recent findings and advancements in AI and education to make sure AI-powered learning resources are reliable and efficient.

By adopting these strategies, a neutral and balanced approach can be maintained to using AI in education, prioritizing human values, transparency, accountability, and continuous reflection and improvement.

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CONCLUSION

Artificial Intelligence (AI) in education has changed the way that people learn and brought up important issues regarding human values, agency, and the basic goal of education. Even though AI has many advantages, including automated grading, individualized learning, and improved accessibility, it also seriously threatens human values like empathy, creativity, and autonomy. We can build more effective, efficient, and inclusive learning environments by utilizing AI in ways that put human values, responsibility, and transparency first. As we proceed, we must continue to be watchful, assessing AI's effects on education critically and making sure that technology developments contribute to, rather than detract from, human life. Maintaining human values and agency while using AI is crucial, as you said, we cannot ignore the importance of being human.

This will allow us to: Enhance human agency: Empower students and teachers to take control of their learning and teaching practices; Foster creativity and empathy; Encourage creative thinking, empathy, and social skills in students; Promote equity and inclusion: Ensure that AI-powered educational tools and systems are transparent, accountable, and fair.

Ultimately, the effective integration of AI in education requires a nuanced understanding of its implications on human values and agency. By embracing this complexity and prioritizing human values, we can create an education system that leverages the potential of AI to enhance human flourishing, rather than diminishing it.

Maintaining human values and agency while using AI is crucial, as you said, we cannot ignore the importance of being human.

FUTURE DIRECTIONS

Examining the implications of AI for human values and agency in education from a philosophical perspective is a fertile area for future research. This could entail creating and deploying AI-powered solutions that uphold human ideals like empathy, creativity, and independence as well as assessing how well they work to advance these ideals. Furthermore, as teachers are crucial in moderating the effects of AI on pupils, it is imperative to investigate how teacher agency shapes the impact of AI on human values and agency.

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