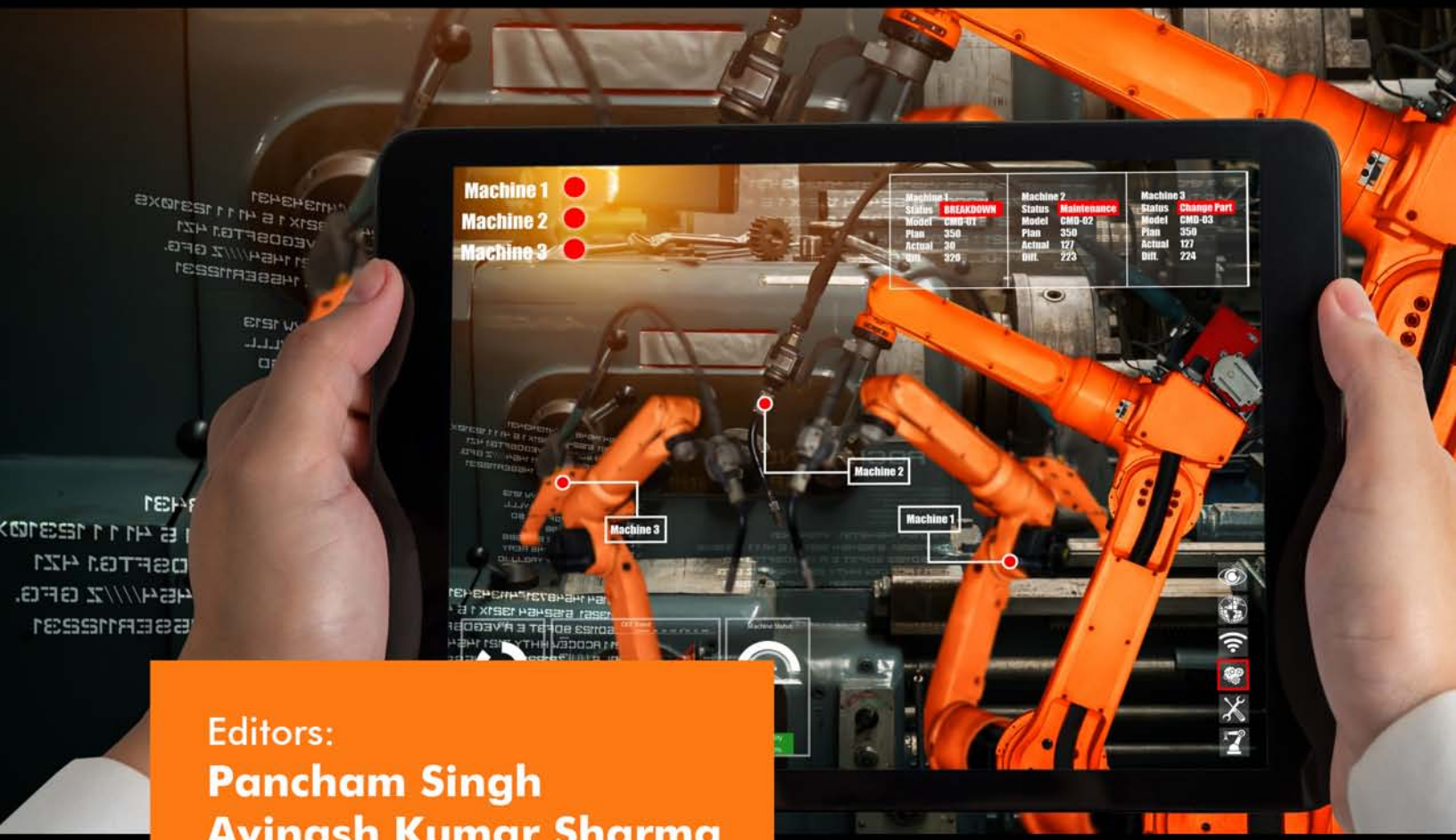
APPLICATION OF ARTIFICIAL INTELLIGENCE IN PRODUCTION AND SERVICES



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FOREWORD

In the rapidly evolving landscape of technology, few fields have captured the imagination and potential of industries and societies alike as profoundly as Artificial Intelligence (AI). The transformative power of AI lies not only in its ability to revolutionize processes and create new opportunities but also in its capacity to redefine what is possible across a multitude of sectors. It is with great enthusiasm that I introduce Application of Artificial Intelligence in Industry and Services, a timely and comprehensive resource that addresses the growing need for accessible, practical knowledge in this critical field.

As someone who has dedicated a significant part of my career to exploring and advancing the frontiers of AI, I am particularly impressed by the scope and depth of this book. The editors, Pancham Singh, Mrignainy Kansal, Dr. Avinash Kumar Sharma, Dr. Ritu Sibal, and Dr. Amarjeet Prajapati have brought together a collection of insights that not only demystify AI but also highlight its real-world applications across various industries. This is a book that speaks to both the novice and the expert, offering clear explanations of complex concepts while simultaneously pushing the boundaries of what we understand about AI's role in modern industry and services.

One of the standout aspects of this book is its focus on practical applications. In a real world where AI is increasingly integrated into everyday processes from healthcare and agriculture to manufacturing and digital marketing, it is crucial that we understand not just the theory behind AI, but also how it is being utilized to drive innovation and efficiency. This book succeeds in bridging the gap between abstract concepts and tangible outcomes, providing readers with a roadmap for how AI can be leveraged to meet real-world challenges. Moreover, the editors have wisely included discussions on some of the most cutting-edge and forward-thinking areas of AI research, such as quantum computing and sustainable AI practices. These fields represent the next wave of technological advancement and are critical for anyone looking to stay ahead of the curve. The inclusion of these topics underscores the book's relevance and its importance as a resource for those who are serious about understanding the future of AI. In addition to its technical and practical insights, this book also addresses the broader ethical and societal implications of AI. As AI continues to permeate more aspects of our lives, it is imperative that we consider the impact of this technology on individuals, communities, and the environment. The discussions in this book encourage readers to think critically about these issues, fostering a more holistic understanding of AI's role in society.

It is my belief that the *Application of Artificial Intelligence in Industry and Services* will become an essential reference for anyone involved in AI, whether they are students, researchers, or industry professionals. The knowledge contained within these pages is not just valuable, it is necessary for anyone looking to navigate the complex and ever-changing landscape of AI. I commend the editors and contributors for their outstanding work in creating a book that is both informative and inspiring. It is a privilege to write this foreword and to endorse a book that I am confident will have a lasting impact on the field of Artificial Intelligence.

Girija Chetty
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PREFACE

In an era where technology is rapidly evolving and integrating into every facet of our lives, Artificial Intelligence (AI) stands out as one of the most transformative and influential fields. The journey of AI, from its inception to its current state, has been marked by ground breaking discoveries, innovative applications, and profound societal impacts. This book, titled Application of Artificial Intelligence in Industry and Services, seeks to illuminate the latest developments in AI, offering a comprehensive guide that bridges the gap between theoretical knowledge and practical applications.

The primary aim of this book is to demystify the complexities of AI, making it accessible to a broad audience, including students, professionals, and experts who are keen to explore the frontiers of AI research. We have endeavoured to present AI concepts in a clear, straightforward manner, ensuring that readers of varying expertise levels can grasp the fundamental and advanced concepts in the subject.

One of the key features of this book is its focus on practical applications. Each chapter delves into how AI is revolutionizing different industries, from healthcare and robotics to environmental science and sustainable development. By showcasing real-world examples, we hope to demonstrate the tangible benefits and challenges of AI, emphasizing its relevance in today's global landscape.

Moreover, this book explores emerging trends that are shaping the future of AI, such as the intersection of quantum computing and AI, as well as the rise of sustainable AI practices. These discussions are not just technical; they also touch upon the ethical implications of AI, prompting readers to consider the broader impact of this powerful technology on society.

As we look ahead, the potential of AI appears boundless. This book concludes with speculative discussions on where AI might be headed, aiming to spark the imagination of our readers and encourage forward-thinking dialogue.

We believe this book will serve as a valuable resource for anyone interested in understanding and leveraging AI in their respective fields. Whether you are an academic, a practitioner, or simply someone curious about AI, we hope this book will inspire you to engage with AI in meaningful and impactful ways.

We are grateful to the contributors and experts who have shared their knowledge and insights, making this book a comprehensive and authoritative guide to the world of AI. We hope that as you turn the pages, you find the clarity, inspiration, and depth that you seek in your journey through the fascinating realm of Artificial Intelligence.

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CHAPTER 1

A Journey Through the Evolution of Code Smell Detection Tools and Techniques

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Abstract: Code smells are prevalent indicators of suboptimal design implementation within source code. Detecting and refactoring these smells can significantly improve code quality and maintenance ease, while neglecting them can amplify technical debt and render systems obsolete. In recent years, researchers have contributed diverse techniques and tools to facilitate the identification of code smells. This article comprehensively reviews the current state-of-the-art strategies for code smell detection. It scrutinizes findings from fifty-eight studies spanning the period from 2004 to 2024. The article provides an inventory of available code smell detection tools, delving deeply into their principal features, detection strategies, and prospects of availability. The study identifies promising avenues for improving code-smell detection tools and proposes directions for future research. The insights and recommendations presented in this chapter serve as a compass for developers and researchers, guiding them in creating and adopting code-smell detection tools, ultimately advancing the quality and maintainability of software systems.

Keywords: Code smell detection, Literature review, Machine learning, Software maintainability, Tool evaluation.

INTRODUCTION

Software systems are embedded in our day-to-day lives, and their importance continues to grow as technology advances. Developing and maintaining them requires lots of time, capital, and effort. Unfortunately, they become obsolete over time; one reason is the ignorance of code smells. A code smell is a structural flaw in source code that violates fundamental design principles [1]. The presence of code smells can reduce maintainability, readability, and reusability, degrade system performance, prevent changes, and increase technical debt. Code smells should always be addressed, as they can result in future errors, defects, and faults.

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Unlike syntax errors, which are easily detectable by compilers, smells are difficult to spot but are a necessary component of the maintenance phase [2]. A complete list of code smells and their categorization is presented in Table **1**.

Table 1. Definition and categorization of code smells.

Code Smell	Definition and Examples
Bloaters	Gigantic classes or methods that become difficult to understand and manage. *e.g.* - Long Method **(LM)**, Large Class **(LC)**, Primitive Obsession **(PO)**, Long Parameter List **(LPL)**, Data Clumps **(DCL)**.
Object-Oriented Abusers	Incomplete or incorrect employment of object-oriented programming principles. *e.g.* - Alternative Classes with Different Interfaces **(ACDI)**, Refused Bequest **(RB)**, Switch Statements **(SS)**, Temporary Field **(TF)**.
Change Preventers	To introduce change, one has to change other modules. *e.g.* - Divergent Change **(DIC)**, Parallel Inheritance Hierarchies **(PIH)**, Shotgun Surgery **(SHS)**.
Dispensable	Superfluous code, like dead or duplicated code. *e.g.* - Comments, Duplicate Code **(DUC)**, Data Class **(DC)**, Dead Code **(DEC)**, Lazy Class **(LAC)**, Speculative Generality **(SG)**.
Couplers	Significantly interdependent classes and methods that share too many objects and data. *e.g.* - Feature Envy **(FE)**, Inappropriate Intimacy **(II)**, Incomplete Library Class **(ILC)**, Message Chains **(MC)**, Middle Man **(MM)**.

Code smell can occur for various reasons, such as poorly structured or poorly designed code that results in complex or redundant code, making it difficult to maintain and update. Overly complex logic, a lack of abstraction and testing, and quick fixes and short-term solutions are other reasons that contribute to the problem. Code written by developers with different coding styles and practices can lead to code smells, as it can be challenging to maintain consistent coding standards.

Detecting code smells in software systems can be a challenging task due to several factors, including:

Code complexity: As software systems grow in size and complexity, it becomes more difficult to detect code smells because they can be hidden in convoluted code structures.
Contextual knowledge: Code smells can be highly contextual, meaning that they may not be easily detected by automated tools without an understanding of the code's intended functionality and design.
False positives and false negatives: Smell detection tools may produce false positives (*i.e.*, identifying code smells that are not actually present) or false negatives (*i.e.*, missing code smells that are actually present), leading to incorrect or incomplete assessments of the code quality.

Lack of standardization: Code smells are not standardized, and different experts may use varying definitions and criteria for identifying them, leading to inconsistent detection.

Tool limitations: Some smell-detection tools may be limited in their ability to detect certain types of code smells or may not support all programming languages, making them challenging to use across different software development contexts.

Addressing these challenges requires a multifaceted approach that combines automated smell-detection tools with manual code reviews by experts with a deep understanding of the code's design and intended functionality. It also requires continuous learning and improvement of the code smell detection tools to increase their accuracy and reduce false positives and negatives.

Code refactoring can be done to address smells and improve the code base [3]. Refactoring is a quick, small strategic change to code to eliminate code smells. It modifies the internal structure without changing the exterior functionality. It can be done during code reviews, fixing or troubleshooting errors, and incorporating new features. As a result, the system's internal structure becomes more robust, readable, efficient, maintainable, and less complex. It improves overall performance, scalability, and security, and reduces entropy, coupling, and rigidity in the system. It can be done manually or with the aid of tools. There are risks involved in refactoring [4]. It may require significant changes to existing code, which can disrupt ongoing development activities. It can introduce new bugs or break existing functionality, especially if the refactoring is not thoroughly tested. It can be time-consuming and require significant resources like development time, testing, and code review. It can sometimes lead to code that is more complex and harder to maintain, rather than improving the quality of the code [5]. Without clear goals, refactoring can lead to wasted effort or, even worse, introduce bugs. In conclusion, while refactoring can lead to significant benefits, weighing each risk and approaching it carefully, with a clear goal and a solid testing plan to avoid potential issues, is crucial.

RELATED WORK

There is a wide variety of literature reviews that pointed out current gaps in research, pros and cons of code smell detection tools, most widely analyzed smells, refactoring practices, and the impact of smells on quality attributes. Some of the related studies are presented below.

Mens [6] presented a comprehensive overview of research on software refactoring and restructuring. The classification was based on five criteria: supported refactoring activities, techniques, artifact types, tool development considerations,

CHAPTER 2

A Novel Extraction of Features for a Speech Recognition System in a Noisy Environment using Machine Learning

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Abstract: Speech has played a significant role in human communication from the dawn of civilization. Emotions should be naturally conveyed in spoken communication. The use of voice to determine human emotions in automated technologies is unreliable. To comprehend human thought processes, a machine must first grasp the aural capacities of the human ear. The processing of emotions enhances the authenticity and importance of contemporary speech technologies. Spectral properties play a crucial role in classifying audio signals. This study focuses on extracting spectral information from speech, specifically pitch and Mel-frequency components. Cepstral coefficients, also known as Mel-frequency cepstral coefficients (MFCCs) and Linear Prediction Cepstral Coefficients (LPCCs). The LPCC coefficients are utilized to achieve emotion categorization. Prior to choosing CAT Boost as the classifier, we compared and analyzed other techniques. A speech emotion database, consisting of over 100 individuals exhibiting a wide range of emotions, is used for training and testing. A supplementary voice database derived from a multitude of movie snippets is used to enhance the authenticity of the vocal output.

Keywords: Artificial intelligence, Authentication, CAT Boost, LPCC, MFCC, Spectral features.

INTRODUCTION

Speaking is a means of interpersonal interaction. Each word that is spoken is formed by phonetically combining a set number of vowels and syllable speech sound elements. Human languages come in tens of thousands of variants, many of which are mutually unintelligible due to differences in vocabulary, grammatical

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organization, and the collection of speech sounds [1]. The majority of polyglots, or speakers of several human languages, are able to converse in two or more of them. Humans can sing because they possess the same vocal skills that allow them to speak.

In many cultures, the language of writing originated from speech, which frequently differs from a similar spoken language with respect to grammar, spelling, and phonetics. This phenomenon is referred to as diglossia. According to certain experts in psychology, speaking functions as a conversation within the neural network to enhance and structure understanding [2]. While also serving as a medium of communication. Speech is most commonly utilized in interactions, or the process of transmitting messages. Both the total amount of knowledge included in the communication, expressed as an ensemble of discrete characters and the rate at which knowledge is communicated can be expressed in words and bits per second (bps). Speech recognition systems have significantly evolved over the past few decades, becoming an integral part of modern technology. Features include artificial intelligence, mechanized customer service, and hands-free control systems. The ability to accurately recognize and process human speech in real time has opened numerous opportunities for enhanced user experiences and improved accessibility. However, one of the most persistent challenges faced by speech recognition systems is their performance in noisy environments [3]. Background noise can significantly degrade speech recognition accuracy, making it difficult for these systems to distinguish the desired speech signal from surrounding noise. It is shown in Fig. (**1**).

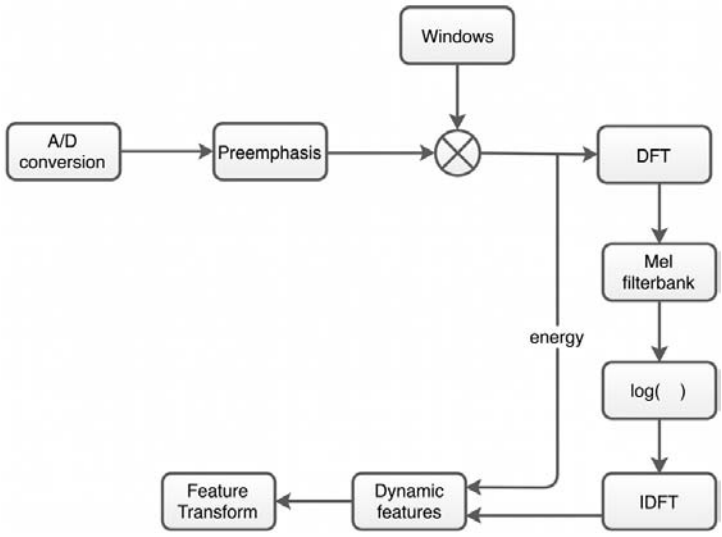

Fig. (1). Signal Processing Flow for Speech Feature extraction.

The process of identifying human emotions is known as emotion recognition. The accuracy with which individuals can gauge the emotions of others varies greatly. The application of technology to assist with emotional identification is a relatively recent field of research. The strategy often works best when it is used in a setting with a variety of modality options. The most focus has been on physiologic mechanisms, as assessed by devices worn, spoken expressions, handwritten responses to text, and gestures in cinematography. Traditional approaches to speech recognition often struggle in noisy conditions due to their reliance on handcrafted features and conventional noise reduction techniques, which may not generalize well across different types of noise and varying acoustic environments. This limitation has driven the exploration of advanced methods that can robustly extract significant characteristics from noisy voice streams to enhance classification performance. Machine learning, particularly deep learning, has emerged as a powerful tool for feature extraction and pattern recognition in complex and noisy data. By leveraging vast amounts of data and the computational power of modern processors, machine learning algorithms can learn to identify intricate patterns and features that are difficult to capture with traditional methods. This has led to significant improvements in speech recognition system performance, especially in challenging acoustic environments.

This chapter delves into the novel extraction of features for a speech recognition system operating in noisy environments, using machine learning. The focus is on identifying and designing prominent features that can enhance the robustness and accuracy of speech recognition systems in the presence of various types and levels of noise. Key goals include developing feature-extraction methods that are not only effective at isolating the speech signal but also computationally efficient and scalable for real-world applications.

Speech recognition in noisy environments remains a significant challenge, as background noise often obscures critical speech features, leading to recognition errors. However, recent advancements in deep learning have introduced powerful methods for overcoming such challenges. One such method, **UIU-Net**, originally designed for infrared small-object detection, has demonstrated remarkable feature-extraction capabilities under difficult conditions [4]. By leveraging advanced Artificial neural networks for language signal interpretation, we can enhance the efficiency of speech recognition systems in noisy settings. These techniques proficiently separate and emphasize the essential characteristics of speech, even amongst considerable activity, thereby enhancing ultimate efficacy in use. During this study, researchers investigated the most effective method for detecting the emotional content of voice signals using a variety of AI architectures. After extensive testing, we advised using this method for speech

CHAPTER 3

AI for Social Goods: Applications in Environment Sciences and Sustainability

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Abstract: The evolution of humanity increasingly relies on the natural environment, yet its future vitality may face constraints due to environmental decline caused by various factors such as population growth, industrialization, and urbanization. This century has seen unprecedented environmental degradation, posing ongoing challenges to life itself. Concurrently, globalization transitioning into digitization has ushered in the era of the Fourth Industrial Revolution, where Artificial Intelligence (AI) plays a crucial role. AI and other advanced technologies are pivotal in enhancing efficiency, speed, and accuracy across various industries and developments. Moreover, AI's integration is crucial for achieving the United Nations Sustainable Development Goals, aiming to improve the quality of life, bolster climate resilience, enhance environmental health, and promote global equity. By 2030, AI is expected to drive environmental intelligence, underpinning efforts towards sustainability. In this context, the focus is on exploring how AI can support environmental sustainability for a brighter future. A critical aspect involves understanding AI's potential in transitioning businesses to a Circular Economy model, particularly in energy management. Through a detailed multi-case analysis spanning different sectors, it is evident that AI positively impacts efficiency and emissions management. This technological intervention aids in mitigating occupational risks associated with hazardous agents, although challenges remain in terms of employee acceptance. These insights are crucial for stakeholders navigating the integration of AI into corporate strategies, highlighting the transformative potential of AI in fostering sustainable practices and outcomes

Keywords: AI tools, Environmental intelligence, Interventions, Machine learning, Sustainability goal.

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INTRODUCTION

Human-induced climate change and environmental degradation are pressing global issues. Advanced technologies, particularly Artificial Intelligence (AI), offer promising solutions to these challenges. AI, with its ability to learn and perform tasks similar to humans, has the potential to lessen our reliance on natural resources and improve environmental governance, thereby supporting more sustainable lifestyles [1]. This study examines AI's potential to address major socio-environmental problems through two case studies. The first case study illustrates how AI can help design and implement strategies to promote pro-environmental behavior in communities. The second case study explores AI-driven methods for efficiently managing wildfires and optimizing renewable energy production. The findings highlight AI's capacity to significantly advance global sustainability efforts significantly, suggesting data-driven interventions and leadership strategies to accelerate progress in mitigating climate change [2].

Humanity is currently facing an unprecedented crisis in the form of climate change, which threatens not only the planet's biodiversity but also the well-being and survival of its inhabitants. This emergency, intensified by decades of unsustainable industrial and economic practices, necessitates urgent and innovative action across all sectors of society, including sustainable economic practices in health and the use of clean resources. Industry 4.0 (I4.0) has introduced a range of innovative tools that could drive the shift towards more sustainable business practices [3].

Artificial Intelligence (AI) is particularly noted for its ability to streamline processes, reduce resource consumption, and enhance decision-making. Despite these advantages, there remains a significant knowledge gap at the business level regarding the concrete and measurable benefits of AI for improving energy efficiency and lowering emissions. This gap is especially notable when considering key strategic factors for businesses, such as product cost, quality, lead time, risk management, and stakeholder satisfaction [4].

Understanding the implications of AI on these variables is crucial for informed decision-making regarding energy efficiency and emission reduction in industrial operations. Efforts to enhance energy efficiency are directly influenced by energy allocations and environmental regulations, which are pivotal in advancing towards a low-carbon energy transition. AI is increasingly recognized as a pivotal tool in addressing the climate crisis. Its potential applications span a wide spectrum: optimizing resource consumption, improving transportation efficiency, enhancing urban planning effectiveness, fostering sustainable energy systems, and even faci-

litating breakthroughs in materials research. However, the environmental impact of AI systems must also be considered critically [5].

The production and operation of AI systems necessitate significant resources. From the mining of rare earths required for hardware components to energy consumption at data centers and the eventual disposal of electronic waste, the lifecycle of AI systems can generate substantial environmental footprints. Improper disposal can further pose risks of chemical releases, undermining environmental sustainability goals [6]. Therefore, while AI holds promise in advancing sustainability efforts, its overall environmental impact must be carefully managed to ensure that its benefits outweigh its resource consumption and emissions, thereby truly contributing to global environmental goals.

Renewable Energy & Clean Fuels

Artificial Intelligence (AI) holds the potential to revolutionize the management of renewable energy through predictive capabilities and intelligent grid systems. By leveraging AI, renewable energy production can be made more efficient and cost-effective. For instance, AI can enhance the accuracy of rainfall predictions, thereby reducing costs and minimizing carbon emissions. Furthermore, AI technologies can optimize energy storage, improve delivery operations, and enhance the reliability and integration of renewable energy sources. These advancements enable dynamic pricing and trading mechanisms that respond effectively to fluctuations in energy demand [7].

An example of AI's impact is IBM's use of AI to enhance rainfall prediction accuracy, resulting in a significant 30% improvement in forecasts. This improvement has led to more efficient operation of their facilities, increased renewable energy production, and reduced carbon emissions [8].

AI for Energy Preservation and Renewable Energy

As the reliability of energy systems and cost management become increasingly critical, optimizing power generation, planning energy storage, and forecasting demand have grown more complex. This challenge is largely due to the rising variability in production and distribution systems, despite the global increase in renewable energy adoption.

Integrating agile supply and demand management is crucial for maintaining stability and efficiency throughout the energy value chain. As electrical grid operations evolve into the digital era, they generate vast amounts of data on energy production and consumption. Effectively analyzing these large data sets enables managers to make quick and informed decisions [9]. Machine Learning

CHAPTER 4

Android Application for Blind People

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Abstract: The visually impaired are people who face many difficulties and are disadvantaged in our society, especially those who live independently without being dependent on others. Technology is shaping the future and changing the way people live. Technology can help people overcome some of these problems. With the voice-based mobile application, where users can tell it to do certain tasks without seeing the application, their lives can be made easier. The project will include two main areas: machine learning research and Android application development. It will include machine learning, data collection, prioritization, model selection, training, evaluation, and deployment. Android application development components will include user interface design, image capture, preprocessing, object detection, post-processing, user interactions, persistent rendering, and integration with other technologies. By combining these two things, we will create an application that can improve the daily life of visually impaired people and make them independent and safe. This project aims to design and develop a mobile application for the visually impaired to help them do the most necessary tasks in daily life demands like scanning any text using the device's camera to read (textbook, newspaper, documents, street address, *etc*.), reading the current location, weather detection, phone battery status, and time and date, *etc*.

Keywords: Assistive technology, Android development, Independent living, Image capture, Machine learning, Object detection, User interface design, Voice-based mobile application, Visually impaired.

INTRODUCTION

The visually impaired are people who face many difficulties and are disadvantaged in our society, especially those who live independently without being dependent on others. This project aims to develop an Android application for object detection that can assist visually impaired individuals in navigating their surroundings. The application will use machine learning algorithms, specifically YOLO (You Only Look Once), to detect objects in real-time from the

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camera feed of a mobile device. The detected objects will be communicated to the user through audio feedback. The project will involve two main components: object detection using machine learning and Android application development [1]. The machine learning component will include data collection, preprocessing, model selection, training, evaluation, and deployment.

Technology is shaping the future and changing the way people live. Technology can help people overcome some of these problems. With the voice-based mobile application, where users can tell it to do certain tasks without seeing the application, their lives can be made easier. This app is for the visually impaired to scan text (books, magazines, documents, addresses, *etc*.) using a camera, read the current location, explore weather, phone battery status, time, and date, and more. The Android application we created for the visually impaired has great potential to be developed and expanded in the future. The visually impaired are people who face many difficulties and are disadvantaged in our society, especially those who live independently without being dependent on others. Technology is shaping the future and changing the way people live. Technology can help people overcome some of these problems [2]. With the voice-based mobile application, where users can tell it to do certain tasks without seeing the application, their lives can be made easier. This project is for the visually impaired to scan text (books, magazines, documents, addresses, *etc*.) using a camera, read the current location, explore weather, phone battery status, time, and date, and more.

Our mobile phone Android app is designed to serve not only blind people, but also older people with vision problems. This kind of help for the visually impaired already exists, but differently,*i.e* Make My Eyes. Make My Eyes is a free mobile application with one goal: to make the world accessible to the blind and visually impaired [3]. The app connects blind and visually impaired people with volunteers and companies from around the world through live calls. Since its inception in January 2015, 5,969,805 volunteers have signed up to help blind and visually impaired users [4, 5]. Be My Eyes users can request help in over 180 languages, making the app the largest online community for the blind and low vision and one of the largest organizations in the world. Volunteers enter Make My Eyes to lend their eyes to the blind and see some to work together and solve problems [6]. The story of Be My Eyes began in 2012 with Hans Jorgen Wiberg, a Danish furniture engineer who is also visually impaired. Through her work with the "Danish Association for the Blind," she realized that blind or visually impaired people often need some help with their daily work. However, it was not until a blind friend told him that he could use the phone to communicate with family and friends who could help him with these tasks. The idea for Be My Eyes belonged to Hans Jorgen [7]. Rather than relying on friends and family, using a

network of people who can help, he believes telephone technology can be used to help people who are blind or visually impaired.

Objectives

The main objectives are that we focus on various areas of this application, including the creation of Smart Calculator, Smart Reader, Text-to-Speech, and Smart Voice Assistant as follows:

OCR Reader: The purpose of OCR is to successfully edit or convert any type of text or text to written. Documents containing text, such as printed or scanned text, are converted to digital text, which can be modified for deepening and further processing.
Calculator: The purpose of the calculator is to get the result and convey it to a blind person *via* text-to-speech so that the user does not need to do any business touches.
Weather: The purpose of the weather function is to show the user current weather information by taking the user's location name.

Second Goal: This project also aims to provide a good GUI for humans, which includes different functions such as reading the current user's battery percentage, reading Weather content, reading history, and a voice-based calculator to calculate simple numbers. It is done by the user, making the user interaction as easy, interactive, and efficient as possible to make the project a good client [8]. The project also looks forward to making a difference in society by making small donations to make a big difference and help those in need.

Purpose and Scope

There are more than 253 million blind or low-vision people in the world. To make the world more accessible to them, we need to create tools that can adapt to the situation that surrounds us. The project was designed with the daily struggles of blind and visually impaired people, such as reading, current location, weather detection, phone battery status, time, and date [9]. This application contains Google Voice input. Blind users need to speak some words to open special functions to help people. This application can also be used for people who are always there. Many visually impaired people make their lives easier thanks to these applications. Thanks to these applications, the lives of many visually impaired people have become easier. Being able to read something that is only in the field of vision is a task that may require a blind person to seek help from others. In the Google Voice Typing app, visually impaired users say a few words to activate special features.

CHAPTER 5

Application of AI in the Education Sector with special Reference to India and the USA

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Abstract: Artificial Intelligence (AI) is reinventing student learning and instructor instruction, and quickly changing the education sector. This study examines the various applications, challenges, and future directions in the Education Sector, with special reference to India and the USA. AI-driven platforms enable customized tutoring, tests, and feedback in adaptive learning settings that address the needs of each individual learner. Furthermore, by automating repetitive tasks such as scheduling and grading, AI improves administrative efficiency and frees up teachers' time to focus on student engagement and innovative teaching methods. This paper outlines the current state of artificial intelligence in the education sector, along with the opportunities and challenges that lie ahead for its application and advancement.

Keywords: Artificial Intelligence (AI), Adaptive learning environments, Education, Education sector, Learning.

INTRODUCTION

Artificial Intelligence (AI) has become a key technological development with significant effects across education and many other fields. AI-driven innovations have begun transforming traditional educational processes over the last few years, opening new possibilities for pedagogical insights, administrative efficiency, and individualized learning. Artificial Intelligence (AI) technologies are multifaceted, ranging from large-scale dataset analysis to interactive natural language processing systems and machine learning algorithms [1]. Adaptive learning environments that accommodate the unique requirements and preferences of each student are made possible by utilizing these skills in education. Based on real-time

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evaluations of students' performance, AI-driven tutoring systems can offer individualized feedback and customize learning paths.

Furthermore, by automating repetitive tasks such as monitoring student records, scheduling, and assessment grading, AI improves administrative efficiency. Researchers [2] found that automation frees up more time for educators to focus on instructional design and student interaction while also lessening their administrative workload. Even with these developments, there are still obstacles and moral dilemmas with using AI in the classroom. A study in [3] suggested that thoughtful deliberation is necessary regarding matters such as data privacy, algorithmic bias, and the fair allocation of AI resources to educational institutions and students.

Globally, Artificial Intelligence (AI) is transforming the education industry, with profound effects on both industrialized countries like the US and developing ones like India. AI is increasingly used in the US to improve administrative efficiency and individualized learning experiences. Personalized learning environments and the ways students engage with instructional materials are being transformed by initiatives such as AI-powered tutoring systems and adaptive learning platforms [4]. According to Artificial Intelligence (AI), technologies facilitate administrative processes by automating tasks such as scheduling, grading, and data management. This allows educators to concentrate more on teaching and student growth. In an educational system as diversified and resource-rich as the US one, this efficiency is essential [5].

On the other hand, India, with its enormous and varied educational landscape, is also adopting AI to solve issues with scale, quality, and accessibility. According to [6], AI-driven projects in India include tailored learning platforms that address a range of learning demands and regional languages. Furthermore, AI is changing Indian educational assessments so they are more responsive to student learning outcomes and adaptive [7]. However, when it comes to ensuring equitable access to AI-powered educational materials, responsibly employing AI, and addressing concerns about computational bias and data privacy, both countries face comparable challenges [8].

REVIEW OF AI IN EDUCATION

The field of education has a revolutionary opportunity in the realm of Artificial Intelligence (AI). Both India and the USA are investigating AI tools and technologies for the purposes of individualized learning, increased administrative effectiveness, and better educational results. This review highlights the parallels and discrepancies between these two nations' approaches to the integration of AI in education.

For both India and the USA, determining the unique demands of respective educational institutions is an essential first step. Personalized learning opportunities, administrative task simplification, student support, and instructor empowerment are a few examples of these needs [9]. Institutions need to identify their AI integration goals and objectives before setting any. Another crucial factor to consider is the availability of resources (money, technology, and teacher preparation) [10]. According to studies, schools in the USA prioritize individualized learning platforms and AI-powered tools to support educators, whereas schools in India appear particularly interested in bridging the access divide through online platforms [11, 12]. The analysis of related documents per year is shown in Fig. (**1**).

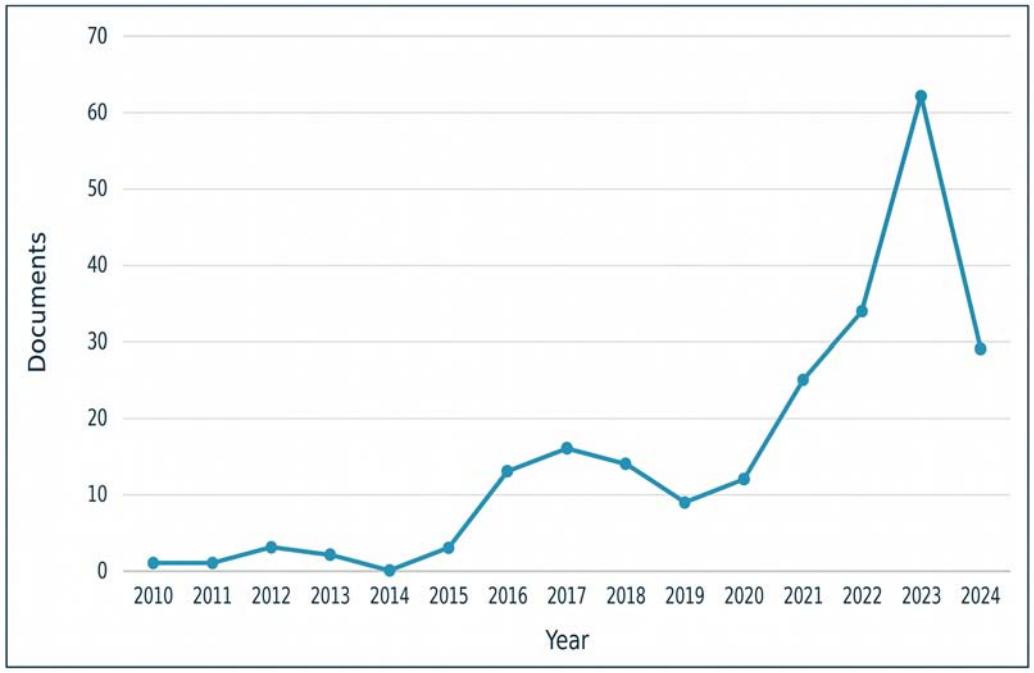

Fig. (1). Analysis of related documents per year.

Figs. (**1** and **2**) show that most of the research articles have been published in 2023 from 2010 to 2024. The USA had the highest number of documents during that time, and after that, India ranked 2 in research publications. From these total publications, some reference papers are discussed below:

CHAPTER 6

Artificial Intelligence (AI) Powered Pedagogy: Transforming Education Through Personalization and Automation

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Abstract: The incorporation of Artificial Intelligence (AI) into educational systems marks a transformative era, promising to reshape both students' learning journeys and educators' teaching methodologies. This chapter embarks on a comprehensive exploration of AI's multifaceted contributions to education, spanning diverse realms. Initially, it delves into the realm of individual learning experiences guided by AI algorithms. These algorithms adapt in real-time to the different needs and preferences of students individually, enhancing learning outcomes and cultivating a more engaging educational experience. Moreover, the chapter delves into the realm of administrative automation facilitated by AI-powered educational tools. These tools streamline cumbersome tasks such as grading assessments, managing administrative workflows, and providing instantaneous feedback. By automating these processes, educators can devote more time and energy to focus on the essential aspects of teaching and mentoring, thereby nurturing a more enriched educational environment. Furthermore, the chapter explores the expansive terrain of AI's role in content creation, curation, and recommendation. AI-driven platforms have the capacity to synthesize and curate vast repositories of educational materials, tailoring the content to match the different styles and preferences for learning. This not only provides an enriched learning experience but also enhances critical thinking skills by presenting students with diverse perspectives and resources. In tandem with these advancements, the chapter meticulously examines the ethical dimensions and complexities involved in incorporating AI into educational settings. Emphasizing principles of transparency, equity, and data privacy, it underscores the imperative of navigating these ethical considerations to ensure that AI-driven educational initiatives remain ethically sound and socially responsible. Finally, the chapter underscores the imperative of collaborative efforts among educators, technologists, policymakers, and other parties to fully leverage AI's potential in education. By fostering robust partnerships and interdisciplinary dialogue, stakeholders can collectively navigate challenges, leverage opportunities, and steer the trajectory of education towards a more innovative and inclusive future for future generations.

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Keywords: Artificial Intelligence (AI), Adaptive algorithms, Critical thinking skills, Education, Grading, Personalized learning.

INTRODUCTION

Most significantly, Artificial Intelligence in education represents a new product for the process of teaching and learning, which has unleashed innovation and opportunity within the classroom. Modern AI indeed has enormous, transformative potential; one that can change educational practices from personalized learning experiences to even automated administrative tasks. It is through such capabilities in leveraging machine learning algorithms and data analytics that AI can provide educational content best suited to students' individual needs and learning styles, optimize and design the process for content creation and curation, and also reduce administrative loads on teachers [1]. Such an integration not only improves the efficiency and effectiveness of teaching and learning but also opens the door to new pedagogical approaches and opportunities for educational equity and inclusion. As AI continues to evolve and permeate educational systems worldwide, it is essential to explore its multifaceted contributions and navigate the ethical considerations to ensure that AI-driven educational initiatives uphold principles of fairness, transparency, and student well-being [2]. It is in this chapter that the full depth of promises, challenges, and implications is undertaken toward the integration of AI in education, aiming to illuminate the path toward a more innovative, inclusive, and impactful educational future.

Importance of Artificial Intelligence Integration in Education

Incorporating Artificial Intelligence (AI) into education is increasingly recognized as a pivotal step in revolutionizing traditional teaching and learning methods (Fig. **1**). Integrating AI into education holds immense importance in shaping the future of learning. AI has the capacity to personalize education, catering to the particular needs and learning preferences of individual students [3]. Through analyzing extensive data, AI can pinpoint areas where students face challenges and offer precise interventions to aid their learning. Additionally, AI-driven tools can streamline administrative duties for educators, enabling them to dedicate more time to teaching and guiding students [4]. AI might also increase accessibility of education by providing resources and aid to learners, independent of geographical location or physical abilities. By adopting AI in education, it will be easy to create learning environments that are inclusive, adaptive, and efficient at helping students succeed in the fast-changing world.

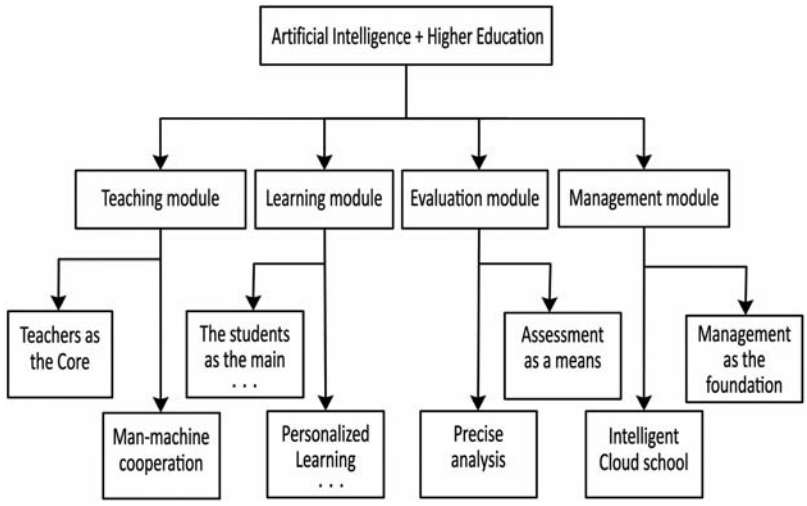

Fig. (1). The integration of artificial intelligence in education.

Personalized Learning: AI enables the creation of customized learning experiences that account for every student's individual needs, preferences, and learning styles. By analyzing student performance and behavior data, AI algorithms can adapt instructional content, pacing, and support mechanisms, thereby optimizing learning outcomes for diverse learners.

Efficiency and Automation: AI streamlines administrative tasks for educators, such as grading assignments, managing workflows, and providing feedback. This automation allows teachers to dedicate more time to higher-value activities, such as personalized instruction, mentoring, and fostering students' critical thinking skills.

Access to Quality Education: AI-powered educational platforms can make high-quality resources and instruction available to everyone, regardless of location or socioeconomic background. By providing personalized, interactive online learning experiences, AI helps bridge gaps in educational access and promotes lifelong learning opportunities for all.

Innovation in Content Creation: AI facilitates the creation, curation, and recommendation of educational content, from adaptive learning modules to interactive simulations. It improves the range and accessibility of educational materials and makes learning more interesting, relevant, and effective for students.

Ethical Considerations and Accountability: AI integration in education demands deliberation on ethical implications: data privacy, algorithmic bias, and

CHAPTER 7

Automated Transcription System for Medical Prescriptions: Merging Technology and Healthcare

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Abstract: The project of machine-generated transcription based on prescriptions centers on the development of an automated transcription system tailored for medical prescriptions using machine learning techniques. By merging technology and healthcare, this initiative aims to streamline and enhance the often laborious and error-prone process of transcribing prescription data into comprehensible and accurate notes. The project's core is encapsulated using libraries such as NumPy, pandas, and Keras. The script carefully preprocesses the prescription data, segregating it into training, testing, and validation sets. The subsequent construction and training of a sequence-t--sequence model, empowered by neural network architectures - Gated Recurrent Unit GRU, enable the system to interpret the complexities of prescription contexts and generate precise transcriptions. Upon model creation and training, the script utilizes an inference mechanism to generate transcriptions from raw prescription texts. The significance of this system lies not only in its automation but also in its potential to significantly reduce transcription errors prevalent in manual processes. It showcases the model's proficiency by displaying machine-generated transcriptions alongside their originals, offering a comprehensive view of its accuracy and efficiency. This project overall serves as an intersection between advanced technology and the healthcare domain, presenting a solution poised to revolutionize medical documentation workflows. The report surrounding this endeavor dives into extensive technical intricacies, including data preprocessing methodologies, model architectures, and the thorough evaluation of the system's performance. Its ultimate goal is to illustrate how this innovation could enhance efficiency and accuracy in the crucial task of medical prescription transcription, potentially reshaping the landscape of healthcare documentation practices.

Keywords: Automated transcription, Data preprocessing, Technology, Healthcare, Medical prescriptions, Machine learning, Neural network architectures, Sequence-to-sequence model, Transcription errors.

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INTRODUCTION

This topic combines advanced technology and healthcare, aiming to automate and enhance the transcription process in the medical field [1, 2]. This innovative project focuses on leveraging machine learning techniques to accurately and efficiently transcribe prescription text. By employing neural networks and sequence-to-sequence models, the system translates medical prescriptions into readable and comprehensive transcriptions.

The primary objective of this project is to develop a sophisticated model capable of understanding and processing prescription data, then generating detailed transcriptions that accurately reflect the intended medical information [3 - 5]. This automated transcription system not only aims to streamline documentation tasks but also seeks to improve accuracy, reducing the potential for errors commonly associated with manual transcription processes [6]. The main script encapsulates the implementation of this project, leveraging libraries such as numpy, pandas, and Keras to preprocess data, build models, and perform inference. It incorporates sequential neural network architectures, Gated Recurrent Unit (GRU) for both encoder and decoder components, essential for understanding prescription context and generating transcriptions, respectively [7]. The script loads preprocessed data, trains a sequence-to-sequence model, and implements an inference mechanism to generate transcriptions from prescription texts. Moreover, it includes functions for model evaluation, such as displaying machine-generated transcriptions and comparing them with original transcriptions, enhancing the system's transparency and usability [8]. This project addresses the critical intersection of healthcare and machine learning, aiming to revolutionize medical transcription by harnessing the power of machine learning models. The report will delve into the technical details, model architecture, data preprocessing steps, and the performance evaluation of this innovative system, showcasing its potential impact on improving efficiency and accuracy in medical documentation workflows [9].

The paper presents the critical need for an automated transcription system that can accurately interpret prescription data, convert it into readable transcriptions, and alleviate the burdens associated with manual transcription. This project aims to bridge this gap by developing a sophisticated machine learning-based solution to revolutionize and optimize the transcription process within the healthcare domain [10]. It encapsulates the challenges and shortcomings prevalent in traditional manual transcription processes within the healthcare sector. In the solution approach, the main script is the foundation. It outlines the step-by-step process to implement a machine-generated transcription system based on prescriptions using a sequence-to-sequence model.

Load prescription and transcription data from the CSV file "updateddf.csv". Split the data into training, validation, and testing sets using train_test_split.

Utilize functions like "load_encoder_inputs" and "load_decoder_inputs" to load and preprocess the prescription and transcription data into numerical vectors suitable for model training.

Construct a sequence-to-sequence model using an encoder-decoder architecture with GRU layers.

Train the model using the prescription and transcription data, optimizing it to minimize the sparse categorical cross-entropy loss. Implement the Nadam optimizer with a learning rate of 0.001 for training.

Load the best weights achieved during training using "seq2seq_Model.load_weights". Implement an inference mechanism "Seq2Seq_Inference class" for generating transcriptions from raw prescription texts using the trained model.

Demonstrate the model's performance by generating machine-generated transcriptions from a subset of test prescription texts. Evaluate the quality and accuracy of the generated transcriptions against the original transcriptions from the test set.

Extract encoder and decoder models for further analysis or potential deployment. Analyze the model's behavior, identify any limitations or biases, and explore potential improvements or fine-tuning methods.

Implementing this approach involves a systematic approach to data handling, model creation, training, evaluation, and analysis, culminating in a comprehensive understanding of the model's performance and its potential to address transcription challenges in the healthcare domain.

LITERATURE SURVEY

The existing research has introduced a prescription transcription system, yet it has also identified notable limitations and gaps in its approach. These shortcomings offer opportunities for refinement [11]. Hence, our project endeavors to build upon this foundation, addressing the identified gaps to enhance the overall efficacy and resilience of the transcription system. One notable limitation observed in prior work, as highlighted in a paper [12], stemmed from a restricted dataset, resulting in diminished accuracy in deciphering handwritten medicine names. To mitigate this issue, our project seeks to explore techniques aimed at enhancing accuracy and scalability. Furthermore, previous studies [13], used only a selected few writers' datasets, disregarding others. In contrast, our project aims to capitalize on a more diverse dataset to improve the model's adaptability across various handwriting styles. Moreover, challenges related to model size and processing efficiency [14], prompted our investigation into methods to optimize

CHAPTER 8

Enhancing Education using AI

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Abstract: Artificial Intelligence (AI) has emerged as a transformative technology benefiting various industries, including education. AI has revolutionized learning by personalizing education, automating administrative tasks, and providing real-time feedback to both teachers and students. With advances in AI, both teachers and students need to understand its capabilities and limitations to effectively integrate it into their learning practices. This study investigates the use of AI in educational contexts, concentrating on its effects on teaching, learning, and administrative operations. The purpose of this study is to provide insights into the prospects and challenges of integrating AI technologies in education by reviewing current research and practical applications. Personalised learning, intelligent tutoring systems, adaptive assessments, administrative automation, and ethical considerations are all important topics to examine. The study concludes with recommendations for educators and policymakers on how to effectively leverage AI's capabilities while addressing concerns about privacy, equity, and the future role of human educators in a rapidly changing educational landscape. Overall, this study aims to contribute to the ongoing discussion regarding AI's capabilities while addressing concerns related to privacy, equity, and the future role of human educators.

Keywords: Artificial Intelligence (AI), Education, Evaluation, Learning, Teaching.

INTRODUCTION

Artificial Intelligence (AI) is a branch of computer science that aims to create machines capable of performing tasks that typically require human intelligence [1]. AI systems can learn from data, adapt to new inputs, and perform tasks autonomously. Artificial Intelligence, including natural language processing, machine learning, and computer vision, is a rapidly evolving field in education

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[2]. It uses data analytics, cloud computing, and algorithmic development to analyse vast amounts of educational data, recognize patterns, and make informed predictions, thereby enhancing human decision-making in the field. It is transforming a variety of industries, including education, by emulating human intellect in robots capable of learning, reasoning, and problem-solving. AI in education has the ability to personalise learning experiences for students, provide real-time feedback, and even help create customised study programmes [3]. As technology advances, AI is likely to play a greater role in determining the future of education. This integration constitutes a paradigm shift, addressing long-standing issues and opening up new possibilities in teaching and learning. AI in education has the potential to narrow the access gap to excellent education, particularly for students living in distant or underdeveloped locations. Using AI technology, educators may build more inclusive and engaging learning environments for all students, regardless of background or learning style [4].

Education is critical for both societal development and personal improvement [5]. Traditional models struggle to accommodate various needs, keep up with technology changes, and optimise resource allocation (Fig. **1**). AI provides a promising solution by personalising learning experiences, reducing administrative procedures, and enabling data-driven decision-making. Machine learning and natural language processing enable educational institutions to adapt training, identify areas for improvement, and improve overall student performance. AI can also help instructors understand students' performance patterns, resulting in more effective teaching tactics and better learning outcomes [6].

AI is transforming personalised learning by adapting to individual requirements using different profiles and historical and real-time data [7]. Thus, optimizing learning paths, increasing engagement, and outcomes across different learner demographics. Traditional educational systems frequently use a one-size-fits-all model thatmay not adequately address individual learning preferences. To facilitate this, new AI-powered adaptive learning systems are making great progress. Intelligent Teaching Systems (ITS) use AI techniques, like Machine Learning (ML), to deliver personalized guidance and feedback to students [8]. These systems combine interactive simulations, virtual mentors, and adaptive evaluations to help students understand complex subjects at their own pace.

AI is also transforming educational evaluation techniques by automating processes such as grading and scoring. Natural language processing algorithms enable AI systems to analyse and evaluate student-generated content with high accuracy and consistency [9]. Automated grading systems save educators' time and enhance the reliability and objectivity of assessment outcomes, ensuring a fair and equitable evaluation of student performance. AI is revolutionizing educational

institutions by enhancing teaching and learning processes and reshaping administrative functions. AI-driven enrollment management systems use predictive analytics to forecast enrollment trends, optimize recruitment strategies, and allocate resources more effectively [10]. These systems help anticipate course demand, allocate faculty and facilities efficiently, and enhance student retention. Collaboration between educators, policymakers, and stakeholders is crucial to harnessing AI's potential while mitigating risks.

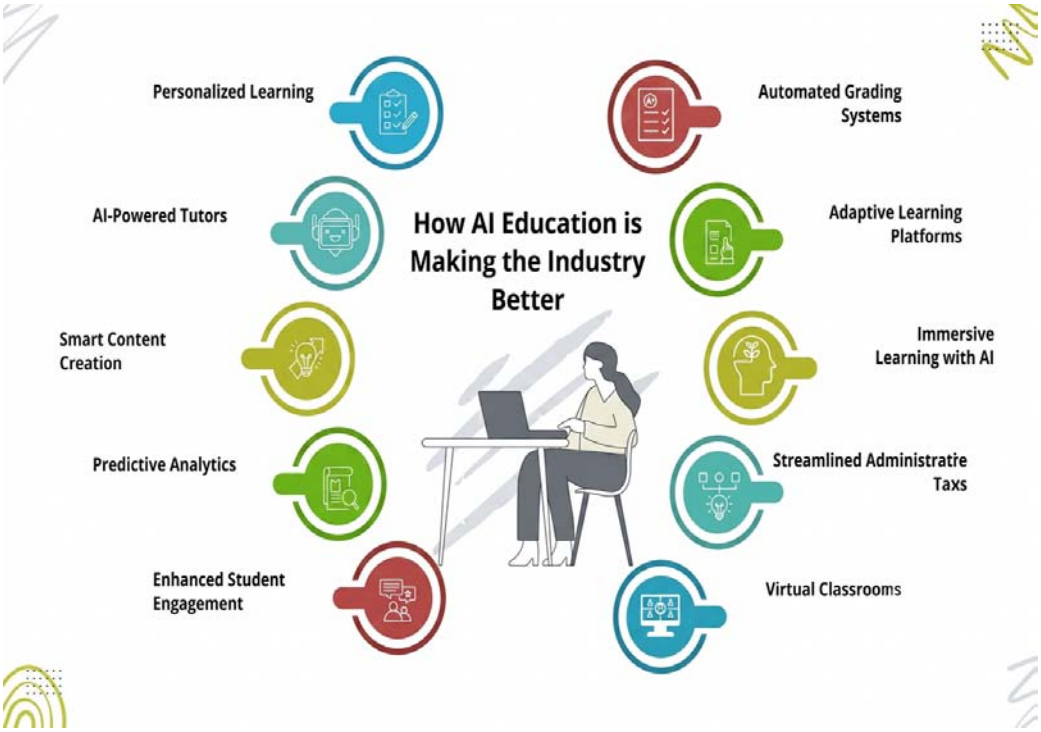

Fig. (1). How AI education is making the industry better.

This study investigates the varied functions of AI in educational contexts, focusing on its applications, benefits, problems, and ethical implications. The study seeks to provide a thorough picture of how AI is revolutionising education and determining the future of learning environments around the world by exploring current research and practical implementations. AI has the potential to personalise learning experiences, provide real-time feedback, and help identify areas where students may want further support. The study also addresses how AI might assist educators in streamlining administrative work, allowing them to focus more on individualised instruction and better student engagement.

CHAPTER 9

Prediction of Air Quality Parameters (NO_2 and SO_2) in Smart Cities Using Seasonal Data: A Comprehensive Analysis

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Abstract: Air pollution poses a substantial worldwide environmental dilemma that can lead to health issues impacting everyone across the globe, regardless of geographical location. It has a significant influence, both directly and indirectly, not only on human health but also on social and economic activity. Scientists globally are conducting research to assess and forecast the air quality index utilising sophisticated computational models. These algorithms have significantly transformed our understanding and methodology for predicting the API (Air Pollution Index). This study presents a machine learning method to forecast concentrations of Nitrogen Dioxide (NO_2) and Sulfur Dioxide (SO_2) using publicly available data from air quality monitoring stations across a large urban area. By preprocessing and extracting features from time-series data, the study employs various machine learning models to predict the levels of these pollutants. The models were rigorously evaluated through cross-validation to ensure their reliability and accuracy. The results confirm that the approach can effectively predict NO_2 and SO_2 levels, offering a robust tool for air quality management in urban environments. The use of linear and Lasso Regression, along with other machine learning algorithms, highlights the adaptability and precision of the predictive models developed in this research. This approach not only enhances our understanding of air quality dynamics but also aids in the proactive management of environmental health risks associated with air pollution.

Keywords: Air quality concentration station, Central pollution control board, Lasso regression, Linear regression, Machine learning algorithm, NO_2 concentration, SO_2 concentration.

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INTRODUCTION

Air pollution in metropolitan areas poses a significant threat to air quality due to emissions of pollutants like Nitrogen Dioxide (NO_2) and Sulphur Dioxide (SO_2). It is crucial to forecast pollutant levels to implement efficient pollution control measures. We utilise a machine-learning method to predict NO_2 and SO_2 levels using publicly accessible air quality data from multiple monitoring stations over a large urban area. Increased urbanisation has led to a rise in human activities that contribute to air pollution. Monitoring and predicting pollutant concentrations are crucial for public health and environmental management. Our research is centred on NO_2 and SO_2, pollutants originating from various sources such as vehicle emissions and industrial operations [1]. Nitrogen Dioxide (NO_2) and Sulphur Dioxide (SO_2) are major air pollutants that degrade air quality. NO_2, mostly originating from vehicle emissions and industrial operations, has a role in the formation of smog and respiratory problems. Sulphur Dioxide (SO_2) from burning fossil fuels and volcanic eruptions can cause acid rain and respiratory irritation. Collectively, these gases have detrimental effects on both human health and ecosystems, as well as the environment. The primary objective is to utilise machine learning to develop precise prediction models for NO_2 and SO_2 levels. Our goal is to create a device capable of predicting pollution levels for any day of any month, differentiating between summer and winter seasons. We incorporate a comprehensive system design into our procedure. We trained our models on data from 2021, split into two sets: summer (April to June) and winter (October to December). We employed machine learning techniques, starting with fundamental Linear Regression. This technique is used to establish the relationship between pollutant concentrations and independent factors. We also explored Lasso Regression and ElasticNet Regression to enhance forecast accuracy.

The data gathered from 40 monitoring stations in Delhi in 2021 was carefully organised. After calculating the average concentrations of NO_2 and SO_2, we separated the data into summer and winter groups. The models were subsequently trained in Python with libraries such as Pandas and NumPy. Linear Regression was used on both summer and winter datasets, showcasing a systematic approach including data import, cleaning, and model implementation. The previous work in this area is shown in Table **1**.

Table 1. Previous work in this area.

Author	Overview	Key Findings
Safeer, S., *et al*. [2]	This study examines recent advances in air quality prediction, with a particular emphasis on machine learning techniques.	Discusses numerous algorithms used in recent studies, emphasising their merits and drawbacks.

(Table 1) cont.....

Author	Overview	Key Findings
Zhang, W., *et al*. [3]	This study looks at the usefulness of linear regression in forecasting NOx and SO_2 levels.	Examines the linear relationship between dependent and independent variables, emphasising the simplicity and interpretability of linear regression.
Amin, F., *et al.* [4]	This paper investigates the use of Lasso and ElasticNet regression in predicting air quality metrics.	Examines how different regularisation strategies help model simplicity and handle multicollinearity.
Zaini, N., *et al.* [5]	Provides a thorough examination of deep learning approaches used to predict air quality.	This paper discusses the benefits of deep learning architectures, such as neural networks, in collecting complicated patterns in air quality data.
Bot, K., *et al*. [6]	Evaluates the predictive ability of several machine learning models for NOx and SO_2 concentrations.	Models such as Random Forest, Support Vector Machines, and Gradient Boosting are highlighted for their benefits and weaknesses.
Sokhi, R.S., *et al*. [7]	Examines the significance of considering temporal and spatial factors in air quality prediction.	Examines ensemble models that combine temporal and geographical data to improve prediction accuracy.
Ghoroghi, A., *et al*. [8]	This overview highlights the importance of feature engineering in improving the performance of air quality prediction models.	Discusses specific time series data properties that contribute considerably to correct forecasts.
Mukundan, A., *et al*. [9].	Investigates the effects of external factors, such as meteorological data, on the performance of machine learning models for air quality predictions.	Methods for using external variables to improve forecast accuracy are discussed.

RELATED WORK

Our research coincides with recent studies highlighting the significance of machine learning in predicting air quality. Significant articles explore the use of linear regression and sophisticated methods such as Lasso and ElasticNet in comparable situations [10]. Our study enhances forecasts by integrating different methods to increase their reliability. The proposed methodology of this paper is depicted in Fig. (**1**).

METHODOLOGY

Dataset Collection

The data was gathered from the Central Pollution Control Board (CPCB) website in Fig. (**1**). The data was downloaded in the form of Excel sheets for all 40 monitoring stations in Delhi for the period of one year, from January 1, 2021, to December 31, 2021, as depicted in Fig. (**2**).

CHAPTER 10

Producing Optimized Test Suites in Software Testing Using a Many-Objective Feedback-Based Model and Differential Evolution Algorithm

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Abstract: In software project development, Artificial Intelligence (AI) may play a crucial role in enhancing Software Testing (ST) processes through automation. By leveraging AI techniques, testers can enhance the effectiveness of their testing processes, thereby improving overall software system quality. Recently, researchers introduced many-objective optimization approaches to address performance issues in Automated Software Testing (AST) within Search-based Software Testing (SBST). Decreased convergence speed to the local optimum and increased time complexity were two main problems identified with Evolutionary Algorithms (EAs) in SBST. These challenges are addressed by our proposed approach, which integrates a Many-objectives Feedback-based model with the Differential Evolution (DE) algorithm, enabling the production of optimized test suites to simultaneously address multiple testing objectives. Our work in this chapter represents a significant advancement in the ST field, enhancing intelligent evolutionary computation for producing optimized test suites for software applications. The control parameters in our proposed algorithm are self-adapted and learned from prior feedback of evolutionary searches. Considerations such as fitness function calculation and multi-criteria coverage were taken into account during AST. To validate our proposed approach, numerous real-time application-based experiments have been conducted. It was recognized that by applying our sophisticated AI-driven proposed approach to ST, testers can streamline their testing workflows, identify defects more comprehensively, and ultimately deliver software products of higher quality to end-users.

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Keywords: AI, AST, Heuristic search algorithms, Many-objective optimization problems, SBST, Test data.

INTRODUCTION

Traditional Software Testing (ST) employs manual methods to verify and validate software products. This approach depends heavily on the expertise and effort of testers who manually input data, execute test cases, and observe outputs to ensure that the software operates as expected [1]. This method is inherently subjective and prone to inaccuracies and inconsistencies. The manual nature of this testing results in lengthy cycles and high costs. Consequently, AST becomes indispensable, as it can dramatically shorten the development cycle and reduce costs. Recently, AI has emerged as a pivotal force in enhancing ST processes through automation. AI is used in SBST to increase testing coverage, efficacy, and efficiency by utilizing cutting-edge computational approaches [2].

To automate the production of a test suite based on predetermined standards like coverage, size, and execution cost, SBST uses search algorithms. The search procedure is guided by AI-driven heuristics, which aid in the prioritization and selection of test cases that are most likely to reveal flaws [3]. These heuristics may be derived from measures for code complexity, historical data, or other pertinent variables. AI systems optimize test cases to meet several coverage requirements, including branch, path, mutant, and statement coverage. This guarantees thorough testing of the program in various contexts. SBST optimizes the testing process by utilizing a variety of AI approaches and algorithms.

Nowadays, bio-inspired heuristic search algorithms are used in resolving the test case production challenge because they automate the testing process, improve test coverage, adapt to changing requirements, and ultimately result in more efficient and effective testing of software products [4]. By leveraging AI techniques, testers can improve the effectiveness of their testing processes, thereby enhancing the overall quality of software systems. In the realm of SBST, many-objective optimization approaches have been introduced to address performance issues in AI-based ASTs. The EAs used in SBST have encountered challenges, including slower convergence and increased time complexity. Evolutionary strategies focus on the optimization of test cases through mutation and selection processes, similar to genetic algorithms but with different strategies for mutation and selection [5].

In AST using AI, heuristic search algorithms have gained prominence for their ability to automatically generate test cases. The integration of heuristic search algorithms with automatic test case production (generation) transforms this process into a many-objective optimization problem, aiming to maximize coverage of branches, statements, mutations, *etc*. within the code. Moreover, the

continuous evolution of software necessitates frequent updates and maintenance, further complicating testing process. As software systems become more sophisticated, the importance of developing robust and efficient testing strategies increases. Therefore, ongoing research and advancements in AI and Metaheuristic Algorithms (MAs) are crucial for addressing these challenges and ensuring the production of high-quality software [6]. In an optimized test case production problem, some complexity arises because a comprehensive test suite must ensure extensive coverage of different software paths, conditions, and potential execution scenarios.

The Dynamic Many-Objective Sorting Algorithm (DynaMOSA) or other existing algorithms are integrated into the EvoSuite framework and serve as a prominent solution for this challenge. It operates by searching multiple objectives simultaneously. However, its efficacy diminishes significantly when the number of objectives becomes excessively high. This is particularly problematic as modern software systems grow in complexity and scale, resulting in an increased number of potential execution paths and branches. To produce optimized test suites for testing the developed software products, a "Many-objectives Feedback-based Model using the Differential Evolution algorithm" is proposed. Our proposed method of Many-objectives Feedback-based test data production is termed MOFMDE. In the ST problem, the MOFMDE is applied to achieve four objectives: branch coverage, line coverage, mutation coverage, and multi-criteria coverage. These are considered while designing the new fitness function. The proposed adaptive feedback model with the DE algorithm has been designed based on various individual selection techniques. The control parameters in our proposed algorithm are self-adapted and informed by feedback from previous evolutionary searches. Key considerations, such as fitness function calculation and multi-criteria coverage, are incorporated into AST. To validate our approach, extensive real-time application-based experiments have been conducted [7]. The experimental results indicate that our AI-driven approach can streamline testing workflows, identify defects more comprehensively, and ultimately deliver higher-quality software products and services to end-users. Therefore, our research presents a significant advancement in ST by enhancing intelligent evolutionary computation for optimized test suite production.

This chapter is structured as Section 2, which reviews work related to optimizing test suite production. Section 3 describes the test suit production as a many-objective based optimization problem. Section 4 details our proposed Feedback-based search model for optimized test suite production. Section 5 discusses the experimental environment used. The outcomes are identified and discussed in Section 6. Lastly, Section 7 provides conclusions with recommendations for future research.

CHAPTER 11

Revolutionizing Drug Discovery and Development through AI and IoT

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Abstract: AI and the IoT are revolutionizing drug development and discovery. By utilizing real-time data and sophisticated algorithms, researchers can rapidly identify potential drug candidates and assess their efficacy. In drug research, AI plays a vital role in predicting the pharmacological properties of lead compounds from their chemical structures, thereby improving the efficiency of medication discovery and development. It is possible to develop predictive models that estimate the key features of solubility, bioavailability, and toxicity by utilizing machine learning methods. These models provide a blueprint for designing new molecules with improved pharmacological attributes, thereby boosting the efficacy and safety of potential therapies. The integration of the IoT in the pharmaceutical industry accelerates the production of new drugs for conditions requiring treatment, reducing both time and costs. Utilizing cell-in-a-chip and organ-in-a-chip devices that replicate human physiological conditions, the early evaluation of potential formulations is significantly expedited. By analysing patient data and electronic medical records more effectively, AI enhances clinical trial design and speeds up patient recruitment. AI also helps optimise trial design by identifying which patient subgroups are more likely to respond to therapies. Real-time monitoring is enabled by AI-driven wearables, which ensure accurate data collection and the necessary modifications to trial protocols to improve patient safety. The chapter also examines how AI and IoT are used in drug research, including target identification, drug design, and clinical trials. Lastly, it addresses potential issues and constraints associated with these technologies, as well as future directions for this field's research and development. In conclusion, this chapter has

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shown how AI and the Internet of Things could drastically improve the development and discovery processes, leading to better and more efficient treatments for a wide range of ailments.

Keywords: Connected and autonomous vehicles (CAVs), Cyber security, Federated learning, Predictive models, Vehicular Network.

INTRODUCTION

The term “drug discovery” refers to the process of identifying and evaluating compounds that can safely modify disease states, with the goal of developing medications that improve patients' quality of life [1]. This process is lengthy and resource-intensive, necessitating close collaboration across multiple academic disciplines [2]. The pharmaceutical industry places great emphasis on optimizing the drug discovery process because quickly identifying and selecting suitable drug candidates can significantly affect the cost and profitability of new medications [3]. The present state of the art estimates that the cost to bring a new drug to market is approximately $2.6 billion. Furthermore, despite promising results in lab testing, a novel medication may face challenges throughout the clinical trial stage [4]. 9.6% of these medication candidates successfully make it to market, according to phase I studies. A novel drug's market development and discovery are both difficult, drawn-out, and risky processes, but the profits can be enormous [5]. The process necessitates a significant financial investment, technological know-how, resources, and adherence to laws, standards, and regulations. All these elements add to the high cost of the R&D industry. Almost all the funding for the “pipeline” of drug discovery and development comes from the private sector, which must make enough money to pay for new treatments while also surviving and meeting its own expenses [6]. For a variety of reasons, the government will neither support nor nationalize drug development; instead, it will continue to take place in the private sector. To formally begin the drug discovery process, one must first choose a disease area and specify the therapeutic need to be addressed. Following this, the procedure identifies the physiological pathways that must be addressed and, ideally, identifies a particular molecular “drug target. In this stage, the main focus is on identifying a lead chemical structure, designing, testing, and optimizing it to ensure it meets all requirements for development into a pharmaceutical product [7]. After receiving approval, the medication can be sold and given to individuals who require it. Drug research and development are typically difficult, drawn-out procedures requiring a lot of resources and skills. AI and IoT have significantly transformed the pharmaceutical industry, accelerating drug discovery and improving patient care [8]. Health policy, medication development, precision medicine, clinical trials, and data-driven techniques are all made possible by the digitization of medical data [9]. The drug development

process has been significantly altered by new analytical methods and computational advancements throughout the last ten years [10]. The use of AI techniques, such as structure-based drug design, *de novo* molecular design and optimization, and pre-clinical and clinical research, has grown in popularity as a result of recent technological advancements. Deep learning models and other analytical methods can be applied to biomedical datasets, such as genetic profiles, imaging data, and chemical and pharmacological databases, to streamline the discovery of effective medications and their therapeutic uses [11].

IoT-based smart gadgets are already becoming popular. One example is "Organ in a Chip," which enables businesses to do real-world diagnostics [12]. Combining the output from these devices with cognitive systems and big data analytics could present previously unheard-of opportunities, significantly increasing R&D productivity and hit rate [13]. "Chip in a pill" is a novel ingestible tablet that, upon ingestion, records health information, including pharmacological effects on important organs, and transmits it to a wearable device, contributing to the expanding influence of smart devices [14]. In addition to lowering the time it takes for medications to reach market, the use of smart devices in clinical development, supply chains, and patient interactions can also improve regulatory compliance by allowing real-time data streams to be proactively used to identify problems along the value chain [15]. Healthcare professionals (HCPs) can use data from wearable devices to administer Personalized Medicines (PM), which can shorten treatment times and increase drug efficacy. Moreover, by enabling targeted therapies, AI and IoT can enhance personalised medicine [16]. Researchers can create individualized therapy programmes that consider a patient's genetic, environmental, and lifestyle characteristics by evaluating patient data. Both patient outcomes and therapeutic efficacy may be enhanced by it. The difficulties encountered have drawn significant attention to AI systems' data-processing capabilities [17]. Experts believe AI can act as a catalyst for drug discovery, speeding up the process and cutting expenses. According to the market research company Bekryl, AI could save the drug discovery process more than $70 billion by 2028 [18].

Traditional Drug Discovery Method

Traditional drug discovery methods have historically followed a systematic process aimed at identifying and developing new medications (Fig. **1**) [19]. This approach typically begins with the identification of biological drug targets by determining the function of a protein or gene that defines its structure. The medicine will target or modify the protein that causes the disease or condition, thereby requiring a new treatment [20, 21]. After being identified and selected, molecular targets must show treatment effects on illness initiation or progression

CHAPTER 12

The Future of AI: Quantum Computing and Beyond

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Abstract: As Artificial Intelligence (AI) continues to revolutionize various industries, the integration of quantum computing promises to propel AI into unprecedented realms of capability and efficiency. This chapter explores the transformative potential of quantum computing in the future of AI, presenting a detailed overview of current advancements and future prospects. We begin by elucidating the fundamental principles of quantum computing, highlighting how quantum bits (qubits) and quantum entanglement differ fundamentally from classical computing paradigms. The discussion then moves to the synergistic relationship between AI and quantum computing, showcasing how quantum algorithms can enhance machine learning models, optimize complex problem-solving tasks, and enable real-time data processing at previously unattainable speeds. The chapter also delves into the potential of quantum computing in enhancing AI through quantum algorithms such as Grover's Algorithm and Shor's Algorithm. Simulation results for different cases have been studied, demonstrating the effectiveness of quantum computing in AI.

Keywords: Artificial intelligence, Grover's algorithm, Quantum computing, Quantum bits, Shor's algorithm.

INTRODUCTION

In recent years, Quantum computation (Qcom) has arisen as a revolutionary field at the forefront of scientific and technological advancement. Unlike conventional computing, which depends on bits that represent either 1 or 0, Qcom harnesses the principles of quantum mechanics to operate with quantum bits, or qubits. These qubits occur in a superposition of 1 and 0, aiding quantum computers to process vast amounts of information simultaneously and explore many solutions at once

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through quantum parallelism. This capability holds the potential to speed up computations for certain complex problems exponentially. At its core, Qcom relies on phenomena such as quantum entanglement and quantum interference, in which qubits can be correlated in ways that classical bits cannot, enabling transformative computational power [1]. While still in its infancy in terms of practical applications, Qcom research is rapidly advancing, driven by academic institutions, major corporations, and government initiatives worldwide. As we delve deeper into the capabilities and challenges of Qcom, its integration with AI promises to unlock new frontiers in fields ranging from cryptography and material science to machine learning and optimization. This chapter explores the fundamental principles, potential applications, and prospects of Qcom, highlighting its role in shaping the future landscape of artificial intelligence and beyond [2].

In the realm of artificial intelligence, the convergence of Qcom represents a transformative frontier, promising unprecedented capabilities that transcend the limits of classical computation. Qcom leverages the principles of quantum mechanics to manipulate information in ways that defy classical physics, offering exponential speedups for solving complex problems that are impractical for today's supercomputers [3]. This chapter explores the intersection of AI and Qcom, delving into foundational concepts such as quantum bits (qubits), quantum algorithms such as Grover's and Shor's, and the quest for quantum supremacy. As we stand on the brink of a new era in computing power, understanding these technologies not only unveils their potential applications across industries but also underscores the profound implications for the future of AI-driven innovation.

Artificial Intelligence (AI) has evolved over several decades, with substantial advances in methodology and techniques. AI has evolved in several periods, each distinguished by advances in techniques and technology. Beginning in the 1950s and 1960s, AI focused on symbolic reasoning, aiming to mimic human cognitive processes through rules and logical procedures, as evidenced by early systems such as the Logic Theorist. The 1970s and 1980s witnessed the growth of knowledge-based systems, notably expert systems, which employed knowledge representation and inference engines to simulate human skill in specialized fields such as medicine and finance [4]. The late twentieth century saw the machine learning revolution, in which statistical methodologies enabled computers to learn from data. Supervised learning permitted tasks such as classification and regression, whereas unsupervised learning found patterns in data without labelled instances. Reinforcement learning evolved as a method for decision-making through trial and error and has been used in domains such as robotics and gaming [5]. The 2010s saw a rise in deep learning, fuelled by huge data and advancements in processing capacity. Deep neural networks, with their capacity to

autonomously learn hierarchical representations, have transformed Computer Vision (CV), Speech Processing (SP), and Natural Language/Linguistic Processing (NLP). Today, AI is advancing with applications in healthcare, finance, robotics, and beyond, propelled by advances in Quantum Computing, explainable AI, and ethical considerations to ensure responsible deployment and societal benefit.

Key methods for AI include a range of approaches that enable machines to emulate intelligent behavior and decision-making processes. These approaches have grown dramatically over decades of study and technology innovation, influencing AI capabilities and applications across several fields [6]. They include symbolic AI, which uses rules and logic to model human-like reasoning; machine learning, which includes supervised, unsupervised, and reinforcement learning techniques for learning from data; deep learning, Artificial Neural Networks (ANN) with several layers inevitably extract complex attributes from large datasets; NLP enables robots to interpret and produce human language; and computer vision, which focuses on algorithms for visual perception, where machines learn through trial and error by interacting with their environment [7]. These methodologies collectively form the foundation for developing AI systems capable of diverse tasks, from image recognition and language translation to autonomous decision-making and problem-solving in complex real-world scenarios.

Symbolic AI: Uses symbols, logic, and rules to model human-like reasoning and problem-solving.

Machine Learning: Includes supervised, unsupervised, and reinforcement learning techniques for learning patterns/attributes and making forecasts from data.

Deep Learning: Utilizes neural networks with several layers that inevitably learn the patterns/attributes from large datasets, particularly effective for tasks requiring complex data representations.

Natural Language Processing: Focuses on understanding and generating human language, enabling applications like machine translation, sentiment analysis, and chatbots.

Computer Vision: Involves algorithms and techniques for analysing and interpreting visual information from images and videos, used in object detection, recognition, and image generation.

Expert Systems: Knowledge-based systems that use rules and knowledge bases to provide expert-level decision support and problem-solving in specific domains.

CHAPTER 13

Towards Safer Roads: Detecting Distracted Driver Behavior in Visual Media

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Abstract: Driving a car demands unwavering focus and attentiveness to ensure road safety. Failing to maintain alertness and concentration on the road and one's surroundings can lead to catastrophic consequences. Approximately 1.3 million people worldwide lose their lives in traffic accidents each year. In India, statistics from 2015-2019 reveal a staggering 23 lakh reported road accidents, averaging over 4.7 lakh annually. The objective of this research is to develop a robust system for detecting and categorizing a driver's activities while occupying the driver's seat. Leveraging various Machine Learning Models and Convolutional Neural Networks (CNNs), this system aims to discern whether the driver is operating the vehicle safely or engaging in activities that pose a risk of accidents or harm to others. Additionally, a comparative analysis of multiple machine learning models is performed to assess their individual accuracy in identifying distracted driver behaviors. This research contributes to the critical endeavour of reducing road accidents and saving lives by mitigating distracted driving behaviors.

Keywords: CNN, Distracted driver, Image classification, Machine learning, Video classification.

INTRODUCTION

A World Health Organization (WHO) survey finds that traffic accidents rank as the eighth most common cause of death globally, resulting in 1.3 million deaths yearly [1]. In addition, 20-50 million individuals are injured or disabled as a result of traffic accidents. The National Crime Research Bureau (NCRB) of the Government of India has determined that India has the highest number of road fatalities in the world, with a steady increase since 2006. In 2015, there were 1.46 lakh fatalities resulting from traffic accidents in India, and irresponsible driving

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was identified as the leading cause [2]. In 2022, road accidents increased compared to 2021, according to an article published in the Times of India (Fig. **1**). Operating a vehicle is a responsibility that requires complex manipulations and the coordination of multiple senses. However, engaging in a variety of other distracting activities, such as using a cell phone, adjusting audio equipment, dining, or conversing with a passenger, can affect the driver. In its survey, WHO identified several risk factors, including human error, vehicle speed, intoxicated driver, non-use of seatbelts, child restraints, distracted driver, and hazardous road infrastructure, among others. In India, road safety is a major concern due to the country's large car population and complex traffic system. The nation has been implementing several regulations, programs, and awareness campaigns aimed at enhancing road safety. The main elements, difficulties, and resources pertaining to road safety in India include a high accident rate, diverse road users, driver behavior, vehicle safety, and infrastructure issues. Driver behavior is one of the primary reasons for road accidents [3]. A driver who is impaired or preoccupied is one of the leading causes of fatal road accidents. Typically, a drunk motorist loses control of the vehicle, resulting in an accident. To enhance road safety and reduce the number of accidents caused by driver error, identifying distracted drivers is the top priority. Detection systems can use various devices or technologies, such as cameras, sensors, or machine learning algorithms, to identify signs of distraction, including irregular or erratic driving behavior, inattention to the road, or failure to heed traffic signals.

1.68L: TOTAL DEATHS AT NEW HIGH

Traffic Rule Violation	Deaths In 2021	Deaths In 2022	% Of Total In 2022
Speeding	1,07,236	1,19,904	71.2
Driving drunk/on drugs	3,314	4,201	2.5
Driving wrong side/ violating lane rules	8,122	9,094	5.4
Using mobile phone	2,982	3,395	2.0
Jumping traffic signal	679	1,462	0.8
Others	31,639	30,435	18.1
Total deaths	1,53,972	1,68,491	

* Highest deaths among 2-wheeler riders (74,897), followed by pedestrians (32,825)
* UP registered most fatalities (22,595), followed by TN (17,884) & Maha (15,224)

Fig. (1). New article from Times of India showing total deaths [2].

Once a distracted driver has been identified, the system can alert the driver *via* visual, auditory, or haptic feedback, such as steering wheel vibration or alarm. In the event that law enforcement or emergency services are required, such as when a motorist becomes incapacitated or an accident occurs, the system can notify them. According to records from 2000-2024, researchers are actively working on driver behavior in road accidents (Fig. **2**).

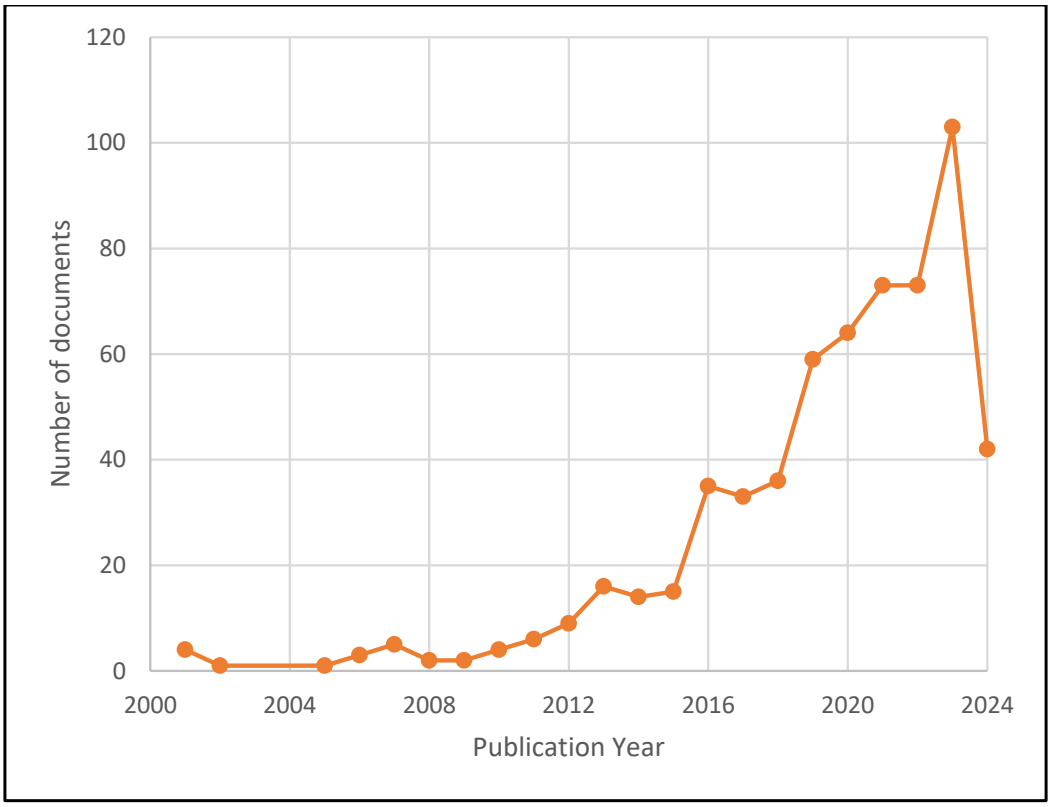

Fig. (2). Publication trend on driver behavior for road accidents.

Overall, distracted driver detection is essential for enhancing road safety, reducing accidents and fatalities, and encouraging responsible driving behavior. India is the second country actively working in this area, as shown in Fig. **3**, while the United States is the first.

LITERATURE SURVEY

This section compiles the work of researchers in the field of distracted driver detection.

SUBJECT INDEX

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