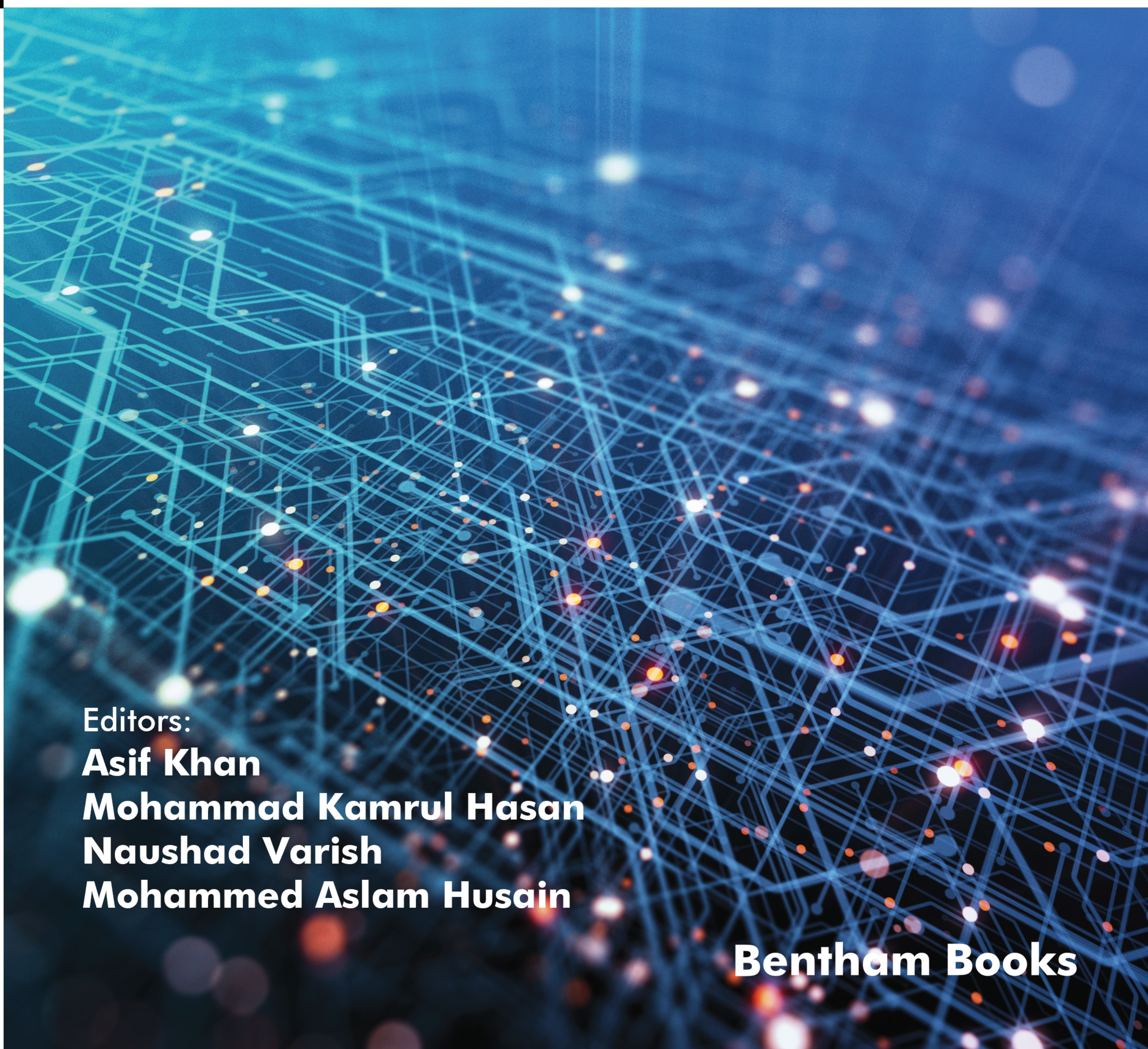
ADVANCEMENTS IN ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING



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Advancements in Artificial Intelligence and Machine Learning

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Advancements in Artificial Intelligence and Machine Learning

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CONTENTS

PREFACE

Artificial Intelligence (AI) and Machine learning (ML) are big fields and their algorithms have been employed in various domains for the last decade to solve complex problems. John McCarthy defined AI in 1956 as "AI involves machines that can perform tasks that are characteristics of human intelligence". In this book, the authors cover the basics of AI, and ML and the applicability of these fields to many real-life applications. Arthur Samuel defined Machine Learning (ML) in 1959 as a "Machine Learning: Field of study that gives computers the ability to learn without being explicitly programmed".

The presented book will consist of twelve full chapters which cover the use of AI and ML tools in a number of practical applications such as the analysis of power transformer oil, awareness and prevention of crimes against women, next-gen mechatronics, social media, digital forensics, cyber security, sentiment analysis, image processing, pattern recognition, medical device network system, business sectors, tumor detection, classification, cloud services, automation in drone robotics and human detection systems.

The landscape has shifted significantly since those early days, with the emergence of advanced AI and ML tools and the exponential increase in computing power. These advancements have enabled the analysis of vast quantities of data on a monumental scale. AI now relies heavily on Big Data and Machine Learning to expand its capabilities. Machine learning involves the training of algorithms, enabling them to learn from extensive datasets and enhance their performance over time. Deep Learning, a subset of Machine Learning, draws inspiration from the intricate workings of complex datasets and functionality.

This book gives a brief overview of Machine Learning and lists various ML techniques such as decision tree learning, Hidden Markov Models, reinforcement learning, and Bayesian networks, as well as covering some aspects of Deep Learning and how this relates to AI. It will help you achieve an understanding of some of the advances in the field of AI and Machine Learning, and at the same time, giving you an idea of the specific skills so that you can apply advanced techniques if you wish to work as a Machine Learning expert.

The authors stand behind the assurance that this book will serve as a valuable asset and a wellspring of inspiration for all those captivated by the advancements in AI and ML. As you delve into its pages, you are invited to embark on a journey into the enthralling realm of intelligent solutions. Let us together envision the limitless possibilities that await us with these transformative technologies, and enthusiastically embrace the opportunity to shape the future.

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CHAPTER 1

Next-Gen Mechatronics: The Role of Artificial Intelligence

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Abstract: The incorporation of artificial intelligence (AI) into healthcare systems has demonstrated significant potential to transform patient care, diagnosis, and treatment. Nevertheless, the implementation of artificial intelligence (AI) in the healthcare sector presents difficulties concerning transparency, interpretability, and trust, especially when there are new possibilities for automated decision-making and enhanced efficiency in many different areas, thanks to the combination of artificial intelligence and mechatronics. Automation and robotics are improving as mechatronics integrates AI. Grand View Research expects the global mechatronics and robotics course market to reach $3.21 billion by 2028, expanding 13.7% from 2021 to 2028. This chapter aims to give a general outline of mechatronics-related artificial intelligence (AI), including its applications, advantages, and challenges. The field focuses on developing intelligent machines with the ability to learn, understand data, and react accordingly. Machine learning and deep learning are two forms of artificial intelligence that have enabled robots and autonomous vehicles to detect their environment, traverse complicated scenarios, and make smart decisions using the data they collect. Artificial intelligence (AI) improves mechatronic systems by expanding their capabilities, which boosts their performance, output, and reliability. Nevertheless, ethical considerations and implementation challenges need to be resolved before the full potential of AI in mechatronics can be realized.

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Keywords: Artificial Intelligence, Deep learning, Machine learning, Mechatronic, Robots.

INTRODUCTION

The primary objective of mechatronics is to build intelligent systems through the integration of several disciplines, including electronics, control engineering, computer science, mechanical engineering, and mechanical engineering. It is a young and expanding area that has already made a big splash in many sectors, including robotics, manufacturing, aerospace, healthcare, and automobiles. In the development of cutting-edge technology and novel approaches to difficult challenges, mechatronics is an indispensable tool. The Japanese invented the word "mechatronics" in the late 1960s, fusing the mechanical "mecha" with the electrical "tronics" [1].

It arose in reaction to the growing need for systems and products to incorporate both mechanical and electronic parts. Intelligent machines that are precise, efficient, and adaptable in their work are the goal of mechatronics.

The remarkable adaptability and versatility of mechatronic systems are attributed to their capacity to perceive and react to their surroundings. To accomplish complicated tasks independently or with little to no human involvement, these systems are programmed to communicate with one another, with other machines, and with the real environment. They can detect, analyze, and respond to data because of the sensors, actuators, microcontrollers, and algorithms built into their software.

Everything from basic home appliances and cell phones to advanced industrial robots and driverless cars falls under the umbrella of mechatronics. When it comes to making sure these systems work, are reliable, and are safe to use, mechatronic engineers are the ones to call. The capacity of mechatronics to unite several branches of engineering is one of its main strengths. More efficient, dependable, and cost-effective systems can be created by mechatronics engineers by integrating mechanical, electrical, and computer engineering principles [2]. By bringing together experts from different fields, we can improve performance and functionality by integrating hardware and software components seamlessly.

Innovation and technological progress are propelled by mechatronics. It makes possible the creation of state-of-the-art technology including smart systems, automation, robotics, and artificial intelligence. In addition to enhancing productivity, security, and quality of life, these technologies may cause a revolution in several different industries [3].

Hence, mechatronics is an interdisciplinary discipline that integrates electrical engineering, control engineering, computer science, and mechanical engineering to develop intelligent systems. Because it facilitates the creation of cutting-edge technology and novel solutions, it has grown into an important field in many different sectors. When it comes to developing flexible and versatile systems, mechatronics experts are crucial in combining software and hardware components [4]. I am confident that mechatronics will revolutionize engineering and our daily lives thanks to its capacity to spur innovation and technical progress.

OVERVIEW OF ARTIFICIAL INTELLIGENCE

The field of Artificial Intelligence (AI) is ever-evolving as scientists work tirelessly to develop increasingly intelligent and powerful machines. Over the past few years, advancements in artificial intelligence (AI) have completely altered our daily lives and the way we accomplish collective goals. An extensive review of AI, including its background, current uses, difficulties, and possible future advancements, will be presented in this essay [5]. Artificial intelligence has been around for a long time; in fact, machines that look like humans first appeared in ancient tales and folklore. In contrast, computer scientists began investigating the possibility of developing computers with intelligence comparable to that of humans in the 1950s, marking the beginning of the contemporary era of AI development. The inaugural use of the term "artificial intelligence" was during the 1956 Dartmouth Symposium, when researchers deliberated on developing intelligent robots [6]. Fig. (**1**) shows just an overview of Artificial Intelligence.

Creating expert systems and rule-based systems that could simulate human decision-making was the primary goal of early artificial intelligence research. Unfortunately, data shortages and insufficient computer capacity caused progress to be slow. A lot of data was available and machine learning techniques came out in the 1990s, but AI didn't take off until then [7]. The term "artificial intelligence" describes computers that can learn, reason, and make judgments just like a person. Two main schools of thought exist within the field of artificial intelligence: narrow AI and general AI. Narrow AI is purpose-built to excel in a small subset of general AI activities. However, the goal of general AI is to make machines as smart as humans are in a variety of contexts. The widespread use of AI is revolutionizing many different industries and bringing about significant gains in productivity. The healthcare industry is seeing a surge in the use of artificial intelligence. Medical data can be analysed by machine learning algorithms to aid in drug discovery, forecast patient outcomes, and identify disorders. The use of AI-powered robots in surgery has also been found to increase accuracy and decrease the likelihood of human mistakes [8].

CHAPTER 2

Advancements and Applications of Artificial Intelligence and Machine Learning: A Comprehensive Review

Santoshachandra Rao Karanam[1,*], **A.B. Pradeep Kumar**[1], **Prakash Babu Yandrapati**[1], **B. Pruthviraj Goud**[2], **S. Vijaykumar**[2] and **Illa Mahesh Kumar Swamy**[2]

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Abstract: Rapid advances in machine learning, deep learning, and AI are changing business and society. The history of these technologies reveals their transformative impact on a variety of industries. Convolutional, Deep, and Recurrent Neural Network studies show their evolution. Deep learning has facilitated the development of novel applications in several industries and stimulated technological progress. Reinforcement learning, a core component of artificial intelligence, has made notable progress, particularly in the realm of autonomous systems. This paper discusses the latest algorithms and their applications, stressing reinforcement learning's impact on robotics and automated decision-making. The study of natural language processing is crucial. Through language modelling, sentiment analysis, and translation, it shows banking, healthcare, and customer service applications. After that, the paper examines real-world AI applications. These technologies help doctors detect, treat, and forecast medical disorders. Fraud detection, risk management, and algorithmic trading benefit financial institutions. Industry 4.0 combines AI-driven autonomous vehicle navigation, control, and ethical decision-making with intelligent manufacturing and predictive maintenance.

KEYWORDS: Artificial intelligence (AI), Computer vision(CV), Deep learning(DL), Industry 4.0, Machine learning (ML), Natural language processing (NLP), Reinforcement learning.

INTRODUCTION

AI and ML are powerful technologies that can profoundly change several aspects of human existence. In recent decades, notable progress in AI and ML algorithms,

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together with the rapid expansion in computer power and data accessibility, have driven these disciplines into widespread use. This review article attempts to examine the development, fundamental principles, current progress, and many uses of AI and ML [1, 2]. It seeks to provide a deeper understanding of their influence, difficulties, and prospects.

BACKGROUND

The notion of artificial intelligence originated in the mid-20th century, aiming to develop robots that can replicate human intellect. Initial AI systems were based on a set of rules and had limited skills, but they provided the groundwork for further investigation and advancement. Machine learning emerged in the late 20th century, representing a significant change in approach. It enabled machines to learn from data and improve performance without programming.

OBJECTIVES

This article's primary goal is to provide a comprehensive analysis of the developments and applications of ML and AI technology. This paper examines the history of AI, key ideas, and new findings in an effort to provide light on the basic principles behind the rapidly progressing fields of ML and AI, particularly deep learning. Additionally, it looks at the many applications of AI and ML in various industries, including healthcare, entertainment, banking, transportation and more [3, 4].

STRUCTURE OF THE PAPER

The paper is divided into many parts, each dedicated to various areas of AI and ML. The “Evolution of Artificial Intelligence” section offers a chronological account of the development of AI, charting its origins from early symbolic systems to the transformative deep learning revolution. The section titled “Key Concepts and Techniques” explores the basic principles and methodologies that form the basis of AI and ML algorithms. It covers topics such as supervised, unsupervised, reinforcement learning, and neural networks.

The next sections examine current progress in AI and ML, including transfer learning, federated learning, and explainable AI, emphasizing their possible uses and consequences. This work explores the use of AI and ML in many fields such as healthcare, banking, transportation, and entertainment, highlighting their significant influence and discussing the related problems and ethical concerns.

Ultimately, the article ends by examining probable future paths and possibilities in the fields of AI and ML, highlighting the need to tackle significant obstacles like bias, privacy, and accountability. This is crucial to fully use the capabilities of these technologies for the sake of society.

EVOLUTION OF ARTIFICIAL INTELLIGENCE

AI has seen a significant transformation since its beginning, propelled by improvements in computational capacity, innovative algorithms, and the amassing of extensive data. This section offers a chronological account of the development of AI shown in Fig. (**1**), mapping its advancement from the first symbolic systems to the transformative era of deep learning [5].

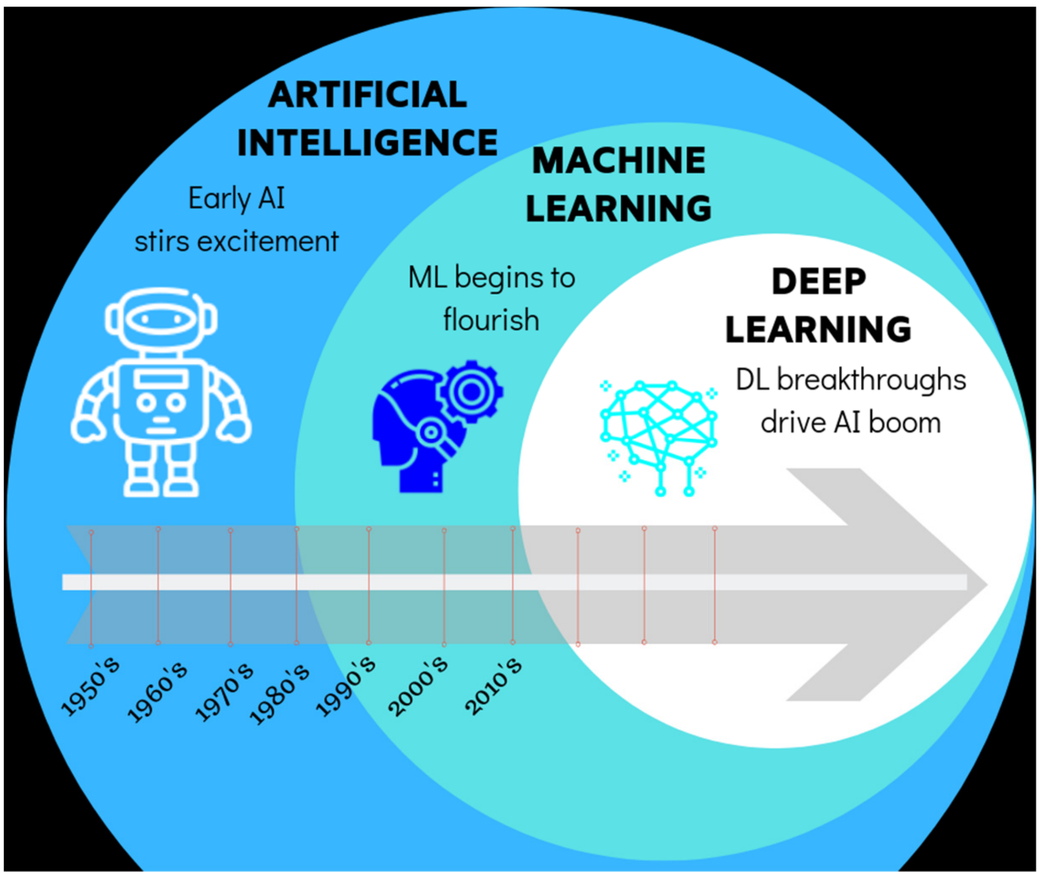

Fig. (1). Evolution of Artificial Intelligence.

Early Developments

Myths and legends about artificial beings with human-like intelligence may have inspired AI. Yet, it was not until the mid-20th century that the contemporary age of artificial intelligence (AI) began, thanks to the ground breaking efforts of

CHAPTER 3

AI-based Aging Analysis of Power Transformer Oil

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Abstract: The power transformer stands as a critical and costly component within electrical networks. Transformer oil serves the dual purpose of cooling and insulation within these systems. Its insulating efficacy and overall health are reflected in its physical, electrical, and chemical attributes, which inevitably deteriorate over the transformer's operational lifespan. The properties of transformer oil, such as volume resistivity, viscosity, breakdown voltage, and dissipation factor, undergo alterations over time. Consequently, regular monitoring of the oil condition is necessary to judge the aging effect. Six properties, including moisture content, resistivity, tan delta, interfacial tension, and flash point, have been examined. Data pertaining to these properties across varying ages (in days) have been collected from ten operational power transformers ranging from 16 to 20 MVA. In this paper, Artificial Neural Network (ANN) and Adaptive Neuro-Fuzzy Inference System (ANFIS) based models are presented for predicting the age of transformer oil samples in service. The ANN model employs a multi-layer feedforward network with the backpropagation algorithm, while the ANFIS model is based on the Sugeno model. A comparative examination of the two models indicates that the ANFIS model demonstrates superior performance over the ANN model, producing better outcomes.

Keywords: ANN, ANFIS, Insulation, Prediction, Transformer oil.

INTRODUCTION

In today's modern industrial landscape, electrical power plays a critical role. To prevent significant power disruptions, utility companies must maintain continuous oversight of the key components within the power system. Liquid-filled electrical power transformers represent an indispensable element within the power system. They constitute a vital asset upon which everyone depends [1, 2]. Within these transformers, insulating oils serve a dual purpose: functioning both as a coolant and as a dielectric fluid [3, 4]. During operational use, the oil experiences gradual

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degradation characterized by aging, elevated temperatures, and chemical processes like oxidation [5]. Therefore, it is essential to conduct regular monitoring of the oil condition. This practice aids in predicting, whenever feasible, the operational lifespan or remaining service life of the transformer oil at various intervals [6]. Typically, power transformers exhibit high reliability, designed for a lifespan ranging from 20 to 35 years. However, with proper maintenance, transformers can often operate for as long as 60 years in practical scenarios [7, 8].

Organizations strive to accurately predict the lifespan of critical assets within various sections of the grid, such as transformers. This foresight enables preemptive measures to be implemented before significant faults arise in the power grid, consequently enhancing network reliability. Moreover, identifying potential transformer faults aids in mitigating aging effects. In essence, the significance of estimating the lifespan of transformers can be encapsulated as follows:

- Enhancing the system reliability
- Developing a maintenance schedule for transformers to ensure optimal functioning and longevity.
- Creating a structured timetable for the replacement of new transformers.

In recent years, various approaches have emerged for estimating the lifespan of transformers. While accelerated thermal aging of solid insulation remains the primary cause of early degradation, moisture also significantly influences the severity of faults [9]. Partial discharge (PD) [10] and dissolved gas analysis (DGA) are two techniques utilized to assess the insulation condition of transformers and ascertain the DP value [12]. An intelligent method for classifying faults in power transformers using dissolved gas analysis (DGA) is introduced in a study [11]. The experimental findings demonstrate that employing the SVM approach notably enhances the accuracy of diagnosing faults in power transformers. Novel methodologies are introduced for Health Index (HI), leveraging machine learning algorithms tailored for comprehensive big data analysis, owing to advancements in computer science and data processing [13, 14]. In another study [15], the analysis explores the impact of data uncertainty on the reliability and precision of lifetime estimation. The primary source of uncertainty stems from insufficient existing data. Another investigation [16] involved a sensitivity analysis of the Health Index (HI) on a transformer, employing a self-adaptive neuro-fuzzy inference system (ANFIS) with parameter tuning accomplished through a partial swarm optimizer (PSO) algorithm. In another study [17, 24], a method is presented that evaluates the effectiveness of various artificial intelligence (AI) techniques in identifying the health index of transformers. In a study [18], a novel AI-driven technique was introduced for categorizing transformer conditions into four distinct classes: 1. good, 2. fair, 3. poor, and 4. very poor. While existing literature has addressed AI-based methodologies for estimating transformer lifespan, there remains a need to enhance the accuracy of these approaches due to data unavailability and uncertainty. Nevertheless, the exploration and examination of AI-based lifetime models in managing data uncertainty have not been thoroughly investigated with established implementation probability.

Understanding the process of transformer aging is intricate and multifaceted. The degradation and aging of transformers result from a combination of factors including electric field intensity, temperature, humidity, oxygen with impurities, water content, and various other elements [19]. Importantly, these factors influencing the aging process of transformers are interconnected and not independent of one another. Discussions on aging are prevalent across various equipment types by researchers. Typically, the lifespan of equipment is influenced by electrical, thermal, and environmental factors. The aging of transformers significantly affects various factors including power outages, environmental impact, and operations of electricity companies. Factors such as excessive transformer loading and harsh environmental conditions are primary contributors to damage to transformer insulation, consequently accelerating the aging process. Additionally, failure to detect equipment defects and faults in a timely manner, coupled with inadequate maintenance practices, further exacerbates transformer aging. Damaged insulation leads to malfunctions and undesirable changes in physical parameters. For instance, the deterioration of paper and oil insulations leads to moisture production, thereby accelerating the aging of transformers. As a transformer reaches the end of its service life, maintenance costs can escalate significantly. The lifespan of the equipment serves as one of the key indicators for determining when a transformer should be replaced [20, 21]. Factors such as alterations in the polymerization coefficient, load variations, and harmonics within the network play pivotal roles in the aging process of transformers. Additionally, external factors including radiation intensity, ambient temperature, and wind conditions contribute to the rate of transformer aging [22, 23].

Motivation: Given the aforementioned points, there are various reasons driving the pursuit of this research, as detailed below:

- Numerous AI-driven techniques have been proposed for predicting the lifespan of power transformers. Nevertheless, their precision remains inadequate and they may not be deemed reliable.

CHAPTER 4

Artificial Intelligence and Social Media: Strength, Management and Responsibility

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Abstract: The rapid development of new digital and online systems that are powered by artificial intelligence (AI), such as social media, targeted marketing, and personalized search engines, has resulted in the introduction of new ways to engage with individuals, collect information about them, and possibly influence the activities they take. Concerns have been expressed, however, regarding the possibility of manipulation brought about by such types of breakthroughs, they provide one-of-a-kind capabilities for targeting and exerting a significant amount of influence over individuals through the persistent application of automated tactics. When it comes to voting, electorates are likely to be influenced to vote for a particular entity. It is important to note that the strategies that involve targeting and profiling on social media platforms serve not just advertising reasons but also propaganda purposes. Through the monitoring of individuals' activity on the internet, social media algorithms can develop user profiles. These profiles are then leveraged to provide recommendations that are specifically customized to a certain audience segment. As a result, propaganda and incorrect information have a greater potential than ever before to influence the perspectives and decisions of voters, particularly in matters related to elections. This chapter provides a detailed survey of the existing literature on manipulation, with a particular focus on the impact of artificial intelligence and other technologies that are connected to manipulation. Furthermore, it considers the ethical imperatives and societal obligations of artificial intelligence developers, social media platforms, and regulatory agencies in the process of minimizing the adverse effects associated with the technology.

Keywords: Artificial Intelligence, Online system, Propaganda, Rapid development, Social media.

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INTRODUCTION

Social media has emerged as the predominant platform for interpersonal communication. Its widespread popularity for news dissemination, information sharing, and event participation is attributed to its ability to swiftly distribute information on a large scale. While this expansive capability fosters social trust and connectivity, it also facilitates the rampant spread of misinformation [1].

Misinformation spreads widely by taking advantage of people's trust and social relationships, spreading false information to stir hatred and hurt individuals or groups. It is widely acknowledged that disinformation poses a serious threat to democracy, justice, public trust, freedom of expression, journalism, and economic growth because it has reached previously unheard-of levels on social media. As a result, addressing the problem of digital disinformation is crucial and urgent [2]. Social media plays a crucial and multifaceted role in contemporary societies, impacting various aspects of communication, culture, politics, and social interactions. Its influence, whether positive or negative, is diverse and depends on factors like geographical location and demographics [3, 4]. The following are key aspects of how social media functions and its effects on societies:

Communication and Connectivity

Social media platforms enable immediate communication, connecting people globally and maintaining relationships despite geographical distances. On the other hand, excessive reliance on virtual communication may lead to a reduction in face-to-face interactions, potentially affecting relationship quality.

Information Dissemination

Social media offers a rapid and widespread means of sharing information, aiding in spreading awareness about social issues, emergencies, and significant events. On the other hand, the rapid dissemination of misinformation and fake news is a concern, leading to the spread of inaccurate or biased information with serious consequences.

Cultural Impact

Social media facilitates the exchange of cultural ideas, fostering a more interconnected global culture and providing a platform for cultural expression. On the other hand, cultural appropriation, stereotyping, and cultural homogenization may occur, potentially resulting in misunderstandings and conflicts.

Political Impact

Social media plays a crucial role in political activism and social movements, providing a platform for marginalized voices and aiding in the organization of protests and campaigns. On the other hand, it can contribute to political polarization, the formation of echo chambers, and the spread of extremist ideologies. Additionally, concerns arise about the manipulation of social media for political purposes.

Economic Influence

Social media platforms serve as effective marketing tools, allowing businesses to reach a global audience and engage with customers directly. On the other hand, ethical and privacy concerns arise due to issues such as online scams, the proliferation of counterfeit products, and the exploitation of user data for targeted advertising.

Mental Health

Social media provides support networks for individuals facing mental health challenges, creating communities of people with shared experiences. On the other hand, continuous exposure to curated and idealized representations on social media can contribute to feelings of inadequacy, anxiety, and depression. Cyberbullying is also a significant concern.

Privacy and Security

Social media allows individuals to control their online identities and connect with others based on shared interests and values. On the other hand, concerns about data privacy, identity theft, and cyberbullying can undermine trust in online platforms and have broader societal implications [5, 6, 7]. In a summarised way, social media has become an integral part of modern societies, influencing communication, culture, politics, and more. Recognizing both the positive and negative impacts is crucial for addressing challenges and maximizing the benefits of social media in a rapidly evolving digital landscape.

The word “manipulation” in common parlance describes the artful or cunning process of influencing or managing someone or something, usually with the goal of misleading or benefiting from it. Investigating this word's etymology offers fascinating perspectives on its meaning. The Latin word “manipulare,” which means “to handle, control, or manipulate,” is where the word first appeared. The term “manipulare” comes from the Latin word “manipulus,” which means “a handful,” “a sheaf,” or “a troop.” [8, 9, 10].

CHAPTER 5

Recent Trends in AI-Driven Human Detection Tactics

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Abstract: In the age of technology, the main function of video surveillance is to detect and track individuals in dynamic environments. This chapter extensively explores and reviews comprehensive literature on various human detection methodologies and datasets, focusing on frameworks that detect human presence through object detection methods by processing video sequences.

The object detection techniques discussed include face detection, motion detection, frame differencing, histogram-based, and geometry-based approaches. These techniques classify objects as human or non-human using different deep learning and machine learning models. This survey explores current technological advancements and their frameworks, revealing insights from studies addressing challenges such as occlusion, pose variation, and environmental complexities.

An overview of prominent human detection datasets, such as INRIA, MIT, CAVIAR, CALTECH, and others, offers valuable resources for training and evaluating detection models. This comprehensive exploration aims to provide researchers and practitioners with a cohesive understanding of human detection methodologies, challenges, and diverse datasets for advancing this critical field in computer vision and surveillance technology.

Keywords: Benchmark datasets, Fuzzy and neutrosophic logic, Human detection, Image analysis, Machine learning, Video surveillance.

INTRODUCTION

Recent advancements in computational intelligence approaches have led to the development of automated systems in several real-life applications, including natural language processing (NLP), recommender systems (RS), sentiment analysis (SA), and computer vision (CV) [1]. The automation of surveillance systems has improved the efficiency of many organizations, and it has gained

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wide acceptance in many real-life applications, including gender recognition, counting and identifying persons entering highly secure and crowded places, detecting road traffic signals, recognizing number plates, violence detection, and many more. Video surveillance systems are highly effective in crime prevention by detecting violence and illegal activities. Traditional surveillance systems rely on humans, leading to delays in detecting criminal activities [2]. Automating surveillance eliminates the delay in manual surveillance and improves the effectiveness of real-time surveillance systems and detection.

Generally, object detection is figuring out if there is an instance of a particular object class in a scene. The CV systems use human detection and tracking to find and follow individuals in video footage [3]. Finding the instance of a person in an image is known as "human detection". It has most commonly been achieved by looking for human occurrences at every size and position in the picture and comparing a small portion of each with known human patterns or templates. Creating permanent routes, or trajectories, for individuals in a video series by temporally linking the person detections is known as "human tracking." In a video surveillance pipeline, human identification and tracking are typically regarded as the initial two steps. These techniques, such as action recognition and dynamic scene analysis, may be included in higher-level reasoning modules.

Fig. (**1**) shows the basic human detection framework that can be used in surveillance and many more applications. The camera takes the input in the form of video sequences. The object detection process is done on these input sequences, which detect the intended objects by analyzing each sequence. Then, these objects are classified, whether the object is human or not, through various classification algorithms.

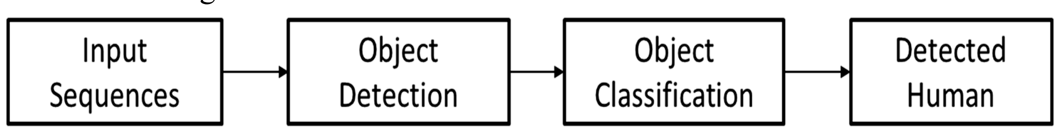

Fig. (1). Human Detection Framework.

Detecting humans in real-time video sequences is challenging due to constraints such as occlusion, cluttered environment, noise, *etc*. Several researchers have worked in this area, and research has been published. The identification of persons is important for many kinds of applications in visual monitoring systems [4], such as person detection and identification, elderly fall detection, aberrant surveillance, gender classification, crowd analysis, and person gait analysis. This chapter aims to provide a comprehensive guide for human detection in surveillance videos. It is believed that the researchers working in the area of CV in general and human detection in particular will find this work useful. The contributions of this chapter are summarised in the following points.

- It presents and discusses different classification techniques used for human detection.
- It overviews the machine-learning approaches used for human detection.
- It elaborates on different benchmark data sets used to train human detection models.
- It discusses potential future research directions in the area of human detection.

The remaining sections of the chapter are organized as follows: Section 2 discusses different human detection techniques and their classification. Chapter 3 covers various machine-learning algorithms used for human detection. Chapter 4 presents the different available datasets for training human detection classifiers. Future research opportunities are discussed in Section 5. Finally, Section 6 provides the conclusion.

CLASSIFICATION OF HUMAN DETECTION TECHNIQUES

Several researchers have provided various methods in the area of human detection. These methods can be broadly classified based on the nature of the algorithm. The classification tree of human detection algorithm is shown in Fig. (**2**). The human detection algorithms are classified into modules, each containing several algorithms, as outlined below.

a. Face Detection Based Human Detection algorithms classify a segment of the face as a person if a human's face is found in that portion.
b. Motion-Based Human Detection Algorithms: the pixel movement vectors are traced in the successive frames, and these pixels are classified into human body or background pixels.
c. Human Detection using Frame Differencing Algorithms: it detects the human by subtracting the current frame from the reference frame.
d. Histogram-Based Human Detection Algorithms: based on various attributes, the histogram vector is made for the image and then trains a classifier using histogram characteristics for the human body.
e. Geometry-Based Human Detection Algorithm: It uses information about the human body, its components, curves, and straight-line information to make a classifier for the human body.

While examining some techniques, many challenges may have to be faced due to shadow, cluttered areas, the wind causing reflections, illumination, noises, object overlapping, the slow movement of objects, *etc*. They may affect the algorithm

CHAPTER 6

A Review of Sentiment Analysis Opinion Mining and Using Machine Learning

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Abstract: Recently, sentiment analysis and opinion mining have drawn a lot of interest. Because user-generated content on the internet is becoming more and more influential, this research examines the various machine learning (ML) techniques used in opinion mining and sentiment analysis applications. The opinion mining and sentiment analysis utilizing machine learning approaches are thoroughly reviewed in this research article. The objective of this comprehensive review is to find the most accurate and efficient models that can automatically classify and analyze sentiments expressed in textual data. A range of machine learning techniques are utilized and assessed according to performance measures including precision and accuracy. The dataset used consists of real-world text data collected from social media platforms, product reviews, and online forums. The findings indicate that Support Vector Machine (SVM)and Naïve Bayes (NB) achieved exceptionally high values of accuracy. SVM and NB achieved an accuracy of 95%. On the other hand, Logistic Regression (LR) and K-Nearest Neighbor (KNN) demonstrated comparatively lower accuracy scores of 57% respectively. Among all the evaluated techniques, KNN exhibited the lowest precision score of 57%. Overall, ML techniques have proven to be valuable in sentiment analysis and opinion mining.

Keywords: Opinion mining, Sentiment analysis, Social media, Sentiment classification, Supervised learning techniques.

INTRODUCTION

There are numerous significant subfields within natural language processing, two of which are sentiment analysis and opinion mining. These topics focus on autonomously obtaining and evaluating subjective data through textual sources. Because of the expansion of online platforms and social media, there is an increasing need to analyze and comprehend the thoughts, feelings, and attitudes that individuals have regarding a variety of subjects, goods or best services [1].

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Machine learning (ML) techniques are emerging as potent tools in this field that enable quick and automatic analysis of large amounts of textual data in search of patterns of interest. Sentiment analysis is a branch of natural language processing that measures sentiment based on opinion and cognition.

Opinion mining goes deeper into understanding the exact opinions, sentiments, or emotions represented within the text, however, sentiment analysis is a well-known scientific field that has seen a lot of recent effort. Billions of individuals have come to social media to engage with one another. These days, a lot of people utilize social media on a daily basis to share thoughts, insights, and experiences in addition to serving as a forum for social interaction. We find phrases that are neutral, negative, or positive to determine the sentiment polarity of a text. This is the aim of sentiment analysis. Individuals can automatically categorize, measure, and analyze attitudes and opinions expressed in a wide variety of textual sources, including customer reviews, social media posts, news articles, and online forums, by applying ML techniques for the classification of sentiments and opinions [2].

Sentiment classification can be done in different ways and opinion mining is made easier with the use of machine learning techniques, which use large-scale annotated datasets to learn patterns. Among the many steps that these methods take, pre-processing the text, extracting features from that text, training the algorithm, and classifying the user's emotions are the most crucial steps [3]. Among the popular supervised learning algorithms used in sentiment analysis are Naive Bayes (NB), Random Forest (RF), and Support Vector Machines (SVM). Opinions in a dataset are discovered and sorted using unsupervised learning strategies like clustering and topic modeling. Deep learning models are remarkably successful at sentiment analysis tasks because of their ability to extract the context and define the semantic information contained in the text [4]. In order to better classify opinions and extract meaningful insights from large amounts of data, these models excel at learning intricate patterns and connections. Fig. (**1**) depicts the process flow of sentiment analysis and opinion mining for applying different machine learning techniques [5].

Machine learning-driven opinion mining and sentiment analysis find extensive practical applications in various real-world scenarios. Brand monitoring, reputation management, social media analysis, and tracking political mood are just a few of the many examples. An organization can improve customer satisfaction, respond quickly to market changes, and cater to individual tastes by automating the study of customer feelings and reviews. Problems with sarcasm, irony, and context-dependent emotions, as well as multilingual and noisy text, remain challenges in the domains of sentiment analysis and opinion mining. Analyzing sentiments is becoming increasingly relevant in fields like healthcare, finance, and social sciences, and future studies will hopefully find ways to make these models more accurate and resilient while also examining how they may be used in these and other growing fields.

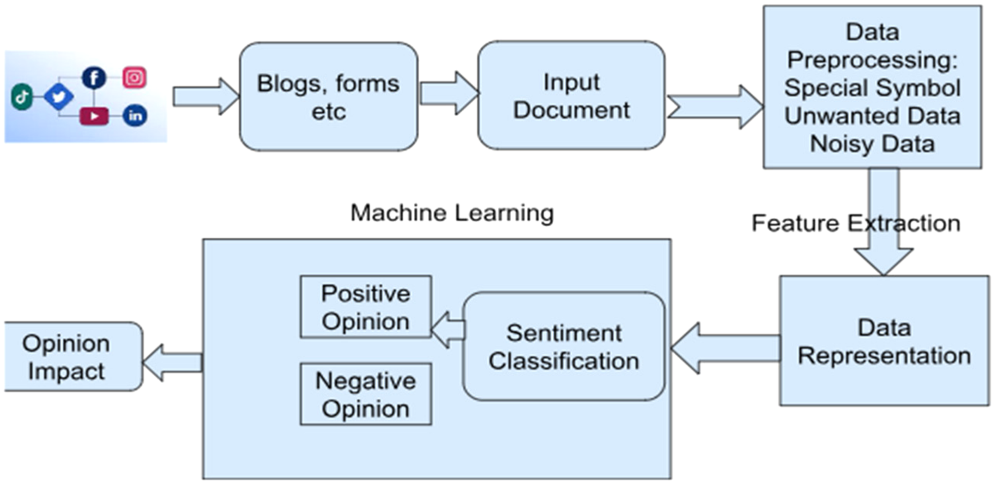

Fig. (1). Opinion mining and Sentiment analysis.

Sentiment Analysis

Automatically identifying a text's underlying emotional state is referred to as sentiment analysis and opinion mining is sometimes called sentiment classification or sentiment polarity detection. Sentiment analysis is the process of categorizing text data as positive, negative, or neutral and assigning scores based on the intensity of the sentiment expressed. Social media posts, online evaluations, client comments, and other types of user-generated material have increased the demand for sentiment analysis in recent years [6]. Fig. (**2**) given below illustrates the classification of sentiments based on their polarity.

analytics, and reputation management. Businesses can use sentiment analysis to make data-driven decisions, uncover new patterns, comprehend client feelings, and enhance their goods and services in response to customer feedback [8]. Despite the advancements, sentiment analysis still faces challenges. The presence of sentiment detection and opinion extraction using Applications for machine learning can be found in a number of fields, such as market available research, branded monitoring, consumer feedback analysis, social media of sarcasm, irony, or subtle sentiment expressions, which can be difficult to detect accurately. Handling domain-specific language and sentiment lexicons, managing large-scale data, and addressing class imbalance are other challenges that researchers are actively working on [7].

CHAPTER 7

State-of-the-Art Techniques in Visual Analysis for Image Processing and Pattern Recognition: A Systematic Review

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Abstract: Visual analysis of human motion has emerged as a frontier vicinity in computer vision in up-to-date years. In visual sequences, it can identify, track, and recognize individuals. It can also comprehend and characterize their movements. With the quick growth and widespread use of information technology, the application of computer vision technology to the study of image processing, pattern recognition, and the efficient extraction and identification of human motion elements from video images has gained significant attention. In order to enhance the capacity to evaluate the attributes of moving human bodies, this work introduces the extraction function method, examines the properties of the extraction function, and proposes a technique for doing so based on picture recognition. The periodic motion in each motion is segmented using the hierarchical clustering approach to obtain precise segmentation. The tests employed self-built data and several benchmark datasets. Tests demonstrate that the method can extract less feature data and retain low computational complexity while producing high classification and recognition results. Additionally, it is capable of naturally integrating both the static and dynamic aspects of human gait.

Keywords: Feature extraction, Image processing, Image segmentation, Image compression, Image classification, Neural networks.

INTRODUCTION

Computer vision, or image recognition, is the process of classifying objects, people, places, or behaviours in digital photographs or video frames. In order to

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enable computers to study and comprehend visual input similarly to humans, it entails the creation and application of algorithms and methodologies. To identify patterns and features in images, image recognition systems usually use convolutional neural networks (CNNs), deep learning models, and erstwhile machine learning approaches. Numerous industries use image recognition technology, including driverless cars, surveillance, medical imaging, facial identification, augmented reality, and satellite imagery analysis. The field of pattern recognition is more expansive and includes more than just visual data; it also includes the identification, categorization, and interpretation of patterns in data. Pattern recognition applies to several forms of data, including signals, noises, texts, and more, whereas image recognition is primarily concerned with visual patterns. Machine learning algorithms, statistical techniques, neural networks, and other computer methodologies are examples of pattern recognition techniques [1-4]. These techniques seek to identify patterns or commonalities in data so that judgments or predictions can be based on them. Many fields use pattern recognition: bioinformatics, speech recognition, handwriting recognition, anomaly detection, fraud detection, and natural language processing. Everywhere you look, you see patterns. It is a part of all that we do in our everyday lives. From the style and colour of our clothing to the use of voice assistants with intelligence, everything involves some kind of pattern.

Overview of Image Processing and Pattern Recognition

The two image processing and pattern recognition, each with a distinct application and focus, are essential elements of Information Technology. Image processing is the use of mathematical techniques and algorithms for the manipulation and analysis of images. Improving the visual appeal of photos or deriving valuable information from them is its main goal. This covers a broad spectrum of jobs, ranging from simple adjustments like cropping and resizing to more complex procedures like feature extraction, segmentation, restoration, and image enhancement. Image processing has several uses in a wide range of industries, including digital photography, biometrics, remote sensing, medicine, and industrial automation. It helps with duties like environmental monitoring, security, and quality control as well as medical diagnostics [3, 4].

Contrarily, pattern recognition is the process of locating, categorizing, and deciphering patterns in data—which could be text, photos, signals, or other types of information. Pattern recognition systems employ algorithms to scan input data for patterns or regularities; they frequently do this by comparing the data to templates or models that have already been created. Pattern recognition has several uses, such as object identification, biometric identification, verbal communication detection, natural language processing, and handwriting recognition. Virtual assistants, security systems, document processing, and many more industries where pattern recognition is automatic find applications for these technologies.

Importance

- Information Extraction: Image processing makes it possible to extract important information from pictures, which mold it to introspect and analyze, comprehend, and make sense of data.
- Automation: The ability of systems to identify patterns or objects in images without the need for human intervention makes pattern recognition a useful tool for task automation.
- Enhancement and Restoration: Through the removal of noise, the correction of distortions, or an improvement in quality, image processing techniques can enhance and restore images.
- Decision Making: By offering insights and spotting patterns in huge datasets, pattern recognition algorithms support decision-making processes and enable the making of well-informed choices.
- Efficiency: Through task automation, a decrease in manual intervention, and workflow streamlining, image processing techniques can enhance efficiency across a range of operations.

Applications

- Medical Imaging: Pattern recognition for illness detection, image enhancement, diagnosis, and segmentation (finding structures within images) are just a few of the many uses of image processing in medical imaging [5].
- Biometrics: Biometric systems use pattern recognition techniques to identify and authenticate people based on their distinct physiological or behavioural qualities, such as facial features, iris patterns, and biometrics [6].
- Image processing is essential to the investigation of GIS Data for uses in agriculture, urban planning, disaster relief, and environmental monitoring [7].
- Security and Surveillance: Surveillance systems employ image processing and pattern recognition to follow objects or people, identify suspicious activity, and improve public safety [8].
- Automotive Industry: Image processing is being used more and more for tasks like object detection, lane tracking, and collision avoidance in automotive applications including driver assistance systems, autonomous cars, and traffic monitoring [9].

Below word-cloud shows applications where image process and pattern recognition play a vital role (Fig. **1**).

CHAPTER 8

Cyber-Physical Architecture of Smart Grid Network

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Abstract: The smart grid (SG) system is a novel concept that introduced bidirectional power and communication infrastructure to traditional power grid systems at the beginning of the 2000s. To make information and communication technologies (ICTs) available in utility grids at every point throughout the generation, transmission, distribution, and consumption (GTDC) of power are necessary. This chapter explains the fundamental elements and cutting-edge technologies that make up SGs, including sensor networks, intelligent management systems, monitoring, and metering systems, communication technologies, regulations, standards, and security needs for this idea. Two-way intelligent communication and real-time measurements are all used in the "SG", an electrical distribution system. A safe, secure, dependable, robust, effective, and sustainable SG is anticipated. Measuring tools like phasor measurement units (PMUs) could drastically alter how grids are monitored. There are a few obstacles, though, like managing the massive volume of data and deploying an adequate number of PMUs. A fundamental need of the SG is communication in both directions. It is necessary to have a communications network that can handle the data traffic and is secure, devoted, and capable. Renewable energy inclusion will change the grid's characteristics. Enhanced distribution-level management and monitoring are necessary, given the current circumstances.

Keywords: Cyber-physical system, Conventional grid, Smart grid, Smart grid architecture.

INTRODUCTION

The traditional electricity system has degenerated since its inception and widespread usage. The four main components of the power grid are GTDC. Bulk-generating systems include hydropower plants, coal, diesel, gas power plants, thermos generators, solar and wind power plants, and nuclear power. The deteri-

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orating utility has several flaws affecting electricity quality and dependability. Among well-known power system flaws are voltage variability, blackouts, intermittency, and imbalanced or heavy-load circumstances. Remote control and monitoring technologies have been enhanced and incorporated into the traditional grid [1, 2].

Since the conventional grid was constructed, worldwide energy consumption has risen. Governments and energy providers have upgraded demand-side management (DSM) and numerous energy projects to fulfill the need. Regulations allowing more distributed generation (DG) have existed for decades. Along with DG initiatives, renewable energy sources (RES) usage has grown steadily. Conventional grid research and development have imposed a new necessity on communication arrangements. These communication arrangements improved the SG by managing sources and loads, monitoring GTDC rates, and control systems. The phrase SG, coined in the early 2000s, refers to monitoring and controlling power system management [3 - 5]. The SG combines physical and cyber communication networks and increases power network communication and control. The SG promotes the power network by allowing two-way communication.

The SG infrastructure provides a data communication means for signal monitoring, control, measurement, and management. In addition to microgrids, the SG interface may be incorporated into the grid at any point. The transmission interface and medium must be secure, dependable, and efficient. Many legislation, standards, applications, and reference works have been produced to advance the SG idea. The Energy Independence and Security Act of 2007 defined SG and its characteristics [6]. Instead of only improving technology, SG has acknowledged the goal.

Table **1** compares conventional and SG's most important properties. Enhanced ICT allowed the traditional grid to supply electricity efficiently. Data transmission over a cyber-secure communication gateway is possible for the SG. Thus, computing intelligence is incorporated into the traditional grid, making grid diagnosis and troubleshooting considerably more efficient. Computing intelligence is included in traditional grid GTDA. Thus, the upgraded grid is far safer, dependable, controlled, and efficient. It is decentralized and DG, whereas the traditional grid relies on centralized plants. Because of decentralized generating, SG monitoring and measuring technologies have been developed. Thus, SG improvements now have two-way communication.

Table 1. Compares among traditional grid and SG.

Feature	Conventional Grid	Smart Grid
Grid architecture	Radial	Network
Power Generation	Central	Decentralized
Power flow	Unidirectional	Bi-directional
Communications	Unidirectional	Bi-directional
Restoration	Local and manual	Self-restoration
Control	Passive and limited	Active
Monitoring	Manual	Self-monitoring
Transducers	Limited sensors	Widespread and unlimited
Metering	Electromechanical and digital	Smart meter

This is done by using smart sensors, and networks infinitely and ubiquitously. The intelligence-based innovative electrical grid construction can self-restore and heal, although traditional grid requires manual or local restoration [5, 7, 8].

IEEE Std 2030–2011 supports the National Institute of Standards and Technology (NIST) outline direction and includes many explanations representing a system-level interoperability method. This capability allows any system to connect with another *via* devices, services, applications, networks, and interfaces, all of which are supported by cyber-physical systems (CPSs). Thus, every SG system must combine data transmission, software, and hardware systems, and exchange networks [1]. The ICT enables combination based on the need for compatibility. The NIST-suggested compatibility architecture is shown in Fig. (**1**).

It facilitates interactions between SG applications and imaginary reference representations (see Fig. **1**). A smart grid conceptual reference model defines characteristics, behaviors, needs, and standards for the SG system *via* views and descriptions. Actors, domains, and layered structures are all described in the conceptual reference models. Of the several reference models presented, NIST and IEC are commonly acknowledged [1, 5].

Markets, operations, and service providers are smart grid domains characterized by electrical flow. As demonstrated in Fig. (**2**), the smart grid interacts with existing systems on both electrical and communication levels. Generating power plants make up the majority of the generation. It is linked to other domains through WANs and substations *via* LANs. All transmission level equipment are field devices and substations. In distribution, data collectors offer connectivity between WANs, field area networks, and substation LANs. A FAN connects field

CHAPTER 9

Improving the Hardware Security of Wireless Sensor Network Systems by Using Soft Computing

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Abstract: Hardware security is a critical concern for organizations that use information systems to protect their assets from unauthorized access and malicious attacks. Hardware security assessment involves evaluating the security of hardware components and systems to identify vulnerabilities and areas for improvement. This research paper proposes a framework for hardware security assessment using the Analytic Hierarchy Process (AHP) approach. The proposed framework is applied in a case study to evaluate the security of a wireless sensor network (WSN) system. Based on this calculation with respect to each alternative, the author finds that Hardware encryption obtained the highest final weighted score (0.555), which would be the preferred choice according to the AHP method for improving the security of the hardware of WSN. Based on the obtained weight, authors assign the ranks S1<S3<S2 <S4. The results show that the proposed methodology can effectively identify better security algorithms and prioritize actions to improve the security of the WSN system.

Keywords: AHP, Hardware, Malicious attacks, Soft computing, Security, WSN.

INTRODUCTION

Hardware security is becoming an increasingly important concern for organizations that use information systems to protect their assets. The security of hardware components and systems is essential to prevent unauthorized access, data theft, and other malicious attacks [1, 2]. Hardware security assessment involves evaluating the security of hardware components and systems to identify vulnerabilities and areas for improvement. However, hardware security assess-

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ment is a complex task that requires the consideration of multiple criteria and the use of objective evidence to evaluate the security of the hardware [3].

Hardware security refers to the measures and techniques used to protect computer hardware from unauthorized access, tampering, and theft. It involves the use of various physical and logical mechanisms, such as access controls, encryption, and authentication, to ensure the confidentiality, integrity, and availability of hardware resources [4, 5]. One of the key reasons for hardware security is to prevent the theft of valuable hardware, such as servers, laptops, and mobile devices. In addition, hardware security is important for protecting critical infrastructure, such as power grids, transportation systems, and healthcare facilities, from cyber-attacks [6].

There are several approaches to hardware security, including hardware-based security, software-based security, and hybrid approaches. Hardware-based security involves the use of specialized hardware components, such as security chips, to implement security functions. Software-based security, on the other hand, uses software programs to perform security functions, such as encryption and access controls. Hybrid approaches combine hardware and software security mechanisms to provide stronger protection against attacks [7, 8].

The Analytic Hierarchy Process (AHP) is a decision-making framework that can be used to evaluate and prioritize multiple criteria in a hierarchical structure [9, 10]. AHP has been applied in various fields to support decision-making, including hardware security assessment. This research paper proposes a framework for hardware security assessment using the AHP approach and applies it to a case study to evaluate the security of a wireless sensor network (WSN) system [11]. These are the main mathematical equations involved in the AHP approach. Note that there are variations in the AHP method that uses different equations, such as the eigenvector method and the logarithmic least squares method.

Overall, using AHP for hardware security assessment provides a structured approach that can help organizations make informed decisions about hardware security. By identifying and prioritizing criteria, assigning weights, and evaluating components or systems against those criteria, organizations can make data-driven decisions to improve hardware security.

Contribution: Our contributions are follows as:

- Identification of hardware security techniques and definition of criteria for assessment.
- An AHP model for the evaluation of hardware techniques against each criterion.
- Interpretation and effects of factors on the security of the results.

- Identification of better security techniques and required factors that need to be improved.

MATERIAL AND METHOD

There are several approaches to hardware security, including hardware-based security, software-based security, and hybrid approaches. Hardware-based security involves the use of specialized hardware components, such as security chips, to implement security functions. Software-based security, on the other hand, uses software programs to perform security functions, such as encryption and access controls [12]. Hybrid approaches combine hardware and software security mechanisms to provide stronger protection against attacks.

Some of the common hardware security techniques include:

- Secure boot: This technique ensures that the system boots only from trusted sources, preventing malware from executing at startup [13].
- Trusted Platform Module (TPM): TPM is a hardware component that provides a secure environment for cryptographic operations and storage of sensitive information [14].
- Physical locks and barriers: These are physical mechanisms, such as locks and fences, used to prevent unauthorized access to hardware resources [15].
- Hardware-based encryption: This technique uses hardware components, such as encryption chips, to encrypt data stored on hardware devices [16].

Hardware security is a complex and constantly evolving field, as new threats and vulnerabilities emerge. Therefore, it is essential for organizations to stay up-t--date with the latest hardware security technologies and best practices to protect their valuable hardware resources [17].

Assessing hardware security through the Analytic Hierarchy Process (AHP) can help identify and prioritize security measures for the hardware components used in a system [17]. AHP is a structured decision-making technique that allows stakeholders to compare various criteria and alternatives in a systematic and consistent manner.

The proposed model for improving hardware security by using the AHP approach consists of the following steps shown in Fig. (**2**):

- Identification of hardware techniques
- Definition of criteria for assessment
- Establishment of the hierarchy of criteria
- Assignment of weights to the criteria

CHAPTER 10

Unveiling the Sky: Exploring Synergies in Drone Robotics and Automation through Artificial Intelligence and Machine learning

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Abstract: In the rapidly evolving landscape of unmanned aerial vehicles (UAVs) and automation technologies, this research delves into the synergistic potential of integrating artificial intelligence (AI) and machine learning (ML) into drone robotics systems. This paper examines the current state of drone technology, focusing on the challenges faced in optimizing their performance for complex tasks. By leveraging AI and ML algorithms, drones can evolve beyond traditional pre-programmed routes and manual control, unlocking the ability to learn from data, adapt to dynamic environments, and make intelligent decisions in real time. As drones continue to play an increasingly pivotal role across diverse industries, from agriculture and surveillance to logistics and emergency response, the fusion of advanced AI and ML promises transformative advancements in efficiency, adaptability, and autonomy. Internet of Drones (IoD) is evidently a promising and versatile application of Unmanned Aerial Vehicles (UAVs) across various domains. The adaptability of drones to unpredictable circumstances and their diverse range of applications make them valuable tools in numerous scenarios. Drones' outstanding mobility and dexterity allow them to identify areas that are dangerous or difficult for people to access.This is especially valuable in scenarios such as inspecting infrastructure, monitoring environmental conditions, or assessing the aftermath of natural disasters.

Keywords: Artificial intelligence, Dynamic environments, Drone robotics, Efficiency, Internet of Drones, Machine learning, Surveillance, Unmanned aerial vehicles.

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INTRODUCTION

The integration of AI and ML into drone systems has the potential to address various challenges, such as navigation, obstacle avoidance, and decision-making processes. This paper delves into the current state of drone technology, identifying areas where AI and ML can significantly contribute to advancing capabilities and overcoming limitations.

Autonomous vehicles (AVs) aim to achieve a high level of automation and safety, reducing the reliance on human drivers. Ongoing research and advancements in these fields continue to enhance the capabilities of autonomous vehicles, bringing us closer to a future where they can be seamlessly integrated into everyday transportation systems [1, 2]. Drones are a type of technology that can fly without the assistance of a pilot, and they can also be ground-based; they are becoming more prevalent in people's lives [3]. As drones' commercial use continues to expand, scientific researcher's attention has been drawn to their core technology. In order to provide services or send up-to-date information to users who are located far away and connected to specialized application servers, drones engage in simultaneous communication with a reference ground structure [4].

By utilizing machine learning approaches, research is done to try and identify UAVs, categorize them, and potentially even identify their flying path. Drones also improve network topology efficiency in terms of latency, performance, interdependence, and reliability [5]. However, there are a number of issues with drone deployment, including the high degrees of mobility, the erratic behaviour of the wireless medium, and the potential for quick topological changes due to battery life. Intelligent approaches and technologies are being employed to enhance decision-making skills in light of autonomous vehicle development, as Khayyam *et al*. noted [6].

Fig. (**1**) illustrates the security and safety features of A.V. In AV's safety system, mechanical and electrical safety systems as well as electrical and electronic safety systems are regarded as safety concerns.

The ability of the drone to make independent decisions in the event that humans cannot operate it or communicate with one another highlights the novelty of this proof of concept. The outcomes are used to give the "pilot" visual information so that it can plan the flight path based on the locations of the objects in its path. This makes employing the drone for rescue operations during natural disasters possible.

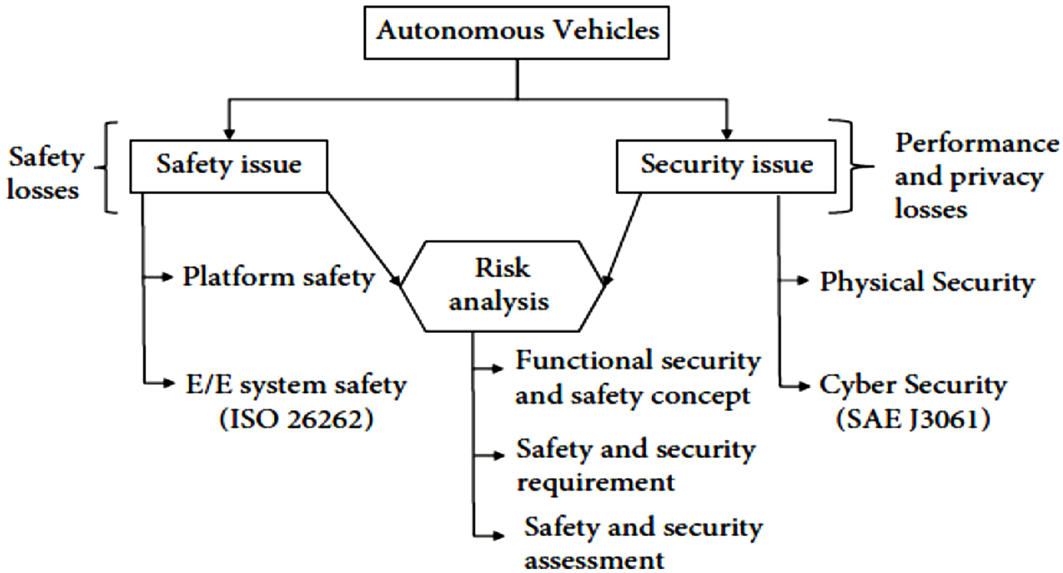

Fig. (1). Security and Safety Features of Autonomous Vehicles.

Integrating AI and machine learning with UAV technology has revolutionized various industries and expanded the capabilities of drones. This synergy has led to advancements in object recognition, autonomous navigation, obstacle avoidance, real-time decision-making, and collaborative operations. It is exciting to see how these technologies continue to evolve and drive innovation across multiple domains.

UAV-based advanced wildfire identification and warning systems are indeed gaining traction due to their ability to incorporate multiple remote smart sensors. Deep learning-based computer vision methods have emerged as effective tools for monitoring wildfires using UAVs. These methods leverage the power of AI and ML to analyze aerial imagery and detect signs of wildfires with high accuracy and speed.

UAVs outfitted with graphical remote sensing technologies have several benefits over more conventional approaches, such as dispatching maintenance teams into dangerous regions or depending solely on ground-based surveillance. They can access hazardous or inaccessible areas that are hard for people to enter, are affordable, and offer real-time data [7].

UAVs may also be swiftly deployed to monitor wide areas and issue early warnings, facilitating quicker reaction times and more efficient tracking and suppression of wildfires. This combination of UAV technology and deep learning-based computer vision holds great promise for improving wildfire

CHAPTER 11

An Expert System-Assisted AI Approach for Awareness and Prevention of Crimes against Women in India

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Abstract: The incorporation of Artificial Intelligence (AI) and its sub-domains for women's safety and security is a major requirement in the present technology-driven world. Most of the works in this context focus on leveraging Machine Learning (ML) technologies to predict harassment, violence, and other women-related crimes. However, ML approaches are mostly data-driven. In many poor and developing countries like India, where criminals' data are not well-documented and publicly unavailable, other alternative ways must be planned to prevent crimes against women. One feasible way is to spread awareness about laws and punishments related to women's crime using AI assistive technology. This will not only help to spread awareness about laws related to crimes against women but also help in preventing by creating fear of consequences for women-related crimes. In this context, a sub-domain of AI, known as a rule-based expert system, is proposed using a top-down inference method to help the user know about the penalty and legal action linked to the crime committed against women in India as per Indian legislative laws. Initially, a comprehensive set of 77 rules is collected from legal domain experts to design the knowledge base (KB) of the proposed expert system. For rapid prototyping, the proposed system is implemented in ES-Builder, an open-source, web-based expert system shell. To check the efficacy of the system, extensive testing of the system has been carried out by querying the expert system, which shows the desired results.

Keywords: Crimes against women, Expert system, Expert system shell, ES-builder, Indian penal code.

INTRODUCTION

A recent survey report by the World Health Organization (WHO) depicts that about one in three women globally suffer from violence directly or indirectly in their lifetime [1].

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This is an act of crime against women. This happens to the women who are close to their friends, relatives, and colleagues directly or by unknown persons indirectly in the society. India, though known for respecting women from ancient times, is in no way away from women-related crimes [2]. As per the recent report, India stood ninth among the world's most dangerous countries for women. It is fifth in case of violence by intimates and ranks first in the gender inequality index. So, preventing women's crime in the prevailing society is of foremost importance for their safety and healthy living in a society.

One feasible way to prevent women-related crimes is to spread awareness about laws and punishments related to women's crimes using AI assistive technology [3]. This will not only help to spread awareness about laws related to crimes against women but also help in preventing them by creating a fear of the consequences for women-related crimes. To automate the awareness and prevention of crime against women, AI approaches have shown significant contributions. Most of the works in this context focus on leveraging Machine Learning (ML) technologies to predict harassment, violence, and other women-related crimes [3, 4]. However, ML approaches are mostly data-driven. In many under-developed and developing countries like India, where criminals' data are not well-documented and publicly unavailable, other alternative ways must be planned to prevent crimes against women. One such field of AI is a rule-based expert system, which has been used successfully for various purposes [5 - 7].

In this paper, a rule-based expert system is proposed, based on a decision tree based top-down inference method, to help the user know about the penalty and legal action linked to the crime committed against women in India as per Indian legislative laws. The major contributions of this paper are as follows:

i. A novel rule-based expert system is proposed to spread awareness and thus prevent crimes against women in India
ii. A comprehensive set of 77 rules is collected from legal domain experts to design the proposed expert system and the rules are categorized as per age group to avoid noisy conclusions.
iii. A rapid prototyping of the system is carried out using ES-Builder, a web-based expert system shell, and the correctness of the system is tested with a series of questionnaires.

The rest of the paper is organized as follows. Section 2 presents a brief overview of IPC sections related to crimes against women and related work.

Section 3 gives the proposed system followed by implementation and testing in section 4. Section 5 concludes with future work.

BACKGROUND INVESTIGATION

This section briefly highlights the different IPCs on crimes against women in India and some important works in this field.

Crimes against Women and Indian Penal Code: A Brief

Indian Penal Code (IPC) is the official criminal code of India with a very clear and vivid objective. The objective of the Indian Penal Code is to provide a general solution and penalties to the citizens of India. These penalties are not subject to any privileges and shall treat people of all categories the very same. The IPC has several rules and regulations which have the whole penalty of crime pre-determined. These sets of rules are subject to change, and that is known to be the amendment acts. Every set of rules and regulations is subject to a lot of exceptions and is prone to be misused when used for the safeguard of women only. However, these rules establish the whole basis of the judicial system of this country. A summary of the crimes that occur against the women and the corresponding IPC is given in Table **1** [8].

Table 1. Penalty details of crime categories against women in India.

Crimes	Sections of IPC
For medical termination of pregnancy with or without consent.	Section 312 | Section 313
For committing rape in its various forms and cases.	Section 375 | Section 376
Kidnapping and Abduction cases of minor and major-aged women.	Section 363| Section 366A | Section 366B | Section 367 | Section 368 Section 369
Trafficking of one or more minor or major-aged women.	Section 370
Committing marital offense and torture to women.	Section 498A
Cases of molestation, stalking, voyeurism and sexual assault.	Section 354| Section 354A| Section 354B| Section 354C| Section 354D
Acid Attack	Section 326
Culpable homicide and Dowry Death	Section 304
Cases of Domestic Violence	Domestic Violence Prevention Act 2005
Child Labor	Child Labor Prohibition and Regulation Act
Child Marriage	Child Marriage Prevention Act

CHAPTER 12

EfficientNet B0 Model Architecture for Brain Tumor Detection and Classification Using CNN

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Abstract: Brain tumors are a life-threatening disease, and a lot of people are losing their lives. These brain tumors are abnormal cells that develop in and around the brain. This research explores the cutting edge of medical imaging processing, focusing on enhancing the detection and categorization of brain tumors. EfficientNetB0 is the most advanced deep learning architecture that has been thoroughly compared with other deep learning models in order to improve brain tumor classification accuracy using the Kaggle MRI image dataset with 7023 images. The drawbacks of manual tumor identification techniques are discussed, and precise classification using deep neural networks is proposed, with special attention to the transition from binary to multi-classification. This chapter's primary focus is on improving and optimizing the EfficientNetB0 model through the addition of trainable layers on top of its basic architecture. Several techniques are used like global average pooling for spatial and dimensionality reduction with reduced parameters, dropout to drop layers, and dense net with softmax for multiclass classification. Concurrently, strategic layer freezing is used to refine the deep learning models for foundation design. The results show that the finetuned EfficientNetB0 model with hyper-parameter optimization guarantees exceptional brain tumor accuracy. EfficientNetB0 has achieved a good accuracy of 99.7% and a precision of 99.5% compared to Resnet50, VGG16, InceptionV3 and Xception. This work presents a unique deep-learning method in accordance with a transfer learning strategy for assessing brain cancer categorization accuracy using the enhanced ResNet50 model. As we advance the state-of-the-art, this chapter offers researchers, medical professionals, and patients a solid foundation for accurate and timely brain tumor diagnoses, thus contributing to the research community.

Keywords: Brain tumor, Classification, Deep learning, EfficientNetB0, Hyper-parameter.

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INTRODUCTION

Medical image analysis is at the cutting edge of technological developments aimed at transforming healthcare diagnostics. Primary brain tumors begin development inside the brain, whereas secondary brain tumors spread outside. Brain tumors are classified into glioma, pituitary, and meningioma using deep learning frameworks [1] as shown in Fig. (**1**). Brain tumors are complex in nature and can have potentially fatal outcomes, so it is essential to classify them precisely and effectively to provide personalized treatment regimens and correct diagnoses. The Cancer Society of America estimates that in 2023, brain and CNS (central nervous system) cancers will take the lives of about 18,600 people and 3,460 youngsters under the age threshold of fifteen. The survival rate for patients with brain tumors is disheartening, with only 42% surviving for five years and 36% surviving for ten years [2]. Traditional manual tumor detection methods are inherently laborious, handcrafted [3], and prone to errors, underscoring the need for advanced computer methodologies. As a subset of deep learning, convolutional neural network models (CNNs) have become highly efficient models able to automate the complex process of classifying brain tumors [4]. To improve the precision of brain tumor identification, this chapter compares and contrasts cutting-edge deep learning architectures like EfficientNetB0. This chapter's primary concern is implementing the switch from traditional binary classification techniques to a multiclass framework. Brain tumors have complex tissue compositions, a range of developmental patterns, and numerous cell sources. It becomes essential to move to multiclass classification to provide precise diagnoses and guide the right medical interventions.

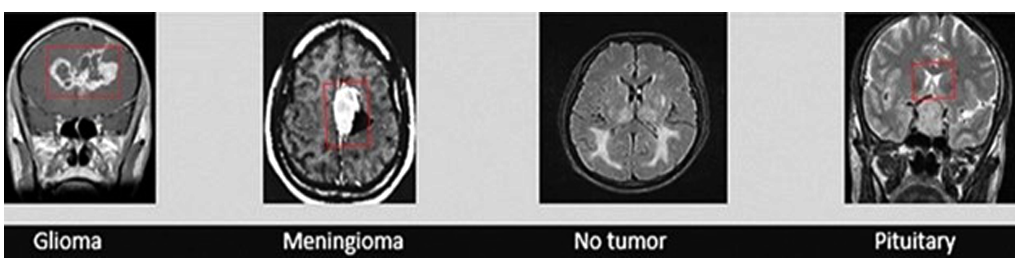

Fig. (1). Various types of brain tumors.

In our analysis, EfficientNetB0 assumes a central role and suggests optimizing its architecture, making every layer trainable, and adding new layers above the fundamental structure. Carefully adjusting hyper-parameters [5] further guarantees the best performance of EfficientNetB0 models, which helps reach the main goal of improving the accuracy of brain tumor classification [6]. Our research extends beyond methodological advancements. We utilize a comprehensive dataset comprising 7,023 images across four distinct tumor classes, providing a robust foundation for evaluating the EfficientNetB0 architecture. The Brain Tumor MRI dataset, sourced from Kaggle, facilitates a thorough comparative study. This chapter provides the scientific community with important insights as we push the boundaries of medical image analysis, providing a thorough understanding of EfficientNetB0's performance in the challenging job of neurological tumor classification. By combining methodological refinement with a diverse dataset, we aim to provide researchers, medical professionals, and ultimately patients with a reliable foundation for accurate and timely brain tumor diagnoses. But rather than focusing on segmentation, we are more interested in categorizing techniques in this chapter, which are grounded on the concept of transfer learning. The two main categories of these associations are approaches that are organized and those that are not. Using a mapping function to determine the input components in relation to their corresponding output labels, the methodology is applied in supervised techniques to evaluate new topic labels. Learning about trained data and its inherent tendencies through the use of techniques like artificial neural networks is the main objective [7]. Despite the numerous attempts made by researchers to identify cancers from MRI images, there are still several shortcomings (*i.e*., poor accuracy, large, sluggish models, and expensive processing costs). Furthermore, the healthcare industry has long faced difficulties with larger data sets since patients' privacy concerns prevent researchers from disclosing medical information in an open manner. Moreover, the current methods' poor recall and accuracy levels lead to low efficiency and longer processing times for image classification, which may cause the patient's course of treatment to be delayed [8]. Recent research has employed deep learning to increase the efficacy of computer-assisted medical diagnostics in the study of brain cancer.

Problem Statement

Brain tumors present a critical challenge in medical image analysis due to their diverse cell sources, varied development patterns, and potentially life-threatening consequences. Traditional binary classification methods have proven insufficient in addressing the complexity and diversity of brain tumors, emphasizing the need for a robust multiclass classification framework. Convolutional neural network networks (CNNs), in particular, are automated methods based on deep learning and machine learning that have shown promise as solutions. This study specifically focuses on advancing brain tumor classification using the state-of-t-e-art deep learning architecture, EfficientNetB0 to enhance accuracy and provide valuable insights into their performance on a complex medical image classification task.

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