RECENT ADVANCEMENTS IN COMPUTATIONAL INTELLIGENCE

CONCEPTS, METHODOLOGIES AND APPLICATIONS

PART 2

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Recent Advancements in Computational Intelligence: Concepts, Methodologies and Applications

(Part 2)

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PREFACE

The rapid evolution of computational intelligence (CI) has paved the way for transformative innovations across diverse sectors. From healthcare and cybersecurity to smart agriculture and human-machine interaction, the integration of advanced algorithms and intelligent systems redefines the boundaries of what technology can achieve.

This volume, RECENT ADVANCEMENTS IN COMPUTATIONAL INTELLIGENCE: CONCEPTS, METHODOLOGIES, AND APPLICATIONS (PART -II), brings together a curated collection of contemporary research that demonstrates how computational intelligence is being harnessed to solve real-world problems. It emphasizes the practical deployment of deep learning, machine learning, graph theory, and reinforcement learning in domain-specific contexts such as medical diagnostics, autonomous vehicles, biometric systems, and more.

The chapters in this book cover a wide array of critical applications. For instance, readers will explore deep neural network models for self-driving vehicles, intelligent methods for cybersecurity using graph theory, and advanced deep learning frameworks for diagnosing brain tumors and forecasting diseases. Novel contributions in assistive technology, such as enhanced audio description systems and real-time eye movement detection for vision-based interfaces, showcase the social impact of applied CI. Additionally, the use of ensemble learning in agriculture and personalized AI mentoring for fitness further illustrates the breadth of this field's relevance.

This compilation serves as a valuable resource for researchers, academicians, practitioners, and students seeking a deeper understanding of how computational intelligence is revolutionizing applied domains. By blending theoretical insights with implementation-driven case studies, this volume aims to inspire innovation and promote cross-disciplinary collaboration.

We express our gratitude to all contributing authors for their commitment to advancing knowledge and the editorial team for their rigorous efforts in assembling this work. We hope this book will stimulate new ideas, foster academic discourse, and serve as a stepping stone for future breakthroughs in the ever-expanding landscape of computational intelligence.

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CHAPTER 1

Deep Neural Networks for Autonomous Vehicles: A Review of Advances, Challenges and Future Directions

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Abstract: Deep Neural Networks (DNNs) have become a vital technology in the quick development of autonomous cars, enabling vision, decision-making, and control systems. This has created new avenues for exploring intelligent traffic safety, comfortable travel, and smart roadways. Because of its enormous potential to decrease traffic accidents and injury to people, autonomous vehicles have recently become a very attractive study topic. However, object detection, scene identification, lane recognition, and additional challenges are crucial for self-driving cars to solve. The development, difficulties, and probable future directions of DNNs for driverless vehicles are thoroughly examined. Perception tasks, sensor fusion, safety issues, decision-making algorithms, and the incorporation of DNNs into practical autonomous driving systems are just a few of the many areas it addresses. This review attempts to offer insights and suggestions for more breakthroughs in the field through the investigation of the most recent state-of-the-art research and highlighting significant difficulties.

Keywords: Autonomous driving and vehicles, Deep neural networks, Decision-making, Object detection, Sensor fusion.

INTRODUCTION

A recent technical analysis claims that the National Highway Traffic Safety Administration (NHTSA), nearly 95% of traffic collisions are prone to human-made errors [1]. Autonomous vehicles play a major role in creating a suitable driving scheme that avoids collisions, reduces emissions, aids in transferring the mobility-impaired, and decreases stress related to driving [2]. ADSs are expected to provide better yearly social benefits of almost $800 billion by 2050, if extensive implementation is successful, it will help in reducing traffic congestion,

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the number of traffic fatalities, and energy consumption, and increasing productivity as a result of smarter driving time. Autonomous driving technologies work to reduce these fatalities while also enhancing traffic flow and overall driving safety. Therefore, reducing the number of fatalities caused by human drivers can be avoided by building an autonomous driving system that would be precise, and reliable to function in a variety of environmental situations, thereby providing quick and efficient decision-making schemes for speed driving at the same time adhering to necessary safety requirements [3].

Autonomous vehicles (AVs) should comprehend driving environments, which include other participating vehicles, bicycles, pedestrians, lane identity information, and constraints like the speed-limit zone given on streets, in order to make them more reliable. The driving environment along with its associated locations is better understood with the aid of perception technologies like object detection. The perception system must provide exact and reliable information on the road conditions and be durable enough to function in inclement weather, such as rain, snow, haze, and driving at night, and be equipped with real-time decision-making capabilities to accommodate high-speed driving. Additional advantages of autonomous vehicles have been noted, including higher fuel economy, decreased pollution, automobile sharing, increased efficiency, and more efficient traffic management [4 - 6].

The University of Bundeswehr Munich and Carnegie Mellon University revealed several early autonomous vehicle studies on driving on highways and structured areas respectively in the 1980s [7, 8]. Since then, research into AVs has continued to advance due to initiatives like DARPA Grand Challenges [9, 10]. Aside from academic institutions, automakers and IT firms have also conducted research to create their AVs. Due to this, modern automobiles now include a variety of advanced driver assistance systems that give them some autonomy, including Collision Warning, Lane Assistance, and adaptive cruise control (ACC)technologies. These developments not only make driving safer and easier in contemporary cars, but they also open the path for fully functional autonomous cars that do not need drivers to operate them.

Numerous discoveries and useful applications in numerous fields have been made possible with the research advances related to machine learning and deep learning techniques [11 - 15]. The automobile industry and the creation of completely autonomous cars are the areas where ML has the biggest impact. Many autonomous vehicle subsystems, including localization and mapping, sensor fusion, perception, and path planning, employ ML techniques [16 - 19]. The present trend is the evolution of multiple automobile platforms concurrent with work in line with fully autonomous commercial vehicles. The sensors-based perception subsystem, path planning subsystem, and vehicle control schemes are the four main building parts which have been shown in Fig. (**1**), depicting the overall sketch of the autonomous driving system. Deep learning has various advantages for controlling vehicles. Deep learning is particularly suited to mitigate issues in varied and intricate environments because of its capacity to self-optimize its behaviour from information and respond to that dynamically changing driving scenarios [20 - 22]. Deep learning algorithms help in predicting the intended behaviour and train the ADS platform to perform effectively and generalise to new contexts through learning [23, 24]. This eradicates the need for modifying each parameter repeatedly while attempting to preserve performance in all possible circumstances. These factors have contributed to the recent surge in demand for deep learning for AV control.

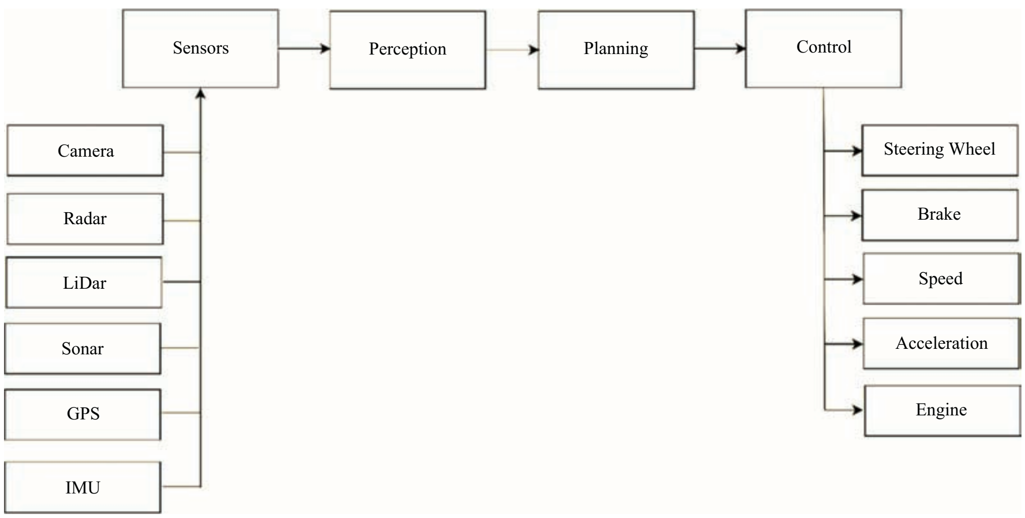

Fig. (1). Generic block diagram of AV system

Several various sensors put on the vehicle are used to sense the environment. A perception block converts sensory data into meaningful information after processing the input from the sensors. The perception block's output is used by the planning subsystem for both long- and short-range path planning as well as behaviour planning. The autonomous car receives commands from the control module and makes sure it travels along the course laid out by the planning subsystem. To perform a proper steering control scheme for ADS, an end-to-end DNN is developed for autonomous driving and employs images from the camera as an input and steering angle forecasts as an output as shown in Fig. (**2**). End-to-end learning describes the training of artificial networks from the start point to the end point without any support from humans. End-to-end learning's goal is to

CHAPTER 2

Tracking of Cyber Crime and Security Using Graph Theory

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Abstract: A network that helps us define and dream up interconnections between various components is known as Graph theory. Here we used nodes and edges to represent the data. There are many uses of Graph theory in real life. Tracking down Cybercriminals is also one of them. Nowadays, with the advancement of science and technology, the number of crimes has also increased. The chapter, "Tracking of Cybercrime and Security using Graph Theory" represents how the concepts of Graph Theory can be used in tracking the crime that is happening in the cyber world. One of the great concerns in the era of digital technology is the security of information. Protecting the data and security infrastructure from unethical hackers is an extreme concern. The advances in science and technology have brought both opportunities and challenges to human life. So in today's world, there is an urgent need to protect data and information such as credit card numbers, personal data, information of national importance, *etc*. In this chapter, the concept of graphs is intended to be incorporated in cyber security and network security. It needs special mention that the main objectives of cyber security are to ensure the ethics, secretiveness, and accessibility of direction systems. In this chapter, we have tried to showcase the use of graphs in cyber security and networks as it is a matter of growing concern for researchers and scientists.

Keywords: Cybercrime, Cyber security, Computer, Graph theory, Internet, Network system, Network.

INTRODUCTION

Graph theory is a field of mathematics that studies graphs, which are structures used to model pairwise relations between objects[1 - 3]. A Graph in this context is a set of vertices (also called nodes or points) that are connected by edges. Graph theory [4], has played an adverse role in our daily life in studying and modeling all kinds of things such as–finding the shortest distance of a route [5], graph coloring, geographic profiling, tracking of cybercrimes, and even in the fields of

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biology and medicine, graph theory is being used. By using graph theory, one can apprehend the criminals involved in a certain crime.

Graph models are very useful in computer networking. The modeling fundamentals of graph theory are simple in terms of its concept. The simplest type of model involves a set of nodes and the connections between them. It would be pertinent to mention here that a graph theoretical model has its built-in facility. This inbuilt facility represents connections between entities. It supplements relational database models and ontological approaches. In this approach, a given system is viewed as a network. A network sees it as a collection of networks. It does not see the systems as isolated entities. However, social network analysis methods based on the graph-theoretic model have been used to model many complex real-world phenomena [6], including social networks, transportation networks, and the Internet. Graph theoretic modeling has been drawing upon the mathematical formalisms of graph theory and analytic methods refined over decades of social network research. Networks consist of nodes, which represent entities, and lines or edges, drawn between the nodes to indicate a connection between them.

Nowadays with the advancement of science and technology, a lot of our work gets finished within seconds. It is a boon to us. But as there are two flips of the same coins, it is the boon and bane that are interconnected with each other. With the development of technology, criminals also get updated. The misuse of the 'Internet' gave birth to many 'cyber crimes'. Nowadays network resources have become the prime source for cybercrime. The criminal activities that use network devices to commit crimes like online threats, stalking, cyberbullying, hacking, ATM skimming *etc*., is known as cybercrime. It is committed by cyber criminals who are also known as hackers for their own purpose.

Most of the cyber criminals are highly technically skilled and they work either individually or as an organization. There are different types of cybercrimes [7 - 14] like:

- Email and internet fraud
- Theft of financial or card payment
- Illegal gambling
- Selling illegal items online
- Criminal activity using computers to commit other crimes
- Criminals activity targeting computers using viruses

With the development of communication and digital technology, many opportunities and challenges come to human life. While digital technology has made human life easy and comfortable at the same time, it is at risk due to unethical cyber hackers. Today human life is dependent upon the internet. In this era of information, for our day-to-day activities and in various educational institutions, financial institutions, business establishments, service sectors, *etc*., the Internet is essential to carry out different financial and nonfinancial activities that are information-based. In today's digital world, data is everything. Data and information are considered a wealth [15 - 17]. Nowadays everything has been digitalized and the banking sector and national security cannot be imagined without the Internet. So, due to our excessive exposure to the Internet, our information system infrastructure is prone to malicious attacks very often. We often become victims of cyber security threats due to various digital activities like purchases from online marketing platforms, Google Pay, Phone Pay, *etc* [18 - 19]. We allow access to various applications to get access to our photos, cameras, and other information while we install them into our system. As a result, both our professional privacy and personal information are at risk due to unethical hackers [20 - 22]. A recent cyber security attack of OIL, Duliajan (Assam) is significant in this case, where the hackers demanded 75 lakhs USD before hacking.

Information security [23 - 26], has been a topic of extreme importance for various reasons. The way cyber war is increasing has become a great concern for all. Our information such as credit card numbers, personal data, or information of national importance, remain secret as they pass through countless elements encountered along the communication path from source to destination.

However, since the events of September 11^{th,} 2001 cyber security has further become an issue of growing concern. These events raise many questions about internet security, the information systems infrastructure, cyber-attacks, *etc*. Cyber security [18 - 20], has the objective of ensuring the integrity, confidentiality, and availability of information systems.

The main objective of this research article is the application of graph theory in cyber security and network security. In this article, we also made an attempt to use graph theory in cyber security and network security.

PRELIMINARY

Graph: A graph G consists of a set of objects

$V=\{v_{1,} v_{2,}........\}$ called vertices(also called points or nodes) and other sets

$E=\{e_{1,}e_2............\}$ whose elements are called edges (also called lines or arcs).

The set V(G) is called the vertex set of G and E(G) is the edge set.

Usually, the graph is denoted as G=(V,E)

CHAPTER 3

Innovative Computational Intelligence Techniques for Region-Based Myelin Segmentation in Pediatric MRI: A Focus on Ages Zero to Two Years

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Abstract: Each brain region is crucial for the optimal functioning of the brain, with each region responsible for distinct functions. Our study focuses on analyzing myelination in four essential sections of brain magnetic resonance images, which are critical areas associated with myelination. This process is vital for proper brain development in children and continues for up to two years, making it essential to monitor myelin growth in various brain regions during this phase. We utilized fuzzy c-means clustering (FCM) to segment myelin from T1-weighted inversion recovery magnetic resonance images (MRI). To validate the segmentation results, we employed several metrics including accuracy, sensitivity, precision, Matthews correlation coefficient (MCC), Dice coefficient, Jaccard index, and specificity.

Keywords: Cognitive functions, False positive, Fuzzy C-Means, Precision, Myelin.

INTRODUCTION

Compared to adults, the process of brain imaging in children presents significant challenges due to the gradual and sequential nature of brain growth in this age group. Particularly, myelination is a highly dynamic process in children under the age of two. Myelin [1], as highlighted in the reference, plays a crucial role in facilitating the transmission of signals between neurons. The efficiency and speed of this signal transmission are indicative of proper brain development. Therefore, for children below the age of two, the process of myelination holds utmost importance.

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Myelination involves the development of an insulating material known as myelin around axons. Consequently, the segmentation of myelin is of paramount significance within the medical domain, as it enables the monitoring of brain growth in children.

Segmenting myelin on a region-by-region basis holds significant importance in comprehending the diverse functions of a well-functioning brain. Among these, the midbrain, cerebral peduncles, basal ganglia, and centrum semiovale stand out as crucial myelination sites. The midbrain, for instance, assumes a pivotal role in motor function, including intricate tasks like eye movement. Moreover, it contributes to the processing of auditory and visual information, while also regulating aspects like body temperature, alertness, and the sleep-wake cycle. Notably, the midbrain plays a central role in managing the release of dopamine, a vital neurotransmitter that impacts motivation, behaviour, attention, habitual actions, movement, and mood regulation.

The cerebral peduncles, characterized by bundles of nerve fibers, play a crucial role in transmitting impulses within the brain. Their significance lies in facilitating the acquisition of new motor skills, honing motor coordination, and translating sensory information from the sixth sense into the maintenance of balance.

Basal ganglia also referred to as nuclei, constitutes a collection of neurons. Its role encompasses cognitive functions, the acquisition of habits, control of eye movements, emotional processing, and procedural learning. Primarily, the basal ganglia serve as the decision-maker for action selection, determining the most suitable course of action based on specific circumstances. In ensuring proper brain function and behaviour, the basal ganglia hold a pivotal position within the brain. Hence, ensuring appropriate myelination in this region is crucial for optimal functioning.

The centrum semiovale, positioned at the core of the white matter, boasts a semi-oval configuration. It is composed of cortical fibers, cortical projection fibers, and association fibers. This region is responsible for fostering communication and coordination functions. Moreover, it plays a significant role in problem-solving, and memory recall of learned information, and surpasses other functions in this aspect. Additionally, the centrum semiovale plays a key role in maintaining balance while walking.

Given the pivotal roles these functions play, the examination of myelination within these specific regions becomes highly significant. Contemporary research is heavily focused on myelin-related studies. However, a notable gap exists [2]: Conventional MRI methods are rarely employed for myelin segmentation. Across numerous investigations, [3 - 12] the myelin water fraction serves as a parameter to gauge myelin content. In contrast, some studies [13 - 15] utilize quantitative MRI techniques to assess myelin levels. Yet, the practical application of quantitative MRI is not universally feasible, particularly when considering children, as it involves substantial time investment. Thus, the segmentation of myelin from T1-weighted MRI imagery emerges as a practical solution within the medical domain. As such, this study focuses on the segmentation of myelin from T1-weighted inversion recovery MRI images, specifically targeting the four aforementioned regions.

RELATED WORKS

Chelli N. Devi *et al.* [2], segmented myelinated white matter (WM) from T1 weighted images. They followed the following steps for segmentation, segmenting brain region using skull stripping, separating the boundary of brain tissue, and finally, segmented the myelinated component of WM followed by verification of their results using manual segmentation. Hyunjin Chung *et al.* [3], compared the three-pool modeling method and regularized nonnegative least squares (rNNLS) algorithm for the measurement of myelin content. They considered discrete and continuous T 2 spectrum for comparison, and they proved three-pool modelling method is more suitable for myelin water quantification. In both methods, they estimated myelin water fraction (MWF). MWF is defined as the ratio of the intensity of the short T2 component of the signal to the total component of the signal. Cornelia Laule *et al.* [4], also calculated MWF using T2 decay signals in case of multiple sclerosis(MS). They observed that a 16% drop in myelin water fraction and a 2.2% rise in water content in MS normally appeared white matter (NAWM) is due to myelin loss. Yiping P. Du *et al*., [5] used multicompartment analysis of T* 2 decay for the quantitative mapping of MWF. C Laule *et al.* [6], determined MWF for different regions of interest. Siying Wang *et al*., [7] presented a work that helps to identify the brain maturation of preterm neonates. Based on the atlas, a spatio-temporal growth model was developed. This growth model is a voxelwise logistic regression model. By using this they calculated gestational ages. A root mean squared error of 10 days was achieved by this model. Markus Zimmermann *et al.* [8], used Multi-exponential Relaxometry using `L1-regularized Iterative NNLS to calculate MWF. Akifumi Hagiwara *et al.* [9], compared Magnetization Transfer Saturation Index(MTsat), Simultaneous Tissue Relaxometry (SyMRI), and T1w/T2w Ratio Methods for myelin measurements. They concluded that there is a high similarity between MTsat and SyMRI. They identified that both methods can be used for the measurement of myelin in the white matter (WM), whereas the T1w/T2w ratio is not thus suitable. However, there are some drawbacks to quantitative MT imaging. Post-processing and time-consuming are significant drawbacks. The T1w/T2w ratio is only

CHAPTER 4

MRI-Based Brain Tumour Diagnosis Using Deep Learning

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Abstract: Magnetic Resonance Imaging (MRI) plays a crucial role in diagnosing brain tumours. Deep learning offers a promising approach for analysing MRI scans and improving diagnostic accuracy. This research explores the application of deep learning techniques, particularly Autoencoders, for brain tumour detection and classification. The focus lies on utilizing MRI data to train deep learning models to differentiate between tumorous and healthy brain tissue, as well as classify various tumour types. The research uses grayscale MRI and applies Adaptive Histogram Equalization for image enhancement. To learn and extract the features from the images, a simple CNN model is employed. Two feature selection techniques are employed to classify tumours: MRMR and Chi-Square. Multiple autoencoders were used in a Parallel Multi-Autoencoder (PMAE) model. In the PMAE model, every autoencoder is trained using a single category of images. For a single input, the PMAE model regenerates several sequences; the class corresponding to the sequence with the least error is designated as the predicted class. When tested independently for each feature selection technique, the suggested model demonstrated an accuracy of 99.90% for MRMR and 99.91% for the Chi-Square method. In the problem domain, the lightweight model performed better than the heavyweight pre-trained models that were already in operation.

Keywords: Adaptive histogram equalization, Autoencoder, Accuracy, Brain Tumour MRI, Binary threshold masking, CNN, Chi-Square, Lightweight, MRMR, PMAE model, Regenerate sequence error.

INTRODUCTION

The tumours related to the brain are a major struggle in the domain of medical science. They are classified as cancerous or non-cancerous, they are the abnormal proliferation of cells that grow inside the brain or surrounding tissues. Other than the classification that they may fall under, brain tumours are classified as hazardous owing to the limited volume of space present within the cranial cavity.

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As it grows, it can put pressure on the surrounding brain tissue, distorting normal function and causing a range of neurological abnormalities. According to a study [1], brain tumours accounted for 248,500 deaths in 2022, ranking twelfth on the list of cancer mortality rates. Between 2014 and 2018, the incidence rate of all brain tumours along with other neural tumours, both cancerous and non-cancerous, was recorded as 6.23 per 100,000 population among children and adolescents aged 0 to 19. Malignant brain and other Central Nervous System (CNS) tumours accounted for 2,693 deaths in children and adolescents 0-19 years of age, from 2014 to 2018. This corresponds to an annual average mortality rate of 0.66/per 100,000 people, or an annual average of 539 deaths from brain cancer and other CNS tumours [2]. According to the National Cancer Institute of the United States, 1,82,520 people with primary brain and CNS tumours were recorded in 2021 [3]. According to the American Brain Tumour Association, 90,000 cases of primary brain tumour are recorded every year [4]. Even while these figures present a worrying image, it is crucial to remember that primary brain tumours, which start inside the brain, are much less prevalent than metastatic brain tumours, which are those that start outside the body and reach the brain.

The fatality rates of different brain tumours depend on their position, form, and aggressiveness, with glioblastoma being the most aggressive kind. Only 25% of people with glioblastoma live longer than a year, while only 5% survive for more than 5 years. The typical survival span for patients with this disease is 12 to 18 months [5]. Benign tumours, on the other hand, typically have a far better prognosis, with a normal lifespan following effective treatment.

There are many different subtypes of brain tumours, and each has its traits, chances of survival, and methods of therapy. While secondary brain tumours develop from cancers that have metastasized from other regions of the body, primary brain tumours start within the brain itself. Approximately four times as many cases of brain tumours are diagnosed with metastatic tumours as with primary tumours, which are much less prevalent than secondary tumours [6]. Gliomas are the most prevalent type of brain cell that leads to primary brain tumours. Glial cells, which give neurons support and structure, give rise to gliomas. Gliomas have several subgroups, including ependymomas, oligodendrogliomas, and astrocytomas, each with a different degree of malignancy [7]. Meningioma tumour originates from the meninges membrane that surrounds the brain and spinal cord. Most of the time, these tumours are benign and grow slowly. Pituitary tumours originate from the pituitary gland or nerve sheath tumours from Schwann cells. Benign tumours can also pose a serious threat if they enlarge and put pressure on the brain tissue.

Brain tumour research is driven by the urgent need to improve patient outcomes. Challenges in this field include the blood-brain barrier, a complex system of cells that restricts the passage of certain substances from the bloodstream to the brain, making drug delivery difficult [8]. Additionally, the heterogeneity of brain tumours, with their diverse genetic and molecular profiles, necessitates personalized treatment approaches. Despite these hurdles, advancements in research offer promising avenues for progress. Increased understanding of the genetic mutations contributing to brain tumour development has paved the way for targeted therapies. A further therapeutic option being investigated for brain tumours is immunotherapy, which uses the body's immune system to combat cancerous cells.

For brain tumours to be effectively treated, early and precise identification is essential. Although comprehensive images of the brain can be obtained by Magnetic Resonance Imaging (MRI) scans, the process of manually analysing these images for tumours is laborious and prone to human error. This is where machine learning and image processing are useful.

The MRI scans are processed using various types of image processing techniques so that they are ready for machine learning analysis. This could entail things like separating the brain tissue from the skull, adjusting for brightness variations, masking unnecessary parts or spots, and eliminating noise. Modern medical imaging technologies such as Photo Counting CT, Dark-Field Radiography, Photoacoustic Imaging, Radiomics, and others have made it possible for us to get high-quality images for studies, which is also an essential requirement for computerized image analysis [9]. Massive datasets of labelled MRI images are used to train machine learning algorithms, especially deep learning algorithms like CNNs or pre-trained models like VGG-19, VGG-16, ResNet-34, ResNet-18, InceptionV3, *etc*. After being taught, these models can evaluate fresh MRI scans and spot patterns that accurately distinguish malignancies from healthy brain tissue. This helps in faster and more objective diagnoses in addition to lessening the workload for medical personnel. These deep learning models are also used as a means of extracting features from the images, and then different classifiers like SVM, MLP, KNN, Decision Tree, *etc*., are used for the final classifiers or meta-classifiers. The use of ensemble models for classification has also seen a rise in the recent decade in the medical domain.

The remainder of this paper has been arranged in the following sequence – Literature review or background work related to image-based brain MRI classification, proposed methodology (describing the methods, techniques, image processing techniques, feature extraction, and selection methods), followed by ex-

CHAPTER 5

InclusiVision: Exploring Deep Learning Techniques for Enhanced Audio Description Generation

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Abstract: The rise of technology has facilitated access to entertainment media in various formats like audio, images, videos, and memes. This diverse multimedia landscape, however, poses challenges for visually impaired individuals who primarily rely on auditory means and cannot consume the visual content freely available today. InclusiVision addresses this challenge by introducing audio descriptions (AD) generated through advanced technology for images and short videos. These narrated verbal descriptions provide details about visual elements such as people, objects, colors, and settings, making the content more accessible and comprehensible for the visually impaired. To enhance accessibility, InclusiVision offers two essential phases: the Image Description phase, which generates short audio descriptions for images, and the Video Description phase, which employs algorithms to narrate key visual aspects in short videos. Both the image and video captioning generate short captions explaining key points of the visuals. It employs basic encoder-decoder modeling to help achieve the task. Hence, the primary objective of InclusiVision is to promote accessibility and inclusivity in entertainment and educational media by providing contextually relevant audio descriptions.

Keywords: CNN, Image captioning, LSTM, Video captioning, Visually-impaired.

INTRODUCTION

Image and video captioning technologies can transform the lives of visually impaired individuals by providing them with detailed and contextually rich descriptions of their surroundings. This capability can significantly improve their ability to navigate and understand the world around them. The primary objective of this work is to develop and evaluate an advanced image and video captioning

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system that leverages multimodal deep learning techniques to enhance the quality and relevance of generated captions. Deep learning is essential in this context because of its ability to model complex patterns and relationships within data, allowing for the creation of more accurate and contextually relevant descriptions. By integrating attention mechanisms and sequence-to-sequence frameworks, our goal is to create a system capable of producing concise, contextually appropriate descriptions that can be used in accessibility tools for visually impaired individuals. The use of deep learning, particularly attention mechanisms, enables the system to focus on significant elements within images and videos, ensuring that the generated captions are both relevant and detailed. These techniques and their impacts are discussed below.

Deep learning is a branch of machine learning inspired by the structure of the human brain and how the brain functions, called artificial neural networks. Deep learning may consist of a neural network with a single layer and still give an approximate prediction, but hidden layers can be added to optimize and refine the accuracy. It is a neural network that typically consists of three or more layers. It is similar to the nervous system structure, where each neuron is connected and can pass information. Deep learning simulates how the brain processes the data and draws conclusions.

Deep learning architecture is made up of neural networks with different topologies. In general, deep learning models are composed of input layers, hidden layers, and output layers. The input layer takes raw data, which is processed and combined in the hidden layers, learns from a large amount of data to make conclusions and finally, the output layer gives a conclusion.

The models can recognize complex patterns in images, text, sounds, and other data types to produce accurate predictions. It can also automate the tasks where human intelligence is typically required, such as describing an image or performing tasks like audio transcripts, where sound files are converted into text format. It derives many applications and services from artificial intelligence (AI) that improve automation and analytical and physical tasks without human intervention. Deep learning technology can be seen in everyday products such as digital assistants (Google Assistant, Siri, Alexa, *etc*.) and credit card fraud detection [1]. It is also used in emerging technologies such as automated or self-driving cars [2].

RELATED WORK

Convolutional Neural Networks (CNN)

A Convolutional Neural Network (CNN) [3, 4] is a multilayer neural network inspired by the animal visual cortex. The architecture is mostly efficient for image processing tasks. The first CNN, which, at that time, was used for handwritten character recognition, including postal code interpretation. The early layers can recognize features such as edges, and later layers recombine the identified features into higher-level attributes of the input.

The CNN architecture comprises many layers that implement feature extraction and then classification. The first step is to divide the image into receptive fields, fed into the convolutional layer as input, extracting features from the input image. In the next step, pooling is done to reduce the dimensionality of the extracted features through down-sampling while retaining the most important information with max pooling. Another layer of convolutional and pooling feeds the results into a fully connected multilayer perceptron. The final layer consists of a set of nodes that identify the features of the image. The network can be trained using back-propagation.

Numerous applications for deep learning neural networks were made possible after the deep processing layers, convolutions, pooling, and fully connected classification layers. CNN has been effectively used for several applications related to natural language processing, video recognition, and image processing.

CNNs [5] are structured in a series of layers, each crafted to extract and handle features from input data systematically as shown in Fig. (**1**). The essential architectural elements of a CNN typically encompass:

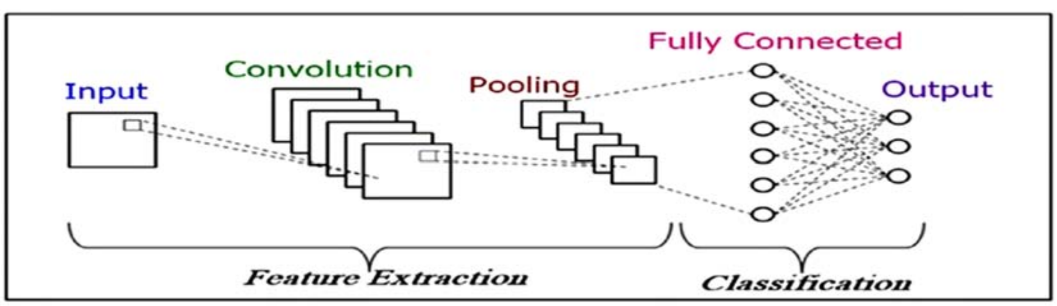

Fig. (1). Convolutional neural network architecture [10].

Input Layer: This initial layer receives raw input data, such as images, and forwards it for further processing.

CHAPTER 6

The Role of AI in Enhancing Customer Experience through Personalized Marketing

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Abstract: The evolution of marketing strategies has transitioned from traditional approaches to more advanced personalized marketing, driven by the capabilities of artificial intelligence (AI). Traditional marketing methods, such as print advertising, billboards, and broadcast media, provide broad reach but face challenges in targeting precision and interactivity. This chapter analyzes the solution as an integration of AI technologies in augmenting personalized marketing through the direct application of Machine Learning (ML) algorithms. The paper will demonstrate how personalized marketing is implemented with the use of AI and how this integration resolves issues related to generic marketing approaches and limitations of traditional customer engagement methods. Beyond the general characteristics of personalized marketing, several major types that can be implemented with the help of AI will be explained, and the benefits of such, including achieving deeper customer engagement, driving conversions through precise targeting, and fostering loyalty with AI-powered personalization, are going to be discussed. Most importantly, the optimal design principles of AI-driven marketing strategies and the tactics for their execution, as well as the suggested ethical considerations and data privacy measures within personalized marketing environments, will be covered in further sections. For example, a key study by McKinsey & Company highlights that personalized marketing is no longer just a trend, but a crucial strategy for businesses, with 58% of surveyed individuals willing to pay a premium for tailored products and services. The conclusion of the paper underlines future trends and considerations about the possibilities and advancements in the AI sphere and its integration with personalized marketing. The information provided throughout the paper will help to go beyond the limitations of traditional marketing by increasing the effectiveness and customization of marketing efforts through the opportunities presented by AI technologies in the scope of different business sectors.

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Keywords: Artificial intelligence, AI-driven marketing strategies, Machine learning algorithms, Natural language processing, Personalized marketing.

INTRODUCTION

The landscape of marketing is advancing at an unprecedented pace, driven by advancements in technology and shifting consumer expectations. Personalized marketing, which tailors experiences and offerings to individual customer preferences, has emerged as a critical strategy for businesses to stand out in a crowded marketplace. This shift is largely fueled by the integration of Artificial Intelligence (AI), transforming how brands interact with their audiences and deliver value.

Traditional marketing methods, with their broad-brush approach, are becoming increasingly ineffective in capturing the attention and loyalty of today's discerning consumers. AI offers powerful tools to unlock deep insights from massive datasets, decode customer behavior patterns, and predict future trends. By empowering businesses to move beyond generic campaigns, AI facilitates a more targeted, individualized approach. This chapter delves into the dynamic intersection of AI and personalized marketing. We will explore how Machine Learning (ML) algorithms are revolutionizing customer experiences [1]. We will examine the implementation of AI-driven personalized marketing strategies, uncovering the benefits of elevated customer engagement, increased rates of successful transactions, and improved loyalty.

The motivation behind this work is to address the limitations of traditional marketing and demonstrate how AI-driven personalized marketing can enhance customer interactions and drive business growth. This chapter will clarify the importance of integrating AI into marketing strategies and provide a comprehensive understanding of the design principles and tactics required for successful implementation. Additionally, we will discuss the ethical considerations and data privacy measures essential in the data-driven approach.

Looking ahead, we will explore the future possibilities and challenges of AI in personalized marketing. The rapid advancements in AI technology promise even more sophisticated and effective ways to build meaningful relationships with customers. However, it is essential to approach these advancements with a responsible and ethical mindset. This chapter serves as a comprehensive guide for businesses seeking to unlock the potential of AI in personalized marketing. By understanding the core concepts, implementation strategies, and ethical considerations, businesses will be equipped to create more meaningful customer experiences, foster brand loyalty, and ultimately drive growth in the ever-evolving digital landscape.

THE EVOLUTION OF MARKETING STRATEGIES

Traditional Marketing Approaches

Traditional marketing is typically viewed as a time-tested and dependable approach to marketing, relying on established channels and techniques. It enables companies to connect with a wide-ranging audience across various touchpoints, contributing to a robust brand presence and reputation. By strategically selecting the appropriate mix of traditional channels, businesses are able to focus their efforts and resources on reaching their intended audience or specific market segment, enhance brand recognition, and boost sales. Traditional marketing encompasses conventional methods of promoting products or services, utilizing offline media channels such as hard print (*e.g.*, magazines, newspapers), broadcast (*e.g.*, TV, radio), outdoor (*e.g.*, banners, billboards), and direct mail (*e.g.*, brochures, flyers). It is characterized by a one-way communication flow, where businesses disseminate information to the public without direct interaction or immediate feedback. For example, a TV commercial advertising a new car model or a newspaper ad for a supermarket sale are instances of traditional marketing as shown in Fig. (**1**).

History of Traditional Marketing

The history of traditional marketing is intertwined with the development of mass media, when business owners started to advertise their products in markets and street corners. In the 18th and 19th centuries, newspapers and magazines became popular platforms for print ads. The early 20th century saw the rise of radio and television, providing new avenues for broadcast advertising. Direct mail gained prominence with the expansion of postal services, providing businesses with a new way to reach target audiences, showcase their product and services and interact with potential customers. Over the years, traditional marketing evolved to include various formats like billboards, telemarketing, and trade shows, adapting to technological advancements and changing consumer behaviors [2].

Features and Types of Traditional Marketing

Features of traditional marketing include mass reach, disruptive nature, one-way communication, and a broad audience. It is less targeted compared to digital marketing and can be more challenging to measure in terms of ROI. Traditional marketing, encompassing channels like television, radio, and newspapers, boasts the potential to reach massive audiences with a single campaign. Take the Super Bowl, for example, where commercials routinely capture the attention of over 100 million viewers, showcasing the sheer power of television advertising [3]. This broad reach extends geographically as well, making traditional media ideal for

CHAPTER 7

Harnessing the Power of Artificial Intelligence for Personalized Exercise Mentoring

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Abstract: Artificial Intelligence (AI) has revolutionized various domains, and its integration into exercise mentoring systems holds great promise for optimizing fitness coaching and promoting healthy lifestyles. This chapter provides an in-depth analysis of the advancements and uses of exercise coaching systems that utilize artificial intelligence. It specifically emphasizes the assessment of performance in various age groups and durations of usage. The aim of introducing an AI fitness trainer is to enhance personalized coaching, improve exercise adherence, and achieve better health outcomes by providing real-time, accurate feedback on exercise posture and performance. Through a comparative study of existing literature, we examine the advantages, limitations, and implications for future research and practice. In this study, we select two of the best-performing machine learning models, Random Forest (RF) and Long Short-Term Memory (LSTM) networks, based on their efficacy in exercise classification tasks. Our experimental results demonstrate that the accuracies of the LSTM and Random Forest models are maximum for the age groups 21 to 60. The maximum values obtained are 82% for LSTM and 78% for Random Forest. Also, detailed comparisons showing variations in performance across different age groups and session durations are explained in the chapter. The review highlights the potential benefits, challenges, and future directions of AI-powered exercise mentoring systems in enhancing individualized support, improving adherence, and achieving better health outcomes.

Keywords: Artificial intelligence, Coaching, Fitness, Long short-term memory, Personalization, Random forest.

INTRODUCTION

Exercise mentoring plays a vital role in guiding individuals toward their fitness goals, promoting physical activity, and preventing chronic diseases [1]. Traditional mentoring approaches rely on human trainers or coaches to provide personalized guidance, support, and motivation. In the current fast-paced world,

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individuals frequently neglect their health and fitness as a result of their busy schedules and heavy responsibilities. It is not practicable for all individuals to employ a fitness trainer [2]. Nevertheless, the development of artificial intelligence (AI) has facilitated the development of innovative solutions that employ digital technologies, data analytics, and machine learning algorithms to offer personalized exercise coaching and support. AI-powered exercise mentoring systems offer scalability, accessibility, and data-driven insights, revolutionizing the way individuals engage with fitness coaching and achieve their health and fitness goals.

Capabilities of AI-Powered Exercise Mentoring Systems

AI-powered exercise mentoring systems possess several capabilities that enable personalized coaching and support:

Personalization: AI algorithms analyze individual preferences, goals, and performance metrics to generate personalized exercise recommendations and adapt coaching strategies over time [3].

Behavior Prediction: Machine learning algorithms can predict user behavior, anticipate barriers to adherence, and provide proactive interventions to support behavior change and goal attainment.

Feedback Generation: AI-powered mentoring systems provide real-time feedback, performance insights, and motivational cues to enhance engagement, adherence, and exercise technique [4].

Benefits and Challenges

The benefits of an AI-enhanced exercise mentoring system are:

Individualization: Custom exercise recommendations and coaching strategies are based on individual interests, goals, and abilities.

Scalability: Must be able to reach more people, and for an on-demand coaching/class service, it is a more cost-effective solution.

Accessibility: Access to fitness coaching for numerous populations, including those with limited exposure to traditional services.

Insights Derived from Data: Instant check, evaluation, and review of exercise regimens, making them better and improving client engagement.

Personalization: Tailored exercise recommendations and coaching strategies based on individual preferences, goals, and capabilities.

Scalability: Ability to reach a larger audience and provide on-demand coaching services at a lower cost.

Accessibility: Increased accessibility to fitness coaching and support for diverse populations, including individuals with limited access to traditional mentoring services.

Data-Driven Insights: Real-time monitoring, analysis, and feedback to optimize exercise programs and enhance user engagement.

AI-Enabled Exercise-Supervision Systems

Although AI-powered exercise-mentoring-promoting systems exhibit powerful capabilities, there are limitations they must overcome, including:

Algorithmic Bias: AI algorithms trained on imbalanced data can result in biased or inaccurate outcomes.

Privacy Concerns: Safeguarding personal information and adhering to privacy regulations (*e.g*., GDPR, HIPAA).

User Acceptance: Challenge of user trust and acceptance to AI-driven coaching interventions, as concerns may manifest for autonomy, acceptance, or desirability of AI-human interaction.

Technical Limitations: Algorithmic complexity, model interpretability, and fitness facilities integration challenges.

This system provides real-time feedback for posture correction during workout exercises without any human involvement. The application compares the accuracy of the proposed approach with various age groups. Because of its real-time capabilities, this new technology has the potential to revolutionize how we approach these activities, giving us valuable feedback in a much quicker time frame.

The objectives of the chapter are:

Designing a framework for an AI-powered exercise mentoring system.

Developing an application for personalized exercise mentoring using machine learning models, Random Forest and LSTM.

CHAPTER 8

An Analysis of Deep Learning and Machine Learning Approaches for Diabetes Mellitus Prediction in Pregnant Women

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Abstract: In our country, one significant public health concern is diabetes mellitus. Thousands of people suffer from this metabolic disease, which is caused by the body accumulating too much glucose. Diabetes can lead to several health problems in humans if it is not identified early on, including kidney issues, nerve damage, vision damage, heart disease, and more. Gestational diabetes mellitus (GDM) is the name for diabetes mellitus that occurs during pregnancy, both the mother and the unborn child or fetus are at serious risk from it. For prompt intervention and better results for the mother and fetus, early and precise GDM prediction is essential. This study aims to predict diabetes mellitus in pregnant women using a real-time diabetes dataset, machine learning algorithms including Random Forest, Gradient Boost, Decision Tree, and XG-Boost classifiers alongside deep learning algorithms like Long Short-Term Memory (LSTM), Recurrent neural network (RNN), Gated Recurrent Unit (GRU), and hybrid GRU+LSTM. In this work, a detailed analysis and methods such as the Synthetic Minority Oversampling Technique (SMOTE) are used to produce the best probable answer for the prediction of diabetes mellitus. The Pima Indian Diabetes Dataset from the National Institutes of Diabetes and Digestive and Kidney Diseases is used in this investigation. All 768 patients are female and at least 21 years old. This dataset contains one target variable and eight predictor variables. It has been discovered that XG-Boost (82.47%) offers the highest accuracy after comparing the accuracies of other algorithms like Gradient Boost (81.82%), Random Forest (81.17%), Decision Tree (66.23%), GRU (79.69%), LSTM (77.08%), RNN (81.25%) and hybrid GRU+LSTM (80.21%) classifiers using imbalanced datasets (without using SMOTE algorithm). This study examines the model accuracies, after applying SMOTE algorithm, Random Forest algorithm, stood top with accuracy such as 88% surpassing

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the accuracies of remaining models XG-Boost (85.2%), Gradient Boost (84.4%), Decision Tree (83.6%), GRU (80.8%), LSTM (78%), RNN (80.4%) and hybrid GRU+LSTM (80.8%). This paper compares the existing model like ensemble model accuracy of 86% with the proposed model accuracies, and the proposed model has been observed to outperform the accuracy with 88% in Random Forest. The proposed work uses the Application Programming Interfaces using Flas. Flask is like a simple toolbox for making websites with Python.

Keywords: Decision Tree, Gradient Boost, Gestational diabetes mellitus, GRU, Hybrid GRU+LSTM, LSTM, Recurrent Neural Networks, Random Forest, SMOTE, XG-Boost.

INTRODUCTION

Diabetes alters the body's energy metabolism and is a chronic (long-lasting) health issue. Diabetes will always rank the highest among the most common and deadly diseases. Compared to male patients, female patients are more precarious. This is a result of the way women's bodies are made and the hormonal imbalances they experience throughout their lives [1]. Diabetes tends to double a woman's risk of having a heart attack twice compared to a man's two times. Women are more vulnerable to many diabetes-related problems, including depression, kidney disease, and vision impairment. Furthermore, it has been discovered that diabetes significantly affects women's unique circumstances, such as pregnancy, menstrual cycle, menopause, urinary tract infection, *etc*.

Diabetes primarily manifests itself in three ways. Insulin-dependent diabetes is referred to as type 1 diabetes. Because pancreatic beta cells, which are responsible for producing insulin, are missing in this instance, the body is unable to create enough of it. It is called Non-Insulin-Dependent Diabetes Type-2. Errors in the action or secretion of insulin cause this condition, which is referred to as impaired glucose tolerance. In this case, the produced insulin is not used by the body. Because type 3 diabetes is associated with pregnancy, it exclusively affects female individuals. While it usually ends with the birth of the child, some women may have it for an extended period due to glucose intolerance. When diabetes has not yet been diagnosed in a pregnant woman, this kind of illness is brought on by elevated blood sugar levels [1].

To identify patterns and project future events, predictive analysis makes use of both historical and current data. This integrates several data mining, statistical, and machine learning algorithms. Using patient records and predictive modeling, significant forecasts and judgments can be made. Physicians have determined that bad lifestyle choices, obesity, heredity, hormone imbalances, and other factors are the primary causes of diabetes in women. Therefore, a dataset with this data can be utilized to identify the diabetic attack pattern. Diabetes is currently diagnosed by laboratory procedures such as fasting blood glucose measurement and oral glucose tolerance testing. Using this strategy is time-consuming and resource-intensive. Because of this, the use of deep learning and machine learning techniques for early illness prediction has become more and more common. After reviewing the earlier studies, it was discovered that the majority of them were based on untreated, unbalanced datasets, lacked appropriate data scaling, and only used basic techniques. The goal of this work is to solve each of these concerns and create an early diabetes prediction model by applying ensemble machine learning and deep learning techniques. Furthermore, the explainable artificial intelligence tool offered detailed information regarding how various features affect the model.

A type of hyperglycaemia called gestational diabetes mellitus (GDM) initially manifests during pregnancy. It is a frequent issue, affecting up to 15% of pregnant women worldwide. GDM can have serious consequences for both the mother and baby, including an increased risk of preeclampsia, cesarean delivery, and macrosomia (large baby). Early diagnosis and treatment of GDM can help to improve outcomes for both the mother and the baby. Conventional GDM prediction techniques depend on clinical risk variables, including age, family history, and body mass index (BMI) before pregnancy. However, these methods are not always accurate, and they may miss women who are at risk of developing GDM.

Deep learning (DL) and machine learning (ML) were potent techniques that could be used to more accurately forecast GDM. ML algorithms can learn from large datasets of patient data to identify patterns that are associated with GDM. DL algorithms are a type of ML that can learn from even more complex data, such as medical images. Numerous research had demonstrated the excellent accuracy with which GDM can be predicted using ML and DL algorithms. An ML method produced an exceptional prediction of GDM and had a 0.90 area under the curve (AUC). A DL algorithm was shown in another investigation to have an AUC of 0.95 for GDM prediction.

The use of ML and DL for GDM prediction has several potential benefits. Initially, these techniques can be applied to detect GDM risk in women before symptoms appear. Second, ML and DL algorithms can be used to personalize treatment plans for women with GDM. Women might benefit from receiving the best care possible for their unique requirements if this is the case. Overall, ML and DL are promising new tools for the prediction and treatment of GDM. These methods have the potential to improve outcomes for both mother and baby by

CHAPTER 9

Analysis of Chest X-ray Images for Anomaly Prediction Using Deep Learning

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Abstract: Medical X-rays are a preferred option for first diagnosis due to their low radiation dosage, cost-effectiveness, and ability to identify previously unnoticed pathological abnormalities. Identifying and classifying these abnormalities accurately might significantly enhance the diagnostic process in real-world scenarios. Automated algorithms and technologies might soon be available to assist with the reading process and enhance productivity. Chest X-ray (CXR) imaging is an imaging option that is not only inexpensive but also approachable and simple to be employed. It can be utilized to diagnose lung disorders that are caused by infectious illnesses such as Pneumonia and COVID-19. In order to identify issues, this study suggests an approach based on CXR image processing. In order to enhance the image's quality for better analysis, a series of steps are taken. These include resizing the image, grayscale transformation, removing noise, thresholding, and performing morphological operations. To extract features, techniques like LBP, GLCM, and HOG are employed. Classification is then carried out using DL classifiers like CNN and transfer learning methods ResNet50, DenseNet201, InceptionV3, MobileNetV2, and VGG16. The first set of steps is for distinguishing abnormal CXRs from normal and abnormal ones, and the second set of steps involves identifying COVID-19 and PNEUMONIA in abnormal ones. Following that, DL model performance will be evaluated using f1-score, recall, accuracy, and precision, which are parameters of confusion matrices. To assess and anticipate infection and recovery rates, as well as to protect individuals from aberrant situations brought on by malnutrition, poor diets, and abnormal lifestyles, these DL models can make use of picture preprocessing techniques. The ability to quickly identify and uncover issues using DL methods is a huge assistance for both us and physicians when it comes to starting therapy early on.

Keywords: Canny edge detection, CXR, COVID-19, GLCM, HOG, LBP, Noise removal, Pneumonia.

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INTRODUCTION

Image pre-processing (IP) positions have grown in recent years due to the increased availability of multimodal material, which includes digital samples and audiovisual assets. The analysis of various medical imaging techniques, object tracking, and identification are some well-known fields of intellectual property. Medical image analysis is one area where IP approaches are helping professionals save time and provide better results. One of these uses is in CXR exams. Images that are most often used for modality utilized to identify respiratory abnormalities, such as pneumonia, COVID-19, bronchiectasis, lung lesions, etc., are CXRs. The chest X-ray modality's more practical and straightforward approach allows for important clinical checks to be conducted every day [1].

Pneumonia is an illness in which the air sacs of the lungs get filled up with liquid and hence inflammation is noticed in the lungs. This causes difficulty in breathing, cough, and chest pain that also leads to other issues such as chills, fatigue, and fever. Some people may experience some other symptoms too such as loss of appetite, and nausea followed by vomiting. In general cases, doctors will prescribe pain relievers and medicines for cough and fever. It is only in extreme situations that the patients may have to shift to the hospital and have to be kept under a ventilator. Pneumonia can occur due to the common cold, and flu. But there are also times when bacterial infection or viral infection can cause trouble too. This is the reason why COVID-19 is considered of the reasons that is said to cause pneumonia. When pneumonia is caused by the novel coronavirus, it is called NCIP or Novel coronavirus-infected Pneumonia. The World Health Organization shortened the name of coronavirus disease 2019 to Covid-19. If a patient has pneumonia and is a COVID-19 positive, the symptoms will be slightly different than normal pneumonia. The symptoms of pneumonia in a COVID-19 patient are rapid heartbeat, rapid breathing, shortness of breath, heavy sweating, and dizziness. COVID-19 can be mild or severe. In most mild cases, the patient is affected by a cold, fever, sore throat, and a minor breathing issue but they can be kept under quarantine with correct isolation measures. On the other hand, people having severe conditions are likely to have pneumonia, which makes the situation much worse. Patients who have got pneumonia have to be kept under a ventilator due to shortness of breath and other complications taking place. One of the major differences between both ailments is that Pneumonia without the infection of coronavirus is not contagious.

DL-based systems can be fantastic preliminary diagnostic tools to alleviate doctors' workloads, thanks to the rising availability of medical data sets and advancements in computing capabilities [2]. Clinicians may be able to prioritize more urgent abnormal tests with the use of a CXR-based abnormality detection system, which is promising because cardiothoracic and pulmonary abnormalities are among the top causes of death and disability globally. Consequently, the "NORMAL" or "ABNORMAL" binary labels, in addition to "COVID-19" or "PNEUMONIA," are the primary emphasis of the chest abnormality identification method discussed in this work.

Chest abnormality conditions include pectus excavatum, and pectus carinatum, a broad group of issues that affect the heart, lungs, ribs or other structures in the chest and also includes diseases like Pneumonia, COVID, Tuberculosis, Bronchiectasis, Pulmonary hypertension, Lung cancer, Pneumothorax etc. Fig. (**1**) represents the worldwide record of chest abnormalities' active, recovery, and death case rate from 2020 to 2024 provided by WHO.

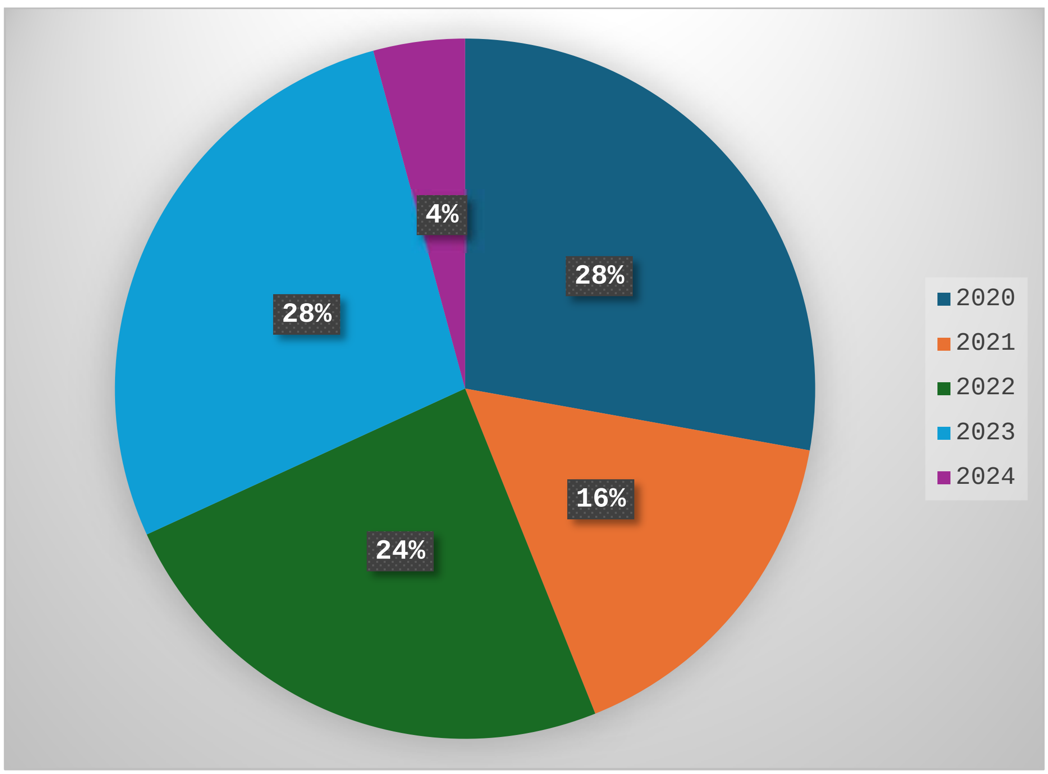

Fig. (1). Worldwide record of chest abnormality active cases, recovery cases, and death cases from 2020 to 2024 provided by WHO [27].

In pneumonia, inflammation develops when fluid accumulates in the lung air sacs. Not only does this produce fatigue, chills, and fever, but it also causes chest pain, difficulty breathing, and coughing. Problems can also develop, though, when bacteria or viruses are involved. Symptoms of pneumonia in a COVID-19 patient

CHAPTER 10

Smart Healthcare System for Disease Forecasting and Analysis

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Abstract: With the emergence of advancements in computing technologies, versatile and distinguished data sources of huge volume are taken into account for developing the healthcare system. Although database processing and data mining systems are available, the diverse, highly complex, and heterogeneous nature of healthcare information resources necessitates the use of innovative techniques and computational models to uncover valuable patterns from the existing healthcare data. This chapter proposes a disease prediction model for analyzing the multiple sources of healthcare big data on the basis of MapReduce-based Fuzzy Inference System. To begin with, various sources of healthcare records are preprocessed using the MapReduce framework, and the resulting key-value pairs are provided as input into the Fuzzy Inference System. The output values obtained from the Fuzzy System are used to predict the disease details. With the introduction of the proposed framework, large volumes of multi-sourced healthcare data can be efficiently processed, leading to improved analysis and disease prediction. The efficiency of the proposed disease prediction framework has been validated with the aid of Hadoop-based experimental setup.

Keywords: Big data analytics, Disease prediction, Fuzzy inference system, Healthcare system, MapReduce.

INTRODUCTION

Nowadays, healthcare systems have experienced significant growth with the emergence of big data and its associated techniques [1]. Big data refers to structured, semi-structured, and unstructured data that can be utilized to generate valuable information. Structured data pertains to an enthusiastic data model with a

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distinct structure. Hence, the storing of structured data is possible with columns and databases and leads to be easily accessed and used. Semi-structured data inherits a few properties of structured data, and it does not obey the formal structure of data models such as an RDBMS. Unstructured data has an inconsistent nature, which varies all the time [2]. The rise of large volumes of multi-formatted data, along with their rapid generation, impacts big data analytics in healthcare systems. The data comprises information connected to clinical and decision support systems, such as prescriptions, medical imaging, laboratory reports, pharmacy details, and insurance information. It also includes machine-generated or sensor data, broader, less patient-specific information, and patient data from electronic patient records (EPRs). The development of new healthcare policies in a number of verticals, including diagnosis and treatment, healthcare resource management, patient-centric services, and the identification of fraud and anomalies in health claims, was prompted by an emphasis on organizing and extracting valuable information from those data sources.

Healthcare Systems with Records

A collection of health data, including diet habits, physical capabilities/status, fitness, age, weight, and blood pressure, can be found in a medical record. These records typically aid in the diagnosis of patients' illnesses by the healthcare systems [3]. Social media networks and clinical forums are examples of digital platforms that have emerged and allowed users to access a wide range of healthcare services at their convenience. Through these sources, patients can interact with people who are similar to them and exchange information on symptoms of their disease, medication information, clinical report feedback, and post-effect scenarios—all while maintaining enhanced privacy. Patients can also receive their medical needs without needing to be physically present by using telemedicine services. The genomic database additionally offers information on the cause of specific diseases and how genes impact health. In order to determine the type of disease and forecast a course of treatment, the patient's genes are examined during diagnosis [4]. The outcomes of the diagnostic can be verified using the resulting genetic information. Electronic health records, or EHRs, provide authorized users with a secure, real-time, digitized representation of patient information. The EHR allows for the study of a patient's diagnosis, prescriptions, course of treatment, dates of immunizations, radiological pictures, and laboratory test results [5]. Sharing health information with other providers, including laboratories, specialists, pharmacies, emergency rooms, and workplace clinics, is an unavoidable aspect of the electronic health record. The other sources include laboratory findings, clinical notes, medical imaging data, classification codes for various diseases and clinical services, and sensor devices that record patient behavior in various contexts. By using these large data sources to build the clinical illness repository, public health surveillance is enhanced, and quicker response times are provided through efficient analysis of disease patterns. For efficient patient care and resource optimization, the hospital operator employs patient records that include treatment plans, patient feedback, and details of numerous tests. In the same way, clinical researchers can gauge the likelihood that planned drug trials will conclude with the use of clinical notes. Owing to its unstructured character, each clinician's portrayal is unique. Furthermore, the difficulty in comprehending clinical data is caused by elements such as misspellings, short words, and grammatical mistakes [6]. Finally, the collection of information from IoT devices, society data, and claim history is a component of what healthcare insurers do. These records, which include details like income, family history, gender, and age, are taken into account when recommending appropriate health insurance to clients.

The rest of the chapter is organized as follows: The Literature Review Section elaborates on various existing healthcare frameworks on the basis of techniques adopted with their results. Followingthis, the next section elaborates on the proposed framework on the basis of the MapReduce programming model and Fuzzy Inference Systems. Experimental setup and analysis of results based on the proposed framework are presented. Finally, the last section concludes the work.

LITERATURE REVIEW

In the area of healthcare information systems, numerous researchers have made contributions, which are reviewed and highlighted in this section. In order to handle massive volumes of data from several data sources, recent research initiatives support a variety of healthcare information systems.

Mir [7] developed a healthcare framework with data analytics to provide on-demand healthcare-related details to the various parties of the healthcare system. The intention of the authors dealt with the security aspects of the overall system. However, the reality with respect to the trust level of the involved parties is not focused well. A healthcare framework using big data analytics was presented by Obijuru *et al.* [8] to preprocess medical data before the decision-making process. A crucial procedure known as the “big data platform” is made up of a number of tools for using big data to accomplish tasks. The research paper highlighted the theoretical aspects with respect to the framework. A more detailed workflow explanation has to be concentrated for their claims. The integration of cloud resources and big data processing frameworks with networked devices in the healthcare system was stressed by Nepal *et al.* [9]. Various devices such as mobiles, sensors, smart cameras, body sensors, and software logs have to be interconnected to provide on-time services. It is important to make sure about the

CHAPTER 11

Ensemble-Based Corn Leaf Disease Classification Using Deep Learning Models

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Abstract: In this chapter, we present a novel ensemble technique for the classification of corn leaf diseases using leaf images. Leveraging the strengths of ensemble learning, our method employs a voting mechanism to effectively identify various diseases afflicting corn leaves. This approach integrates three advanced deep learning models—VGG19, ResNet152, and DenseNet121—to enhance the robustness and accuracy of disease classification. We utilize the PlantVillage leaf disease dataset for both the training and testing phases of our proposed detection system. Through comprehensive experimentation, our ensemble model achieves a remarkable classification accuracy of 99.48% on the test dataset. This significant performance underscores the efficacy of our approach in accurately diagnosing corn leaf diseases, thereby enabling timely interventions to reduce crop losses. The proposed ensemble technique not only improves classification accuracy but also enhances the model's reliability and generalization capability, making it a promising solution for automated crop disease detection systems. This chapter will delve into the methodology behind our ensemble approach, detailing the integration of the deep learning models and the implementation of the voting technique. Additionally, we will discuss the results of our experiments, highlighting the superior performance of our ensemble model compared to individual models. The chapter will also explore the implications of our findings for the development of more reliable and efficient crop disease detection systems, emphasizing the potential benefits for agricultural practices and crop management.

Keywords: Automated crop management, Corn leaf disease classification, Deep learning models, Ensemble learning, Plant disease detection.

INTRODUCTION

Corn, or maize, is one of the most crucial staple crops worldwide, serving as a primary source of food, feed, and industrial raw materials. Its significance spans across various sectors, including agriculture, biofuels, and food industries [1]. The

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productivity and quality of corn, however, are severely threatened by numerous diseases affecting its leaves. Corn leaf diseases, such as Northern Corn Leaf Blight (Setosphaeria turcica), Gray Leaf Spot (Cercospora zeae-maydis), and Common Rust (Puccinia sorghi), can cause substantial yield losses, impacting both economic stability and food security [2].

The timely and efficient implementation of management measures necessitates the early detection and precise classification of these disorders. Conventional disease identification techniques are labor-intensive, time-consuming, and frequently subjective, resulting in inconsistent diagnoses [3]. They mainly rely on visual inspections by agricultural professionals. With the advent of technology, there has been a significant shift towards automated and precise diagnostic tools, offering a promising solution to these challenges. Historically, traditional approaches for plant disease detection have included expert visual inspections and microscopic examinations. These methods, while valuable, have several limitations, including the requirement for trained personnel and the inability to process large-scale datasets efficiently [4]. Moreover, these conventional techniques can be influenced by environmental conditions and human error, reducing their reliability and effectiveness.

In recent years, the rapid advancement in computational technologies has paved the way for modern approaches, particularly leveraging image processing and machine learning techniques. These modern techniques provide scalable, automated solutions for disease classification. Plant diseases have been classified using machine learning models, such as Random Forests, k-Nearest Neighbors (k-NN), and Support Vector Machines (SVMs), based on leaf pictures, with encouraging results [5]. Nevertheless, manual feature extraction is frequently necessary for these models, which can be difficult and inefficient. The discipline of image-based disease identification has revolutionized with the introduction of deep learning. Convolutional Neural Networks (CNNs) have shown impressive results in automatically extracting characteristics and accurately classifying images. Plant disease classification challenges have been effectively tackled by renowned deep learning architectures such as AlexNet, VGGNet, ResNet, and DenseNet, yielding cutting-edge outcomes [6]. Despite these advancements, the reliance on a single deep learning model can limit the generalizability and robustness of the classification system, particularly when dealing with diverse and complex datasets.

In machine learning, ensemble learning—which combines several models to enhance predictive performance—has become a potent method. The underlying idea of ensemble learning is that numerous models working together can make decisions that are more accurate and broadly applicable than any one model working alone [7]. A sophisticated machine learning technique called ensemble learning combines several models to create a composite model that performs better in predictions than any of its individual components. By combining diverse models, ensemble methods aim to enhance accuracy, robustness, and generalization capabilities. This methodology is particularly effective in reducing overfitting, minimizing variance, and capturing a broader array of data patterns. Ensemble learning techniques can be broadly classified based on how the individual models, also known as base learners, are generated and combined. The primary types include Bagging (Bootstrap Aggregating), Boosting, Stacking (Stacked Generalization), Voting, and Blending.

In order to obtain an aggregated predictor, bagging entails creating several versions of a predictor [8]. The procedure starts with bootstrapping, which is sampling with replacement, to create many subsets of the training data. A distinct base model is trained using each subset. The final output is then generated by averaging (for regression) or voting on (for classification) the predictions made by various models. Since decision trees are very sensitive to the variability in training data, bagging is especially useful for lowering variance and enhancing the stability of these kinds of models. Fig. (**1**) depicts the bagging process's workflow.

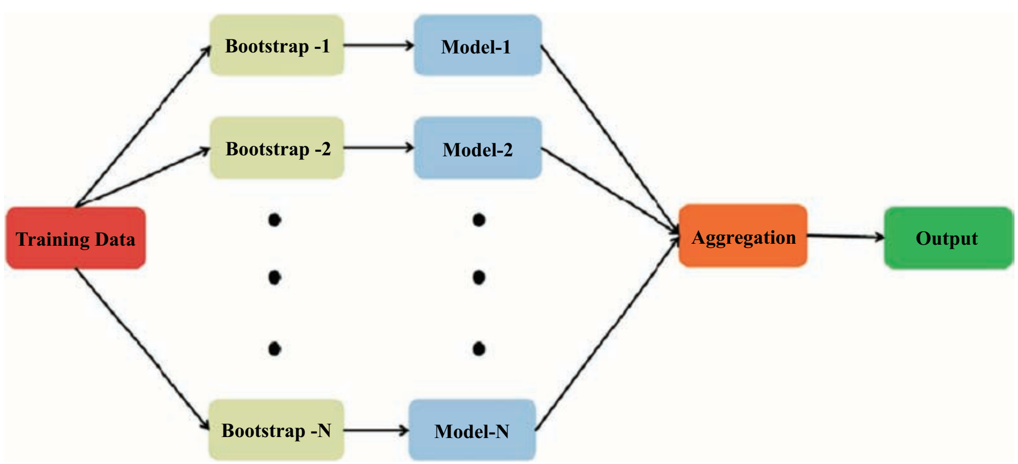

Fig. (1). Illustration of the bagging Process.

Research has demonstrated the efficacy of bagging in improving model accuracy and robustness. For instance, Breiman's seminal paper on bagging predictors illustrates its advantages in various machine learning tasks.

Another potent ensemble strategy is boosting, which produces models one after the other in an effort to fix the mistakes of the one before it [9]. In contrast to

CHAPTER 12

Real-Time Eye Movement Detection for Vision-Based Interfaces

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Abstract: In today's world, computers are essential for communication, education, business, healthcare, and technical innovation, all of which improve productivity, connectedness, and general quality of life. They play a vital role in promoting and supporting human endeavors in a variety of fields. For those with impairments, using computers can be quite difficult because of a variety of physical, sensory, and cognitive limitations. For people with physical disabilities, such as those who have restricted mobility or motor impairments, vision-based interfaces offer vital solutions that let them communicate with technology in ways that are not possible with traditional input techniques. This study project fosters equality of opportunity and inclusivity by making sure that technology is available to all people, irrespective of their physical capabilities. This endeavor aims to compensate people, especially those who are physically unable to operate a mouse because of their disabilities. Without the need for further hardware, users can click and move the pointer using the suggested interface merely by looking at it. In this work, the face and eye are detected using a Haar-Cascade classifier. Twenty individuals participated in the study test. The subject's face and eyes are captured and mouse events like left and right clicks and the cursor movements are mapped to the eye movements. The experimental sections showcase the results of the experiments. Each subject's accuracy will be computed. The right-click event yields a greater accuracy of 85.7% in this work.

Keywords: Cursor movement, Eye detection, Face detection, Haar cascade classifier, Mouse click operations.

INTRODUCTION

The primary goal of the suggested work is to construct an effortless mouse-direct system that will allow people to communicate with computers without requiring any other hardware. The eye and face positions in the recorded video patterns are

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identified using the Haar cascade classifier. The field of human-computer interaction, or HCI, studies how people communicate with computers through novel means such as speech, gestures, and tangible objects equipped with sensors [1, 2]. Eye gazing is an additional input modality that is used in accessibility systems these days. As a result, eye gaze may be used as an interaction technique outside of the accessibility domain.

Eye-movement measures are used in human-computer interfaces to enable explicit eye movements by the user to operate the interface. These systems usually employ eye movements for pointer movement and eye blinks for initiating mouse clicks or other actions. The goal of this effort is to identify novel, user-friendly eye gesture-based interaction modalities. To identify the faces of humans, an object identification algorithm known as the Haar cascade is employed. By training a cascade function with a large number of positive and negative images, the Haar cascade methodology, a machine learning-based object recognition method, locates faces and pedestrians.

Using eye detection, new rectangular features are created. Based on face geometry, a region of interest (ROI) is chosen from the face region once a face has been recognized. With the addition of eye detection to this ROI Haar cascade classifier, a closed eye condition will arise whenever all of the array indices for the eyes are zero. Haar classifier for open eyes is verified if closed eyes are not recognised. When it is finished, it grabs and processes the following frame from the camera. Fig. (**1**) illustrates the eye centroid.

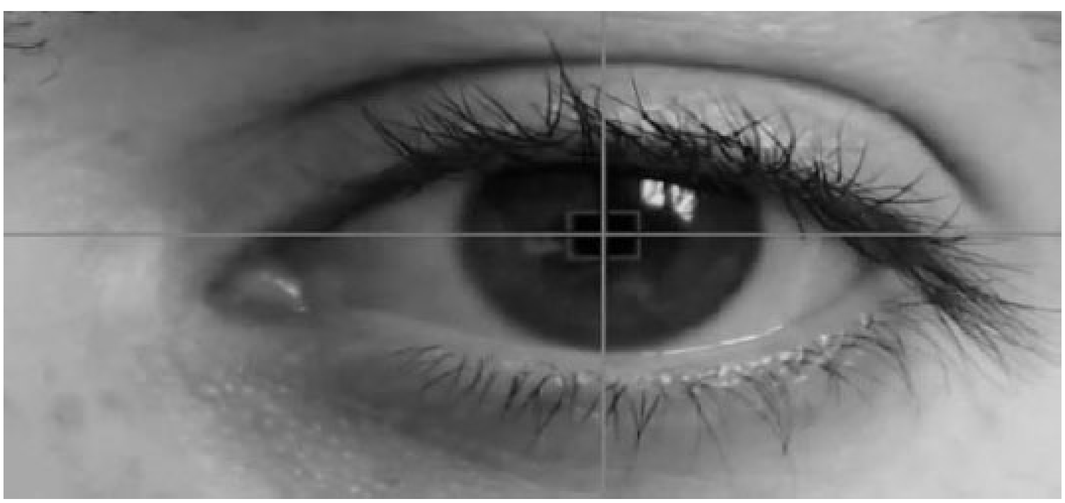

Fig. (1). Eye centroid.

The ROI of the face, collected from the web camera, is where the eye centre location begins. After capture, there's a calibration step where the eye gaze is adjusted to the pointer's starting location on the screen. To distinguish between the two eyes, classifiers that split the left and right eyes are employed.

The following hands-free interfaces can be used with the suggested system: ATM operations, mobile operations, computer games, printer operations, multimedia operations, internet browsing, GPS operations, and web applications for smart home environments.

LITERATURE SURVEY

Marco Porta and Alessia Ravelli [3] suggested a project with the help of the browsing system WeyeB, two fundamental tasks of Web browsing—scrolling pages and selecting links—can be effortlessly completed without the need for manual assistance. In that work, there are four eye-sensible areas on the screen: top, bottom, left, and right. These areas allow for eye-controlled scrolling. Every region has four sub-areas inside it. The content scrolls up, down, left, and right when the user stares at the centre of the screen. But the content disappears if nearly two seconds pass while the user's gaze is not on the rectangle.

Disha H. Nagpure *et al.* [4], presented a paper that explains the use of a five-stage method for eye motion detection to determine eye movement direction and operate a computer system. Head detection is the primary application of the Viola-Jones object detection technique. The mouse is manoeuvred by dragging the cursor in relation to the eye's corresponding movement.

Kunhui Lin *et al.* [5], introduced a quick system of eye detection that can be used on video streams instead of static photos. The detection speed was significantly increased by utilising the temporal coherence of consecutive frames. To get the approximate eye locations, the AdaBoost algorithm-trained eye detector is first used. Next, the geometric patterns of human eyes are used to filter these potential places.

S.S.Deepika and G.Murugesan., [6] described an image-based eye tracking technology is employed for interaction in this suggested work. Its foundation is the ability to move the cursor around the screen with just your eyes. The eye tracking device presented in this study makes use of a poor-quality camera that is fastened to a wearable glass. Iris centre is located by processing of the webcam photos. The eye gaze is estimated using this. The pointer is positioned on the screen in the proper direction based on the predicted eye gaze. Additionally, selecting the tabs is done by blinking.

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