

Role of Intelligent CAD Systems for Real Word Applications - A Review

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Abstract - In recent years there is a rapid deployment in computer aided techniques that has been widely adopted to solve real world problems and mostly attributed to the increasing demand in the medical community. Recent innovations like Big data analysis, pervasive computing, and eventually Artificial Intelligence (AI) are employed on top of the IoT to discover any new innovation to save patients and help physicians in the medical community, which is much need of the hour. In this context, we present a comprehensive survey of the latest innovations developed using AI techniques. Specifically, we present an overview of applications that use AI approaches to solve the emerging problems and show how AI plays a dominant role in wireless network functionalities. Particularly, we provide an in-depth discussion on medical applications where AI proves extremely useful for automatic diagnosis and decision making. Finally, open issues and promising areas for future research are also discussed.

Keywords: Medical applications, IOT, Artificial Intelligence, and CAD

I.Introduction

Artificial Intelligence, when we hear this term, many thoughts pass our mind in a whirlwind for some, some fear of this term and most of us don't know the exact meaning of this word. People fear that artificial intelligence is so powerful if developed far will overtake humanity. Well, this fear is caused due to a lack of understanding. Artificial Intelligence (AI) has several definitions. It is defined as the study of "intelligent agents". But often used to describe machines which mimic cognitive functions that associate with the human mind such as learning and problem-solving. According to the dictionary, it is "the study and the development of computer systems that can copy intelligent human behaviour". In simple words, it is also described as any human-like intelligence exhibited by a computer, robot or other machine or the ability of computers or computer-controlled robots to perform certain tasks commonly associated with human intelligence or any technique which allows



Jeremy Achin[1], CEO of DataRobot, defines AI as a computer system that is able to perform tasks without requiring human intelligence. These AI systems are mostly powered by machine learning approaches, whereas some are powered by deep learning techniques. The ideal characteristic of AI is its ability to rationalize and take actions that have the best chance of achieving a specific goal. It is apprehensive with building smart machines capable of performing tasks that demand human intelligence. So, we saw what artificial intelligence is, but what exactly do they refer to while saying 'human intelligence'? Intelligence has five components, they are learning, reasoning, problem-solving, perception and lastly using language. The development of AI has had its impact, called the "AI effect". As machines become increasingly capable, tasks that were considered intelligence, are often removed from the definition of AI.

II. Recent Works

The term “Artificial Intelligence” was coined by the father of AI, John McCarthy. AI is a very vast and fast-developing field. How can we say a field is developing? Well, it is said mainly based upon the discoveries and inventions made in the field. This term is not something new. AI has been in existence since the mid 20th century. If we trace back, we are being exposed to the early development made by Norbert Weiner. He was one of the first people to theorize that all intelligent behaviour was the result of feedback mechanisms and that it could be simulated by mechanics. "The Logic Theorist" is considered the first AI program, it was designed by Newell and Simon in the year 1955, is a further step towards the development of modern AI. As the development continued the inventions have become accessible to common people for regular use. Speech recognition, where the computer or machine is programmed to recognize and translate the spoken words into text. Like speech, there are some things called image and emotion recognition, wherein image recognition a feature in a video or an image is identified and detected. In emotion recognition, the emotions expressed by humans are read and interpreted using advanced image processing or audio data processing. This is used in law enforcement for interrogation purposes. Natural Language Processing, it focuses on the association between human languages and computers. This technology is widely used in fraud detection and security systems use text analytics to analyse the structure of sentences, their interpretation and intention through machine learning. Even amidst this pandemic, companies have launched products based upon AI. BrainBox AI uses self – adapting AI technology which optimizes the energy consumption of a building, which is the largest climate change contributor. LOVOT, developed to bring emotional peace at our homes, where it uses more than 50 sensors to create a behaviour, which is very much like a human and senses the mood of an individual and reacts accordingly to elevate the mood the individual, which is a perfect addition to a peaceful, lovely and comfortable environment. L’Oreal Perso, developed by L’Oreal Technology Incubator is an in-home system which uses virtual reality tools to provide personalized beauty care for the



user. This system is connected with the app under the same name which not just analyses the overall skin, but also the geographic location, climatic and environmental condition of the user which impacts the human skin. Kuri mobile robot, a home robot integrated with IoT (Internet of Things) sensors, that interacts with people and captures moments of every day with sensor-enabled cameras. [2] proposed a secure hash message authentication code. A secure hash message authentication code to avoid certificate revocation list checking is proposed for vehicular ad hoc networks (VANETs).

III. AI based Medical Projects

Samira Yeasmin conveys that the application of AI is discussed in 4 different categories with the future of AI in medicine. The first step in curing a patient is the diagnosis and AI has found itself very useful here. Followed by a diagnosis we move to the ways AI can be used to reduce human errors in this field and getting to the point of virtual presence as supervision for 24X7 is impossible for a doctor or any other caretaker, at last ending with the future of AI in medicine as this field has a very crucial impact in the lives of people, by improving AI in medicine we can reduce mortality rate, reduce the stress doctors experience and possibly their work time too, and this also would have a positive impact on the patient's mental health.

Yu-Jin Lin & etal[3] talk about the application of Artificial Intelligence of Things (AIoT) in electrocardiogram analysis and cardiac disease detection. Here a front – a user interface on smart devices application, end IoT based hardware, a cloud database and an AI platform for cardiac disease detection is used. The study has focused on several common arrhythmias and building a convolutional neural network (CNN) – based algorithm for cardiac disease classification. This algorithm for arrhythmia has 4 categories: normal ECG, atrial fibrillation, atrial flutter, and ventricular fibrillation. This work takes single – lead ECG as the measurement, which means it cannot analyse some types of arrhythmia.

Chun-Li Chang & etal are focusing on the connection of data changes between back-and-forth analyses. Through the method of energy adjustment, the detective process of AI Medical equipment is used to analyse how civil physical and mental balance works. The value of this research is to promote a stable balance between the subject's body and mind in addition to work safety to prove that integration of the human body and mind is the structure of coherence. This research can be considered as the foundation of integration theory on the subject's body and mind to make sure one's physical and mental balance state. There is “a very significant correlation” between detection values and current evaluations, especially for the total energy variations during the back and forth working operations. Subjects with abundantly spiritual energy and stably emotional conditions can strengthen the “highly-focused” mental function during the working operation.

Xiao Fu's[5] idea focuses on the application of AI in cell biology and cancer treatment. This application of AI in the medical field, no matter how much farther it goes, cannot replace doctors, but this development and integration of AI in medicine reduces the workload on doctors and improves work efficiency. This paper conveys how AI can assist doctors in the diagnosis of illness, about the accurate detection of rare diseases and provide



effective treatment. How gene sequencing lays the foundation for the precise treatment is also discussed here, as gene sequencing is the first step in both gene therapy or cell therapy and the support of gene sequencing is required in the implementation of gene diagnosis and treatment programs. Following this, the paper discusses the application of AI in pathological diagnosis, skin disease diagnosis and tumour therapy.

Joan Cabestany & etal have pivoted on the implementation of AI in data collection for patients suffering from Parkinson's disease. So, what is Parkinson's disease? Well, when we hear the name, it sounds fancy and so is the disease. This disease is caused due to the degeneration or death of neurons in the brain which leads to the reduced supply of dopamine to the brain, which causes tremors, shakiness, stiffness, difficulty in walking, balance and many more. During the starting stages of this disease, these symptoms are light and don't cause any interruption to the day-to-day activities, but as time progresses this gets worse. Taking dopamine supplements doesn't work as they can't reach that far into the brain to work, so instead, the precursor of dopamine is used. This disease has no cure but the symptoms can be controlled, that is why the precursor of dopamine, levodopa, is taken.

This medication causes the fluctuation between ON/OFF periods, ON is the period during which, according to the motor sensor, the person is 'almost normal' and OFF is the period during which the person experiences the symptoms. Just as any other drug, this also wears off, and on continuous intake the dosage must be increased for it to work. REMPARK has developed a closed-loop detection, response and action capabilities for the management of Parkinson's disease patients.

Here they use two sensors, one in the wrist to measure tremors and slow movement, bradykinesia, and the other one in the waist near the Iliac Crest for detecting the other symptoms and bradykinesia. This system uses a mobile phone camera, Nexus S, for video recording and a specific JAVA – based application that is executed on a tablet, DELL Latitude ST, to annotate symptoms, day to day activities, postures and medication intakes. So, at last, what REMPARK wanted to achieve, that is the main benefit of REMPARK for the patients is that it records real-time data, stores and sends it to the patient's neurologist, a non-invasive wearable sensor is used and the AI system which detects the signals are labelled, filtered and separated from false-positive signals.

Min Lei & etal[7] have focused on the identification of non – standard movements which happen during rehabilitation, fitness, gymnastics, yoga or any other movements using an AI-based strategy. The first step in this is data acquisition. Here the data signals are recorded and stored in a local database and then uploaded to the cloud server. The data signal is recorded in a 3 – axis form, those 3 are acceleration, gyroscope and azimuth with time also as a factor. The second step is data processing. Data errors, like noise generated by body jitters, are removed using a filter during this process. After that, the data undergoes a binary classification, which is done by a classification algorithm that is based on the integrated decision tree. According to this decision tree, there are three main integrated algorithms, random forest algorithm, adaboosting algorithm and gradient boosting algorithm. The last is system problems and solutions. Here the quality of the data is identified by the method of ranking data and by dynamically determining the sample adoption rate. A scheme for



classifying the collection locations is also used. This paper implements action accuracy judgement systems based on shared data. [4] proposed a novel method for secure transportation of railway systems has been proposed in this project. In existing methods, most of the methods are manual resulting in a lot of human errors.

IV. Automatic car parking system

As we are discussing the applications of AI in different fields, well, we couldn't leave automated car parking systems (APS). So, what is an automated car parking system? Well, it's a mechanical system that is designed to minimize the area and volume that is required for parking cars. The automated car parking system is of two types, one is fully automated while the other is semi-automated. In fully automated parking, the driver drives the car into an APS, where the passengers and driver exit the car and buy a ticket and pay at the automated terminal set nearby. After they have left the entry area, the mechanical system lifts the car and transports it to a predetermined parking space in the system. The driver can retrieve their car by inserting the ticket or the code into an automated terminal. The APS lifts the car from the parking spot and delivers it to an exit area. Semi-automated parking system uses a mechanical system to move a car to its parking spot, but this process requires some action by an attendant or the driver. Automatic car parking systems play an important role in space-saving. But its importance doesn't just stop there. The cars which are parked here and their contents are safer as there is no public access. Minor parking lot damages like scrapes and dents are eliminated. The safety of drivers and passengers is more ensured as the walk-through parking lots or garages are not necessary at all. Driving through the parking lot in search of parking space is eliminated, which also reduces engine emissions. These are just some secondary benefits for automatic car parking systems, but the application of AI much further into it we get "Smart parking system" where cameras and sensors are used to analyse data and predict future trends and provide a seamless parking experience.

V. Smart embedded systems

As we are discussing the applications of AI, smart embedded systems cannot be left out. They play a very important role in our everyday life. So, first what is an embedded system? It is a small computer system, which is a part of a larger system, device or machine. The main purpose of this system is to control the device and allow the user to interact with it. So, what makes this embedded system smart? Well, any device which can connect to the internet is called "Smart" or "Intelligent". This system is also referred to as an integrated system because of the combination of hardware and software, also referred to as Firmware. This system uses a microcontroller or microprocessor to perform a single task or job. This smart embedded system can be seen in central heating systems, digital watches, smartphones and watches, electronic calculators, home security systems, fitness trackers and even more.



The advantages of these systems are not just limited to the application's uses. These systems have a very limited number of functions means that they are cheaper to design and build. They require less power, do not require much processing time and can be built using cheaper and less powerful processors. These systems have the capacity of reasoning about their external environments and adapt their behaviour accordingly. This is what makes them so useful at present, has helped it develop over these many years and is going to help develop this smart embedded system in the future.

VI. Need of AI

After learning what AI means, we can't say that without AI we can't live by ourselves, but we live a normal one, but as humans, we have the greed in our blood, which drives us to development and more civilization. AI can make our life easier, simpler and sophisticated in a way we could never imagine. AI is not sold alone as a separate application in most cases, it is combined with existing machinery, giving new features and increasing its capabilities. AI is of four categories but we are using only two the others are still in development. First is "Reactive machines", they don't have memory, they cannot use past experiences to foresee the future, they just use the current situation in a way it can handle it at that moment. This is intended for the application of small situations. Second is "Limited memory", this is applied where there is a need for memory, this makes it capable of using the data collected in previous situations to facilitate any work. AI can automate repetitive learning, this makes it efficient in performing frequent, high – volume, computerized tasks with high reliability and no fatigue. Everyone thinks if AI is involved in business and menial work, that will drag the family of thousands to the streets, rendering their livelihood. But the truth is, AI can create new jobs, millions of jobs. It will become the most significant job engine the world has ever encountered. AI can eliminate low – skilled jobs and efficiently create a bulk of high – skilled job opportunities that will give rise to a new economy in all the sectors. AI is a gift to mankind, but still a two-edged sword. Like a child, it is developing, what we feed it grows into it. All AI needs is a self – learning algorithm, with the given data it becomes an intellectual property. As said before, it is the data, not the algorithm that matters more.

VII. Applications of AI

After learning the need for AI, we can say that AI is a technology which helps in the development of every other field, even those that seem to have no connection with it. So, where and all can this be applied? Well, starting from agriculture and cybersecurity to astronomy everywhere AI is applied. In agriculture, AI is used to calculate the time it would take for a crop to be ready for picking, hence increasing the efficiency. In cybersecurity, AI is used to sort the information into high – risk and low – risk data automatically, which enables the security team to focus on the attacks that have the potential to cause real harm to the organization. In banks, AI is used to organize operations, maintain book-keeping, invest in stocks and manage properties. In law, it is used for legal analysis, and law enforcement and legal proceedings, where AI is growing as a mainstay component. AI also helps in searching for jobs. In astronomy, it is used to solve complex universe problems and to understand the

universe as a whole. Like this, AI can be implemented in every unimaginable way, making our life much less complicated and comfortable.

VIII. Challenges

A. Security Threats: Security is a major concern in artificial intelligence and IOT systems. Data collected from sensors and IoT devices are exposed to adversarial attack. In these contexts, ensuring high security for IOT based AI systems is highly important.

B. Privacy Issues: Privacy is another growing concern for AI systems, especially in the medical domain to preserve the safety of patient data.

C. Limitations of AI Algorithms: Though AI shows impressive results in almost all applications, its models still have performance limitations. A critical issue is the need for a large dataset that incurs high cost and high specification systems to train AI models.

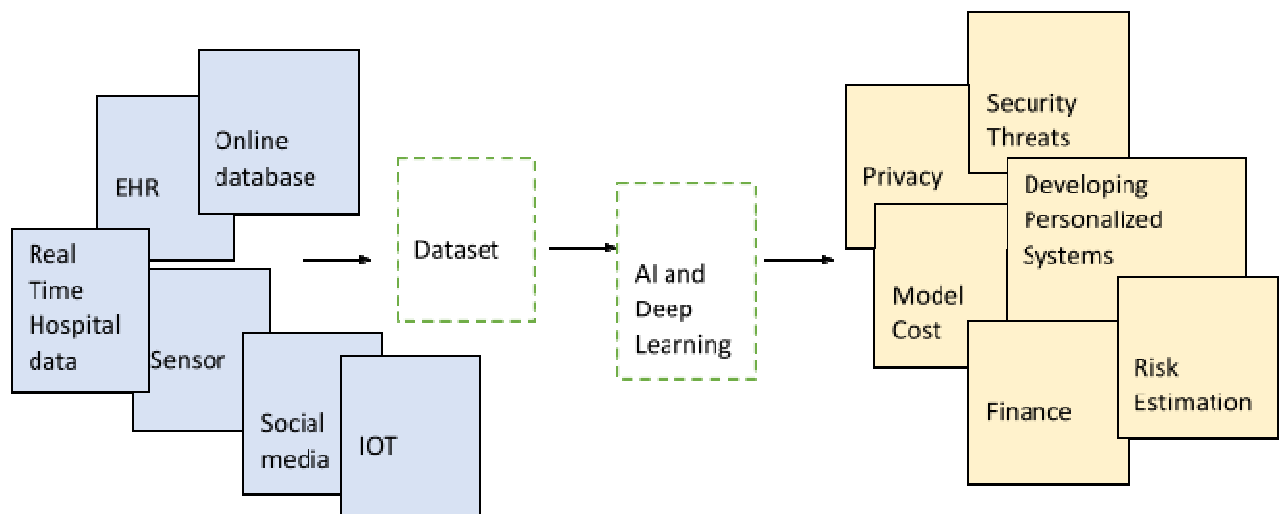


Figure 1. AI Based System: Challenges and Future Research areas

As shown in the above Fig 1., collecting large amounts of data from different sources is challenging and providing security and privacy is another major issue. [6] discussed that the activity related status data will be communicated consistently and shared among drivers through VANETs keeping in mind the end goal to enhance driving security and solace. Some of the issues and details about future scope is discussed below.

IX. Future Directions

Motivated from the recent success in the field of AI, some of the future research directions are discussed below.



The AI architecture has significant impacts on the overall performance because the model design is quite simple. Many AI models can be proposed for data augmentation, data compression and data decoding using neural networks. Therefore, developing adaptive AI frameworks is the key for empowering future medical intelligent applications. AI functions can be implemented in medicine using wireless networks in a distributed manner. This architecture not only influences the wireless data transmission but also provides security to the patients' data and modernizes the way how communications are organized and managed.

B. Bringing AI based projects From Simulation to Implementation:

Reviewing the literature, most of the AI algorithms are initially tested using simulation tools and then the researchers and practitioners implement the AI functions in the real-world. As a first step, collect real-world datasets, say deepMIMO dataset and then make use of the real time data to train and test the AI models in Nvidia platforms using the standard TensorFlow library, that accepts reduced data training and improves learning accuracy substantially.

C. How AI is integrated with 5G and Beyond:

AI technologies are expected to play an indispensable role in medicine and the heterogeneous nature of 5G with a wide range of services, such as intelligent resource allocation, network traffic prediction, and smart system management helps to integrate with AI to provide ubiquitous local applications for mobile users, and service provisioning management. With the rapid development of edge 5G services, AI can be used to predict the disease in advance and saves patient life to some extent. In fact, IOT and mobile edge computing (MEC) can be integrated by using intelligent AI software for learning and understanding historical data. Lightweight AI algorithms help in decision making without the need of human intervention. Beyond the 5G networks, so-called 6G, may appear to provide superior performance and meet the increasing demand and help nations to enjoy the service of intelligent wireless networks around the 2030s. The automated intelligent wireless inventions are envisioned to provide new human-centric values in almost all applications such as wearable computing, autonomous driving, space-air-ground networks, advanced data sensing, data communication, signal processing, etc.

CONCLUSION

In this article, we have presented a short review about state-of-the-art methods that have been developed using AI techniques. We have our perspective with a focus on three main themes : role of AI in medicine, Automatic Car parking systems, and in embedded wireless projects. Then, we have focused on analyzing the use of AI approaches in the medical domain. Based on the holistic survey done, we have pointed out the open challenges to be considered for further investigation based on AI and finally, we have outlined potential future research directions towards using AI and IOT based on 5G wireless networks in medicine.

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