Chapter

Artificial Intelligence and IoT: Past, Present and Future

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Abstract

Artificial intelligence (AI) approaches have recently made major impacts in the healthcare field, igniting a heated discussion over whether AI physicians would eventually replace human doctors. Human doctors are unlikely to be replaced by machines anytime soon, but AI may assist physicians make better clinical decisions or even replace human judgment in certain areas of healthcare (e.g., radiology). The increased availability of healthcare data and the rapid development of big data analysis tools have made recent productive applications of AI in healthcare possible. When driven by appropriate clinical queries, powerful AI systems may find clinically valuable information hidden in enormous volumes of data, which can help clinical decision making. The internet of things (IoT) is a network of many interconnected things that may communicate with one another across a computer network. We may get information from this global network by connecting sensors to it. Thanks to the computer network, we can obtain this information from anywhere on the planet. The internet of things (IoT) enables physical objects to connect to the internet and create systems using various technologies such as near-field communication (NFC) and wireless sensor networks (WSN).

Keywords: WSN, artificial intelligence, deep learning, IoT and health sector

1. Introduction

Wireless sensor networks (WSNs) have been shown in a range of applications during the past several years. A WSN is a collection of wireless devices that are typically small, battery-powered, and self-contained (also known as nodes). These devices include on-board computers, communication, and sensing capabilities, enabling them to monitor and transfer data on physical or environmental factors like temperature, sound, and pressure through a unidirectional or bidirectional network. The nodes are made up of a low-power CPU with limited processing, a memory device with limited storage capacity, a radio transceiver with low-power internal/external antenna, a low-data rate and limited range, sensors (scalar, cameras, microphones), and a power supply (batteries and solar cells). In most cases, each device is powered by a battery. Examining each of these gadgets individually may seem to be pointless.

WSNs play an important role in military applications. The increasing deployment of WSNs drives sensor network research. WSNs, on the other hand, maybe used for environmental monitoring, habitat monitoring, classroom/home monitoring, structural monitoring, and health monitoring, among other things. Based on its characteristics, each application has its own design concept and execution to meet its own demands. The qualities of WSN, together with technology improvements, give the greatest benefits to healthcare. A sensor network designed to identify human health indicators is known as a body sensor network (BSN). Because BSN nodes are directly attached to the human body, considerable vigilance is required. For many days, several healthcare applications need the BSN to collect patient data indefinitely without user intervention. Such applications must take into consideration the energy constraints of sensor networks [1–15].

The challenges of WBS networks healthcare is a need for everyone's quality of life in today's environment. The population of developed countries is growing at a pace that is proportional to the government's budget. Healthcare systems will face challenges as a result of this. One of the most difficult challenges is making healthcare more accessible to elderly people who live alone. In general, health monitoring is done on a check-in basis, with the patient remembering their symptoms; the doctor performs tests and develops a diagnosis, then monitors the patient's progress throughout therapy. Wireless sensor network applications in healthcare provide in-home assistance, smart nursing homes, clinical trials, and research advancement. Let's take a look at some of the challenges and basic features of BSNs before we get into the medical uses of this technology. In healthcare applications, low power, limited computing, security and interference, material restrictions, resilience, continuous operation, and regulatory requirements with elderly people are all issues.

Modern modelling approaches such as fuzzy logic (FL) and artificial neural networks (ANN) are frequently employed in hydrological modelling for a number of applications. The main benefit of these techniques is that they are not constrained by restrictive assumptions such as linearity, normality, or homoscedasticity and that they provide promising and acceptable alternatives to classical stochastic hydrological modelling in time series analysis, such as the auto regressive moving average exogenous (ARMAX) model (autoregressive moving average with exogenous inputs). When applied to hydrological systems, however, traditional stochastic models have many drawbacks, the most notable of which are short-time dependence and the normality assumption, as previously mentioned. Hydrological processes are well recognised for defying these assumptions. ANNs have been recognised as a tool for modelling difficult nonlinear systems and are widely used for hydrological prediction. Their applications range from forecasting hourly and daily river stages to further FL modelling applications in: rainfall-runoff groundwater; and time series modelling [6–10]. Fuzzy neural networks (FNN) are a unique approach for river flow prediction that blends FL and ANNs.

Because they can estimate any continuous function to any degree of accuracy, the Mamdani and tidal sequence (TS) systems are referred to as universal approximators. The smaller the error tolerance, the more fuzzy rules are necessary. In practise, fuzzy models can always yield nonlinear modelling solutions when the required number of fuzzy sets and rules are provided. In comparison to the TS approximator, the Mamdani approximator has the benefit of being able to use both numerical and verbal data produced from human knowledge and experience.

When nontrapezoidal/nontriangular input fuzzy sets are used, TS fuzzy systems may be more cost-effective than Mamdani fuzzy systems in terms of input fuzzy sets and fuzzy rules. They discovered that TS and Mamdani fuzzy systems have comparable minimal system configurations when trapezoidal or triangular input fuzzy sets are used. The performance of Mamdani (linguistic) and TS (clustering-based) fuzzy models was examined in the spatial interpolation of mechanical features of rocks. In terms of prediction performance, the clustering-based TS fuzzy modelling technique beats the Mamdani model, according to their results. The main purpose of this study is to develop a hybrid model for streamflow forecasting that incorporates both a genetic algorithm and fuzzy logic. Genetic algorithms and neural networks (NNs) were used to train the Mamdani and Takagi-Sugeno fuzzy logic modelling systems, respectively. According to the comparison, the Mamdani approach beats standard methods in terms of avoiding restrictive assumptions, insight into the modelling structure, and modelling accuracy.

Health is always a major concern as the human race improves in terms of technology. The current coronavirus outbreak, which has hurt China's economy to some extent, exemplifies how healthcare has become more vital. In areas where the pandemic has spread, it is always preferable to monitor these people using remote health monitoring equipment. As a consequence, the current solution is a health monitoring system based on the IoT. Remote patient monitoring provides for patient monitoring outside of typical clinical settings (for example, at home), increasing accessibility to human services offices while cutting expenses. This project's primary purpose is to design and build a smart patient-health monitoring system that uses sensors to monitor patient health and the internet to alert loved ones if there are any issues. The purpose of developing monitoring systems is to reduce healthcare costs by reducing the number of needed inspections. In an IOT-based framework, different consumers may be able to see sensitive aspects of the patient's blooming. Because the information should be double-checked by visiting a website or URL, this is the case. In GSM-based patient observation, the rising parameters are communicated utilising GSM through SMS techniques.

In most rural areas, the medical facility would not be within walking distance of the residents. As a consequence, the majority of people must attend doctor's visits, stay in hospitals, and undergo diagnostic testing procedures. Each of our bodies uses temperature and pulse recognition to determine our overall health. The sensors are linked to a microcontroller that monitors the state and, as a result, is interfaced to an liquid crystal display (LCD) as well as a remote connection that may send alarms. If the framework detects any unusual changes in heart rate or body temperature, it warns the client through IoT and also shows subtle features of the patient's pulse and temperature on the web in real-time. An IoT-based tolerant wellness monitoring framework efficiently leverages the web to monitor quiet wellbeing metrics and save time in this manner. There is a significant ability to disregard any form of minor health concern, as shown by changes in important components such as body temperature, pulse rate, and so on in the early stages.

When a person's health condition has developed to the point that his or her life is in peril, they seek medical assistance, perhaps wasting money. This is crucial to consider, especially if an epidemic spreads to a place where doctors are unavailable. Giving patients a smart sensor that can be monitored from afar to avoid the spread of sickness would be a realistic solution that might save many lives. Sensors monitor physiological signs, which are transformed into electrical impulses when a patient enters the healing centre. The basic electrical flag is then updated to an advanced flag (computerised data), which is then stored in RFID. To transfer computerised data to a local server, the Zigbee Protocol is employed. For this framework, Zigbee is a good choice. In this location, there are the most cell hubs. It's better for gadgets that are smaller and use less energy. A nearby server sends information to the therapeutic server through WLAN.

When the data is transmitted to the therapeutic server, it checks to see whether the patient already has a medical record, then adds the new information to that record and sends it to the specialist. If the patient has not had any prior treatment records, the server creates a new ID and stores the data in its database. The IoT is becoming more widely recognised as a feasible solution for distant value tracking, notably in the field of health monitoring. It permits the secure cloud storage of individual health parameter data, the decrease of hospital visits for routine checks, and, most critically, the remote monitoring and diagnosis of sickness by any doctor. In this research, an IoT-based health monitoring system was developed. Body temperature, pulse rate, and room humidity and temperature were all measured by sensors and shown on an LCD. The sensor data is then wirelessly sent to a medical server. These data are then delivered to a smartphone with an IoT platform that belongs to an authorised person. Based on the findings, the doctor diagnoses the condition and the patient's current state of health.

The advantages of AI have been extensively researched in the medical literature. Using complicated algorithms, AI can 'learn' characteristics from a large quantity of healthcare data and then apply the results to clinical practise. It might potentially include learning and self-correcting capabilities to improve accuracy as input changes. AI systems that give up-to-date medical information from journals, text-books, and clinical practises may support physicians in providing proper patient care. In addition, an AI system might help to reduce diagnostic and therapeutic errors, which are inevitable in human clinical practise. Furthermore, an AI system extracts important data from a large patient population to assist in the generation of real-time health risk warnings and prediction findings [11–15].

In this chapter, we look at the current level of AI in healthcare and predict its future. First, we will go over four crucial factors from a medical researcher's perspective: (1) Justifications for AI use in healthcare, and (2) The sorts of data that AI systems have examined AI devices may be classified into two classes, according to the previous description. The first category includes machine learning (ML) approaches that analyse structured data such as imaging, genomics, and EP data. ML algorithms are used in medical applications to cluster people' traits or forecast the probability of sickness consequences. The second category includes natural language processing (NLP) tools, which extract information from unstructured data such as clinical notes and medical journals to supplement and enrich organised medical data. Texts are converted into machine-readable structured data, which may then be analysed using ML algorithms.

2. Artificial intelligence in health sector

Lung- and heart-related ailments are at the top of the list of health-related problems/complications. Wireless technology, which is a relatively new concept, may be used to track one's health. Wireless health monitoring systems make use of wearable sensors, portable remote health systems, wireless communications, and expert systems, among other technologies. Life is valuable, even a single life is valuable, but people are dying due to the lack of health facilities, sickness awareness, and sufficient access to healthcare systems. In all conditions, the IoT assists in the identification of diseases and the treatment of patients. In IoT healthcare systems, there are wireless systems in which different applications and sensors are linked to patients, information is gathered, and the information is communicated to a doctor or specialist through an expert system. Medical devices for the Internet of Things (MD-IoT) are connected to the Internet and use sensors, actuators, and other communication devices to monitor patient health. The expert system uses these devices to transfer patient data and information to a secure cloud-based platform, where it is stored and analysed.

Telemedicine is the practise of caring for a clinician and a patient while they are not physically present with each other. 'The delivery of healthcare services at a distance' is how telemedicine is defined. Telemedicine provides a variety of benefits, but it also has many disadvantages. Providers, payers, and politicians all recognise the difficulty of navigating some grey zones. While the sector will rapidly develop over the next decade, it will also provide practical and technological challenges. IoT is the most trustworthy and cost-effective alternative in certain circumstances, and the connection between different devices and interactive communication systems also need further formal examination. By communicating information to healthcare teams such as doctors, nurses, and specialists, IoT (Internet of Things) and mobile technologies make it easier to monitor a patient's health. Professionals would benefit from using the store and forward method to save and collect patient data that could be accessed at any time.

A smart healthcare system is a piece of technology that enables patients to be treated while also improving their overall quality of life. The smart health concept incorporates the e-health concept, which emphasises a number of technologies such as electronic record management, smart home services, and intelligent and medically connected items. Sensors, smart devices, and expert systems all help to create a smart healthcare system. Healthcare facilities are a big concern in today's globe, especially in developing countries where rural areas lack access to high-quality hospitals and medical experts. Artificial intelligence has benefited health in the same way it has benefited other aspects of life. The IoT is expanding its capabilities in many areas, including smart cities and smart healthcare. The IoT is now being used in healthcare for remote monitoring and real-time health systems. Controlling and preventing catastrophic events, such as the one that happened in 2020 when the coronavirus disease (COVID-19) ravaged the world, maybe done via IoT technologies without imposing severe restrictions on people and enterprises. COVID-19, unlike SARS in 2003, causes respiratory symptoms and seems to be more contagious. One way to restrict viral transmission until a vaccine is developed is to keep a close eye on physical (or social) distance. Improved surveillance, healthcare, and transportation networks will make it less probable for contagious diseases to spread. An IoT system combined with artificial intelligence (AI) may give the following advantages when considering a pandemic: (1) utilising surveillance and image recognition technologies to enhance public security, (2) using drones for supply, transportation, or disinfection, and (3) leveraging AI-powered apps and platforms to monitor and limit people's access to public places.

In healthcare, an IoT system is often made up of a number of sensors that are all connected to a computer and allow real-time monitoring of the environment or patients. AI-assisted sensors might be employed in the case of a pandemic to help predict whether or not people are sick based on symptoms like body temperature, coughing patterns, and blood oxygen levels. The ability to monitor people's locations is another useful function. During an outbreak of severe disease, tracking the distance between people may provide vital information. Using technologies like Bluetooth, we can get a good estimate of how much distance people maintain when walking in public places. This information might be used to target people who are not physically separated by a specified distance, such as 2 m, to stop the virus from spreading further. To prevent the abuse of personal information, security and data management must be addressed throughout the development of such platforms. Following a pandemic, governments may try to use these platforms and data for long-term monitoring to control and monitor people's behaviour.

One of the problems with traditional medical diagnosis is its inaccuracy and imprecision, which has resulted in the deaths of thousands of people. The development of various algorithms, models, and technologies to ensure accuracy and precision has considerably reduced the number of people who die every day in hospitals, and fuzzy logic, a branch of artificial intelligence, is one of these technologies. Medical diagnostic processes are carried out with the use of computer-assisted technologies, which are growing more common by the day. These systems are based on AI and are designed to diagnose as well as recommend treatments based on symptoms. Many decision support systems (DSSs) have been developed in the medical field, such as Aaphelp, Internist I, Mycin, Emycin, Casnet/Glaucoma, Pip, Dxplain, Quick Medical Reference, Isabel, Refiner Series System, and PMA, to assist medical practitioners in their decisions for diagnosis and treatment of various diseases.

The medical diagnostic System (MDS) is used to diagnose various ailments in an expert system like this. Fuzzy logic was chosen as the AI tool in the recommended system since it is one of the most efficient qualitative computational approaches. Fuzzy logic has been proved to be one of the most effective techniques to offer clarity to the medical field. Medical applications include CADIAG, MILORD, DOCTORMOON, TxDENT, MedFrame/CADIAG-IV, FuzzyTempToxopert, and MDSS, to name a few.

3. Artificial intelligence in open data

Control systems, household appliances, decision-making systems, and the medical and automotive industries all use fuzzy logic-based automated systems. Some of the concepts used in fuzzy logic include fuzzification, defuzzification, membership function, rules, domains, linguistic variables, and so on. While Boolean algebra's set values are confined to 0 and 1 or False and True, fuzzy logic proposes that there are extra values between 0 and 1 or False and True, referred to as in-between values. To put it another way, on its set of 0 and 1, Boolean logic employs entirely inclusive and exclusive rules, while fuzzy logic employs wholly inclusive, exclusive, and 'in between values' rules. Both expert systems and fuzzy logic control systems are designed to tackle difficult and intricate jobs, but a fuzzy logic control system has the benefit of being able to cope with ambiguity. Language standards are employed to enhance decision-making in the face of uncertainty, emulating a human operator. This decision-making power saves time and reduces or eliminates the need for the human element in control models, which was previously required. A closer look into this cluster reveals that similar themes include the use of intelligent data analysis and related domains to anticipate outbreaks, simulate disease transmission, and screen for the virus on a broad scale. Epidemiology is the term used to describe all of this. Modelling and forecasting the spread of COVID-19 using AI and ML methods may help governments, health organizations, corporations, and people manage the pandemic. In this regard, NNs have also played a significant role. To forecast situations, multi-layer feed-forward NNs and convolution neural networks (CNNs) were utilized. Other well-known algorithms for predicting time series data, such as ARIMA (auto-regressive integrated moving average model) and support vector machine (SVM), have been studied. Several of these models have been used to estimate daily infections during various sorts of lockdowns, assisting government decision-making. Public policies have been effectively planned using ML approaches.

In the creation of vaccines, AI and intelligent data analysis have also proven critical. ML and AI are particularly useful for repetitive activities that need large-scale data processing, making them ideal for drug-development. Deep learning has shown to be a very useful technique for predicting the qualities and uses of pharmaceutical compounds that might trigger a body's immune response to an illness. Because this analytical method often needs long periods of testing and a considerable expense, automating this contact would be quite beneficial. Scientists have developed algorithms that anticipate which immunogenic regions should be included in a vaccine, allowing the immune system to learn and prepare for specific antigens. Antigens already found in pathogens that may be related to antigens for a new infection may also be recognised by AI, speeding up the process even further.

AI is assisting in the development of vaccines by simplifying the comprehension of viral protein structures and assisting clinical professionals in sifting through hundreds of relevant study findings at a faster rate than would be achievable otherwise. The ability to understand the structure of a virus may aid in the creation of effective vaccination.

AI and soft computing (SC) play a crucial role in healthcare medical diagnostics. Doctors nowadays are unable to advance without the help of technological advancement. This digital advancement will be incomplete if AI and SC are not included. AI is a technique for constructing intelligent machines. The SC is a collection of computer algorithms for seeing and learning real-world information, which allows computers to create AI. As a consequence, the computer can perform as well as a person if the philosophy of human labour can be expressed using AI and SC technologies. In the healthcare sector, this technological development is being used for long-term medical diagnosis. AI is defined by Alan Turing, the discipline's inventor, as 'the science and engineering of building machines, especially sophisticated computer programmes.' Artificial intelligence systems are computer programmes that can mimic human cognitive processes.

In the early phases of AI, philosophy, potential, demonstrations, dreams, and imagination all played a part. In response to a variety of conflicting needs, possibilities, and interests, the field of IA developed. In a range of fields, including healthcare, AI combined with analytics (AIA) is becoming increasingly commonly employed. Medicine was one of the most successful applications of analytics, and it is now a prospective AI application sector. As early as the mid-twentieth century, clinical applications were designed and provided to physicians to assist them in their practise. Among the applications are clinical decision support systems, automated surgery, patient monitoring and assistance, healthcare administration, and others. The current methodologies are mostly focused on knowledge discovery via data and ML, ontologies and semantics, and reasoning, as we will see in the next sections. We will look at how AI has advanced in healthcare over the last 5 years in this piece.

Data mining, ontologies, semantic reasoning, and ontology-extended clinical recommendations, clinical decision support systems, smart homes, and medical big data will be the focus of the examination. The multiple artificial intelligence features of our study were not chosen at random. Indeed, we have noticed that they have developed a strong interest in medicine in recent years. Data mining methods are used in learning and prediction, as well as picture and speech processing, and anything involving emotion and sentiment. Because of their ability to reason, as well as its usage as a way of learning, sharing, reuse, and integration, ontologies have gained momentum in medicine. Clinical decision support systems that assist improve the quality of treatment in clinical practise draw on both disciplines. They are also used in smart homes to help those with cognitive impairments with daily tasks. Big data in medicine is becoming increasingly common, and its application in analytics is unavoidable.

Electricity engineers formerly concentrated their efforts on the production and transmission levels, with the distribution system receiving less attention. Engineers have only recently been provided with the tools necessary to cope with the computational burden of distribution systems to undertake realistic modelling and simulation. The majority of primary distribution systems are built up in a radial configuration, with one end providing each load point. The radial type system is the simplest and most often used for effective coordination of their protective systems. Fuzzy set theory has been developed and used in a range of engineering and non-engineering domains where the evaluation of actions and observations is 'fuzzy' in the sense that no clear boundaries exist. The fuzzy set theory provides for the inaccurate representation of evaluations and observations, which may then be utilised to describe and solve issues.

The use of fuzzy set theory to distribution system analysis may aid professional judgement and prior knowledge in distribution system planning, design, and operations. Future computer technology will be considerably more advanced than our greatest imaginations, and far more advanced than anything we can envision right now. The IoT is one of the most cutting-edge technologies, with IoT-enabled things all around us. With the help of RFID (radio frequency identification) and sensors, it will create its own world in which everything will be managed and transmitted over the Internet. The devices will create their own environment. The enormous amount of data created will be recorded, analysed, and presented in a timely, seamless, and understandable way. Cloud computing will provide us with virtual infrastructure for visualisation platforms and utility computing, enabling us to integrate device monitoring, storage, client delivery, analytics tools, and visualisation in one place. Cloud computing, which will provide an end-to-end solution, will allow users and businesses to access applications on-demand from anywhere. One of the most important IoT applications is in the field of healthcare. We designed a health monitoring device using current low-cost sensors to monitor and maintain human health parameters such as heart rate, temperature, and air quality. The approach of fuzzy logic was used. In 1965, Lotfi Zadeh presented the concept of fuzzy logic for the first time.

Fuzzy logic is a kind of multivalued logic with truth values ranging from 0 to 1. Fuzzy logic deals with the concept of partial truth, in which the truth value varies from completely false to completely true. The fuzzy logic technique includes fuzzification, inference, and defuzzification. The sensors capture crisp input data, which is then converted via membership functions into a fuzzy input set, linguistic words, and linguistic variables. The rules are used to make inferences. The system will work on the same principles as the IF-THEN system. The membership function is used to convert the fuzzy output to crisp output.

Vital signs are the four most important markers that reveal the condition of the body's vital functions. These measurements are used to assess a person's general physical well-being, detect probable diseases, and monitor healing progress. The fuzzy inference system is a computer framework that makes choices based on fuzzy set theory, fuzzy if-then logic, and fuzzy reasoning. Over the last decade, fuzzy set theory has advanced in many directions, with applications in taxonomy, topology, linguistics, automata theory, logic, control theory, game theory, information theory, psychology, pattern recognition, medicine, law, decision analysis, system theory, and information retrieval, to name a few. A fuzzy inference requires three parts: a membership function generation circuit that calculates the goodness of fit between an input value and the membership function of an antecedent part, a minimum value operation circuit that finds an inference result for each rule, and a maximum value operation circuit that integrates a plurality of inference results. When these components are combined into a system, the system can do inference. Each externally supplied input value, this membership function generating circuit creates one membership function value. The decision-making logic of the fuzzy inference machine is crucial, and it may be the system's most adaptive component. The fuzzification interface corresponds to our sensory organs (e.g., eye, ear), the de-fuzzification interface to our action organs (e.g., arms, feet, etc.), the fuzzy rule base to our memory, and the fuzzy inference machine to our thought process when a fuzzy system is compared to a human controller. It is called a fuzzy expert system when an expert system uses fuzzy data to reason. It is important to know what makes up a fuzzy expert system. The fuzzy expert system consists of a fuzzy knowledge base (based on fuzzy rules), an interference engine, a working memory subsystem, an explanation subsystem, natural language interference, and knowledge acquisition.

4. Conclusion

The number of individuals visiting hospitals has grown in recent decades as a result of population expansion and changing lifestyles throughout the world. As a result, the medicare healthcare system is overburdened. On the other hand, for the old, crippled, underprivileged, or those who live far away, visiting the hospital is quite tough. As a consequence, their health may worsen to the point where they die. The Internet has now become a necessary component of our daily life. Education, finance, business, industry, entertainment, social networking, retail, and e-commerce are just a few of the uses of the internet. The IoT is the web's next big thing (IoT). As a consequence, remote healthcare solutions were created to meet the medicare health system's above-mentioned difficult challenges. The patient's vital signs are monitored by electronic sensors and communicated to the hospital server through the Internet, allowing the doctor to examine, diagnose, and prescribe the required medicine to treat the patient without the patient needing to visit the hospital.

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