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REVIEW ARTICLE

AIoT in Healthcare systems: a Thought on Approaches and Criticism

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Abstract

AIoT is the melding of AI and IOT. The use of artificial intelligence in conjunction with the Internet of things is a modern trend in the field of digital devices and their respective data processing (IoT). AI is capable of giving these devices a sense of life while IoT can give them a global link. To help keep everyone informed, the system will also send information about the patient's current health status and full medical information to any family members and doctor. Preliminary stage illness prediction using data mining techniques would also allow deciding the best approach. It is anticipated that the internet of things (IoT) will combine the power of artificial intelligence, blockchain and other emerging technology in order to create future "smart hospitals." The emerging categories of IoT devices, including adhesive sensors for skin, will make a financial contribution and will enhance the security, interoperability and analytical potential of these tools while developing technologies including block channels. By using AI to incorporate things into our environment, death rates can be substantially reduced, enabling us to identify high-risk patients early on, monitor disease spread, and predict mortality risk by examining the health history of the patient. Standardization is a major challenge in this area, with obstacles including the protection of patients' privacy, operational simplicity, portability, and low power requirements.

Introduction:

Technology has made the world smaller, and people are increasingly interacting with things as well as one another. Everything can now be interconnected thanks to the Internet of Things (IoT).

In the Internet of Things, billions of devices are linked together. As a result, this idea greatly simplifies the lives of ordinary people. Humans have been plagued by health problems since the Stone Age. Health disorders are now more easily regulated and managed because of advances in technology. Despite the fact that we still have a long way to go, we've gone a long way since we started.

The World Health Organization (WHO) estimates that the average life expectancy in 2020 will be 73.16 years (Banerjee *et al.*, 2018). In spite of escalating health issues, the world does not have enough doctors to deal with them. Public health is a top priority for governments and non-profits in underdeveloped countries. A lack of in-house treatment facilities is a serious issue. A growing number of researchers are focused on IoT as the most promising option since it allows patients to take control of their own health and receive assistance in an emergency (Diène *et al.*, 2020). While patients are difficult to handle and consult, doctors are able to do so. Several cutting-edge Internet-of-things (IoT) applications have been created to assist patients and medical professionals over the past few years. There are several ways in which IoT enhances the quality of healthcare applications by assisting in the administration of patients' medical data; medical emergencies; treatment management; and other services. The Internet of Things (IoT) is used by hospitals to keep track of their patients in real-time and give them on-demand medical care. (Diène *et al.*, 2020; Liu *et al.*, 2017; Li *et al.*, 2020; Vocke *et al.*, 2019; Bini, 2018). Using the Internet of Things, it is possible to accurately track individuals, businesses and other objects. In other words, examining such numbers yields correct

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Ambient Science, 2022: Vol. 09(2); 55-60
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outcomes. Accurate knowledge in the medical area leads to the most effective treatments. Doctors can use sensors attached to patients to monitor vital signs and other biometric data. As a result, diseases and other issues could be identified more quickly.

What is IoT? In the Internet of Things (IoT), devices, items, animals, and even humans are linked together via a network and given unique identifiers and the ability to send data over that network without the need for human-to-human or human-to-computer interaction. To put it another way, it's the process of connecting everything on the planet to the internet (Liu *et al.*, 2017).

Commodity sensors, real-time analytics, machine learning, and embedded systems have all contributed to the evolution of the Internet of Things (IoT).

What is AI? An artificial intelligence (AI) is a machine that is trained to think and act like a human, from the simplest to the most sophisticated behaviours. Learning, thinking, and perception are some of the primary aims of artificial intelligence (AI). One of the artificial intelligence's greatest strengths is its capacity to think through an issue and take action that has the best possibility of succeeding (Li *et al.*, 2020). An algorithm's role in artificial intelligence is often significant, with basic algorithms being used in simpler applications and more complicated algorithms being employed in more advanced AI systems.

Bringing AI and IoT together: Digital twins, IoT and Artificial intelligence play a proactive role in a pandemic in numerous ways. Artificial intelligence (AIoT) is a trend in the development of a network of digital devices that communicate and process data, combining artificial intelligence with the Internet of Things (IoT). AI gives these devices live while IoT creates vast links. This paper examines AIoT's common applications, the challenges facing us during the implementation of AIoT, wide application fields, and how AIoT is working in the future.

The decision-making skills of healthcare 4.0, due to the type of algorithms used and the decision paradigms used, are limited. Using AI we can identify and implement the necessary measures in advance for critical medical conditions. Implementing artificial intelligence of things can substantially reduce death rates that enabling us to detect high-risk patients early on, monitor disease spread, predict the mortality risks by analysing the health history of the patient, remote or home therapy, and other techniques that can significantly reduce hospital occupancy.

Internet of things devices as the digital nervous system while artificial intelligence is the brain of a system. When artificial intelligence is added to the internet of things it means that those devices can analyze data and make decisions and act on that data without involvement from humans (Leung, 2020).

Techniques

Machine Learning: artificial intelligence (AI) is used in machine learning to enable systems to learn and improve on their own, without having to be explicitly programmed. The goal of machine learning is to create computer algorithms that can learn on their own from data. It all begins with observations or facts that can be used to find patterns in data and make better decisions in the future, such as examples, direct experience, or teaching. Automated learning is the primary goal, and computers should be able to learn without human intervention or support (Vocke *et al.*, 2019).

Deep Learning: uses many non-linear transformations to construct high-level abstractions from data in a way that can be easily understood by humans. This is called deep learning. There are many methods for machine learning that use data representations as a basis for learning. In this context, "machine learning" refers to the idea that robots may pick up new skills on their own, without the assistance of humans. There is a kind of machine learning known as deep learning, in which artificial neural networks, algorithms based on the human brain, are used to learn from vast volumes of data (Chen *et al.*, 2022).

Ambient Intelligence: with the goal of improving human-environment interactions, the term "ambient intelligence" has been coined. In the long run, the area's goal is to make our lives and workplaces better. While Smart Homes are one type of system, the concept can also be used in hospitals, public transportation, and other places of business besides. Technology (sensors and gadgets linked by networks) and software intelligence are two of the most important factors in bringing Ambient Intelligence to life (Bini, 2018)

Smart Objects: a smart object is one that makes it easier to communicate with other smart objects as well as with people. Products, assets, and other things that can share data with each other, their surroundings, the product's producer, the user, and other products and systems are referred to as "smart connected things" (SCoT). As well as dealing with real-world things, it can also apply to virtual ones (those found in a computer environment). The information gleaned through the use of these items can be used to make better decisions, increase operational effectiveness, and enhance the product's overall performance (Sholla *et al.*, 2017).

Big Data: the term "big data" refers to ever-increasing collections of data that are both huge and diverse in nature. In this context, data volume and velocity and range are synonymous, as are the number of different data points that may be gathered in a given period of time. Big data often comes in a variety of formats and comes from a variety of sources. Structured and unstructured big data exist in tandem in the world of big data. A large portion of

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DOI:10.21276/ambi.2022.09.2.rv02

structured data consists of data that has already been entered into databases and spreadsheets by the organisation. The term "unstructured data" refers to information that has not been organised into a model or format in advance. It includes information gleaned from social media, which institutions use to learn more about their customers' needs (Abo-Zahhad *et al*., 2014).

Data analytics: AIoT systems require a wide range of data analytics, including real-time and predictive analytics, to function properly. When data is accessible, real-time analytics is used to analyse the data as soon as possible. User insights are gained instantly or quickly after the data is entered into the system. Preventing issues and seizing opportunities can be done before they occur. For real-time decision-making, logic and mathematics are used to analyse data. Predictive analytics is a subset of big data analytics that uses techniques like statistical modelling, data mining, and machine learning to make educated guesses about what will happen in the future. AIoT systems will be able to foresee equipment faults and take corrective actions without human intervention thanks to advanced deep learning algorithms (Grady *et al*., 2017).

Embedded Systems: it's possible to think of an embedded system as a computer hardware system that has software embedded in it. Embedded systems can either be a stand-alone system or a component of a larger one. It is a microcontroller or microprocessor-based system designed to execute a certain purpose. An example of an embedded system is a fire alarm, which only detects smoke. Embedded systems are made up of three components: Hardware; Application software.

Because of its Real-Time Operating System (RTOS), it is able to regulate the latencies of the CPU and allow it to carry out tasks as scheduled (Yoo *et al*., 2019).

Facial Recognition System: human faces can be recognised through the use of facial recognition technology. A facial recognition system employs biometrics to identify a person's face from a photograph or video. To identify a match, it runs the data against a database of well-known individuals' faces. Facial recognition can be used to authenticate a person's identification, but it also raises concerns about privacy. Using a photograph or video, facial recognition software deduces information about a person's facial features. Using facial landmarks, the software creates a unique identifier for each user. Signatures are checked against known faces using an algorithmic method. This information is used to make a decision. The most difficult part of implementing this system should be ensuring it has enough security safeguards (Ryan *et al*. 2009).

Blockchain: data records are stored in a distributed digital ledger known as a blockchain. The blocks of data are placed sequentially and encrypted using cryptography. A blockchain's original model used cryptographic techniques to protect digital documents against data manipulation in a chain of blocks. To put it another way, the term "blockchain" refers to a system in which records of previously confirmed transactions are stored in a chain of blocks. The blockchain is a decentralised database since it is maintained by computers all around the world (or ledger). All participants (nodes) have their own copy of the blockchain data and communicate with each other to guarantee that the data is consistent (or block). A blockchain-based system ensures that all of the data, variables and processes used by AIs in their decision-making processes are immutable. Our sensitive data can be safely stored while benefiting from personalised suggestions if it is stored on a blockchain that can only be accessed by an AI with permission and after it has gone through the right procedures (Rajashekaragouda *et al*., 2020).

Application of AIoT

The WHO (World Health Organization) predicts that by 2020, health issues will be the most pressing challenge we face due to our ageing population and the unhealthy way of life. These difficulties necessitate technological answers, and academics are working harder than ever on IOT-based solutions.

Monitoring system for heart disease: when it comes to heart-related issues, many patients die before they receive any therapy. Because patients with heart failure are unable to contact or request assistance from health care agencies on their own.

It is now possible to monitor the essential functions of patients throughout the world with the help of the Internet of Things.

Using a remote monitoring system is crucial in order to solve this problem. Pervasive monitoring systems transmit patient vital signs in real-time to a remote medical application.

Sensors are used to measure blood pressure, ECG, heart rate, SpO2, pulse rate, blood fate, and blood glucose levels with the help of the system. Monitoring systems include three layers of architecture: sensing, transport, and application. Sensors are placed in the sensing layer in order to gather data about the body. Real-time continuous data transmission is provided via the transport layer. Analysis of data is possible in the application layer for medical experts. Remote practitioners can use the technology to keep tabs on their patients' status and anticipate potentially problematic ones (Li et al., 2017).

Intelligent Ambulance and Traffic Clearance: traffic bottlenecks and human contact make it difficult to get patients to the hospital on time. When ambulances and other medical vehicles are slowed down by traffic, patients are at risk. With an intelligent ambulance system, all of

these challenges can be avoided.. Using RFID technology and sensors, these IoT-based intelligent ambulances relay signals to the traffic light at the intersections. In order to make room for an ambulance, a green light will flash on the traffic light receiver. When an emergency arises, the car in the back may be used to change the direction of traffic lights. Traffic lights are equipped with receivers that pick up signals from emergency vehicles while they're in "emergency mode." Ambulances can get to hospitals faster if the new system is implemented as designed. The research is really helpful because it is critical to get patients to the hospital. The proposed system could save a lot of lives (Gotadki *et al.*, 2014).

Smart Hospital: despite the fact that hospital systems can store a certain amount of information, they have a number of drawbacks, such as manual input of medical information, interdepartmental interdependence, and a single function. IoT can be used to solve these issues, according to the proposed system. The system under consideration is capable of exchanging data and performing intelligent recognition, tracking and determining one's exact location. There are a number of significant technologies in this system.

The Internet of Things (IoT) can't function without it. An object or other thing can be automatically and non-intrusively identified using radio frequency identification (RFID). It is the sensor network technology that is at the heart of the Internet of Things (IoT). Things can be tracked using a sensor network and RFID, such as their position, temperature, pressure, movement, and so on.

WIFI, UWB, Zigbee, and Infrared are all examples of wireless communication technology.

Perception layer: this layer is subdivided into two layers in the proposed system. Identifying hospital networking networks and gathering related data are the next steps in the data collection process. This layer allows the system to identify assets, identify patients' medical information, and follow doctors and other medical officers. inpatients' physiological data Information about the surrounding area and the hospital itself. To put it another way, the system relies heavily on this layer. Data is sent to the backbone network via the access layer, the next lower sublayer. Using a mobile network to access a smart hospital is the primary method for patients, doctors, and other staff members to get in touch with one another and collaborate. The second and last layers are called the Application layers. Information and decision-making applications for the healthcare industry. Patients would have a better experience and medical staff would be able to manage information and patients more easily if the proposed technology is implemented.

Medication reminder: among patients of all ages, especially those who take multiple medications and vitamins each day, missing a dose is common. For patients and caregivers, a smart pill box with advanced features has been proposed in the research paper [6]. For both hospitals and retirement homes, this device is a must-have accessory. Taking medicines has never been easier with this pill box's configurable dose and timer. Patients will be reminded to take their medications with the help of the pill box. The pill box has been offered as a means to alleviate the pharmaceutical issues faced by the elderly. The medication reminder system was developed by researchers to assist the elderly in taking their medications at the appropriate times and in the correct amounts. As a result of their hectic schedules, some patients fail to remember to take their medication on time. The smart bill box can help people remember to take their medication. The Internet of Things (IoT) allows patients to delegate the management of their medications to a mobile app. The programme tells the patient's family if they miss a medication. Pillboxes have two modes of operation: normal and management. In normal mode, the pillbox waits until the patient needs to take a dose before it can be activated. The pillbox will automatically dispense medication when the user presses a button. After a predetermined amount of time, a notification will be sent to the medical staff or the patient's family members. The medical staff or caretakers are in charge of the pillbox in management mode. If the pillbox is malfunctioning, they can run diagnostic tests and make adjustments to the software that controls it. Researchers have created a pill box that is both inexpensive and of the highest possible quality (Minaam *et al.*, 2018).

Orthopaedics: the quality of orthopaedic treatment for patients can be improved through the use of IOT, as researchers have proposed methods for this. In a matter of seconds, sensors are able to provide information about bone and fracture measurements. Sensors connected to the internet of things (IoT) can provide precise data on things like blood pressure, bone pain, and even brain activity. Patients who have sustained an injury can speed their recovery by engaging in safe and effective physical activity. In addition, patient satisfaction, effectiveness, and outcomes are all improved as a result of this practice. It is important for orthopaedic surgery patients to undergo a lot of physical therapy and precise exercises, so sensors can alert doctors if something is wrong. In addition, doctors are able to provide guidance to patients even if they are not nearby. Without the need for an appointment, patients and their loved ones can check on the progress of their recovery and receive the necessary medical advice. Below are some of the most common uses of IoT in orthopaedics (Singh *et al.*, 2020).

a) description of the deformations and fractures of the broken bone, Doctors can use a variety of sensors and a visualisation panel to learn more about fractured bone.

Ambient Science, 2022: Vol. 09(2); 55-60
DOI:10.21276/ambi.2022.09.2.rv02

b) Health monitoring and the generation of reports
c) Because orthopaedic patients necessitate individualised care, It has a significant impact on orthopaedics to meet the needs of patients with personalised information solutions.
d) Monitor orthopaedics equipment
e) It is possible to track IOT tools and devices and conduct virtual consultations as a result.
f) replacement of a knee
g) Knee replacement surgery can be performed successfully with IoT. In addition, patients might be instructed on how to perform the required exercises after surgery.

Criticism

The edge of the Internet of Things necessitates AIoT components that can withstand the wide range of conditions that exist there. Onboard ships and planes, at factories, or in the middle of the Sahara Desert are all possibilities. Component production must be adaptable and versatile in order to meet this need. Artificial Intelligence (AI) also promises to reduce the human factor when it comes to making decisions.

IoT has had a significant impact on the health care industry, according to research. Using AIOT, researchers have come up with a new way to assist patients and healthcare professionals. With the support of AIoT, patients can receive high-quality medical services and doctors can provide their services more easily, from consultation to surgery, for the convenience of their patients.

AIoT is still a new concept, even if it helps with health care in several ways. Medical personnel, in particular, lack the technological know-how necessary to run IOT-based equipment and apps. Technology should be more abstracted from people and more beautiful user interfaces with step-by-step instructions should be developed in the research outlined above. Because of this, people are able to use the systems with ease.

Researchers, in my opinion, should be more concerned about protecting the privacy of patients' data. It is common practice in the medical sector to keep patients' personal information private. Internet of Things (AIoT) requires researchers to take additional efforts to protect their data and information from cyber-attacks. In addition, they should make sure that their systems are safe so that there are no security holes. Because the proposed system is dealing with people's lives, security is of the utmost importance.

System and access security must be addressed by researchers using appropriate authentication techniques. There is always a risk associated with using LAN networks in the study indicated in the papers. As a result, an appropriate remedy must be provided. Data loss due to noise is another major issue I discovered when sending data from sensors to servers. These issues can be resolved by employing a noise removal approach. Data can be analysed using machine learning and the Internet of Things. As a result, both productivity and expenses will be reduced.

System integrators are under more pressure to guarantee quality control as a result of this. When transmitting data, there is yet another issue to deal with: acquiring and managing the data. Large amounts of bandwidth are being squandered as a result. The protection of AI assets is a major concern for AIoT. Real-time detection, evaluation, and response are all commonplace in AI systems. Internal databases and interfaces for AI are therefore not ideal for encryption due to the high time and resource demands of such a process, which is a serious security problem. Big data and interface designs, on the other hand, are both proprietary and must be secured.

According to research papers, the majority of researchers aren't concerned with the product's pricing. Maintenance costs are very high, and this can lead to a lack of interest from potential customers. IoT devices in health care should be a greater priority for researchers. Another problem with wearable gadgets is that they have limited battery life. Wearable devices should be recharged often due to their limited power source. This is inconvenient and may lead to devise exhaustion. In my opinion, solar power can be employed to solve this issue Many users and sensors demand a lot of storage space, however, this can be addressed by using cloud computing technologies.

However, the integration of cloud and IoT adds another layer of complication. The AI- Internet of Things (AIOT) should also be used to connect medical devices such as x-ray scanners, beds, insulin pumps, anaesthetic machines, and patient monitoring. However, this can be costly, but it will be possible in the near future. If a gadget does not have internet access, IoT cannot connect with doctors to assist patients. One example of this is sensors that monitor patients. Other technologies, such as Bluetooth, can be used to connect to another IoT device and send data between the two devices.

The system needs, however, to be protected against hackers before this can be done. Everything will be affected by IoT, and healthcare is no exception. However, in order to realise the full potential of IoT in healthcare, these research gaps must be solved.

Conclusively, AIoT techniques and applications led us to conclude that the technology can replace human attention to a degree that results in fewer job opportunities being available. Since the quality of life of individuals on our planet improves, it also raises their living costs, which in turn has an impact on our economy. As a result, our young people must be familiar with the technology and tools needed to develop AIoT-based technologies. Future advances and understandings are needed to make this technology easier to utilise.

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