Artificial Intelligence in Smart Health Monitoring System

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ABSTRACT

The spread and emergence of diseases have emerged as a crucial issue in the quickly expanding world of technology and evolution. The main challenge facing medical professionals and the healthcare sector today is the use of technology for precaution, prevention, and disease control. Keeping a healthy lifestyle has because of the demanding work schedules, impossible. Smart health monitoring system is the solution to the above poses challenges. Industry 5.0 and 5G's recent revolutions have sparked the creation of smart, affordable sensors that can track people's health in real time. Traditional healthcare systems were unable to provide quick, affordable, and dependable health monitoring services from remote regions until the advent of the SHM. The blockchain framework's integration improved patient confidentiality and data privacy, preventing data misuse against patients. Deep learning and machine learning have been used to evaluate health data to achieve a number of goals, including managing patient mortality and providing preventive healthcare. This has helped in the early detection of chronic diseases which was not possible recently. The implementation of cloud computing and cloud storage integration has made the services more affordable and real-time. The article presents the comprehensive review of SHM together with recent achievements in SHM with remaining obstacles.

Keywords— Artificial Intelligence, Deep Learning, Smart Monitoring System, Blockchain.

INTRODUCTION

The adage "Health is Wealth" has been proven true in modern times as well. The busy lifestyle, increasing pollution and outbreak of epidemic and pandemic diseases has led to poor and unhealthy life quality of the human being. Recent statistics show that over 90% of the population has been exposed to a polluted environment. Most people now live poor lifestyles because of the industrial revolution and population explosion. Monitoring, enhancing, and promoting a healthy lifestyle are therefore necessary. The development of affordable sensors and devices for real-time monitoring and data capturing has been made possible by industry 5.0 and 5G telecommunication technology.

In the realm of internet of things (IoT), the internet of medical things (IoMT) plays a vital role in Smart health Monitoring (SHM). The idea of interconnecting electronic devices on a network to enable data transmission is where the term "internet of things" originates. in return for a particular application domain. The term "internet of medical things" refers to a network of interconnected electronic devices specifically designed for use in the medical field. Examples include systems for remote and telemedicine care, disease, anomalies, and patient monitoring and conditioning. IoT and SHM (smart health monitoring) are the extensions of medical systems in hospitals by which the patients can take under the interpretation without any carelessness nothing like traditional techniques.

Throughout the previous few decades, life safety and lowering inspection costs have been given top priority by our technology. There are many different emerging methods, including ground penetrating radar, electrical resistivity, and ultrasonic surface waves, to mention a few. Other growing methods include smart home monitoring (SHM) and general smart monitoring (GSM), which both use IoMT to reduce direct and indirect costs.

IoTs are a collection of different electrical and wireless devices that are all interconnected, share patient data for diagnosis and analysis, and are also used to store patient data. There are many sensors and gadgets used in wireless communications that gather patient data. At the core of these, SHM is a development in the medical field for tracking patient conditions (especially those of coma patients) and identifying their body movements using IoT accelerometers (body movement measuring devices and sensors), eye blinkers, temperature measuring devices, etc. Elderly and chronically ill individuals can benefit from these remote monitoring devices.

Fig. 1. Benefits and applications of SHM

In recent years, the number of elderly and chronic patients who need a remote health monitoring system has increased significantly. Hospitalization and patient care are increasing globally with the arrival of an increase in patients. According to a poll, 770,000 Americans die each year, a rise in mortality from day to day. This is caused by improper medicine use, delayed treatment, inappropriate dosage, etc. In these situations, SHM models are beneficial and lessen the workload for employees and other medical specialists.

Several types of stakeholders, including doctors, patients, and other organizations, make up the smart healthcare system. Even some hospitals have begun using smart beds, which can determine a patient's actual status without the assistance of a nurse. These beds are very good at detecting, monitoring, analyzing, and responding to the activities of coma and chronically ill patients. IoMT is crucial in creating a healthy environment to promote healthy lifestyles and real-time monitoring of routine and unique medical procedures.

The fundamental technologies included in SHM for the security and privacy of patient and doctor-restricted data are then discussed, along with some specific case studies where SHM played a significant role and closing remarks about the potential impact of SHM technologies on society and daily life in the future.

Features of Smart Health Monitoring

Several important characteristics of smart health monitoring devices include the ability for doctors to remotely monitor patients' conditions in real time and the reduction of needless hospital visits. These gadgets generate data that is safe from hackers. Today's health care services are expensive, and these devices help to address this issue, marking a significant advancement in the medical field. IoMT and SHM will continue to play a significant part in the general evolution and growth because of people's growing expectations for and beliefs in the sophistication of devices and digitalization. Being a cutting-edge medical technology, SHM can be utilized to remotely regulate medical facilities and save the lives of vital patients suffering from heart attacks, asthma attacks, diabetes, etc.

Regressive analysis and computation are required for the data produced by SHM networks and IoMT devices in order for various inferences to converge. The control of certain disease outbreaks, predictive health monitoring, prevention of chronic diseases, and reduction in patient fatalities are just a few of the objectives that this data analysis and computation aid to attain. To analyze health care data effectively, deep learning and artificial intelligence are essential [14]. There are numerous public domain frameworks and recommended architects available for the study of healthcare data in SHM networks.

Artificial Intelligence (AI) and Deep Learning (DL) in SHM

Machine learning (ML) is divided into two categories: deep learning (DL) and transfer learning (TL), where numerous layers are utilized to acquire useful data, which is then used in its applications to deal with vast amounts of data that have been successfully confirmed on various platforms. By gathering concealed data with the aid of staked blocks of layers of the DL skeleton, DL provides useful information. The application of DL models is widespread, including in telemedicine, SHM, and research. The TL poses challenges for researchers and engineers even though it is a crucial component of the learning machine that humans use when they have learnt from prior experiences. The correlation between DL, ML, and TL is displayed in Fig. 2.

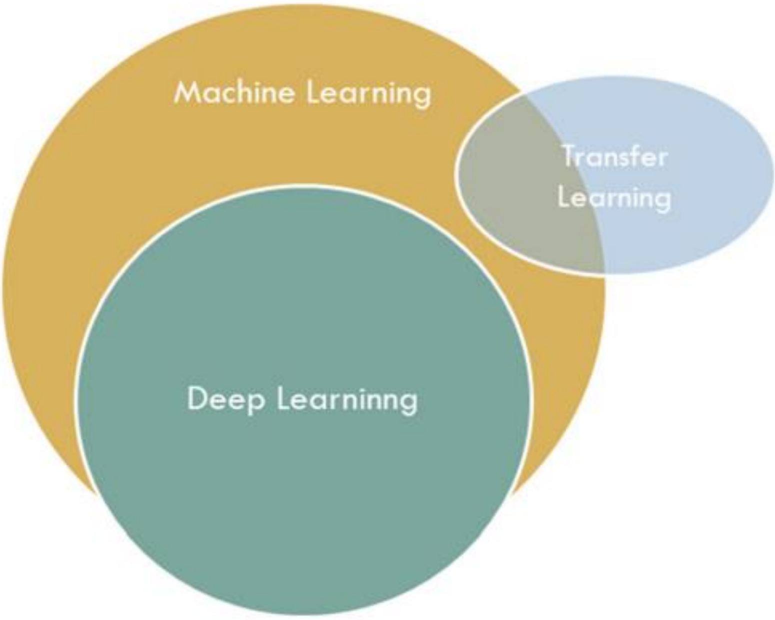

Fig. 2. Relation of deep learning, machine learning and transfer learning.

Using DL in a SHM network has numerous benefits. DL models provide accurate and effective information that is also useful for gathering large amounts of data. Reduce the time it takes to report important instances, and facilitate quick and simple diagnosis. Computer-based learning systems, SHM, IoTs, and experienced clinicians with the ability to identify patients' current conditions in real time as well as provide accurate information or future condition predictions and anomalies of diabetes, Alzheimer's diseases, cancer, respiratory illnesses, etc.

Convolutional neural networks (CNNs), a type of artificial neural networks (ANNs) used for the visualization of images like ultrasound, MRI, CT scan, and X-ray, to name a few, are the foundation of deep learning models. By studying the genes, deep learning enables the discovery of common disorders including Turner's syndrome, hemophilia, sickle cell anemia, and others, making it easier for clinicians to find future treatments as well as medication.

To avoid time exploitation while training deep neural networks. By utilizing numerous IoT, GSM, and SHM modules, DL is excellent for gathering in-depth information about many important patients, especially coma sufferers. The analysis of medical information from wearable and medical devices, such as smart watches, pulse oximeters, blood pressure monitors, thermometers, eye blinkers, computed tomography (CT) scans, X-ray images, magnetic resonance imaging (MRI) ultrasound images, etc., is also done using DL. The primary goals of real-time health data monitoring are the prevention of chronic diseases, trauma cases, disease outbreaks in specific states and nations, as well as the maintenance of a healthy lifestyle.

Structural of IoTM and SHM

These devices may be divided into several subparts based on various criteria, including.

1. Based on transfer of health-related data or information from phone to phone i.e., from patients to the doctors.
2. Publisher
3. Broker
4. Subscriber

Blood pressure, environmental elegance, blood sugar level, and other medical records are included in the publisher's arrangement of connected sensors. The data can be stored by the broker in clouds, and the broker gets the data or information from the publisher. The last is a subscriber, which is used to continuously monitor data that has been retrieved from a publisher and may be seen or recognized by a smart device like an Android smartphone, laptop, tablet, wearable technology, etc. The classification of IoMT is shown in Fig. 4.

The following subcategories of SHM can be determined by the ranges of one or more parameters. In Fig. 3, the classification of SHM is displayed.

1. RHMS (remote health monitoring system)
2. MHMS (mobile health monitoring system)
3. WHMS (wearable health monitoring system)
4. GHMS (general health monitoring system

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The remote health monitoring system (RHMS), which can transfer data to or from a location and covers a wide range of symptoms, is useful both at home and in medical facilities. The main processing station for the MHMS is made up of mobile phones, smartphones, laptops, and pocket personal computers. Wearable technology, such as digital watches, wristbands, eye blinkers, oximeters, and pulse trackers, collects authentic health data and pertinent information. by keeping and processing real-time data the last ten years have seen advances in medical technology. GHMS keeps track of common illnesses and is crucial today. This reduces the number of hospital admissions for common ailments.

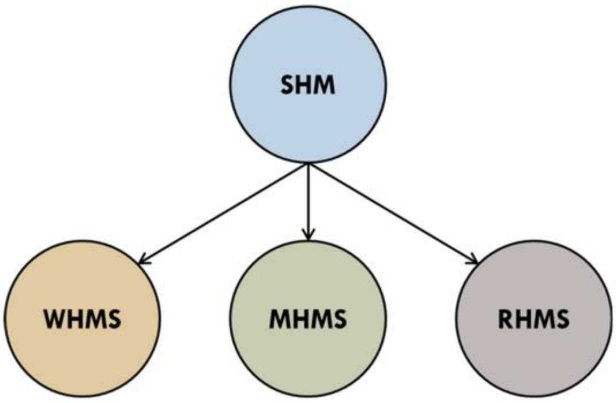

Fig.3 Sub Classes of SHM

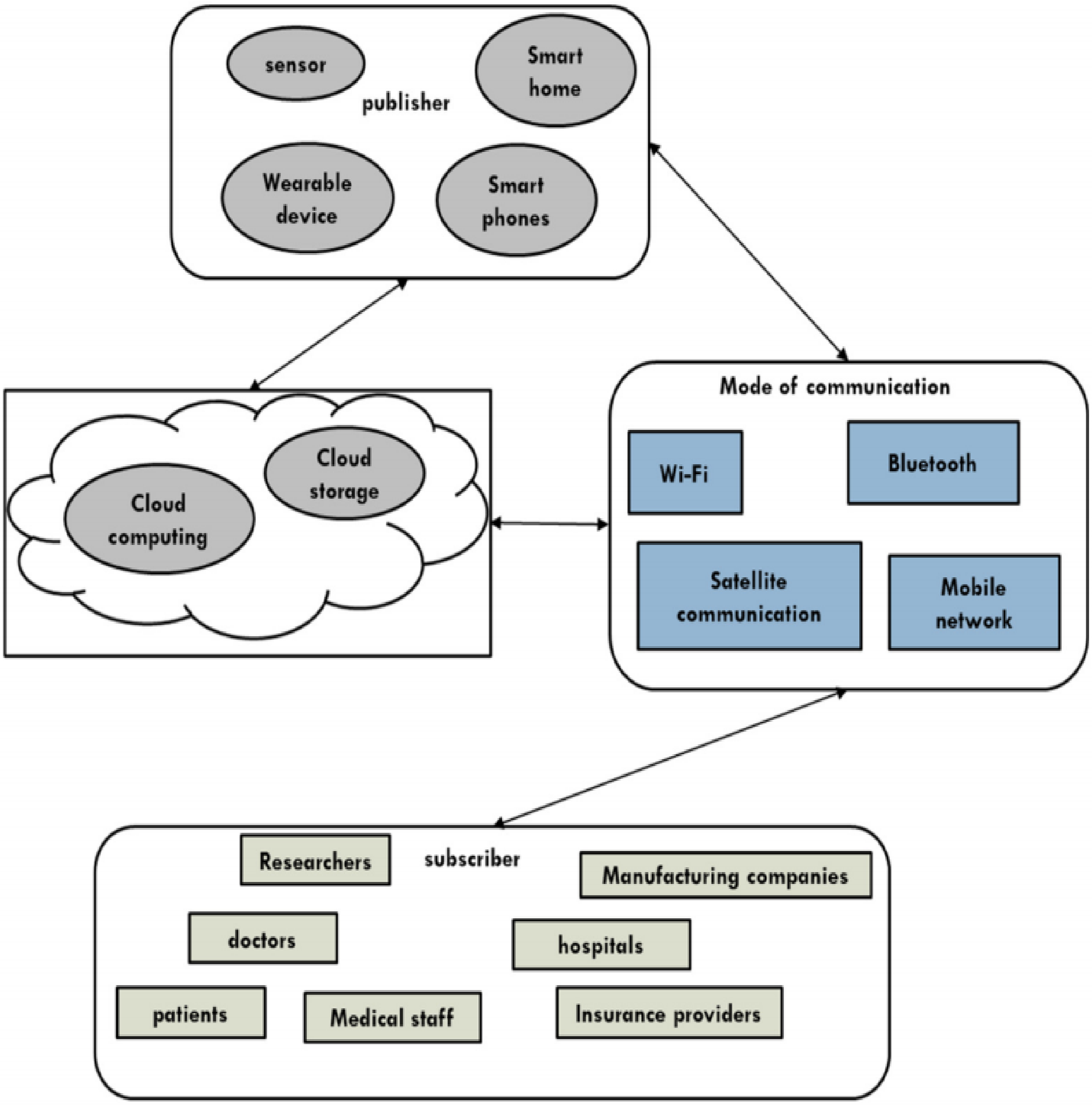

Fig. 4. Components of IoT based networks

Data security in SHM

Big data or health data are terms used to describe the information produced by IoMT and SHM networks. High computational power and data storage are needed to handle this healthcare data. The solution to handle health care data in the cloud is cloud computing and cloud storage. Most of this information is, however, patient confidential. The biggest issues in SHM are data security and privacy. It is best to prevent some users, people, and organizations from misusing this confidential data for their own personal gain. Physical security, authentication, network security, computer security, and storage security are all parts of data security. More people are using data encryption, genetic algorithms, encoding, and decoding techniques. Most of the security and privacy frameworks provide third parties, where trust is a constant concern.

Blockchain and the Interplanetary File System have recently acquired popularity for their safe data transmission capabilities in the banking and financial industries. Blockchain is made up of data sets that are organized into blocks connected by chains, with several transactions contained in each block. When a new block is added to the chain, the entire public ledger of transactions is updated, and new blocks are validated using cryptographic techniques.

Limitations

For a thorough understanding, intelligence algorithms a list of most of the potential restrictions, effects, and development procedures for IoT-based smart healthcare implementations is offered. Statistical analogies was linked to ML in terms of decision-making. It makes predictions about the future based on historical facts. The ML-based approach looked at the training dataset while monitoring a patient, which was essential for accurately forecasting the likelihood of a problem in the future. The primary issues were that the dataset can be biased and that not all potential models were included. The likelihood of making a conclusive health-related diagnostic and advisory remark might be lowered by problems like noisy data, dirty data, and incomplete data. For instance, the patterns and routines used to monitor and track sleep apnea in patients varied from person to person based on age and health state, creating uncertainty in the data. As a result, it may not be possible to track sleep habits using an extensive dataset from some case studies. This material may be in short supply. Energy was used to power ML apps, devices, and bandwidths, which primarily relied on electrical resources to send data Due to erratic power sources, certain difficulties included the quality of the electric supply. The IoT has improved cloud computing consumption, but the system still has issues with energy efficiency. One of the main issues that academics in the field of IoT and the cloud environment are focusing on is the rate of power consumption. When IoT and cloud computing took off, they were accompanied by devices that were resource- and energy-constrained.

The heterogeneous data acquired by many types of sensors, which is prone to errors, makes it difficult to read or diagnose the patient's conditions. This is one of these SHM and medical IoT devices' shortcomings. The wireless sensors are preferred since worn sensors irritate people, especially kids. Because that patient information is confidential and subject to hacking, security concerns cannot be ignored. The fraudulence is a concern while employing an IoT healthcare system. In essence, chronic patients benefit more from smart medical systems than they do from ordinary healthcare services. IoMT devices require continuous electricity, which is not available in distant areas. They also run on batteries.

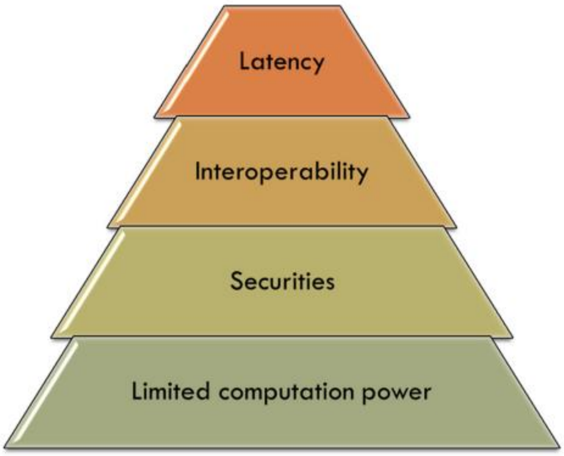

Fig. 5. Challenges in SHM

Real-time monitoring necessitates a quick and dependable network connection, which is challenging to establish in remote places and on low-powered devices. As these restrictions are not restricted to developing technologies, they can be controlled by time and technology.

Recommendation

Data learning is important because, by using different labelled trained instances, it may aid in predictive analysis. Determine accurate locations, risk rates, treatment times, and heal times in advance using data acquired from collected data. Some domain expertise is necessary to make sure that the implementations are error-free. Successful implementation should be aided by having a critical grasp of the connections between the various systems, devices, and networks. Prior to implementation, it is necessary to do well-designed study using the appropriate data. A functional trust framework would aid in delineating the responsibilities of service providers and system developers and give instructions on which components may operate IoT-based systems with the least amount of technical knowledge.

Functional characteristics should be used to provide a high chance of compliance to the weighting factors based on models and features that have been shown to be effective. Confounded providers and consumers can manage services effectively and functionally by using a human-centric trust paradigm. The widespread adoption of IoT and similar technologies will be significantly influenced by network security, data privacy and safety, and related issues. Because of its ambiguity and diversity, IoT is relatively susceptible to attacks to security and privacy. To ensure security management and control distribution for IoT-based systems and software programmers, a trust framework that can scale as needed is required. The handling of vast amounts of data is another feature of the IoT framework, and applying the IoT model helps with software programmed distribution. Application designers should maintain simplicity in their designs and make sure hazards are handled within a trust framework with good manual driving and simple messaging. Instead of depending on a spontaneous addition of components that exposes the whole system, this trust architecture may also incorporate novel components into the system that could be introduced safely when a necessity is satisfied.

Additionally, systems could be told to implement a simple reference control when communicating with other systems on the network channels to ensure availability. Interconnected IoT computers must be protected if user privacy, critical infrastructure, and websites are to be kept safe from large-scale threats. Potential assaults utilize Internet of Things (IoT) devices as bots to flood specific websites or networks with traffic, extending their bandwidth capacity. The IoT-based system's creators and suppliers must use cutting-edge features after thoroughly vetting any possible privacy protection threats. The IoT model will probably need to be scaled up to properly connect the modelling process to specific components. This might include globally approved components with a range of capabilities, standardized names and references that are simple to understand, and paradigms built for interactions with the IoT system that are both comfortable and secure. To guarantee adequate security implementation on the IoT-based systems, it was crucial to make the features simple to use for users of different skill levels. To facilitate data transmission through IoT, it is necessary to investigate power-aware and power generating strategies. There are several power generation techniques in place that might help power generation be more ecologically friendly. These energy-harvesting techniques could help network channels last longer and encourage environmentally friendly communication. Future communication network channels will benefit from SDNs' enhanced models, which can manage hybrid power resources and high-powered applications more effectively. To aid in the extraction of valuable data content, a thorough investigation of the use of DL inside a software-defined network is required. M-IoT encourages compression models to operate more actively and simply, ensuring a lower output bandwidth while maximizing the spectrum and network channel resources. Research on compression models and how they might be used to transmit data across wireless channels is extensive.

Several ML methods have been proposed for attack detection and prevention: Particle swarm optimization (PSO), rider optimization algorithm (ROA), whale optimization algorithm (WOA), and the genetic algorithm (GA) are a few examples. Nevertheless, there are no actual studies on models or compression techniques for encoding data content sent through the M-IoT framework. This topic must be carefully investigated, especially in terms of data service coding on the M-IoT network while also taking into account the energy consumption and interface constraint issues.

Conclusion

When compared to old health monitoring systems, which were confined to delayed services, late medicine, and precautions, the SHM has demonstrated remarkable success. In terms of data security and privacy, the integration of cloud computing and blockchain technologies in SHM has won the trust of medical care professionals as well as patients. To attain specific health goals and healthy lifestyles, SHM was shown to be able to provide both general health monitoring services and the specialized demands of critically sick patients. The limited usage of SHM in sports and general care can be further investigated with ever-evolving technology. “The SHM creates several chances for medical services that were previously unattainable.

The assessment of smart health monitoring frameworks that effectively applied deep learning and machine learning methodologies and algorithms to get better results is presented in the current work. Similar review works on SHM do not report integrated ML and DL related works. Fast and effective remote and real-time monitoring-related medical services have been made possible by the usage of IoMT in SHM.

We discovered that the development of smart healthcare models and designs has created certain difficulties by analyzing and comparing the work of other scholars. Nevertheless, there is room for to these difficulties, which are also covered in the study, refinement and improvement are still possible. One issue raised is the lack of a single standard for medical institutions across various organizations and areas, and the need for reform to assure data integrity. As a lot of data needs to be collected, the system will probably become very complex, which will make communication and data management challenging. The investigation also revealed an issue with data identification and analysis across numerous connected platforms and devices.

With the help of controlled or unregulated learning, machine learning will mostly rely on the dataset and algorithms available to arrange the information. People do make poor decisions since we rely on our information base while making choices. Although they may affect the decisions humans make, emotions do not control machines.

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