Patients' Health Surveillance Model Using IoT and 6G Technology

Sifat Nawrin Nova, Md. Sazzadur Rahman, and Chinmay Chakraborty

Abstract To upgrade the healthcare infrastructure, it is now possible to collaborate Information and Communication Technology (ICT) and the medical field together. After the pandemic of Covid-19 worldwide, it has been more crucial to renovate a new dimension to make the healthcare system more predictable, controllable, and handy. This chapter focuses on a patients' health monitoring system model based on the advantages on IoT and 6G technology. It identifies a cluster of patients for whom a continuous surveillance over health is priority. About 30–35% of deaths occur each year because of the time delay in getting the right treatment or having obstacles and less facilities in the rural area. Lack of an even distribution of a sound treatment everywhere in the country is a big challenge. To overcome the geographical barriers and human intervention, we propose a wireless health monitoring model where treatment is possible from any location without thinking about physical distance or networking barriers. On one hand, Internet of Things (IoT) is making life easier in every sector including healthcare and disease management system. On the other hand, 6G technology is a newly known terminology in the field of wireless cellular communication. It can provide a sustainable healthcare system for the citizens and make wireless devices more viable to the community, even in the remote area. This chapter aims to combine the idea of these two utmost new technologies to provide a better health monitoring system for a sustainable future and also discusses healthcare system establishing challenges and possible solutions for a better health service and support. The major contribution we provide here is the deployment of two biggest technologies in the health sector to provide higher degree of automation, reduced operating costs, and fastest decision-making process.

S. N. Nova
Department of Information and Communication Technology, Bangladesh University of Professionals, Dhaka, Bangladesh

Md. S. Rahman (✉)
Institute of Information Technology, Jahangirnagar University, Savar, Dhaka, Bangladesh
e-mail: sazzad@juniv.edu

C. Chakraborty
Birla Institute of Technology, Ranchi, Mesra, Jharkhand, India
e-mail: cchakrabarty@bitmesra.ac.in

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1 Introduction

An improved version of healthcare system is a crucial demand in order to reduce health risks worldwide. Healthcare defines a set of parameters followed by a society to maintain the fundamental needs of human being. The effectiveness of any healthcare system depends on the services it provides, the feasibilities and availability it may have, and the usability, acceptance, and reliability rate of the citizen. In spite of standing in the era of twenty-first century with all the modernized technological supports, the world has still faced the ferocity of Covid-19 pandemic in 2020. The spreading of the virus was fast evolving and elusive even before understating the biological properties of it. Less than 20% cases could lead to serious clinical conditions in young individuals and adults >60 years, who are identified as the most vulnerable group [32]. It is incurred that a situation similar to Covid-19 pandemic can arise again and question the existence of the mankind at stake. Since the beginning of the century, the world has faced many natural disasters, calamities, and, in this decade, the biggest pandemic. These fatal damages not only caused the death of thousands of people and health at stake but also collapsed financial and economic mobility. With all of the unprecedented behaviors, it can result in more damage even in countries with the best facilities in health system. To avoid these circumstances, a new thought, a reconstruction, is necessary in this field. During the period of quarantine in Covid-19 pandemic, there is a focus on paradigm shift in sustainable development for the green environment [1]. Utilization of the newest emerging technologies, stronger communication network, AI-driven data analytics, and smart devices can carry out improvements over the limiting factors and provide a developed healthcare system.

Also, most countries with lowest-middle-income economy and densest population can hardly deal with impulsive crisis cases. Countries like Bangladesh suffer from both shortage of hospital facilities in rural areas and geographic maldistribution of human resources in healthcare (HRH). In Bangladesh, there are 3.05 doctors and 1.07 nurses per ten thousand patients estimated by the Ministry of Health and Family Welfare (MoHFW) HRD in 2011. Maximum health workers, medical service providers, and doctors are concentrated in urban secondary and tertiary hospitals, whereas 70% of the population is remaining in the rural area [30]. As a result, basic healthcare support, elderly lifestyle disease patients, children's malnutrition, hygiene awareness, pregnant women's healthcare support get disrupted in the rural and remote areas. The preemptive issues include the unorganized healthcare

infrastructure, weak administrative activities, fragile public service community and delivery, and overly capital-centric health services with outnumbered patients and less equipment. These scenarios regarding the public healthcare system can be mitigated by using modern science and technology. Thus, healthcare needs to be more preemptive, focused, collaborative, and supportive throughout the barriers. With the help of emerging technology, we already have been introduced to the smart healthcare system, which is based on the communication network and AI-driven machines. It has been initialized in many developed countries but not been yet applied or used widely in the developing and lower developing countries. Most of the death cases can be reduced by a robust response time and faster medical support, but most of the time we lack this because of mismanagement and insincerity toward working on the system. Most of the health workers are city or capital centered, whereas maximum patients cannot afford to come and have treatments in the city because of geographical hindrance or living in a remote area. It also complies more cost and hassle to the family of the patients and patients themselves to come over a long distance for a treatment and stay within a limited budget parallel to maintaining the health cost.

This chapter provides a conceptual model of establishing a healthcare framework which can enable a strong communication network between the hospital and the patients, home treatments services (HTS), Emergency Support (ES) for example, ambulance services, first aid providers, online consultations from the doctors or pathologists, etc. Our prioritized patients are adults >60 years with elderly and lifestyle diseases such as blood pressure, diabetics, asthma, pregnant women, patients with critical diseases such as cancer or kidney failure. This system model focuses on this group of patients so that they can have better health support without moving physically. However, this system model must be addressed to a strong wireless communication network which can be provided by 6G wireless communication network, and the surveillance of the patients' health logs can be obtained by using Internet of Things (IoT) devices. Our most primitive technological innovation is to surplus the basic advantages of both IoT and 6G technology in the healthcare monitoring system for sustainability in near future.

This chapter provides a perceptual model of patients' healthcare surveillance system by combining these newest technologies to ease the concepts of the manual healthcare system and break the geographical barriers. Despite having challenges to blend these technologies, a sustainable wireless healthcare surveillance model can be made for future use. It can ease and aggregated the process of collecting potential data from the users by the sensors, transferring data to cloud for archive storage hereafter retrieved by the medical teams. The data are analyzed and valuable information can be collected by the back-end users. The most crucial challenge in this stage is the confidentiality and security of the data provided by the patients. If the security is not ensured properly, confidential data can be interrupted and have security threats from intrusive third party. Therefore, security, secrecy, and privacy management are important features that need to be ensured by this model. Also, this chapter provides a feasibility study over how the communication network can reduce the cost and mobile devices can be a self-sufficient user end for the benefit of the patients even if they are staying in the rural area. By studying the general

nature of the healthcare system, it has been incurred that heterogeneous amount of data are generated by sensors in IoT networks that need to be managed efficiently for further analysis and decision-making [3]. IoT has been keeping contributions in healthcare since several years and 6G is newly being introduced in this sector. 6G can bring a huge change over the scenario of healthcare system. Connecting objectives and components with promising determinants can bring together the biggest revolution in this field. The quality of life (QoL) can be improved by using 6G network features [4]. We primarily focus on the application scenario where IoT and 6G can be blended together to develop a novel approach for coherent health monitoring system. It provides a holistic manner over how sensitive patients can be treated with utmost facilities in remote areas using modern technologies.

This entire chapter is segmented into eight sections. Section 2 describes some of the related works in healthcare implementations. Section 3 presents a brief discussion over 6G technology in healthcare. Section 4 elaborates the illustration of hypothetical IoT healthcare services. Section 5 presents the methodology of the proposed model. Section 6 discusses the results expected from this model. Section 7 highlights some vulnerabilities and challenges regarding the model. Finally, Section 8 concludes the chapter and also discusses future scopes for improvements.

2 Related Works

To obtain a robust and successful healthcare system as well as avoid disastrous situations, the first priority for any medical professional is fast and rapid access to the healthcare database and information [26]. In the last 50 years, life prospects have led to a percentage increase of over 64, and by 2020, there will be more 60-year-olds than children under 5 [23]. This shows that aged population is increasing by each year. People aged from 55 to 59 years generally suffer from chronic lifestyle diseases. Several research studies have been done regarding the improvement of the healthcare sectors. Some of them are discussed in this section. In [24], a K-healthcare model is proposed which coordinates four corresponding layers, which are "sensing layer," "networking layer," "internet layer," and "application service layer." They have also discussed cloud IoT platform implementation over remote patient monitoring with critical issues. In recent years, many research and studies have been done for a healthcare support and innovation involving elderly patients in remote area. In [25], the authors have studied different healthcare systems based on various perspective and properties, such as disease management, various kinds of chronic and critical diseases, patients from different ages, etc. Then they have discussed and presented different IoT-based healthcare systems, some implemented with existing technologies such as networking, sensing, and data analysis. In [4], the authors have shown a different perspective on 6G technology-based smart healthcare system. They have proposed some future works and possibilities using 6G technology in health market sector. For example, in future using 6G technology, telesurgery can be enabled based on holographic communication. They presented some remarks on

how 6G technology can provide a better lifestyle by enhancing quality of service (QoS), quality of experience (QoE) and quality of life (QoL) of patients. They addressed how pandemic and epidemiology crisis can be managed using 6G and how holographic communication can take part in the intelligent healthcare system. They also draw a business model where hospital can become health insurance mediator for patients and how to reduce cost over the business model. The authors in [33] present a survey on IoT-based healthcare system and their various applications such as monitoring kids, surgery handling, chronic disease management, and motion sensors. They have also studied the healthcare management of the IoT devices based on their battery life, network connectivity, and other parameters.

The researchers in [27] have surveyed on Cloud of Things (CoT) and the service provided by them in smart healthcare applications. They have also reviewed CoT issues, their platform, compatibilities, and energy efficiency-related issues in the healthcare applications. In [28], the authors present a health monitoring model which can be used in emergency services. They have used Intel GALILEO 2nd Generation development board which connects to a server for displaying collected data and integration among the data. They also discussed compatibility rate of IoT data in healthcare management system. They claim that this model helps to reduce risks in emergency scenarios and manages to collect, sense, and store and transfer data in real time. Another research work in [23] presents the study of future healthcare module using 6G technology. They have presented a study of wireless healthcare network and Internet-of-Big-Nano-Things for a sustainable healthcare solution in future. They have reviewed future parameters on how aged population can undergo a wireless healthcare support without being deprived of physical treatments.

3 Wireless Healthcare Service Using 6G Technology

6G technology will dominate the health sector in near future by providing an integrated smart heath service. It is an AI-driven communication technology [6] with some basic features that are discussed in this chapter. The fundamental requirements of 6G technology for healthcare system is high data rate, low latency, high capacity, high mobility rate, and wavelength of $\leq$300 μm [5]. It is expected that 6G technology will be backed up fully by satellite and will consume 3D architecture including space-time-frequency [4]. Thus, 6G will overcome the geographical barriers which are the major problems for most of the remote patients. Also, with the strong communication facilities between sensors and other devices, it can stream real-time data. 6G technology is an integrated schema that includes AI algorithms and edge technology. By blending these technologies, edge intelligence (EI) can be designed. Edge intelligence (EI) is edge computing with machine learning (ML), data mining (DM), and advanced networking capabilities that are associated with the domain of computational intelligence [2]. It is a distributed smart computer paradigm that can be implemented through 6G as a self-sufficient data processing, analyzing, and decision-making module.

6G communication technology requires 1THz frequency operation, 1Tbps data rate and 1000 km h mobility range, and wavelength of ≤300 μm [6]. These prominent and promising features of 6G enable a fast real-time operation, and user can have the full support from the medical system immediately. In the application of recent years' smart healthcare, it is shown that some aspects are needed to be considered to fulfill the reliability rate of the users. However, 6G technology illustrates an AI-based intelligent system which can be self-sufficient, self-compute, and self-aware based on any stochastic situation. As aforementioned, 6G will be an AI-integrated network so it will provide real-time communication which is an important aspect for modern healthcare. AI can provide high accuracy and performance in real-time communication which is a prerequisite for an intelligent healthcare system. Mostly 6G is considered to have deep learning algorithm (DL), which does not require data preprocessing. It can process data in real time. Deep reinforcement learning (DRL) is an AI algorithm which has been recently implied in health technology [4]. DRL includes advantages of both deep neural network (DNN) and reinforcement learning which can bring about the huge revolution if implemented in the 6G technology as well. 6G can also provide vital role in integrating communication medium, promising better reliability, Big data analytics, and pandemic and epidemic crisis management. Most importantly, the purpose of this chapter which is the distributing healthcare support by monitoring patients in real time can be fulfilled by using this technology. Remote or rural areas' geographical barriers, human resource in healthcare (HRH) crisis, can also be overcome by implementing this technology over the field of public health management.

With high modulating frequency and high mobility rate, it is also important to take account the security threats that can be raised using 6G technology. Physical layers include the raw data collected by the sensor devices from the user, data link layer, transport layer which directs to the cloud storage, and the application layer which switch backs to the user end. The entire process needs a step-by-step security enhancement scheme.

4 Role of IoT in Healthcare

Internet of Things (IoT) is a technological paradigm that includes physical objects, sensors, and other devices into a common integrated network. It has been enabled by the implementation of enhanced technological advances, spectrum sharing, identification of radio frequency, and big data analytics. The network things, objects, and devices can communicate between each other to retrieve required and vital information, analyze data, and complete each other's tasks [7]. Most of the objects in IoT is deployed with sensors, actuators, integrated micro-controller chips, communication networks with a set of standard protocol stacks that can communicate throughout the network [8]. To enhance the implementation and applications of cyber-physical IoT, a massive amount of devices are expected to be involved for sensing, processing, and controlling those models [2]. Usually IoT-based healthcare

module sensors are supposed to monitor and collect data from the user or patients and transfer them to the cloud for archival storage over the internet. In most of the cases, these are the real-time data [9]. Thus, IoT provides a smart healthcare platform which can measure attributes of patients in a ubiquitous and pervasive manner [10]. Device-to-device (D2D) communication paradigm is a central part of the third-generation partnership project standards to facilitate peer-to-peer connectivity that will be an important part of IoT [21]. It gives a solution to the health management challenges with optimum costs.

IoT works with multiple devices with divergent protocols. They connect together to produce information. IoT includes very low powered devices such as "Bluetooth sensors," "RFIDs," "Zigbee," etc. These devices do not cover a wide range of communication network. Generally, these devices are only used in personal area network (PAN). By using IoT over these devices, the services can be amplified. IoT also introduces intelligent wearable devices (IWD) that can measure several body parameters of a patient, such as blood sugar level, nutrition level, water level, etc., and produce a diet chart for the patient [4]. Mostly, IoT gives a flexible and convenient framework by which human can communicate with devices even with a huge amount of heterogeneous environmental data [11].

As an embedded service, IoT is segmented into four layers in a sequence: 1. physical layer, 2. network layer, 3. middleware layer, 4. application or service layer [12]. Every layer performs defined tasks and serves the layer upward. "Physical layer" is considered to be the first layer of the system which includes physical objects as sensors. Sensors can sense information from the environment and collect them to transfer in the upper layer for further prosecution. The next layer is the network layer assigned with IP addresses to transfer information to the destination node. Middleware network combines the idea of smart management which can be established using Cloud platform and data storage. Finally, the application layer provides the final service such as smart healthcare.

Cloud platform and big data are two major aspects considered in IoT-based healthcare model. The adaption of Cloud platform in IoT is economic, cost-effective, scalable, and reliable. Cloud provides an on-demand platform to store, transfer, deploy, and retrieve data in a cognitive and efficient way. It has been widely used in many applications such as smart city, smart agriculture, smart industry as well as smart healthcare system. Cloud platform plays a vital role over remote health monitoring because of its less complex features, optimal costs, and flexibilities [13]. It also enhances the quality services over patients' life. Hybrid cloud is an integrated platform where it can be segmented into three parts: "private cloud," "public cloud," and "community cloud" [12]. In this way, security and privacy of the data are preserved in an efficient way. Additionally, cloud plays an important role to break the geographical barriers as the information are available and accessed from any location worldwide within the shortest range of time [14].

Big data is used in IoT healthcare as a value-based system [31]. Enormous amount of data with diverse properties can be collected by the sensors. They are handled using the Big data technology. "Big data in healthcare" refers to the abundant health data amassed from numerous sources including electronic health records

(EHRs), medical imaging, genomic sequencing, payor records, pharmaceutical research, wearables, and medical devices, to name a few [31]. It changed the typical method of manually managing medical health records with the manipulation of human interference. It helps in risk management of losing or distorting sensitive medical logs and data because of its three distinguishable features. These three characteristics of Big data is known as 3Vs of Big data. They are: velocity, variety, and volume. It comprises a massive amount of data, consumes a high speed of data at a time, and comes from different resources with different types. Analyzing these data are crucial for feature extraction, prediction and decision making. Recently Big data has a widespread implementation in most of the fields including medical technology. Undoubtedly, keeping patients' health in a sound state is the first priority for healthcare data analysis. It delivers the lower cost on investing health monitoring and basic health treatments with better outcomes, flexible treatments, and enhanced diagnosis procedures. With the wealth of data gathered each day worldwide, healthcare data analytics provide medical and technological administrators or caregivers a high accuracy-enabled medical and financial decisions that accelerate the care giving process of the patients with critical or minor health issues. It reduces time and increases reliability, scalability, and acceptance among people, thus contributing to improve quality of life.

5 Methodology

The proposed model of patients' health surveillance includes IoT and 6G communication technology. A conceptual framework has been proposed in Fig. 1, the entire process of the model is discussed in this section.

This model is designed for a specific patients' group. They include patients from rural and remote area, patients carrying lifestyle diseases such as blood pressure, diabetic, and asthma, adults >60 years with critical conditions, and pregnant women. This group of people has sensitive cases, and they need a continuous monitoring by a system. It is not always possible to ask for human resource support for this type of maintenance. Elderly people suffer from loneliness and lack of treatments sometimes. Pregnant women specifically in the remote area lack sufficient knowledge about their own healthcare and amount of nutrition they need for both themselves and the infant. Critical patients, such as patients with cancer or dialysis, need chronic support from the healthcare system. Considering these scenarios, this model is designed to give a healthcare support using technological objectives. Thus, dependency on human resource-based infrastructure won't be necessary, and it will minimize the cost of the user as well. IoT devices are user friendly and low powered device so with little amount of skill and knowledge they can be operated by the patients themselves, and they can get full support from hospital to home only by using their smart phone or mobile healthcare service. To make this schema more practical and realistic, we merged the concept of 6G technology so that the communication network can get more scalable and highly reliable for the user. It reduces

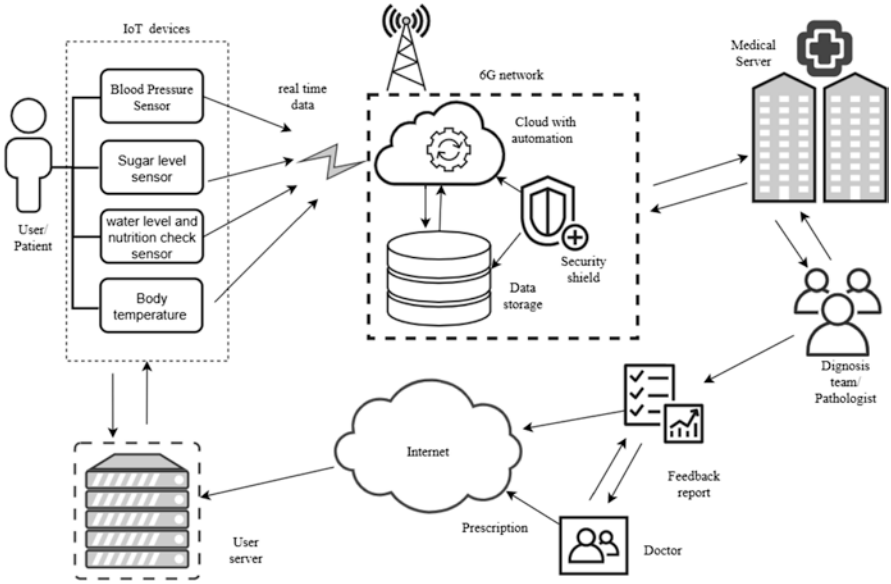

Fig. 1 The proposed model

the problems of communication between the doctor and the patients from remote area. It also gives an idea of wireless health service come true.

In the proposed model, user node consists of several IoT devices including blood pressure sensor (BPS), blood sugar sensor (BSS), nutrition measuring sensor (NMS), and intelligent wearable device (IWD) [4]. IWD is considered to be one type of Intelligent Internet of Medical Things (IIoMT) which can measure the nutrition level as water level of the patients and make valuable decisions accordingly [4]. The sensors are implied to the user as per the requirement of the disease they have. They can have subscription to the local as well as remote hospitals with flexible choices. Medical servers must consist of several diagnosis teams or pathologists and consultation doctors for the verification of the data sent by the IoT devices from the user nodes.

Though 6G technology is considered a fully AI-driven communication paradigm, still it is in the very premature stage of implementation. Also, AI-based system is not completely accurate or reliable yet in the health sector. As the health of a person is a very sensitive issue, to take care of, it is wise to start with human influence at the start of the study. Therefore, the data we can store at the cloud platform need to be check-listed by a team of pathologists or corresponding responsible doctors. The additional help which 6G AI-based algorithm can provide is a prepared data, which can be necessary in decision-making and saves valuable response time. To avoid redundant data and information silos, cloud platform needs to auto updated. Also, a data warehouse is saved in the network for saving vital information of the patients. As security is one of the key features of this model a secured framework

must be developed to protect information of the user. As a solution, a hybrid cloud model can be implemented where private and public cloud storage will precisely be distinguished to keep confidential information safe and encrypted and cannot be accessed without the permission of the user. Sensors can pass real-time data to the cloud for archival storage and database communication from the user body and environment values. The medical server can keep a surveillance log over the data time to time. They can retrieve processed data and check the patients' condition by a team of diagnosis or pathologist. If the feedback report needs doctors' consultation, the report is directly forwarded to the consultation doctor. The doctor will verify the feedback report and give bookmarks if necessary. They can send e-prescription, online video consultation alongside the final feedback report to the user over the internet as well. If any emergency situation arises, IoT devices can send alarm notification over the internet to the medical server, for example, they need an urgent consultation or ambulance service for the patient. To save response time and valuable bandwidth, the system will be auto sensible if there is no continuous data transmission needed. The system will go in hibernation in such cases so that data won't be wasted over high data rate speed unnecessarily. The system will be auto alarming and send immediate notifications if any emergency situation arises. We expect this model to give a satisfactory and remarkable result close to the desired output with higher accuracy and smoother performance. Cryptographic algorithms will give efficient service in case of data privacy and confidentiality.

Hence, this model introduces a new dimension to the healthcare system. It enhances the facilities user can get from the health services. It reduces the possibilities of patients' deaths because of not being capable of reaching hospitals in time. Also, it helps to take care of the pregnant women so that they can have a safe delivery with a healthy infant. With the help of AI-based communication network, high reliability, high data rate, and scalability, a smooth system can be designed and maintained. So forth, the need and dependency to the fragile human resource support in the healthcare system can be reduced with a minimum amount of cost.

6 Discussion

In this chapter, the proposed model prioritizes a specific cluster of patients which includes rural and remote area-based patients, pregnant women, patients with critical issues such as cancer and dialysis, and lifestyle diseases such as blood pressure, diabetic, and asthma. A hypothetical study over the expected result is done in this section.

In the results of patients group, the utilities that are statistics of male, female, and children will be clarified. Some important statistical representation is necessary while clustering the patients' data. Some inputs parameters needed to be taken in consideration are as follows:

- Data sharing
- Non-data sharing

- Diagnosis
- Treatments
- Task scopes
- Prescription and drug dose

Evaluation matrices can be classified by various data analysis and verification platforms. After collecting sufficient amount of data from the targeted patients, data analytics can be performed to extract hidden information such as how critical the condition of the patient is or what requirements and necessary steps they desire for that particular moment. These data will be sensed and collected by the sensor devices that might be integrated in the smart phones or remain independently. Afterward, these data will be sent over cloud platform for archival storage following the standard network protocol of 6G technology. The cloud platform will be hierarchical to maintain data privacy and have auto update feature for processing data in an efficient way. Data can travel within the range of terahertz frequency bandwidth which will have minimum distortion and reach the destination faster. This will be a compatible application than Bluetooth or Wi-Fi in local area network (LAN). The data will be received in medical server, and they can analysis the data for further requirements by a group of expertise. If any doctors' consultation is necessary, there will be a viable communication to the corresponding doctor before sending the feedback report to the user node back.

In [29], the authors discuss a systematic review on the implementation of augmented reality (AR) and virtual reality (VR) in spinal navigation where clinical results have shown considerable accuracy. This paper also proposes an effective scheme of how AR-VR-based healthcare technology for spinal surgical operations helps to get an economic feasibility for the stakeholders and the users. The estimated reduction of reoperation procedure by accepting AR-VR imaging technology is $2.74 billion in total on an annual basis of US market. This can reduce the hospital stay cost of patients up to $8.945 in 2025.

In [15], they have considered several attributes as provider profession, task scope, data sharing, experts support, and measured the sub-levels between patient and non-patient group by conjoint analysis procedure to detect lifestyle disease management. Some of the statistics are insignificant, whereas some are statistically significant. For example, relative importance of task scope (9.02) and data sharing (10.39) for patient group and task scope (5.08) and data sharing (12.00) for the non-patient group. Nevertheless, both groups have shown least utilities in medical data sharing to the public healthcare. They have shown the results systematically with different parameters and coefficients precisely.

We have estimated that by 2020–2030, the market demand of IoT-based healthcare system will accelerate up to 20%. Already the healthcare system is getting popular in North America and Europe. Other countries such as Malaysia are focusing more on developing smart hospitals that would be much more cost-effective and optimal in the near future. We anticipate if 6G technology can be merged successfully in the deployment of this model, then it can superimpose the highest

reachability in the remote area with 89–92% accuracy and drop of extravagant costs in healthcare maintenance up to 34%. 6G is a great medium for telemedicine technology though this technology adoption has been slower for the past years, but after the Covid-19 pandemic, it has thrown a rejuvenated reason to think again about utilizing it. If this model gets market acceptance by both the stakeholders and service providers, it can offer more sub-technologies by 2027.

Moreover, managed service segments will have higher demand on IoT and 6G technology in the healthcare sector within the forecast timeline. The improvised operational efficiency will definitely influence the market growth by service, platform, and region.

7 Research Challenges

7.1 Providing Service

As medical IoT healthcare model is a convergence of ICT and medical field, it will involve stakeholders from both sides. So a critical question arises that who will lead as a key player in the field of technological healthcare service. It is necessary to maintain a professional discipline as a service provider to gain trustworthiness and acceptance capability of the user in this field [15]. The aim of developing a model using IoT and 6G technology is to reduce human intervention. To develop a business strategy over this type of system also needs a sincere and responsible patronization and investment. As the two fields relates to the model, they need to be explored for further collaboration. An efficient administration, public demand, a strict government regulation is also some major prerequisites to develop such projects in reality.

7.2 Device Management

Devices used in IoT are sensors that sense, collect, and transmit data over the internet. Usually, these devices consume low power and are less costly. They can be independent devices with microcontroller chips, monitoring screen, standard protocol stack, and wearable in body parts or they can be integrated into the smartphone of the user. In both cases, the features of these devices have to be user friendly and scalable. In real scenario, people living in the rural area, especially elderly person, aren't very familiar with the technological products and supports. They hardly can use any types of devices let alone IoT medical devices. Therefore, it throws a major challenge in this issue to increase the acceptability response rate from the user for developing this model in reality. Encouraging the community to rely on the system, usefulness of the technological support in the healthcare, and provision of the

process are also some necessary steps regarding this context. Expert support to enhance the usability of the devices is a major task. Expert support can be supplied from valuable resources including IT expert and rural area volunteers as well. Range of medical data sharing is a fundamental requirement of knowledge that should be acquired. They need to know the limit of information they can share to the medical server; concurrently the service providing team shall keep complete integrity in the context of receiving information from the user. Medical data carry enormous amount of personal data of the user. The big data analytics require vast range of openness and accessibility from different sources. Management of this huge amount of data and keeping consistency and security intact is a crucial task. Otherwise, the unawareness may lead to fatal damage to the whole system infrastructure.

7.3 Security and Threats

IoT-based systems are designed by combining various types of objects, components protocols, and network services. Objects in IoT can communicate with each other, make decisions in some cases, and compute data if necessary. By this procedure, a smart city, smart industrial automation and management, smart home, and healthcare system can be developed. This improvement needs lots of things to come together to collaborate and share common platform [16]. Cloud platform for IoT model is a necessary stage where all the computation, data storing, data accessibility, availability, robust applications, and data mining are performed [17]. Confidential data of the patients are collected by smart phones or sensor devices than cycles back with feedback to the user node through the same devices. During passing these feedbacks sensitive data can get leaked to unauthorized third parties. This scenario can get more vulnerable when the information carries the location of that particular patient, behavior, habits, personal details, and so on. Sometimes cloud suffers from vulnerability management dilemma because some of the smart phones suffer from code injection attacks while sharing and accessing information. In code injection attacks, the unauthorized user can control the device and memory from remote location and create malicious activities [19]. However, cryptographic deployment is very crucial for this system also keeping some security checking goals in mind, such as:

- Compact confidentiality
- Privacy and Availability
- Integrity from each node
- Ensuring efficiency during transmission
- Fault tolerance ratio
- Keeping resources robust in a distributed system
- Avoiding deadlocks
- Continuous monitoring of malicious activities
- Identifying security loopholes

- Security shield for the encrypted data
- Authentication of the user

Though cloud has given so many overwhelming benefits to the humankind and eased our daily life activities, still it can cause some vulnerability while performing huge data management and analytical tasks. Health cloud is a sensitive platform. The services it makes need to be specified and sincere. The transmission delay, data packet loss, malicious activities should be monitored continuously. Data packets which are lost should be identified by the service management teams. The network demands more security while flaws like packet loss should be lessened [18].

7.4 IoT Limitations

In healthcare hierarchy, IoT system suffers from severe types of attacks. Some attacks can directly hamper the whole system. For example, at the "physical layer" state, all of the data are collected by sensor nodes [12]. Malicious attacks can be made by "node prediction" attacks. Third party can identify nodes in a remote location and crush that particular node to affect the whole hierarchy. Onward, they can create a clone of that node to retrieve sensitive information such as encryption keys, cryptographic algorithm, etc. and use them later in a harmful way. As IoT devices are low powered devices and not much AI driven, they won't be self-sufficient to damage this type of attacks. As mentioned earlier, code injection attacks do similar activities as such. If the attacker succeeds to deploy malicious virus to the node, they can control the devices as well as the process of the system. They can drain battery, create storage leakage and information distortion, and send them to the unauthorized destination for further fatal damage and malicious use. In "network layer" while the transmission of the information is occurring, they can get interfered by several attacks. For example, "Denial-of-Service" attacks where lots of network traffics are sent to the victim nodes which results in transmission delay and lengthy response time. These attacks can cause the system quality degradation, user dissatisfaction, unreliable acceptance, loss of important data packets, storage consumption, power loss, and other massive damages. In the "application layer" on the IoT system, other vulnerabilities may occur such as password stealing, login failure, etc. Thus, a standardize IoT system model for any of the application fields are yet to be developed. For an improved provision to avoid deadlocks of the resources, the system needs to be independent so that while any of the nodes faces any attacks, failure, or damages, other part of the system may run with any affects or influences from that particular damaged node.

7.5 Challenges of 6G Technology

From the professionals' point of view from both medical and ICT fields, 6G can change the future vision of healthcare technology. It enables new windows of communication strategies, multidisciplinary visions, research aspects, and challenges. 6G technology is an AI-driven communication network which integrated many other technological features [4]. But some obstacles may have to be faced while having services from 6G technology:

(i) Providing quality of services (QoS): 6G-enabled network ensures terahertz communication operation, high data rate of 1 Tbps, high reliability, availability, high mobility, and accessibility. Thus it gives provisions of all possible QoS parameters such as: extremely reliable and low latency communication (ERLLC), enhanced mobile broadband (EMBB), long distance and high mobility communication (LDHMC) [20]. In terahertz communication, spectrum reuse techniques need to be addressed to cut of the extra expenses and cost saving. Cognitive radio (CR) spectrum reuse techniques have already been introduced to some field where wireless devices can share same spectrum at a time with some interfacing protocols without getting disrupted by others [4]. However, designing an antenna with such spectrum and terahertz frequency communication is very challenging and difficult. Situation may arise like signal gets attenuated at zero and molecular absorption may occur time to time [34]. This can bring extra hassle to the system and can get cost expensive for designing, deployment, and maintenance. QoS may enhance the quality of life (QoL) of the patients, but QoS is not a direct key functionality of 6G technology. Trade-off between the low-cost feature with high quality service might get difficult while deployment.

(ii) Artificial intelligence in 6G: 6G technology provides AI-driven features to boost up the healthcare industry. Algorithms like deep learning (DL), convolutional neural network (CNN), deep reinforcement learning (DRL) can be used as AI-driven 6G technology so that devices can be self-sufficient, self-driven, and can make decision by their own valuable values and analytical capabilities. AI also provides high accuracy and performance to the health data so that it can get precise results from the computation. Intrusive properties of AI also reduce human intervention. Nonetheless, AI algorithms take account of high computational tasks which can be time consuming and difficult at some point. High computation takes longer times and consumes massive amount of power. 6G is not capable to bring relaxation or solutions to such cases yet. Additionally, depending on AI completely for a sensitive field like healthcare would be an unwise and unrealistic step to take without the help of any human expertise at all.

(iii) Contrast with IoT devices: IoT devices are less expensive and do not consume a huge amount of power. They can be independent devices or integrated as a software system in a smart phone. Challenges arise when they are blended with the implementation of the 6G technology. IoT devices are less power consum-

ing and capable of small area network transmission whereas 6G is a powerful communication network with large frequency bandwidth. Thus, it throws a huge challenge regarding the compatibility and interoperability of these two technologies working together to have a successful desired output. Moreover, transferring data through a huge range of terahertz frequency bandwidth may cause human body difficulties is also a matter of discussion.

8 Conclusion and Future Scopes

This chapter proposes a model of healthcare monitoring system based on IoT and 6G technology. Most of its features ameliorate the hassle patients go through from the medical health support in physical architecture. Our system with modern technological support IoT-based devices, and stronger communication strategy feature of 6G can give a better expected result in the deployment. In this model, both the advantages of IoT and 6G have been utilized. Also, auto-updated Cloud platform is integrated in this model to have a robust application and user acceptance. To handle a huge amount of big data passing through the user node, the medical server needs maintenance. It can be handled by automated cloud platform. Also to secure the system with highest privacy, several security parameters have also been addressed. Majority of the research study regarding healthcare has implied IoT or 6G separately. This chapter incorporates basic features of both IoT and 6G technology to build an integrated model of improved healthcare.

The most significant strength of this model is that it aims to develop a collaborative healthcare support system to the people in remote area and deprived to get a proper healthcare support. There is room for improvements in this system model and lots of scopes to work on future as this has not been deployed yet. Sensitive and important parameters need to be taken in consideration while developing such systems. In near future, 6G will dominate the health market and promises to enable a suitable framework with utmost facilities. It is hoped that 6G will provide a deeper and stronger navigation and satellite network. Internet of Things (IoT) will be changed to Internet of Everything (IoE). IoE is the intelligent connection of people, process, data, and things. The Internet of Everything (IoE) describes a world where billions of objects have sensors to detect measure and assess their status; all connected over public or private networks using standard and proprietary protocols [22]. Smart devices will be transformed to intelligent devices with self-computation and navigation facilities. Edge intelligence will give birth to a new revolution to the health market which can enable virtual heath service, mobile hospital, emergency doctor consultation, enhanced telemedicine facilities, improved quality of life, and an integrated system where patients will not be deprived of getting necessary treatments. In near future, blockchain can provide better support to the security system management of healthcare. Blockchain is the newest technology that has been started to imply in most sectors and is hoped that it will also contribute to healthcare for more scalable and secured data management. Efficient and effective

implementation of 6G technology can also add more features to the patient monitoring system. As it is very suitable to process big data analytics, it can provide a suitable framework handling pandemic and epidemic crisis in near future. With real-time simulation and navigation, patients from remote area can be monitored easily with the help of smooth 6G communication technology. As a result, the spreading of any virus and their motion can be easily monitored and controlled within the systems regulations.

IoT has many applications in several fields, and it is also contributing successfully to healthcare market mostly in the developed countries. But the features of 6G technology need more familiarization in this field, and it has yet to be implemented. This chapter reviewed some related articles about IoT-based healthcare architecture as well as the studies have done based on 6 g technology. It also describes briefly how 6G technology can enhance the health market within the next few years. The basic requirements of 6G technology, its functionalities, and properties are also discussed. 6G will play a key role in healthcare with its promising features and higher accuracy level. From the perspective of society, the foreseeable implementations of 6G and IoT are multiple. Indeed, they will introduce personalized healthcare support system in next decade. This will make the whole medical infrastructure more flexible and resources will not go at waste. The dynamic adaption of healthcare policy will bring evolution worldwide. The rationalized health costs will be introduced so that improper distribution of hospital services can cut off. This chapter also presents the key role of IoT in healthcare sector, fundamental architecture of it, and the functions it plays. This proposed model can ease the obstacle of patients they get while having treatments for critical diseases and enable a home hospital service. It will reduce the human intervention and facilitate to have communication faster virtually. Patients can communicate to the medical server for any kind of help with fastest replies. With the help of this model, dependency over human resources would be reduced and remote patients can get an improved support from the medical team. It will reduce the barriers of geographical distance. With the help of 6G technology, a wireless healthcare communication system can be introduced to the mankind. This chapter discusses about major challenges while establish such model. However, these challenges will be overcome with further improvements to the system. This intensive research leaves room for further study in this field to make this system developed and usable to the humankind. Despite having facilities, this system incurs some weaknesses too such as high deployment cost, acceptability among stakeholders and service providers, and lack of awareness. It has room for improvements, and further research can be done in this field as well. Although it needs to overcome few challenges, collaborating two technologies together, it requires assistance from each node: administration both from the medical-ICT field and the users to emerge a new dimension of innovation in the healthcare industry.

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