Developing Healthcare using Internet of Things (IoT): A Survey of Applications, Challenges and Future Directions

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Abstract. The importance of each person's healthcare should be viewed as fundamental in the modern world due to the rise in various health issues. A decrease in the proportion of doctors is caused by an increase in the number of cases. The diagnosis is consequently delayed, or some patients are overlooked. As a result, people become more reliant on doctors for checkups. In order to retain each patient's digital identification, in light of all these worries, health and medical care systems have begun to connect and interact with the internet of things (IoT). Many health disorders in the healthcare system go undiagnosed resulting from a shortage of doctors and other medical experts, as well as a lack of access to healthcare services. These IoT-based healthcare options, on the other hand, have made it possible for patients and medical professionals to continuously track and analyze patient data. In this study, IoT for healthcare systems is discussed. These included applications, structures, and potential design snags and issues. It has been demonstrated that these systems could be very beneficial to people, especially during the (Covid-19) pandemic's global isolation and the growing challenges in treating patients intelligently. This paper also presents a survey study on the use of IoT in smart healthcare, its applicability, the future directions for its development, and a review of past researchers' applications.

1 Introduction

IoT [1] is a concept in computing that envisions a time when actual objects will be connected to enhanced cellular networks and the Internet, be able to self-identify, and be able to interface with other devices both locally and remotely. As a result, IoT illustrates the idea for tying together a group of elements for any service and any network, anytime, anywhere, and at any time with the provision of excellent smart services in all spheres of life, particularly in smart healthcare. To connect billions of smart elements, tablets, wearable technology, smartphones, and cloud health apps via a variety of communication channels like Bluetooth, Radio Frequency Identification (RFID) and Wireless Sensor Network (WSN), IoT revolution will be crucial. The Since the Internet is now accessible to almost everyone, which is a historical first. As a result, the rapid progress in internet technology and artificial intelligence, there was an effective need for IoT as a new, advanced technology [2][3]. In addition to serving as networks for communication and information transfer, The Internet and cellular networks have evolved into a network of all kinds of gadgets, including toys, cellphones, and medical equipment, industrial systems, people, and animals, all of which are capable of communication and sharing. Cars and home appliances are also now all connected to these networks, which use protocol-based structures for smart reorganizations and electronic upgrades. The concept of things in general, and specifically ordinary objects that are recognizable, understood, defined, managed via the Internet, addressed via information sensing devices, and/or independent of communication channels, are known to as the IoT [3].

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IoT refers to smart things and gadgets that can connect to the network internet via physical devices, microcontrollers, sensors, and networking systems that allow data sharing and data collection [4]. The way people and medical professionals interact and work together daily in the healthcare sector is undergoing a paradigm shift. Nowadays, information technology is used in healthcare to develop creative solutions that improve health diagnostic and treatment accuracy and efficacy. Services are provided by intelligent health surveillance frameworks and automated medical diagnosis systems in a range of contexts and circumstances, including hospitals, workplaces, and homes, as well as transportation assistance, in order to significantly reduce the cost of doctor visits and improve overall patient care quality [5]. The use of IoT in the healthcare field is expected to reduce costs, enhance living standards, and enrich health data collected for use in health research. IoT for healthcare systems is discussed in this study. This covers potential uses and difficulties encountered when creating such systems. The remainder of the essay is arranged as follows: Section 2 describes the IoT in healthcare. Related work is given in section 3. Architectures and technologies required for IoT based healthcare systems are explained in sections 4 and 5, respectively. Advantages and disadvantages of using Healthcare systems are given in sections 6 and 7, respectively. Applications using Healthcare systems based on IoT are illustrated in section 8. Possible challenges and design issues for designing these systems are in section 9. Section 10 contains future directions. Section 11 recent survey in healthcare. IoT & Covid 19 in section 12. Conclusion is in section 13.

2 IOT IN HEALTHCARE

Smart gadgets known as the "IoT" enable computer and machine-to-machine connection as well as human engagement. They are called "smart" in large part because of the integrated sensors that accurately collect data for future analysis and action. By integrating sensors and actuators for patient monitoring and medication tracking, smart healthcare plays a vital part in the applications of healthcare. As more individuals use wearable or embedded microdevices for health monitoring, the amount of data created will increase logarithmically, eventually connecting every facet of an individual's existence.

Improvements in healthcare systems have created enormous prospects for smart technology and smart healthcare implementation. Many sensors have been developed, particularly in the health and medical fields, to check many types of vital signs, including oxygen levels, temperature, body pressure levels and heartbeat rate. Many IoT-related concerns in healthcare were studied [6]. The IoT was a topic that researchers explored in many different fields. For instance, the IoT is predicted to have about 500 billion or more from additional things by 2030, which is almost 60 times the amount of people on earth [7].

All things are remotely connected via the IoT for data exchange and control. The gateway collects physical health data provided by the sensor, such as blood pressure, ECG, EEG, and body temperature, among other things [8]. Several sensors can be used with various technologies on a gateway. This data is analyzed, compiled, and sent to connected hospitals or healthcare providers through the internet for further action. The IoT-based monitor application in healthcare is shown in Figure 1.

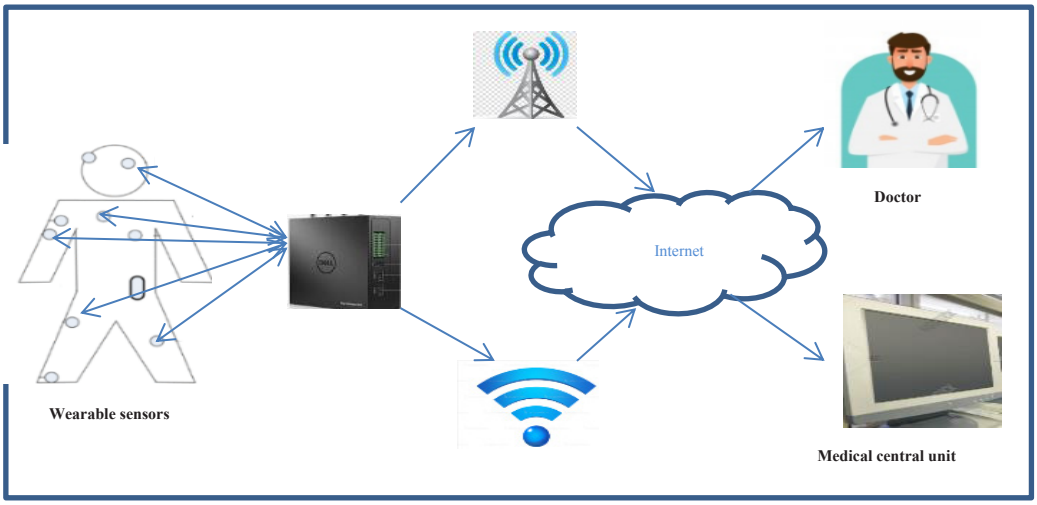

Fig. 1. Monitoring Application Scenario

Over the past several years, some research projects have proposed smart health monitoring systems based on IoT. As indicated in Table 1, this study summarizes a wide range of research articles to show the advancements in IoT-based healthcare systems.

Table 1. Overview of IoT in healthcare.

Ref.	Aim	Intelligent Sensor	Method
Villarrubia et.al [9]	Mechanism for monitoring and following patients with health issues	ECG sensor and Measure accelerometer	patient monitoring at home with an accelerometer and wi-fi
Babu et al. [10]	clinical care and collecting and analyzing the persons' data and sending it to the medical center to take the appropriate action by doctor	Motion sensor and ECG sensor	Developments in RFID, communication technologies, and Internet protocols
Amandeep Kaur et al. [11]	Monitoring of body temperature and heartbeat rate	Sensors for temperature and heartbeat rate	Bluemix technology is used for remote data collection through the cloud
pham et al. [12]	Monitoring speech and motion signals at home	OpTitrack camera, breath sensor, infrared, and ECG sensor	A local gateway sends a wearable sensor signal for activity detection and pre-processing
Dhanvijay et al. [13]	Provide home health and monitoring for the provision of healthcare	Wireless Body Area Network (WBAN)	Potential healthcare solutions based on IOT
Choi et al. [14]	Presenting an example of conduct for senior citizens using the healthcare system	smart home, smart phone, smart watch, heart rate, blood pressure	Smart application and gadgets connected to a residential place using smart home technologies
Raykar et al. [15]	An application that helps provide early medical assistance to the patient and enhance the knowledge of health conditions for patients	Smart phone	Health app designed for Android A technology called Enabled Remote Terminal (ALERT) collects the data and sends it to the cloud

3 Related Work Survey

This section covers studies on healthcare systems utilizing various systems.
By reducing extraneous hardware and sending data via a web interface, authors of [16] presented a remote mobile health monitoring system delivers patient health measurements. In three stages, it simplifies end-to-end screen monitoring.

Wearable sensors calculate real-time safety parameters, which are then transferred to a smartphone, which displays the patient's health condition in a graphical interface.

The program offers family members and doctor data for further tracking via a web interface.

A warning is sent in real-time warning if the patient is in a condition of emergency such as heart attack etc. [16].

In [17], IoT eliminates uncertainty and uncertainties in the healthcare system even with smart apps. The expansion of mobile technology and smart gadgets in the healthcare system has a significant impact on the globe. People in today's world are becoming more conscious of the full-fledged usage of M-health and E-health apps in order to improve and preserve high quality of life. Aside from routinely monitoring patients' symptoms using the M-health application, the main goal is to educate them on good eating habits and effective exercise routines in order to enhance their overall quality of life.

In [18], despite surveillance, extensive use of wearable tracking systems poses quite a few challenges. First, wearable monitoring systems are used every day primarily on the basis of small scale, rough usage and low energy consumption. Second, the major problem with other instruments is the precision, validity, and credibility of

measurement data. Third, The accessibility and user engagement with application and its friendly auxiliary applications play a critical role in the daily and long-term use of wearable monitoring devices.

In [19], Bluetooth activated computer often used for monitoring of patients at home. A Bluetooth-enabled in-home patient monitoring gadget was created to help diagnose Alzheimer's disease. An access point is placed in each room of the patient's home, where the monitoring system is activated through Bluetooth and connected to a local database. The monitoring equipment selects the access point with the strongest signal when the patient moves from one room to the next. After the connection is made, Bluetooth communication is used to track the patient's movement and current location, saving it in a local database. The hospital decision engine receives the acquired location data and timestamps.

In [20], eliminate the need for a computer The WSN was set up at home. These nodes are subsequently connected through the internet to the hospital server. The sensors used here were only for collecting ECG signals. Initially, the ECG signals were recorded and delivered to the patient's home access point. These signals were then transmitted to the hospital through the internet and examined in order to identify heart issues.

In [21], introduce a new Wearable Mobile Monitoring System (WMMS). This model was built based on an approach to smartphones. This device is conveniently wearable on the belt of the patient, tracking the movement of the patient and taking photos of any change in condition. Those photos were used for research.

In [22] a comprehensive survey of the latest literature in the field of the IoT, artificial intelligence (AI) in healthcare was conducted. Therefore, important artificial intelligence and IoT technologies were highlighted, with special emphasis on the methods used to maintain data privacy. Table 2 shows a survey about the advantages and disadvantages of techniques that are used in modern important papers based on the IoT.

Table 2. Methods utilized in these surveys have both advantages and disadvantages.

Ref.	Advantages	Disadvantages
Yunzhou et al. [16]	Wi-fi fingerprints are used to identify patients in indoor environments during emergency situations.	Data cannot always be reliable due to Wi-fi-signal interference with the environment.
Jorge et al. [17]	Context Model by OWL and SWRL, Contextual guidelines such as daily workouts and healthful dietary habits in addition to regular monitoring	Recommendations for every treatment are so generic and not personalized.
Matevž et al. [18]	Wearable, Compact, and user-friendly monitoring tools	Imprecise data due to incorrect placement of the instruments
H. T. Cheng et al. [19]	This system is made up of two parts: patient monitoring and telediagnosis at home, and it makes use of the Bluetooth connection technology.	Not appropriate when the patient travels outside the AP coverage area and loses protection
Reza et al. [20]	The new patient monitoring system does away with the computer by using a variety of ECG sensors. WSN	No monitoring of the outdoor climate, and no protection.
Gaëtanne Haché et al. [21]	Introduces a new WMMS to track mobility. When a state changes it takes photos. Usage of Condition Detection Algorithm	The change-of-state algorithm needs enhancement. Its performance is poor

4 IOT ARCHITECTURE IN HEALTHCARE

The growing number of architectures available did not converge into a reference model. The basic model is a 3-layer architecture made up of application, network, and layers of perception that applies to all the models that are currently accessible. IOT architecture in healthcare is shown in Figure 2.

The Perception Layer: That is the actual stratum. This layer focuses on information collecting and item identification. This consisted of physical objects and detection apparatuses. The layer of sensors comprises terminals and sensor networks. There are several sensor kinds that may be used for a variety of purposes. Moreover, a variety of measurements may be made utilizing sensors, including those that monitor movement, direction, voltage, temperature, humidity, air quality, wind, vibration, and other variables. The information obtained is forwarded for transmission to the network layer[1] [3].

The Network Layer : This layer's main function is to move data collected from the Perception Layer to the application layer [1][23]. It has the responsibility of linking to other smart objects, network devices and servers. The network layer will also include data from existing IT infrastructures (e.g. highway systems, business networks, healthcare systems, power systems, energy systems, etc.).

Application layer: The framework layer's chief duty is to figure out the operation. This layer is an IoT connecting system, a platform for achieving a large smart application that offers numerous solutions. The fundamental issue for the application layer is the interchange of society's information while still assuring information security. Moreover, the application Layer is in charge of providing user-specific services to applications. Many forms are described here, including those related to transportation, housing, cities, lifestyles, markets, agriculture, farms, supply chains, emergencies, healthcare, user interaction, culture and tourism, environment, and energy.

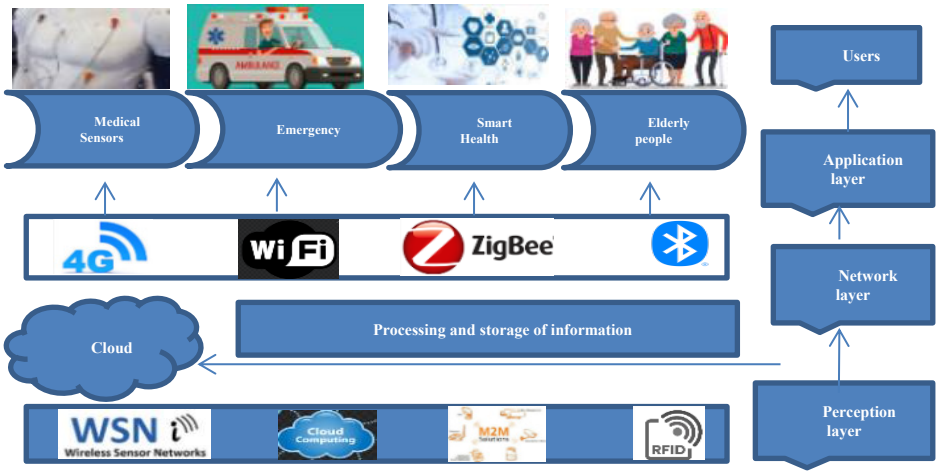

Fig. 2. IoT Healthcare Architecture[1]

5 Iot Technologies

In this section, the important technologies of the IoT are explained.

- Radio Frequency Identification (RFID): It is an automated, contactless technology that offers the tagged items a wireless data transfer communication interface in order to gather pertinent information [1]. RFID systems consist of a scanner, antenna and RFID tag, radio wave communication, and three tag types (passive tag, semi-passive tag and active tag) are also available. In the IoT scenario, RFID systems with one or more readers and many tags play a significant role. These technologies enable the automatic identification of the objects to which they are connected to, the process of assigning separate digital identities to objects, integrating them into networks, and connecting them to digital information and services [21][24]. A recent example of the use of RFID in healthcare is monitoring system for covid 19 patients[25].
- Near Field Communication (NFC): The settings are identical to RFID's. Customer-oriented NFC can be made by cell phones using the RFID reader. Moreover, It is a type of radio communication that connects NFC-enabled mobile devices within range of another phone. Its technology will play a significant part in the potential growth of IoT. It will provide the requisite tool for wireless communication with other intelligent objects [1].
- Machine-to-Machine Communication (M2M): It is the exchange of data between intelligent sensors, actuators, computers, mobile devices, and embedded processors. This type of engagement is becoming more common these days. The components of M2M communication include diverse access, sensing, information processing,

applications, and processing [1]. It has several applications, such as smart home technology, smart robotics, healthcare, cyber transport systems (CTS), smart grids and production systems[26].

- Wireless Sensor Networks (WSN): It is a network of small embedded devices known as sensors that communicate wirelessly in an ad hoc method and are used to sense or monitor physical and environmental factors such as pressure, temperature, position, and movement [1]. WSN may give a variety of relevant data and are utilized in a variety of industries including defense, seismic sensing, hazardous environment exploration, education, government, and environmental services [2].
- Big Data Collection (BD): It is a new term for the massive volumes of data that have been collected or as a result of technological developments in a variety of domains, such as the expansion of social media, wireless communication technologies, and cloud computing. For the purpose of producing data, it is characterized by volume (data size), velocity (temporal frequency), and diversity (source-based data kinds); every minute, day, month, or decade [1]. Accurate data collection is to reduce the time and obtain an accurate result to administer medical procedures quickly.

6 ADVANTAGES OF IOT IN HEALTHCARE

The main advantages of the IoT in healthcare are discussed in this section.

- Decreased costs: The ability of linked medical equipment to follow patients in real time is one of the biggest benefits of IoT for healthcare. This results in fewer unnecessary doctor visits. Related home care services can also help minimize stays and readmissions at hospitals.
- Reduced errors: Internet of things allows automated workflows and reduced duplication, accurate data collection, but above all eliminates the risk of error [27].
- Improved disease management: Patients are constantly tracked with real-time data from the healthcare providers. This means they can detect any disease before it spreads and gets serious [27].
- Better patient experience: Patients become more interested in their diagnosis across the Internet of Things, a linked healthcare network. Dedicated protocols, improved treatment choices and improved accuracy of diagnosis allow for a better patient experience [27].
- Homecare: M2M enables monitoring of patients in the privacy of their own homes. A patient's bedside is equipped with a number of medical devices with sensors (e.g. heart rate monitors). The hospital receives the collected data and sends it to a skilled staff member who examines it for any problems [27].

7 DISADVANTAGES OF IOT IN HEALTHCARE

The most significant disadvantages of IoT in healthcare are described in this section.

- Privacy Of Patients: Privacy was also a big problem. There will need to be a lot of commitment to data protection, which needs considerable additional spending. Unfortunately, this data is compromised by applications and access to the IoT network of healthcare [28].
- Accidental Failures: A small error in a patient safety management program based on IoT can lead to severe consequences. There is no technology which can prevent failure entirely. Therefore, considering every detail in the production of software and in the manufacture of hardware is important [28].
- Lack of encryption: Another method of security is the customization of the encryption system. Not every device has great encryption, sadly, not every person can get access to it. To encrypt all patient- doctor data is beastly [28].

8 IOT APPLICATIONS FOR HEALTHCARE

In this section, healthcare applications are classified, and this criterion is divided into two phases.

8.1 Types of Healthcare Applications

IoT encourages and supports a variety of healthcare delivery options. The following categories can be used to categorize these systems [29]:

- Clinical applications include fitness apps and other programs that assist the aged.

- Remote monitoring applications specialized to chronic illness monitoring, newborn care, infectious diseases and the elderly.
- Medical applications such as medical emergency applications, real-time monitoring, and early diagnosis are used to monitor patients' compliance with treatment programs at home [13]. Help for chronic illnesses, early diagnosis, real-time monitoring, and medical crises.

8.2 IoT-based Healthcare Applications

The IoT Healthcare Systems may be used for the following purposes:

- Glucose Level Sensing: Due to the rising number of diabetic people, diabetes is one of the biggest issues and also one of the most common diseases. Diabetes is a category of metabolic diseases marked by persistently high glucose (sugar) levels. Monitoring of the glucose level can produce reliable results of the glucose level and it is a process in real time [27][30].
- ECG: The electrocardiogram is used to track heart electrocardiogram operation. ECG contains many measures such as: regular heart rate, basic heart rhythm, myocardial ischemia, etc. The ECG contains full knowledge about the heart muscle in the fetus. ECG control consists of a transmitter and a wireless receiver[1][30].
- EEG: Electroencephalography is the method used to graphically quantify and monitor electrical activity of the scalp and neurons. It is a medical apparatus for creating contemporary brain-machine interfaces (BMI) and brain-computer interfaces (BCI) [30].
- Blood Pressure Monitoring: Mostly, blood pressure readings are monitored with it. IoT-based blood pressure (BP) monitoring system includes KIT's activated BP sensor and mobile phone [29].
- Oxygen Saturation Monitoring: To continuously monitor blood oxygen saturation, pulse oximetry is acceptable. Pulse oximetry integration is beneficial for usage in technology-driven medical healthcare [29]. The IoT dependent oxygen saturation is intended for various methods of wearable pulse oximetry [27]. This gadget transmits sensor data and has connection based on the Bluetooth system health profile. Low-power, inexpensive sensors are improved by IoT for remote patient monitoring. This allows the oxygen saturation testing to be precise.

9 Challenges For Iot In Healthcare

When any application for IoT based Healthcare systems is designed, the following challenges need to be considered:

9.1 Security and Privacy

With IoT-based healthcare, the primary unresolved issues are security and privacy. To monitor access to patient requests and sensitive information, it is also important to encrypt data while sharing data from one computer to another because threat of cyberattack [6][29]. Here are a few IoT healthcare security and privacy concerns that are covered.

- Devices that are connected: Because healthcare relies on larger records of privet data, this data is considered important and crucial, as patients share it with IoT networks and thus these devices are vulnerable and a main target for external attacks[31].
- Not educating the users: Most dangers and destructive activity in the healthcare system are caused by employees and users' failure to protect their data from strangers. It is practically hard to distinguish between employees with good intentions and outsiders without the use of extremely accurate analysis tools [31].
- Cloud computing: Where data is kept for analysis[32], if don't protect Information related to the patient's health be vulnerable to attack and easily accessible by all parties.

9.2 Integration

Another daunting challenge for effective IoT implementation in healthcare is the incorporation of multiple protocols and devices within the network. When several people can interact effectively with one another and numerous devices are interconnected, a problem arises. Ensuring that all smartphone makers adhere to all communication standards and procedures The network is home to several mobile devices that routinely gather data. Moreover, a variety of connection protocols make the information aggregation process more difficult.

9.3 Device Designing issue

IoT devices used in healthcare are tiny sensors with insufficient CPU power, storage capacity, and battery life. Internet of things apps also have a phone and internet connection. Connecting the wearable devices to the different networks to provide caregivers with health information. Improving an internet of things system with high battery life, increased storage space, increased processing power and protection of usability complaints is still a research challenge [29].

9.4 Reliability

Health systems relying on the IoT may experience systemic malfunctions and software problems, as most surveys of IoT systems rely on the assumption that there is a low level of problems. However, because the IoT devices and sensors are spread geographically and are rarely safeguarded, this system becomes more susceptible to external threats like power outages or environmental risks. Furthermore, in a big IoT system, the likelihood of an error occurring increases with the number of active nodes, potentially leading to system malfunctions. Some data is precious and shouldn't be lost because of system malfunctions. Still, not many research works have focused on mistake rates in IoT contexts. To create a daisy chain in the event of fault tolerance enduring at the category level, Min-woo and collaborators have devised a viable enduring defect algorithm for the applicable IoT system[33]. The most recent gateway's backup copy can be kept safe and promptly places itself in the lead gateway of the daisy chain. enhance dependability even further while accommodating more connections. Increased data rates will be another feature of IoT in healthcare, allowing for speedier exchange of larger data types, such streaming video[22][34]. These advancements in the healthcare IoT space have obvious advantages because time-sensitive medical situations depend critically on high reliability and low latency[34].

10 Future Directions

The huge number of advanced internets of thing (IOT) technologies emboldens the researchers to access advanced applications with high speed and accuracy. New technologies, including, 5G and 6G networks, artificial intelligence (AI), telemedicine, and others, have a major role in the future of healthcare and have created a great chance to build integrated ecosystems for new healthcare prospects[35].

10.1 5G Network for IoT in Healthcare

Fifth-generation wireless networks (5G) have much lower latency (less than one millisecond (ms) compared to around 70 milliseconds on the 4G network) and faster data transfer speeds than existing networks because they use higher frequency millimeter waves (roughly 100-fold higher than the current 10 megabit per second on 4G) [36]. 5G technology parameters Nowadays, the most common mobile data transfer technologies are 4G/LTE or Wi-Fi. Although it is primarily intended for internet usage, The minimal signal delay for 4G/Long-Term Evolution (LTE) is (20 ms), which is significantly less than that necessary for real-time sensor data integration (such as browsing and video streaming).

5G networking enables lower latency, reduced reliance on network bandwidth and accessibility, and maybe improved security. From a technological sense, 5G communications technology holds out a lot of potential for greatly improving healthcare. However, a word of warning is necessary, when creating and implementing the new potential that the 5G ecosystem provides, notably for telemedicine, crucial biological and physiological fundamental science elements must be considered. In particular, the vast array of healthcare related IoT sensors and gadgets means that not all of 5G's potential are presently being used. It is also necessary to do specific research in the field of human interface technology (HIT) in order to improve human exploitation of new communication capabilities.

Additionally, using the communications spectrum to its full potential is challenging and restricted. Finally, 5G's enormous power paired with artificial intelligence (AI), and the ability to communicate data in order to collect and analyze big data (BD) can be beneficial in understanding the disease development process and increasing forecasting capacities. In light of everything said above, 5G has already been deployed in a few spots throughout the world [35]. Table 3 shows summary of surveys research on 5G Medical Applications and the Relevant Variables.

Table 3. Summary of research on 5G medical applications

Ref.	Country	Research method	Main clinical specialization/ Research or both	Conclusion	Comments
Jell et al. [37]	Germany	Education in Telesurgery and Surgery	Both clinical and fundamental studies are being conducted	95 to 106 MB/sec of 5G data are sent in 30 ms for 75% of the data. Telesurgery is possible with latency of 146–202 ms.	2 patients - 1 to 6 kilometers further clinical research is required
Ryan et al. [38]	USA	Preclinical studies	Transnational Cardiovascular Interventional Both	In ex-vivo simulations, transcontinental robotic percutaneous coronary intervention is possible with a 3500 mi delay of 162 ms.	With 5G, percutaneous coronary intervention is simple to execute.

Angelucci et al. [39]	Italy	Observational	Pneumonology Both	superior to conventional telemedicine platforms	Using a smartphone 5G app, you may monitor your chronic obstructive pulmonary disease from home.
Lacy et al. [40]	Spain	Clinical	only for clinical surgery	Telemedicine-assisted surgery using 5G is practical and safe.	It would be the best resource for impoverished areas and/or locations where there aren't enough skilled surgeons.
Zhen et al. [41]	China	Observational COVID-19. Research on the functioning of 5G multimodal telemedicine networks.	Different research in healthcare	The COVID-19 telemedicine system enhances the diagnosis of challenging situations and the management of severe/critical cases.	Moreover, 137 doctors provided telephone consultations or interventions to 1094 patients.
Zhou et al. [42]	China	Observational	COVID-19 cab hospital. common healthcare profile	The possibilities for 5G software wireless networks are better than those for traditional wired networks	A day or two to set up. network created by software

10.2 6G Network for IoT in Healthcare

Beyond 5G, the next generation of communications to sixth-generation wireless (6G) is nearing the end of its research and development (R&D) phase, with a huge increase in bandwidth and capabilities, allowing the deployment of applications that 5G cannot.

With the present overall total development of the life cycle of a technical product requiring 10-15 years from concept to commercialization, the 6G is likely to be available within that time range, if not somewhat sooner [35]. With the integration of additional modern technologies, automatic diagnosis can be created at the point of care (edge computing) and relayed to a waiting consulting physician or immediately to the electronic medical record, such as smart gadgets comprised on micro-electromechanical-systems (MEMS) sensors, artificial intelligence (AI), and computationally analytics on one chip. Another rapidly expanding area of 6G will be virtual reality (VR), in which computer graphics create a simulated presence and enable users to engage with the simulated elements in a manner that seems natural. The use of augmented reality (AR), which allows for the visual overlaying of computer-assisted information on a real-time display, can have significant effects on the healthcare industry [43]. Augmented reality (AR) has the potential to improve patient counseling and preoperative consent, as well as nonclinical duties in hospitals, such as navigation, particularly for patients who are blind or visually impaired. 6G will be used by both humans and robots, generating highly realistic mobile holograms and completely immersive extended reality (XR), which will be crucial in the field of healthcare. Yet, despite the fact that 6G networking will provide a ton of possibility for VR/AR or even XR, the clinical healthcare sector has yet to discover a viable use for the immersive experience of these parallel worlds [35][43]. From Table 4 shows the expansion of bandwidth, capacities, speed, and latency for current and Next networks, these are projections of the generational averages [35].

Table 4. Current and 6G telecommunications parameters [35]

Network	Year	Bandwidth	Speed	Response time
4G	Current	5 to 200 MHz	10 to 50 Mbps	50 to 60 ms
5G	2020–2030	1 to 23 GHz	10 to 200 Gbps	1 to 10 ms
6G	2030–2040	1 to 7 THz	1 to 7 Tbps	1to 10 ms

10.3 Artificial Intelligence (AI) for IoT in Healthcare

Artificial intelligence (AI) is a field of computer science that models human behavior, two AI subfields in the healthcare sector have gained attention [35]:

Machine Learning (ML) is the primary source for predictive analytics, particularly speech translation and clinical examinations, and refers to algorithms that learn naturally rather than through programming [44].
Deep Learning (DL) is the process of detect crucial "features" and "meaning" (such cause and effect) in data at various processing stages by using neural networks, replicating how the human brain accomplishes it [45][46].

The finest infrastructure in healthcare is DL, which enables automatic presumptive diagnosis of recognized [47] illnesses using a variety of imaging methods, including X-rays, CT, MRI, OCT, etc.[48][49]. Table 5 shows a summary of some of the research using AI in healthcare.

AI has not yet reached the stage where it autonomously can evaluate, treat patients and manage tasks without human input. There is now a clear distinction between autonomous and assistive AI, as all the methods that use AI in healthcare need human intervention to assess the condition of patient[35].

5G and 6G Networks control centers are supported by artificial intelligence, for the enhancement of the current smart healthcare, smart feeders, and smart sensors. Because the 6G for the IoT is vulnerable to cyber-attacks, modern healthcare technologies will be more reliable, secure, and flexible in performance and public order [50].

Table 5. Summary of some Research using IoT and AI in healthcare.

Ref.	Aim	Method	Comments
Priyadarshini et al.[51]	Classification and prediction of stress for heart rate diabetes monitoring	Deep learning is used to detect stress and forecast type 2 diabetes early signs	It needs more data and more tuning of neural models for different user-based studies.
Abdel-Basset et al.[52]	Monitoring and identification of type-2 diabetes	A hybrid deep learning algorithm for predicting type 2 diabetes.	By connecting everything and making it accessible through autonomous services, it can help to establish the next generation of IoT systems and services.
Mathur et al. [53]	Using hand orthoses, gait analysis for lower limb rehabilitation	MATLAB is used to implement machine learning for temperature detection	It needs more accurate data for the user for the review and accurate diagnosis.
Queralta et al.[54]	Diabetes and heart disease monitoring with fall detection	Deep learning algorithms to carry out tasks related to health monitoring	Due to their constrained transmission capacity, Low power wide area networks (LPWANs) are unsuitable for high data rate applications like electrocardiography monitoring or fall detection systems. As a result, data processing and compression at the network's edge are required.
Uddin et al.[55]	Recognizing activity with wearable smart sensors	Using a Recurrent Neural Network (RNN) model, activity detection	prediction using a RNN is very important in smart medical care, but it need to train it on multiple and different data.

11 RECENT SURVEYS IN HEALTHCARE

Modern living will be drastically changed by 6G communication networks and AI. The medical sector will be affected by this[56]. It is expected that 6G will remove the current clinical barriers. 6G is also a breakthrough in medicine. In light of this, our work is to compare modern research that uses these advanced technologies, find differences between them, add our ideas as researchers in this field, and link all these technologies together to suggest a modern, advanced idea that will be applied realistically in the near future. AI algorithms are very many and varied, and there is a lot of modern work that hybridizes or modifies algorithms to obtain highly accurate results in the process of medical care and disease detection. Previous research that uses AI in healthcare has increased its uses in the recent period, so we will make a systematic comparison of a group of modern studies and identifying the most important and most used technologies. Table 6 shows all these details.

Table 6. An overview of relevant surveys.

Ref.	IoT	AI	Networks	Sensor's devices	Privacy	Security	Reliability
[57]	✗	✓	✓	✗	✗	✗	✗
[33]	✓	✗	✓	✗	✓	✓	✓

[58]	✗	✓	✗	✗	✗	✗	✗
[59]	✓	✗	✓	✗	✓	✓	✗
[22]	✓	✓	✓	✓	✓	✗	✗
[60]	✓	✓	✗	✓	✗	✗	✓
[61]	✓	✓	✓	✓	✓	✓	✗
[62]	✓	✓	✗	✗	✓	✗	✗
[63]	✓	✓	✗	✗	✗	✗	✓
This survey	✓	✓	✓	✓	✓	✓	✓

In this regard and according to what is available in table 6, the survey outlines the ways in which the research community is tackling the following issues:

- Is the presence of the IoT essential in research for healthcare?
- How have existing AI with IoT?
- What is the role of modern communication networks 5G and 6G?
- What are the common Sensors devices used to enable healthcare?
- Is the level of privacy in all available areas at the required level?
- What is the real assessment of security?
- What level of reliability did researchers focus on and the trust that supports the user in all embedded technologies?

All these important questions are to determine the most important things to be added in future work and to address the negatives in previous research. This survey will have an important role in building a smart medical system linked to fast communication networks with high security and privacy and with very high reliability between the user and source.

12 Iot And Covid 19

we remember very well the virus (covid 19) that spread rapidly in the world and caused damage to speed of its spread. Ban restrictions were imposed all over the world and staying at home was the only solution. People are becoming more using cellular networks and internet. Healthcare, education, work, and the majority of other human connections have all been abruptly relocated to the virtual domain. As a result, healthcare using IoT has been shown to be safe, effective, and inclusive under the condition that measures to ensure security, robustness, and capacity are taken, particularly in densely populated areas with massive competing demands for bandwidth [41]. Therefore, a smart technique to detect the health of the patients remotely are very crucial to be designed. IoT is one example of such techniques where doctors can be informed if any unexpected symptoms occurred. In this case, IOT may be used to facilitate capabilities such as remote health monitoring for people working at home and then tracking them to make sure they are in a safe place. This is crucial for identifying the illness and potentially assisting in its combat.

13 Conclusion

This paper discussed Healthcare Systems based on IoT. Applications, challenges, the required architectures, and future directions for such systems were explained. In addition, reference was made to design issues and future directions for 5G, 6G and AI, and their integration with the IoT to create smart healthcare systems that have a significant impact in the future. It is shown that these systems can help people to make their life easier by using systems to help them how to manage their daily life. However, these systems require efficient protocols in order to provide the required performance when different factors are crucial. Contribution summary include, comparing and analyzing algorithms, modern wireless communication and methodologies utilized in real-world data extraction in healthcare, as well as implementing developing IoT solutions in healthcare systems.

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