

## IoT Applications in Healthcare Segment

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### ABSTRACT

IOT (Internet of Things) is being extensively used world-wide. The expansions done in IoT has specified a new face to see the emerging world. IoT is a small unit of Artificial Intelligence. It is trending in fields like Industry, Business, Health Care and abundant ones. Healthcare applications of IoT (HIIoT) became an important part of human life. To bout with diseases and reduce physicians' load, HIIoT has provided us with variability in strategies and humanoid machines too. It has become possible to discover the outcome of the easiest and the toughest problem in any arena due to IoT. This paper focuses on the applications of IoT in Healthcare and the challenges in adopting it in the modern era.

**Keywords:** IoT, Development, Healthcare, Challenges, Applications.

### I. INTRODUCTION

Information is very useful about anything we do. To preserve the large amount of data, we need strong database. IoT provides a strong network to share the data privately. In the world of development, large amount of data is obtained and due to this a problem matures of arranging the data in an organized manner. From every aspect of life, data is gained. Every sector whether industry, agriculture, healthcare or any other, generates huge amount of data or tons of data, which is to be managed and have it in required manner. This introduced a term named 'Big Data'. Managing the data in any field is a difficult or challenging task. It requires genius technologies to solve this problem. To overcome this problem, IoT is introduced.

IoT is not a new subject but it is a hot topic. The IoT is a system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifiers (UIDs) and the ability to transfer data over a network without requiring human-to- human or human-to-computer interaction [1]. IoT refers to a smart system of inter-related devices (computers, sensors, actuators, etc.) connected to the internet each with a unique identifier that are able to continuously communicate with each other with a common language over the network and collectively make intelligent decisions by analysing the gathered raw data [2]. The main aim of IoT is to connect electronic-sensing device, internet-based communication and sending and receiving of messages, with the current and upcoming generation. So that

they are able to preserve important information for further use.

Health care is a system which is derived with the objective of anticipation, finding and dealing of health-associated problems of humans [4]. The most important and growing sector, Healthcare, generates lots of data every minute, that needs to be kept secured. By introduction of 'IoT' it has been possible to distinguish between 'health data' in the analysing and diagnostic of a physician after systems of physical sensors. The biggest benefit of the 'IoT in healthcare' is to reduce maintenance burden, followed by an increase in the chance of healthcare [5].

## II. DEVELOPMENT OF IOT IN HEALTHCARE

The IoT domain leads to world of technology and communication to a new era where objects can communicate, compute and transform the information as per the requirements [19]. The Internet of Things is a technological revolution that represents the future of computing and communications, and its development depends on dynamic technical innovation in a number of important fields, from wireless sensors to nanotechnology [9]. The term "Internet of Things" was disseminated by the research work of the Auto-ID Centre at the Massachusetts Institute of Technology (MIT) in 1999 [3]. IoT came into Health care due to its vast technological development and its benefits gave medical field a huge profit in business as well as medical management.

The appearance of IoT in healthcare started with remote patient monitoring system that assisted physicians and nurses in taking medical decisions and reduce interaction with patients to eliminate error possibilities. From here, the track of progress started and devices were invented by researchers. Devices like health monitoring system, Heart Monitoring system, Glucose Monitoring system, Cancer detecting and reporting machines, Pulse-Oximeter, ECG machines,

Fluid-level sensors, Depression and Mood Monitoring devices, IoT-connected Inhalers, Ingestible sensors, Surgical Robots etc. provided medical field with new ways of treatment and numerous strategies to cure diseases. Till now many such inventions acquired place. Seeing the rapid growth in recent 25 years no one can predict how much progress will be done in next several years.

IoT healthcare systems have been developed for specific purposes, including rehabilitation, diabetes management, assisted ambient living (AAL) for elderly persons, and more [6]. As IoT enabled patients can be accessed over the Internet and by other machines, the health condition of a patient can be monitored uninterruptedly, allowing critical illness to be detected at the right time so that proper actions can be taken. Also, IoT can help to collect health records [11].

## III. SIGNIFICANT CHALLENGES FACED BY IOT

□ One of the most significant challenges faced by IoT is Data Security and Privacy. IoT-enabled mobile devices capture data in real-time, but most of them lack adherence to data protocols and standards. There is significant ambiguity regarding data ownership and regulation. Hence, the data stored within IoT-enabled devices are prone to data thefts and it makes the data more susceptible to cybercriminals that can hack into the system to compromise personal health information. Some examples of misuse of IoT device data are fraudulent health claims and the creation of fake IDs for buying and selling drugs [12].

□ The data transmitted from the sensor to the control device and further transmitted to the monitoring centre, which will affect the quality of the data due to noise. Better architecture helps to transmit the data without affecting its nature. Noise removal technique can also help to enhance the data signal.

□ Most of the existing method in ECG monitoring involves analyzing the signal in a supervised manner. This increases the cost and it may produce the error in

detection. Machine learning can be applied in analyzing the signal, which helps to improve efficiency and reduce expenses.

□ An increasing number of sensors and the devices require higher energy to process, and it increases the power leakage and energy consumption. An optimization algorithm can be used to reduce the usage of energy.

□ Monitoring many numbers of users in the IoT requires more storage and mainframe, which can be overcome by storing the data in the Cloud. However, the IoT integrated with the cloud increases the complexity [13].

□ The integration of multiple types of devices causes hindrance in the implementation of IoT in the healthcare sector. The reason behind this hindrance is that device manufacturers haven't reached a consensus regarding communication protocol and standards. This results in a scenario where every manufacturer creates its own separate ecosystem of IoT devices that do not work with the devices and applications of competing manufacturers [21].

□ The networks which transmit data are often highly heterogeneous and are frequently managed by third parties which makes the protection of security and privacy as well as governance of this data even more challenging [22].

#### IV. APPLICATIONS OF IOT IN HEALTHCARE

**Implantable Glucose Monitoring Systems:** We use a simple sensor with low power and low-cost solutions for the glucose monitoring application. The patient's data is updated in the cloud every day. The collected data is used by the doctor to monitor the patient's blood glucose variation visually and protect the patient's health from a critical condition. With the help of sensors, the current health parameters of patients are collected and forwarded to the cloud for storage. Each health dataset is analysed and verified to determine precisely if the current values are within the normal range or not. An SMS is sent to notify the

doctor in the case of any change in the vital signs. The critical data is then sent directly to the prediction system. The system will consider this data as trial data and predict whether or not the patient has a high risk of stroke. This method can be improved to increase the accuracy value [10].



Fig. 1 Proposed Scenario [10].

**Health Monitoring Systems:** Health sensing components have become very compact and portable, allowing patients to wear them round the clock for monitoring. If these monitoring devices are equipped with unique identifiers like RFID, then those devices can be uniquely identified over the Internet. It acts as an information retriever, retrieving information from the physical world to the digital world [11].

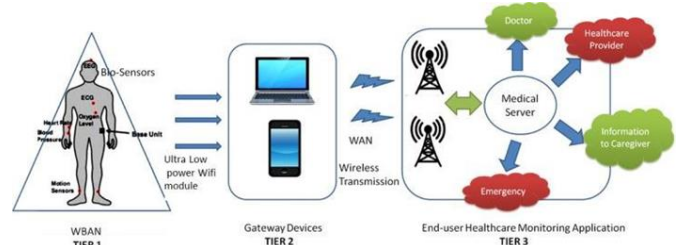


Fig. 2 Energy-Efficient IoT-Health Monitoring System using Approximate Computing [14].

**Ingestible Sensors:** There are ingestible sensors that are developed for measuring physical parameters such as core temperature and pressure. There are chemical and biochemical components that are related to the balances in the gut and the functionalities, but the field is still relatively new with a great prospect for growth. The potential monitored markers include: electrolytes that are responsible to keep the gut environment at the right pH and ionic concentrations; metabolites, including digestion and fermentation metabolites,

which play great roles in the function of the body and gastrointestinal tract; enzymes that are the catalysts for digestion and also perform other activities in the gut; and additionally, a large number of microbial communities. Ingestible sensors can directly measure these components and may also target the by-product of chemical and biochemical activities such as gases [15].

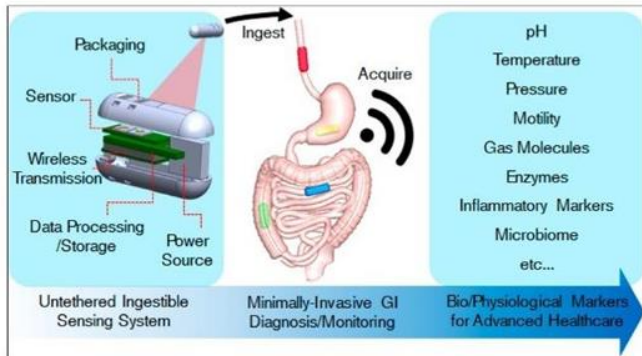


Fig. 3 Ingestible Sensors and Sensing Systems [16].

**Robotic Surgery:** Earlier studies in the field of robotics were mostly focused on increasing robot autonomy, perception, and data processing, which are important criteria for the independent functioning of a robot. However, in the IoT-aided robotic system, the functionalities of a robotic system are integrated with various sensors to achieve a common healthcare goal. Besides monitoring, diagnosing, and performing simple tasks, the integrated systems are designed to perform complex operations. Furthermore, at the same time, the sensor information from the smart environment can be efficiently shared and used by the robotic system. In simple words, the IoT-aided robotic system can be defined as an extension of the IoT that possesses the advantage of robotic technology [17].



Fig. 4 Surgical Robot Assistants Are Becoming a Reality in Indian Hospitals [18].

**Wearables Devices:** Another use of healthcare IoT is mobile medical applications or wearable devices that allow patients to capture their health data. Much of this can be attributed to the data revolution which is empowering us to live healthier lives by using connected devices such as tablets, wearables and hand-held devices. The analysis of the data collected through electronic medical records, diagnostic information gathered through imaging equipment and hand-held personal devices will enhance the decision-making powers. This will allow patients to take a more active role in managing their personal health [7].



Fig. 5 Benefits of Wearable Technology in Healthcare [8].

**Activity Trackers During Cancer Treatment:** The basic technology is designed for through-the-skin detection and measurement of key cancer biomarkers called microRNAs circulating in the bloodstream [20]. It is stylish as a wearable gadget and works with the help of biosensors. They are made of numerous nanotubes



(needle-like structures) and are attracted towards molecular biomarkers circulating in the blood. To start monitoring, an infrared excitation beam from the external device is transmitted through the skin on to the nanosensor implants. Under optical stimulation, the sensors absorb a quantity of the IR energy and re-emit it back through the skin to the device's external detector. The returning signals are analyzed to calculate biomarker levels as an indicator of a cancer's current stage and rate of growth [20].



Fig. 6 A small device worn on the wrist could send light into the sensors (excitation beams) and analyze the light coming back out (nanotube emission) to provide constant updates [21].

## V. CONCLUSION

IoT in Healthcare has its precious contribution in medical arena. It has provided us with various devices for making human life easy and fast. Multiple applications of IoT helps physicians in treating their patients in more convenient way and giving attention to the patient whenever and wherever needed. Doctors can keep checking the condition of patients time-to-time and recommend medicines as per requirement. Devices like Health-monitoring system, blood pressure monitoring system, glucose monitoring system, activity trackers for numerous diseases, heart monitoring system, wearable devices, ingestible devices, surgical robots, etc. have made human life easier to fightback against ailments and reduced

burden of exertion from doctors. Hence IoT, Artificial Intelligence, Deep Learning and Information Technology, all must be considered as one of the most important part of human life, that led to fast growth and development of every field and make the opinions of our generation modern and evocative.

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