

# Chapter 2

## Internet of Things in Healthcare:

### An Extensive Review on Recent Advances, Challenges, and Opportunities

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#### **ABSTRACT**

*Healthcare motoring has become a popular research in recent years. The evolution of electronic devices brings out numerous wearable devices that can be used for a variety of healthcare motoring systems. These devices measure the patient's health parameters and send them for further processing, where the acquired data is analyzed. The analysis provides the patients or their relatives with the medical support required or predictions based on the acquired data. Cloud computing, deep learning, and machine learning technologies play a prominent role in processing and analyzing the data respectively. This chapter aims to provide a detailed study of IoT-based healthcare systems, a variety of sensors used to measure parameters of health, and various deep learning and machine learning approaches introduced for the diagnosis of different diseases. The chapter also highlights the challenges, open issues, and performance considerations for future IoT-based healthcare research.*

#### **INTRODUCTION**

The technological evolution results in the increase of electronic devices in many fields which can be connected over the Internet termed as Internet of Things (IoT). IoT nowadays becomes a huge network

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of physical devices such as smartphones, sensors, actuators, with global network connectivity in order to store and exchange data. It plays a vital role in many applications including smart homes, smart cities, automotive, smart grid, healthcare etc. Among the wide applications of IoT, it plays a significant role in the healthcare industry. Today, the healthcare industry faces many challenges in the early diagnosis of diseases which is essential for initial treatment to save the lives of patients. In recent days, health monitoring is gaining importance and wearable health monitoring systems have become popular among industries and researchers. The wearable devices collect the patient's health information including heart rate, blood pressure, and blood glucose level. These devices enable patients to monitor their health condition and make a precise analysis related to treatment. Due to the increased population and advancement in technology, the volume of the data generated from healthcare industries is huge. Henceforth, a mechanism is required to store and analyze big medical data over the cloud environment. With huge measures of information spilling out of EMRs, wearable's, and various other new sources, the significance of machine learning and artificial intelligence is intense than other industry. Machine learning accelerates disease diagnosis and classification of health data and empowers physicians to make quick decisions. In addition, machine learning and deep learning methods work in conjunction with IoT to diagnose diseases early. With a detailed history of patient records, an IoT system blended with a deep learning method enables early diagnosis and prediction of numerous diseases.

## **WEARABLE DEVICES IN HEALTH MONITORING**

Information and communication technology (ICT) plays an important role in society nowadays. The impact of recent technology on improving the health and prosperity of people is remarkable, that converse about the digital revolution in the healthcare industry (Birkler and Dahl, 2014). The digital revolution provides an opportunity for individuals in taking care of their own health with the assistance of monitoring devices (Kostkova, 2015; Klonoff, 2013). These devices generate more and more data about individuals, transmit and analyze to monitor the individual health conditions through the technology, Internet of Things (IoT). IoT is defined as the network of physical objects connected through internet. It provides the possibility of continuous and close monitoring of individual healthcare using wearable devices (LeHong and Velosa, 2014). In recent years, wearable devices become popular among the academic and research community (Gao et al., 2016). Wearable devices are autonomous devices that can be mated with the human body for continuous monitoring of individual's activities (Gao et al., 2016). Now-a-days, wearable devices including eyeglasses, splints, bandages, and contact lenses are employed to provide medical functions like medical monitoring, rehabilitation assistance, and medical aid for long term (Barfield, 2015). The objective of this paper is to address the important most important wearable devices.

In today's fastest world, people spend their time in doing various tasks and fail to take care of their health and fitness. And also, a lot of time is needed for making an appointment with the doctor in a clinic. Therefore, people are finding alternative through devices that can be mated on the human body and provides continuous health monitoring of user (Xu et al., 2014). Wearable monitoring devices provide assistance for the treatment of diseases like heart diseases, diabetes, treatment and vital sign monitoring of heart rate, the oxygen level of blood, respiration, and body fat. Such device gathers and broadcast the information related to the person health condition through the wireless connection and provide an instant alert to the health care provider (Bowman and Schuck, 1995). Figure 1 represents the working

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