The Role of the Internet of Things (IoT) and Wireless Sensor Network (WSN) in Healthcare

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Abstract: *Healthcare is considered as the key factor of economic and social tasks in all over the world. The use of the Internet of things (IoT) for healthcare is an important initiative of development. The present study aims to explore the role of the Internet of things (IoT) and Wireless Sensor Network (WSN) for healthcare. The study explores the IoT and WSN are the advance emerging innovations for tracking health factors such as body temperature monitoring, blood pressure monitoring, glucose level monitoring, temperature, electrocardiogram (ECG) monitoring, and heart rate monitoring, etc. It monitors several patients in a hospital-based large dataset as well as monitor the patient within a different location with the help of sensors as called the distant based healthcare monitoring system. The study concluded that IoT and WSN based healthcare system are easier and cost-reducing and advance innovations for healthcare security and supporting technology to provide on-time treatment to patients.*

Keywords: *Healthcare, Innovations, Internet of things, Wireless Sensor Network*

I. INTRODUCTION

Healthcare is considered as the key factor of economic and social tasks in all over the world, now a day's the researchers, medical experts, and the experiment practitioners recognized the growing pressure healthcare created by increasing expectations of government and private organizations. However, the increasing healthcare cost effects to the living standard of the social beings, constantly increasing the population as well as increasing age of peoples increases the demand of healthcare and required modern medical techniques [1, 2]. Now a day's many health problems identified and resolved with the help of modern technological innovations such as the internet of things (IoT). The use of IoT for healthcare is an important initiative of development. The term internet of things (IoT) is defined as the connectivity of devices and things such as mobile phones, internet, televisions, and sensors to the internet where the devices are connected together and enables a new system of connection and communications between peoples and objects [3]. With the application of internet of things (IoT) the new data streams collected, recorded and analysed very fast and highly perfect with gathering devices and direct share information to each device and cloud. It will impact on various applications domains, which can be categorized on the basis of available kind of network, scale, heterogeneity, repeatability, user involvement and impact [4]. The application can be divided into four domains such as personal and healthcare, enterprise, utilities and mobile. These applications show the personal and healthcare, IoT at the scale of individual or home, enterprises IoT at the scale of community, the utility IoT at the scale of the region or national level and the mobile IoT which is normally moving and spread around other domains. The dependence of healthcare on IoT day by day increases to access quality healthcare and reduces the cost of healthcare [5]. The modern technology of IoT accounts about 30 percent implementation in the field of medical science and healthcare practices [6-8]. It improved access to healthcare enhancing the quality of healthcare and reduces healthcare costs [5]. The fast-emerging progress of cloud computing, mobile applications as well as wearable apparatus supported the implication of IoT from the conventional healthcare system to the modern personalized healthcare system. It monitoring the various medical factors such as blood pressure monitoring, Electrocardiogram (ECG) monitoring, body Glucose monitoring, body temperature level sensing with the use of smart sensors, network system and remote servers [9&8]. The wireless sensor networks have increased the interest of academic research and industry in the recent period, which considered to monitors the body signs under natural physiological conditions using wireless sensors attached with the body [10].

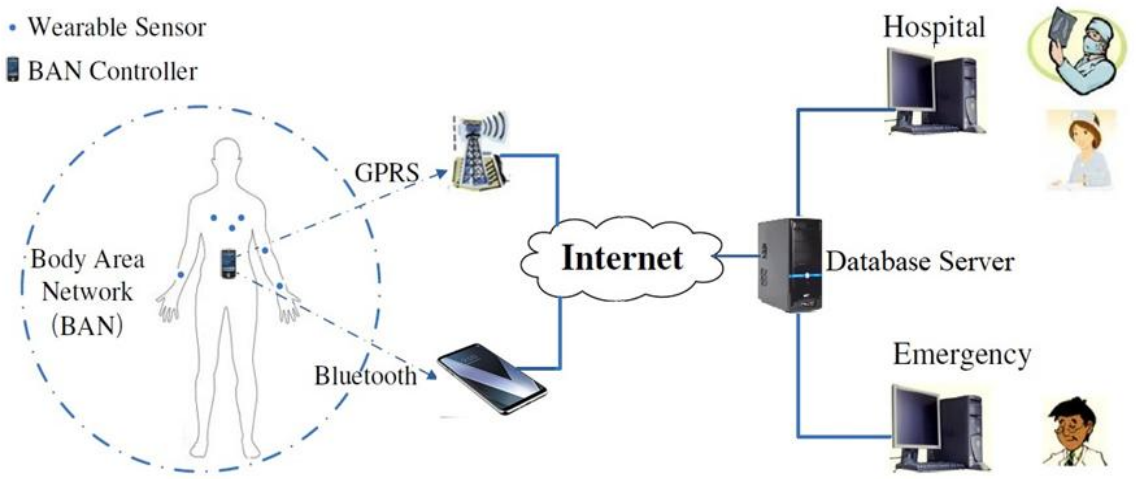


Fig. 01 shows a modern personalized healthcare system.

The IoT devices diagnose the health problem quickly and help to provide medical care to the patient on an immediate basis to secure life. The figure 01 represents that these devices diagnose the patient and report the diagnoses results to the database server through a connection such as Bluetooth, ZigBee by the transferring via patient's smartphone or General Packet Radio System (GPRS) service. While the server receives the diagnosis results, it matches the results with prefixed normal data every time. The system displayed the emergency alarm when the received data exceed or lowers from the normal range, which indicates the patient is going to suffer from a health problem. The Global Positioning System (GPS) helps to display the accurate location of the emergency and patient Figure 01.

In healthcare the implication of IoT is very important, it playing a vital role in extended quality healthcare services with reducing health cost [11].

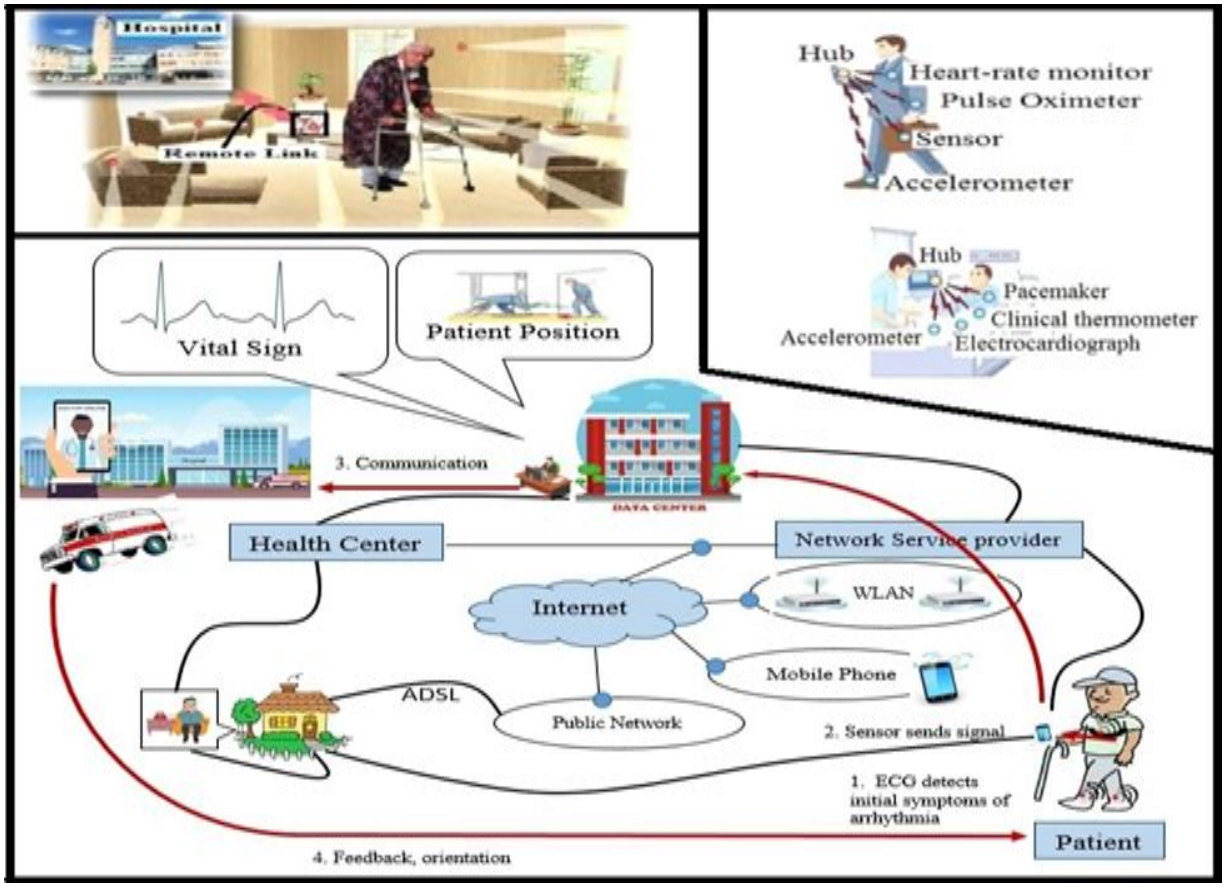
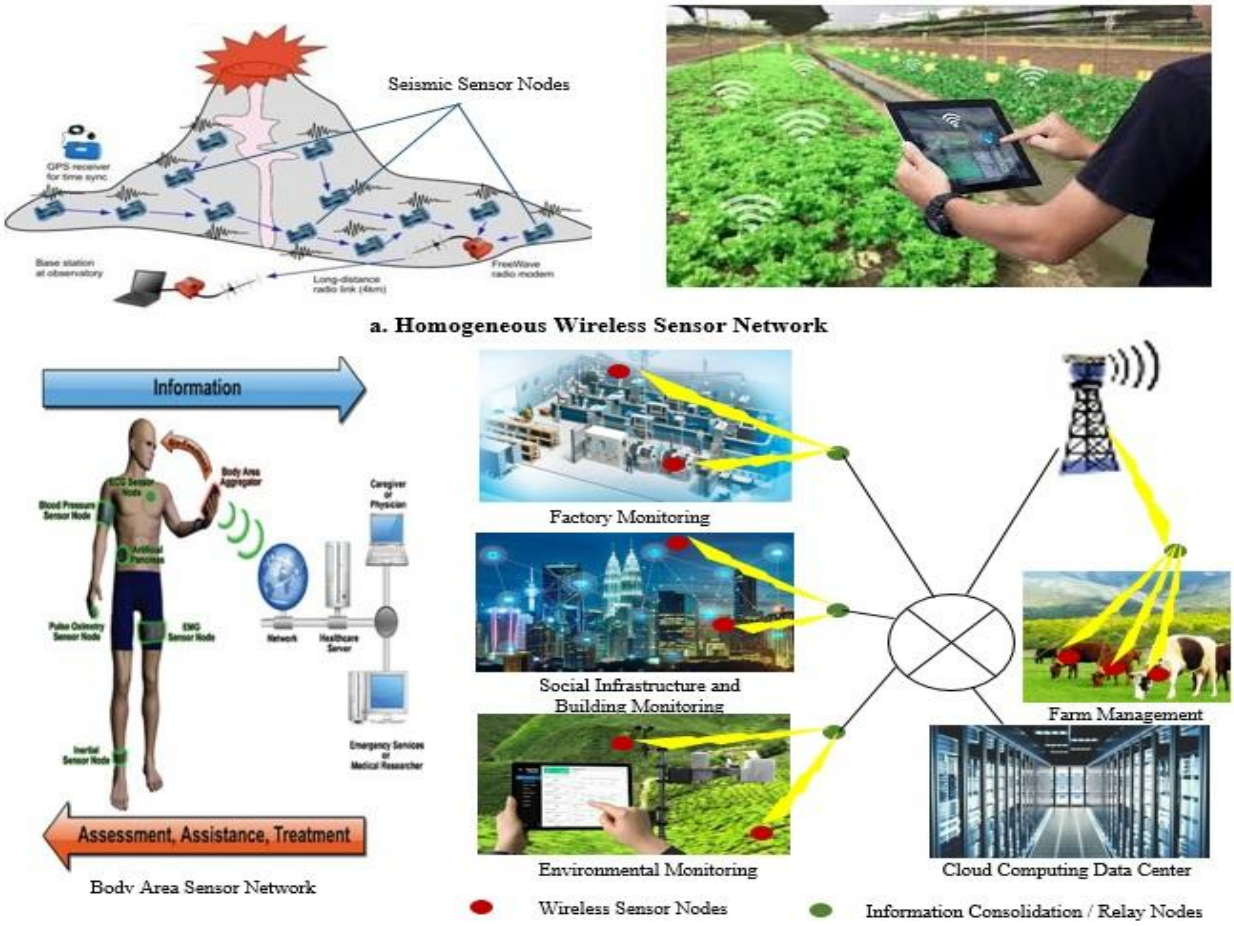


Fig. 02 represents the hospital-based and distant based healthcare system

Tracking health factors i.e Blood pressure, body glucose, temperature, ECG, etc. can be measured with the usage of IoT services of the wireless sensor in real-time. The application of IoT in healthcare services improved by the adoption of advanced technologies of wireless sensors, the development of wearable devices of sensors network frequently track the patients and reports the health condition of the patient on time is considered the advanced innovations of IoT [8].

Modern technology of wireless network used in smartphones advances the healthcare services for monitoring patients [12]. The electronic healthcare and IoT technologies developed the innovation such as satellite, internet, mobile phone health tracking, and monitoring services and cloud computing system [13-15]. Wireless sensor network provides an advance field of body area network in which different sensors are organized in body side of human, which monitor the health of condition. The healthcare monitoring system categorized as hospital-based and the distant based health monitoring system as shown in figure 02. In hospital-based healthcare monitoring system, the data of several patients collected and transferred to a database system and make it easy for monitoring the exact location of the abnormal situation from a large dataset. Moreover, the sensor network used for patients especially for elders to provide the freedom to move and monitored at the same time with the help of sensors is considered as the distant healthcare monitoring system figure 02.

Wireless Sensor Network are widely categorized into homogeneous and heterogeneous networks and data types as shown in figure 03. The kind of network consisting of the nodes of similar function capabilities are called as homogenous networks, and the function of these networks sensing the similar types of data. While the sensor network with complex type data processing capabilities called heterogeneous sensor network figure 03. The healthcare system can be monitored by the application of heterogeneous sensor network. The sensor network makes easier the health monitoring system of several patients. In the body area network, heterogeneity arises with nodes applied to measure the different health factors and has different power consumption levels to perform various tasks. Generally, sensors network are dense network because sensors attached with the body lie in the same radio range [16, 17].



a. Homogeneous Wireless Sensor Network

b. Heterogeneous Wireless Sensor Network

Fig. 03 represents Homogeneous and Heterogeneous Wireless Sensor network.

II. TYPES OF INTERNET OF THINGS AND WIRELESS SENSOR NETWORK-BASED HEALTHCARE

The internet of things has three types of system for healthcare such as the system for the perception of information, system for transferring the information or network transmission and services application. The sensors network basically supports the information perception and frequently monitors the health condition of patients [18, 8]. The collected health information transferred by the networks and stored in cloud data centers and the wireless devices such as Wifi, ZigBee, EnOcean, etc are applied for transforming the data over the network. However, the third system as application services layer involves the internet of things application in a healthcare center or hospitals to provide the remote healthcare services [15, 8]. The main IoT and Wireless sensors based healthcare approaches are as follows:

A. Body Temperature Monitoring

Body temperature monitoring is one of the innovations of IoT and Sensor network. [19], developed an IoT based system which can monitor the body temperature. The variations in body temperature used to identify the homeostasis, which forms an important part of healthcare services. TelosBmote used IoT healthcare system, which has embedded sensors to record the body temperature. The system basically includes the RFID model that works in collaboration with body temperature recording devices.

B. Blood Pressure Monitoring

The blood pressure can be measured with the help of IoT based wearable devices. The machines contain a blood pressure measurement device which has network-based communication capabilities. The Blipcare is such a device which applied as a home Wifi network to monitor the blood pressure and transfer the monitored and recorded information. The device also has an LCD display to show the blood pressure [15].

C. Glucose-Level Monitoring

Nowadays diabetes is a common health problem, which requires a frequently monitor the glucose level to monitor the health condition. The application of IoT based healthcare technologies is capable to continuously monitor the glucose level in a non-invasive method. The wearable device can be used with sensors to track the healthcare monitoring factors and collected information in transmitted by internet protocol network to important healthcare providing systems. The tracking IoT based device contains the glucose collectors, a mobile phone and an IoT and Wireless sensors based medical acquisition detector to record the glucose level [20]. This device monitors the glucose level in normal or modification with the utilization of food, physical work, at the medication time, etc.

D. Electrocardiogram (ECG) Monitoring

The IoT devices have a significant role in healthcare monitoring such devices monitor the electrocardiogram (ECG). The device keeps the track of their and the basic rhythm, with the identification of multifaceted or complex arrhythmias, myocardial ischemia, and prolonged QT intervals by recording the electrical work of the heart. The ECG monitor contains the wireless transmitters and receivers. The automated application can identify the abnormal work of heart. The network system helps to transfer the information to the smart mobile phone, doctors as well as a hospital. The IoT devices use algorithms to monitor ECG frequently [18].

E. Heart Rate

The IoT based devices such as smartphones are vital for healthcare monitoring, it controls almost all of the IoT based healthcare services. Various medical-based hardware products have been interlinked into smartphones as well as many of the application of smartphones developed for healthcare monitoring [21]. The application of IoT and wireless sensors used on image analysis and algorithms also implicated for healthcare monitoring applications. It helps to diagnose diseases such as Asthma, chronic obstructive pulmonary disease, respiration system, etc. Nowadays the IoT based devices and wireless sensors and wireless communications make easier the system of healthcare. These devices monitors and health conditions with sensors such as heart rate sensor. The IoT and WSN assess the heart rate and record the safety and early detect the disorders [22].

F. Wheelchair Management

The IoT based healthcare industry facilitate patients every time and everyplace in terms of health in daily life [23]. The smart wheelchairs are the significant innovation of IoT and WSN in recent technologies. [24] proposed the usage of wheelchairs for diabetic patients. The wheelchair can be controlled by the sensors and a system can control it accordingly, it also monitors the sitting position of the patient with the given surrounding information.

III. CONCLUSIONS

The healthcare monitoring based on internet of things and Wireless sensors network is an emerging innovation in the modern period. Now a day's many health problems identified and resolved with the help of modern technological innovations such as the internet of things (IoT) and Wireless Sensor Networks (WSN). The present study explores the IoT and WSN based healthcare system, the study heightened healthcare implication of IoT is very important, it playing a vital role in extended quality healthcare services with reducing health cost. Study

shows that IoT and WSN are the advance emerging innovations for tracking health factors such body temperature monitoring, blood pressure monitoring, glucose level monitoring, temperature, electrocardiogram (ECG) monitoring, heart rate monitoring and Wheelchair management, etc. can be measured with usage of IoT services of wireless sensor in a real-time. The study further explores IoT and WSN are emerging innovations to monitor several patients in a hospital-based large dataset as well monitor the patient within the different location with the help of sensors as called the distant based healthcare monitoring system. Therefore, the study concluded that IoT and WSN based healthcare system are easier and cost-reducing and advance innovations for healthcare security and supporting technology to provide on-time treatment to patients

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