Wireless Health Monitoring Systems for Patients - An Overview

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***Abstract*: This study seeks to assist people suffering from chronic diseases that worsen with age. This method involves wirelessly transmitting basic determinants such as SPO_2, ECG, NIBP, and body temperature to an online server. This data can be viewed in real time by doctors and carers from any location that is connected to the internet. The necessity of this system is to ease the difficulty that medical specialists face when monitoring several patients at the same time. This research will allow them to observe patients without needing to be physically present at their bedside, whether in the hospital or at home. The body temperature, heart rate, and electrocardiography (ECG) of a patient are wirelessly transmitted via an agent such as Bluetooth technology. To address this issue, a wireless health monitoring system was created, for which an Android and a Web Application were constructed. By monitoring numerous medical parameters such as blood pressure, ECG, heart rate, and temperature, remote patient monitoring systems significantly reduced patient burden and gave high quality care with minimal risk. The implemented technology is being improved in each region and uses IoT to solve all medical problems of patients in remote locations. Wireless Health Monitoring Systems for Patients are described in this paper.**

***Keywords*: Wireless Health Monitoring System, Personal Sensor networks, Body Sensor networks, Electrocardiography, Heart Rate, GSM, Healthcare Services, Internet of Things.**

1. Introduction:

A wireless health monitoring system, also known as a patient monitoring system or wireless Health wearables, contains devices that wirelessly send patient data to remote locations to remotely monitor a patient's vital signs. The usage of communication devices in healthcare lowers the difficulty that medical professionals experience when monitoring multiple patients at the same time or monitoring the health of elderly persons who lives alone [1]. It enables them to monitor patients without physically being there at their bedside, whether in a hospital or at home.

A wireless patient monitoring system is a type of technology that enables for continuous monitoring of a patient's vital signs such as blood pressure, heart rate, oxygen levels, and other parameters. The technology is intended to give healthcare practitioners real-time information about their patients, which may be utilized to improve care quality and patient outcomes.

Sensors placed on or near the patient's body to collect physiological datas, a wireless transmitter that sends the data to a monitoring device or central hub, and software or application that allows healthcare providers to view and analyse the data are typical components of a wireless patient monitoring system. Monitoring devices or a central hub can be linked to a computer, mobile device, or display, allowing healthcare personnel to access patient data remotely or at the point of care.

Health is the essential capability that humans require in order to perceive, feel, and act properly, and it is a critical component in the development of the individual. As a result, effective healthcare management methods such as monitoring and medical support are required. The elderly's increased life expectancy, along with technology advancement, has resulted in new and effective methods for patient monitoring and treatment at home. This chapter introduces telemedicine and home monitoring via the Internet of Things (IoT).

The safety of older persons should be regularly checked in different areas, such as the home or at hospitals. Access to information about the user's condition should be restricted to certified individuals designated by the user. In the event of a threat, it should allow for almost rapid response.

The necessity for cardiac diagnostics, such as electrocardiography (ECG) holters or cardiac event recorders, led to the development of such devices roughly 50 years ago. This need has migrated into everyday life, resulting in the commercialization of heart rate monitors and personal health monitors in the form of a compact, light electronic device. The introduction of wireless connectivity was the most important enhancement in these gadgets over their predecessors.[2]

Nowadays, such devices are quite popular, particularly in sports, owing to technological advancements, availability, and functionality. The best example is wrist heart rate monitors in the shape of watches. Heart rate monitors worn on the chest are another example of this type of equipment.
Wrist monitors, unlike chest belt monitors, use optical sensors to assess heart rate using pulse oximetry. Because these sensors are more convenient and easier to use than chest belt heart rate monitors, they have grown in popularity. However, measuring biological signals such as blood flow to calculate heart rate yields less data. Furthermore, vigorous hand movements and shaking will cause the measurement to shift. As a result, devices that measure health parameters should analyse ECG traces collected from the chest to monitor heart activity.
A system that merely monitors the heart rate offers insufficient information about the general health of the person and should be supplemented with additional capabilities. The system should be capable of monitoring a variety of users, including athletes, the old, the lonely, workers, and rescuers. It must be capable of detecting faintness, slip-ups, stumbles, and falls, among other things. Accelerometers, which should be embedded inside the gadget, can detect these events. The aforementioned incidents were anticipated to be detected and reported to the supervisor.
Environment characteristics should be examined for the safety of a monitored person using sensors embedded into the system. Temperature, atmospheric pressure, and altitude sensors should be included in the bare minimum of sensors for monitoring the environment. This data will allow us to predict any potentially unsafe circumstance, where motion sensors are used.The real time acquisition of biological parameters, a combination of Zigbee technology, 13 bit A/D chip with high resolution, template matching algorithm and Artificial Neural Network algorithm is used [3]

1.1 Benefits of using a wireless monitoring system:

- Improved productivity
- Continuously monitors 24/7, 365 days a year
- Scalable
- Generates audit approved reports
- High level of security
- No ongoing costs

2. Review of Literature:

Traditionally, patient monitoring systems used cable sensors connected to computers within hospitals. The downside of these devices was that they limited the mobility of the patients. The instruments utilised were also enormous and costly, and they could only monitor a few people. When healthcare facilities began to offer home-based care, RPMS were introduced. This technology, like traditional patient monitoring, was not user-friendly. As technology advanced, researchers were able to develop solutions for remote patient monitoring and wirelessly connected patient monitoring. The health sector is fast improving as more researchers and businesses use remote patient monitoring technologies to improve care [4] [5]
Kantoch et al. developed a wearable health monitoring system for tracking and analysing human physiological signals using a wearable body sensor network. The scientists looked at WBSN measures in the context of a research scenario that included common daily activities like working, relaxing, walking in different directions, and physical exercise. For these activities, the trial findings indicated a 95% categorization accuracy. [6]
Meanwhile, Kakria et al. created a remote cardiac patient health monitoring system based on modern wireless and wearable sensor technology. The project's goal was to make it easier to provide cutting-edge healthcare services to remote cardiac patients. The authors proposed a location-based real-time monitoring system that includes a wearable sensor based on WBSNs, a smartphone, and a monitoring web interface. With an accuracy of more than 90%, the system detects abnormal health parameters such as arrhythmia, hypotension, hypertension, fever, and hypothermia and delivers alerts to the patient monitoring centre in less time than other devices. [7]

3. Objectives of the systems under study

- The suggested system's major goal is to provide efficient and fast patient monitoring services to critically ill patients.
- Wearable gadgets worn by the patient, such as smart watches, fitness trackers, or dedicated monitoring equipment.
- Wireless bedside monitors that can be placed in a hospital patient's room.
- Portable monitoring devices for monitoring patients during medical transit or routine check-ups.

4. Research Methodology:

The general design of this investigation was exploratory. This paper reveals a study of real-time patient monitoring systems for critically ill patients in the Intensive Care Unit and those who are alone in remote locations. It is a warning system based on threshold values. The developed systems consists of wearable sensors and associated wireless accessories. The equipment is capable of obtaining physiological parameters such as the patient's heart rate, blood pressure, and temperature. The collected physiological data is transferred via a wireless network for the real time collection and processing of biological parameters kept in a database. [8]

5. Result and Discussion:

Wireless sensors and wireless communication are used during remote patient monitoring to collect and communicate data to the hospital. Wearable and implanted (contact-based sensors) as well as non-contact sensors are utilised to collect data [9]. The acquired data can be examined and altered using an internal or external controller before being wirelessly transferred to the hospital. Various short and long-range communication mechanisms are utilised to transfer data to the end user. As illustrated in Fig. 1, this sort of tele-health undergoes three communication network phases. The process involves data acquisition and processing, data aggregation and end user.

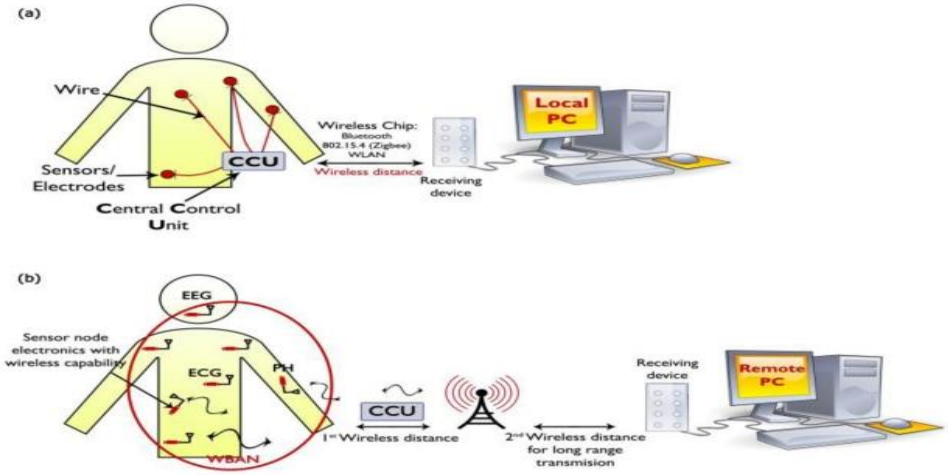

Figure 1: Remote Patient Monitoring System Architecture. [13]

Figure 2 depicts the Wireless Health Monitoring System (WHMS) block diagram.

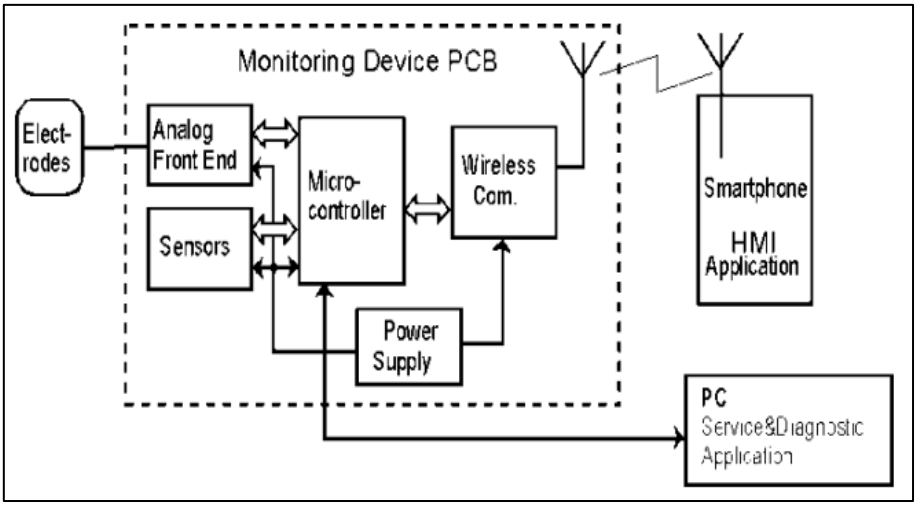

Figure 2: Block diagram of Wireless Health Monitoring System. (Source: www.sciencedirect.com) [11]

A powerful ARM Cortex M4F microprocessor is at the heart of the monitoring device worn by the user over their breast. It communicates with sensors and the Bluetooth Low Energy SoC via Serial Peripheral Interface (SPI) and the Twin Wire Interface (I2C). The electrical activity of the heart is gathered and amplified by the Analog-Front-End (AFE) block, which sends the signal to the microcontroller's analogue to digital converter (ADC) input.
Micro-electromechanical sensors (MEMS) such as a 3-axis accelerometer, pressure sensor, and altimeter are used in the proposed system. User activity can be seen and classified by combining all collected data from sensors.

Bluetooth Low Energy is used to establish a wireless connection between the monitoring and supervising devices. To preserve power during communication, processed data is sent at predefined time intervals (for example, one, two, or more seconds) based on the HMI application settings. [6]

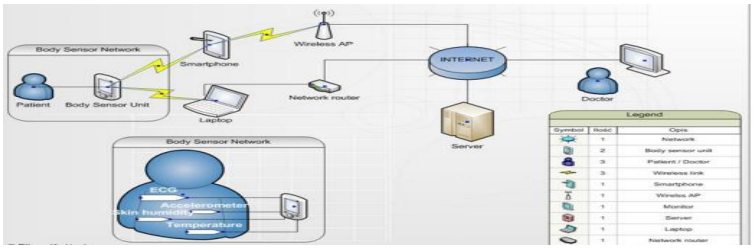

Figure 3: Architecture of BSN based system [6]

5.1 Automatic Wireless Health Monitoring System:

In today's hospitals, health care sensors are indispensable. Because of its revolutionary technology, the patient monitoring system is one of the most significant advances. [10] is proposed with ubiquitous ECG monitoring system which makes use of wireless system consisting of Zigbee and SIP. The system was very efficient for monitoring, analysis and diagnosing. Using GSM technology, an autonomous wireless health monitoring system measures a patient's body temperature and heartbeat. Both sensors, such as a heartbeat sensor and a temperature sensor, are used in the suggested system. These sensors primarily monitor the patient's conditio [12]. Health care delivery cost is reduced and provides user friendly atmosphere.

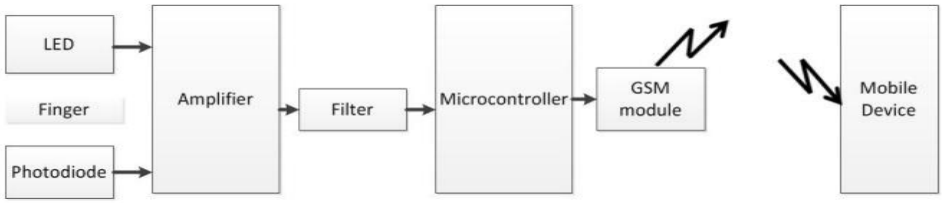

Figure 4: Block diagram of the proposed system [12]

IoT palays a major role in remote health care monitoring providing better efficiency in data collection and processing. [8] proposes a system in which the overall system is divided into I class in which Zigbee sensor network which works in a distributed manner, in II class the internet associated circuitry collects the datas, processes it and makes it available to the user.III class includes the decision making agency to take corrective measures if necessary.

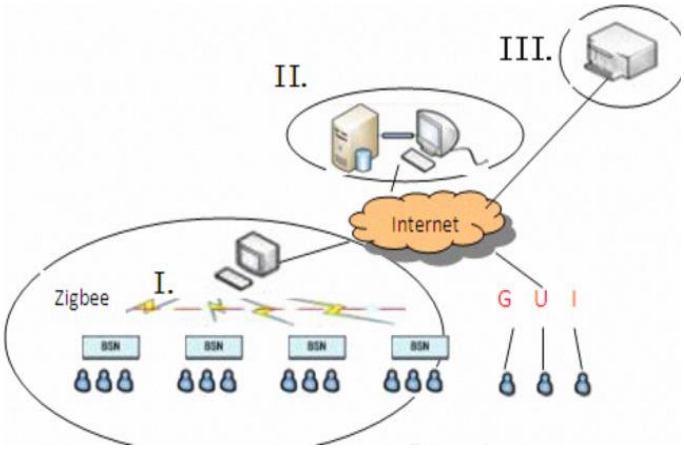

Figure 5: Proposed system block diagram [8]

The main aim of the system [1] is to monitor the health conditions of multiple people which provides user friendly recorded datas for current and future analysis. The system comprises of input module, communication module, user interface module and processing module. The main advantage of the system is that the doctor gets timely informations about the patient via SIM. Hence eventhough the doctor is not in his console he can instruct for further actions.

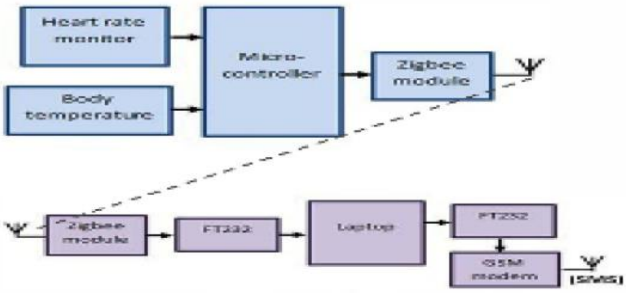

Figure 3: System architecture-Health Monitoring System For multiple patients [1]

Nowadays, systems and projects for healthcare monitoring rely on a common set of components and use standard or commercial sensors to collect raw data in order to monitor persons and their surroundings[14] Personal Sensor Networks (PSN), Body Sensor Networks (BSN), and Multimedia Devices (MD) are the three primary classes of interconnected networks that are frequently employed in this area, according to the research projects reviewed in this paper. Selected sensors and devices are embedded into home objects and infrastructure, and network technologies are used to connect them. At any given time, each sensor is in charge of one or more tasks.

PSNs are used to detect human daily activities and to assess environmental variables. BSNs measure physiological parameters and detect ambulatory activities to monitor vital signs and health problems. Finally, more contextual information about human activity is gathered using MD to track movement, ambient changes, and to improve interaction between the monitored individual and the e-health application. Figure 4 depicts an overview of sensor networks in HMS.

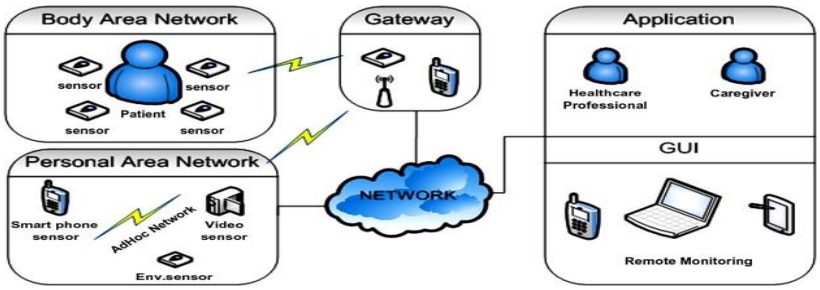

Figure 4: An Overview of Sensor Networks used in HMS [14]

The Internet of Things-based health monitoring and medical information system integrates technologies such as wireless networks and mobile computing, with the goal of providing patients with remotely receivable sensing, sound, image, and video multimedia information, improving medical diagnosis accuracy and clinical service quality. Wearing associated equipment allows accurate collection of the patient's blood pressure, heart rate, body temperature, pulse, and other information. Figure 5 shows the framework of health monitoring and medical information system based on the Internet of Things. Informations like pulse rate, are exchanged utilising sensor network technologies such as Zigbee, Wi-Fi, Bluetooth, ultra-wideband, and short-range wireless transmission. [15]. The informations exchanged are pulse rate, temperature, heart beat rate etc.

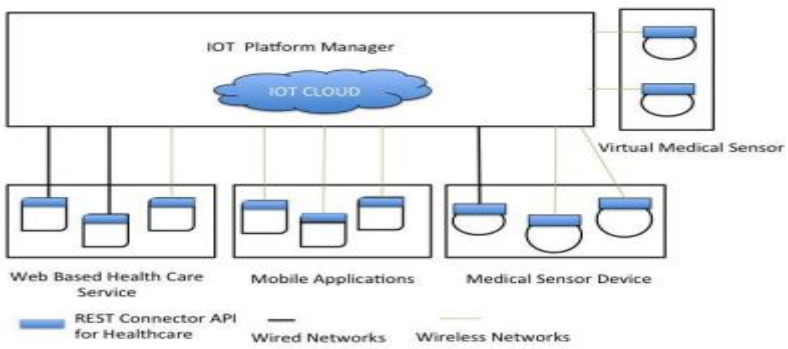

Figure 5: The framework of health monitoring system based on the Internet of Things [15].

Conclusion:

The Wireless Health Monitoring System can track a user's health metrics in real time. The usage of wireless technology improves the overall functionality of the system by transmitting information about any anomalies in the user's health. The projects' most essential features is that it monitors a moving patient or immobile patient. This mechanism ensures that the sufferer receives medical attention before it's too late. Continuous health monitoring and cost-effective illness management are the only ways to ensure the healthcare system's economic viability. This paper gives a study of the advanced methods of patient health monitoring .

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