

A survey on instantaneous data transmission in Wireless Sensor Networks for Healthcare Monitoring

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Abstract: Real time health monitoring using WSN of imbed and wearable sensors is visualized as a continual monitoring solution of bedridden outpatient with motility. This paper aims to implement an instantaneous patient monitoring framework, which is proficient in collecting, transmitting and monitoring patient's perceptual conditions. In present Health monitoring frameworks, the patients are supervised by medical professionals using various equipment's which are hardwired to nearby bedside monitors or PCs, and essentially these equipment's are substantial and consequently it keeps patients confine to bed. The drawbacks of these frameworks may affect the patient's mobility during monitoring the vital signs. Our proposed real time health monitoring framework can detect patient's health conditions like pulse rate, body temperature and electrocardiograph using different bio sensors, the collected data will be processed using ARM7LPC2148 and the processed data is efficiently transferred wirelessly to LabVIEW software via ZigBee. In case of abnormalities, the SMS will be sent to doctors/care givers using GSM. In addition, the proposed framework uses ZigBee technology since it is low cost and achieves low power usage to maximize the network lifetime, accelerate and expand transmission protocols and also battery life is significantly improved. This framework will help patients to recover easily and also provides enhanced medical care to patients at a low cost. Furthermore, the framework provides profitable benefits for virtually monitoring individuals living away from the remote areas, old individuals, heart patients and can be used for COVID-19 patients in home and hospitals thereby improving medical administrations.

Keywords: ZigBee, Realtime Monitoring, Wireless Network, Wearable sensors, Healthcare, Pulse rate, temperature, ECG.

1. Introduction

According to recent studies by World Health Organization each year, 134 million adverse events occur at hospitals in low and middle-income countries (LMICs), due to unsafe and poor quality health care, resulting in 2.6 million deaths. Also, in India many medical practices and risks associated with health care are emerging as major challenges for patient safety. According

to current estimates of WHO, the greater achievable standard of living is a basic right for an Individual. Normal people contrive to assure their lifetime earnings and in consequence to expand the Gross domestic product and in Tax revenues.

As the population ages and the risk of Arrhythmia, Heart Infections, Myocardial infraction, Preeclampsia, Hypertension, Atherosclerosis, corona virus disease, lower respiratory infections, renal failure, Chronic obstructive pulmonary disease increases, simultaneously the cost of healthcare will rise and QoS will not satisfy the requirements of society. Real time health monitoring offers a potential way to solve these problems of Continuously monitoring patient's wellbeing via wearable devices.

WSN play a pivotal part in this kind of tracking framework owing to the fact that Wireless sensor network can give several benefits among other kinds of Wireless frameworks in particular their interoperability, improved productivity, energy consumption, Cost efficiency and design versatility. Wearable devices are contributing in a significant manner to disease prevention, diagnosis, and precautionary steps. As Wireless technology and healthcare advance, they will become more sophisticated with enhanced patient safety. Developments in sensing technologies, the pervasive accessibility of wireless technology and declining prices of communication systems are launching fresh mechanisms for enhancing health care and quality of the well-being. Rapid development of wearable biosensors is changing the way we gather and interpret the information.

Although number of radical accomplishments has seen in medical service field over the last few days. Adhering to an excellent standard of measure cause-of-death data remains crucial for improving health and decrease preventable deaths in every country. Ultimately, this paper presents the development of Remote Patient monitoring framework, which has potential to identify the exact disorders of cardiac function, measure human temperature and measures Pulse rate. Furthermore, it ensures to notify the warning messages namely short message service (SMS) to the healthcare personnel in case of emergency.

The remaining paper is as follows, Related work and Drawbacks of certain systems are listed in Section II, Section III outlines the proposed framework in detail, Section IV depicts the Conclusion.

2. Related Work

Few of the recent works on mobile based healthcare monitoring framework was proposed in [1]. The presented framework provides real-time medical conditions of a patients which is capable of sending alerting notes through SMS when the health status of the patient is critical. Data from sensors is collected by Arduino, ZigBee is used to transmit the collected data to smartphone which has LabVIEW software running in it, LabVIEW is used to gather and transmits physiological information, finally results are published on internet with the intention of the caretaker can access the data from any place at one's convenience.

Remote monitoring framework for supervising various metrics such as Electrocardiogram, pulse rate, SpO₂, respiratory rate, and temperature has been designed in [2]. The data from the sensors is obtained and processed by microcontrollers, the processed information is delivered

to smartphone through Wi-Fi module. The application rises an auto alarm when abnormal values are detected in patient's data and delivers a alert signal to the professionals software via 3rd Generation mobile communication and Wi-Fi network.

Monitoring wellness of a pregnant woman with preeclampsia has been proposed in [3]. This framework detects the abnormal conditions of pregnant women, if the event is serious it issues notifications to caretaker. The author has used burst transmission mechanism to reduce the overhead, Time division multiple access (TDMA) to transmit only one node in each time divisions, CSMA is used to limit the transmissions and reduce the conflict between data sent and also proposed minimum path algorithm to find minimum path to transmit the data.

Smart health care monitoring framework for remotely monitoring the elderly people was proposed in [4]. The framework comprises of four main components viz., (i) Wearable sensors (pulse sensor): the wearable devices are connected to the human body to collect biological data. (ii) Gateway: the recorded data from the wearable devices will be sent to data centres via gateway. (iii) Cloud: the recorded data will be stored in cloud data centre and it also performs machine learning activities to detect abnormalities in patient's data (iv) Monitoring platforms: If any abnormalities are found then the data will be reported to authorized health personnel for immediate treatment.

A healthcare monitoring framework with a 3-tier architecture has been developed in [5] composed of a wearable sensor that can continually track the patient health. This system involves multiple sensors that capture data in terms of biomedical signals which are interpreted into digital form using microcontrollers that acquires data and then transmits it to clinical server for storing and handling through wireless networking. These details are made accessible to medical staff on internet across the world using IOT software.

Wireless Body Area Sensor Network built using ZigBee module is proposed in [6]. consisting of a series of biosensors connected to a body of patient. The usage of wireless router is to relay the records to a transceiver attached to processing unit and chosen LabView software because it has powerful DAQ. The collected data is carried out using Data Acquisition Framework (DAQ) provided by the National Instrument. So, the performance data produced by the LabView software procured quickly.

Wearable Wireless Body Area Networks are proposed in [7] as a key mechanism that enables subtle, continuous, ambulatory health monitoring has been empowered. This new innovation can offer a wide range of advantages for primary identification of unhealthy situations, managed retrieval and eventual detection of awareness by Data analysis among all collected data. Major implementation issues, and a WWBAN prototype focused on WSN and customized ECG and gesture sensors has been identified.

Patient health monitoring framework with LabVIEW and WSN to monitor the patient's vital signs was presented [8]. The framework is able to take biological parameters from patients and transmitting them wirelessly via XBee. The authors have paid much attention to the development of this subject in order to enhance access to care and improve patient health.

A BSN architecture intended for continuous healthcare tracking using biosensors has been developed in [9]. A number of wireless biosensors were devised with the BSN architecture, including ECG and Blood oxygen saturation, Context Sensors such as accelerometers, humidity sensors, temperature and are also combined with the BSN cluster to assist the amalgamation of gathered data. In addition, a lightweight flash BSN card is designed for PDA, where the PDA will collect, analyse, display sensor signals can also act as router connecting the BSN clusters and host computer, rather than serving as processor it can collect sensor data and transmits for extended storage and pattern discovery through Wi-Fi/GRPS network.

The author has presented some noteworthy healthcare applications and challenges for WSN[10]. The level of authenticity required and necessity that guarantee the confidentiality and safety of patient database. The resource depletion inherent in wireless sensor network platforms exacerbates these challenges. The author has also outlined prototype frameworks from neurobiological and action tracking to comprehensive biological and metabolic experiments covering different domains and highlight current scientific experiments.

A Study on WBAN for medical care has been discussed[11]. WBANs consist of advanced miniaturized devices has a capacity to detect, interpret and transmission. They are intended to be worn, track and relay sensory data to healthcare professionals. The author has also discussed about sensing and tracking in WBAN, analysis of energy efficient guidelines, explore the WBAN frameworks, methods to WBAN routing, various security techniques including protocols.

A real-time, portable wireless remote monitoring framework was developed[12]. The framework tracks and control Heart rate and oxygen saturation in the blood of patients using ZigBee wireless technology, the pulse oximetry data are transmitted to database computer server in the area of WPAN. The sensor modules were developed with a framework for low energy which can configure energy consumption according to power source and current power operation scenarios.

In [13] the author presents the state of the art of different forms of the network of WBASN, their Networking mechanisms, applications of WBASN program design frameworks, privacy problems and protocols for power efficient networking. By means of some analysis about existing radio technology for such kind of network, the author has covered the latest developments. The author has also outlined numerous factors and problems of WBASN, possible visualizations and obstacles in this field are addressed.

The solution in [14] supports the mobility of nodes with no limitations in communication. The author has presented a reliable solution to enable nodes mobility in controlled situation such as in hospital environment. The solution suggests a new approach to an intra-handover process that minimizes the exchange of messages between nodes and points connected to their network (Aps). Even if the patient's travel across various coverage areas of WSN Aps, it guarantees connectivity to the mobile nodes.

The author in [15] illustrates the use of WSNs as a main infrastructure that allows for unobtrusive, continuous, primary care health monitoring. Through continuous monitoring the framework can detect the unusual behaviours, structured recovery and has the possible knowledge consciousness by data analysis of all information collected and it offers a wide

variety of advantages for patients, health professionals and community. The author has illustrated a overall WWBAN framework, Major deployment problems and WWBAN framework focused on standard wireless sensor system and customised prototypes of ECG and gesture sensor designs.

Advanced study on biological parameters and performance tracking framework is presented in [16]. The framework can provide tracking and data processing, as well as predictive algorithms, which can potentially offer a higher level of trust in the prognosis of such illness, contributing to early detection and treatment. An overview on textile-based sensors which are possibly utilized for embedded frameworks are additionally discussed. Consequently, the consistency of numerous consultation innovations and perhaps even forthcoming bits including development issues for Realtime healthcare systems are analysed.

Realtime health tracking framework for cardiac patients found in distant ranges has been proposed in [17]. Portable sensors, web applications and android hand-held gadgets are included in proposed framework. The framework is versatile yet has capacity to obtain specific parameters for example pulse rate, temperature also blood weight of different patient's at same time. The collected information is transferred to android gadgets utilizing bluetooth and also transmitted to web application for advance handling. In the event of variations from the norm, the framework sends alarm messages to the specialist.

Healthcare internet of things services and people system has been proposed in [18] which is intended to gather information through embedded devices besides the fact it screens well-being of person but allows automated services to expand the quality of life. The computerized sequence of amenities based on perceptual behaviour and utilization of portable gadgets that are easy to use and are widely viable, is one of the highlights of the framework. The framework moreover coordinates multiple facilities that permits the collaboration with certain individuals such as specialists and practitioners through the notice hub. In order to demonstrate the comprehension of system in a real scenario.

The author in [19] depicts clinically significant biological measurements that can be restrained from sustainable gadgets nowadays and emphasizes its points such as wellbeing, steadiness and recuperation of COVID-19 people and lead specialists. The objective spreading from the paper is to start a call over activity among lead specialists and technicians toward creating advanced wellbeing stages for checking and overseeing this widespread.

A novel chronic patient healthcare monitoring framework was introduced in [20], which coordinates advanced innovations such as data processing, web services, Big data, ontology and Machine Learning. The system improves execution of dynamic information management ,transmission performance and also enhances consistency of the classification of medical information. The recommended strategy accurately looks at diabetes and blood weight patients utilizing different channels for patient's information for example cellphones,portable sensors, restorative reports, and community systems.

Technology for stress detection and monitoring could assist more individuals in a finer way and reduce anxiety on enhancing one's consciousness of anxiety levels which often remain

undiagnosed. In [21] author examines newly proposed human stress monitoring systems based on wearable sensors and risks that need to be noticed in order to address the hurdles.

The novel system for patient health monitoring is proposed in [22] which is focused to develop a design framework for tracking patient in real time. The Framework is often used to assess physiological conditions such as heart rate, SpO₂ and body temperature supervising using sensors. The obtained data is sent wirelessly to Wi-Fi embedded processor supports the analysis of patient input and stores the reports of all parameters in the server repository. The system implementation is achieved by sending indications to medical officials in case of abnormality felt by the patient.

The detailed description of current approaches to well-being and behaviour screening relying on embedded technology is explained in [23]. It illustrates a new wearable IoT cloud-based Health Monitoring framework that allows real time tracking of patients and enable access to Cloud information. Some wearable devices such as pulse rate, blood pressure and temperature sensors has been incorporated. The information collected from Wearable sensors is transmitted sent back to cloud and a portable wireless LCD could be integrated as another option to quickly display instantaneous data.

An anomalous incident like Coronavirus pandemic causes one to revise the impact of innovation in healthcare services operations. Author has addressed the various existent health tracking sensors such as heart rate, respiration rate, temperature, SpO₂ and respiratory assistance services like ventilation systems, Continuous Positive Airway Pressure systems, and surgical interventions are commonly used to help people impacted by coronavirus [24]. Embedded technology is alone expected to be efficient in delivering preliminary medication which may prevent the outbreak of this pandemic.

The evolution of adaptable and portable hardware combined which is capable to measure metabolic analytes and physical vital signs, permitted discovery of essential execution as well as anxiety has been discussed[25]. Biochemical sensors like microelectromechanical (MEMS), electrocardiogram (ECG), electromyogram (EMG), and electroencephalogram (EEG) offer a incentive for measuring patient's vital signs continuously in real time.

Medical management system to track patient's vital signs such as body temperature, Pulse rate and other room state measurements such as CO and CO₂ gas levels, humidity has been proposed in [26]. The system will track the vital signs of a patient and also room environment at which patients are probably in real-time. Some of the Sensors like room temperature sensor, pulse sensor, CO sensor and a sensor for CO₂, temperature sensors are used to collect data and also the status of patients is reported to medical personnel via a platform where they can examine and evaluate the present condition of patient.

A portable biomedical checking framework has been developed in [27]. The system can periodically track the patient's pulse rate, body temperature and humidity using sensors that are presented on LCD and data is transmitted wirelessly to medical server and that information is collected by approved staff using IoT framework. Doctors can retrieve the data stored by IoT Framework and the Illnesses are diagnosed from a distance.

Remote medical care infrastructure provides various tasks such as node mobility support, efficient data transmission and prompt data distribution, fast event detection, energy control

etc. The safety and security problems in health services using WSN are discussed [28]. For the successful implementation of such a wireless system, it is seen that a well-planned production framework must be configured. In this respect, developing a safe medical screening system using wearable sensors, we have found many significant threats, reflecting the fact that if a platform is secure, then people will perceive it.

In [29] the authors proposed a framework based on telemedicine system, of a body area sensor network. It consists of three phases. The phase 1 of this system consists of Body sensor network which collect precise biological information from patient and communicate it with BANC (Body area network coordinator). It's phase 2, a fast and secure service is used to transfer the physiological patient data from the BANC to the TMH. Finally, in Phase 3, the patient's vital data received by the TMH (telemedical hub) central unit is stored in the Electronic health record. The author also discussed the various types of sensors available, the QoS requirements, how to manage medical data, various routing techniques, the standard technologies, security issues and simulation environment for the system.

A network mobility-based ZigBee mobile router architecture and ZigBee network connectivity applications are proposed in [30]. The authors discussed the current wireless technology RFID (Radio Frequency Identification) used for tracking device and monitoring and its drawbacks with respect to power consumption, network lifetime and increased costs. The framework uses sensors to analyse patient's physiological data using heartbeat sensors, temperature sensor and microelectromechanical sensor to detect unusual signs of the patient. The signals from the sensors are sent to a (Peripheral interface controller) PIC microcontroller to process the digitalized input signals, which then sends them to the ZigBee module. Then the PC receives the output using Zigbee receiver and gets stored in the doctor's database. In addition, it provides an efficient way to transmit patients' data to the doctor's PC at an overall lowered cost.

Wireless sensor network in medical framework for Patient tracking to ensure security, where the confidentiality and security aspects are addressed in [31]. The usage of WSN, where an allotted telemonitoring device utilization is proposed. The patient's data is first sent to their personal device and then transmitted over the internet to the healthcare professionals. Patient monitoring with the help of cell phones, where Health network cell tracking is provisioned. The system is easily wearable on patient's body or clothes such as belts and it shows the video of patient's movements using Bluetooth, where a Bluetooth enables monitoring a patient affected with Alzheimer's disease. It delivers a far-flung care system based primarily on Wi-Fi sensor community, which provides excessive flexibility and right scalability.

WBAN supports medical technologies at initial stage of development that provide substantive tracking, diagnosis or curative commitments has been discussed in [32]. The WBAN sensor devices are used to collect sensor data and may fall into unfavourable conditions, in order to avoid caustic communications within the system, they need a complex and very secure security channel. The author has aimed to use the biometric technique as it is more reliable than other cryptographic techniques and algorithms to procure security. While developing a security solution for WBANs, it complies with all aspects of WSN, such as data security, authenticity, freshness of data, integrity and accessibility that make WBANs secure.

Healthcare Monitoring System in terms of emerging wireless communication, the use of WSN supports infrastructure, technology and challenges design problems, as well as security,

mobility and energy consumption are analysed in [33]. It provides a study comparing wearable body area network technologies such as WBAN, Structural health monitoring, and Zigbee. Also, the author addressed various technical issues such as network time synchronization, energy conservation and sensor node.

A smart healthcare system architecture based on an advanced wireless sensor network has been proposed in [34]. It primarily targets residents of assisted living and others who may benefit from continual, remote monitoring. The infrastructure manages a continuous medical history while preserving resident convenience and privacy. Unobtrusive sector and environmental sensors integrate to analyse the health of spaces and the people who inhabit them with wearable devices. Authorized health personnel will track the health and life habits of residents and watch for chronic pathologies.

An Elderly healthcare expert system in old individuals homes adapted to certain requirements of old aged individuals has been developed in [35]. Additionally, some chronic conditions, Elderly health care system aims at developing an innovative and integrative approach with the use of information technologies and knowledge to cover the significant medical requirements of the aged people, especially those who are at greater threat due to socio-economic problems. EHC offers personalized chronic disease intervention plans. For sensing tasks and access rights, various patients and their resident families as well as residents are differentiated.

An effective medical care tracking framework focused on an embedded system using ZigBee was discussed in [36]. The framework has capacity to deliver data over a long spectrum between two embedded systems through two transceivers. Wireless transmission was applied across two categories in the framework. The very first part containing the Arduino with ZigBee will relay information to the second device containing the ZigBee Raspberry. The second device will assess patient information and transfer it through the ZigBee transceiver to the first device.

The architecture of wearable sensors composed of three tiers for Remote Patient medical tracking framework was discussed in [37]. The usage of sensors are to collect and transfer patient biomedical signals to the Intelligent personal digital assistant using ZigBee and to hospital database for 3rd Generation communication. A differentiated service scheme was presented based on Scheduling and data processing techniques. In addition, this technique minimizes the propagation time of biological data and also improves the utilization of throughput.

The implementation of existing state of art WSN in healthcare framework is explained in [38]. The usage of sensors to collect the physiological signals of the environment particularly patient biological data like SpO₂, blood pressure, Pulse rate, blood glucose and actuators transform the virtual data into sensory perceptions such as Syringe pumps, surgical techniques etc. The Internet of Things systems include sensing devices for collecting and processing the data or actuators for input-based environment monitoring or both sensors and actuators via internet connection and data storage on cloud and individuals communicate with each other.

WSN for continuously monitoring the medical conditions of patients using Zigbee was introduced in [39]. The system tracks physiological conditions such as pulse rate, body temperature and measures salinity. Output of these sensors is sent through Zigbee and to the

remote wireless monitor to receive the biochemical signal of the examined patient. Zigbee and Personal Computer are integrated into the remote wireless display (PC). The obtained signal has to be delivered to the PC, which can analyse data.

An integrated Early Warning Score (EWS) health monitoring system for remote individuals with IOT technology to smartly track vital signs and eliminate medical impairment has been proposed in [40]. It provides healthcare providers with a 24/7 real-time service to track in-home patients remotely through the Internet and receive updates in the event of Emergency space. The EWS System implemented a Proof of concept for continual processing, transmitting and reporting of physiological data.

Several architypes for medical care monitoring framework is identified in articles. In the recent times, multiple and consistently growing technological innovation activities have been acknowledged. Subsequently our project is connected with ZigBee architecture, we concentrate mostly on the Realtime healthcare frameworks that have already been developed.

ZigBee is better than Wi-Fi or Bluetooth, since it requires low power so that it improves battery life and it is cost effective. Table 1 depicts the comparison of wireless technologies as shown below.

Description	ZigBee	Wi-Fi	Bluetooth
Maximum Range	10 – 100 mts	50 – 100 mts	10 – 100 mts
Power Consumption	Very Low	High	Medium
Network Topologies	Ad-hoc, star and mesh	Point to hub	Point to point or point to multipoint
Data transfer rate	250 Kbps	450 Mbps	2.1 Mbps
Channel capacity	5 MHz	160 MHz	902 MHz
Cost	Low	High	Medium

Table 1: Comparison of wireless technologies

3. Proposed Framework

The proposed framework comprises of two major sections Hardware and Software.

3.1 Overview of System architecture

The entire Framework architecture is shown in figure 1.

It is comprised of

- (i) Wearable biosensors that can be embedded in a patient’s body to fetch the biological data.
 - a. Heart rate sensor: An optical Heart rate sensor measures pulse waves in the volume of blood vessels that occur when heart pumps blood.

- b. Temperature sensor: used to measure temperature anywhere between -55°C to 150°C .
 - c. Electrocardiograph sensor: It is used to process the recording of electrical impulses of heart over a span using probes placed on skin.
- (ii) ARM7LPC2148: It is used to process input data obtained from the biosensors.
 - (iii) ZigBee modules: Used to transfer the input data from sensors at the rate of about 250 kbps.
 - (iv) LabVIEW tool: It is used for data analysis, signal processing and present results to the user.
 - (v) GSM modem: It is used to alert the patients critical parameters to the physicians through SMS.

3.2. ARCHITECTURE

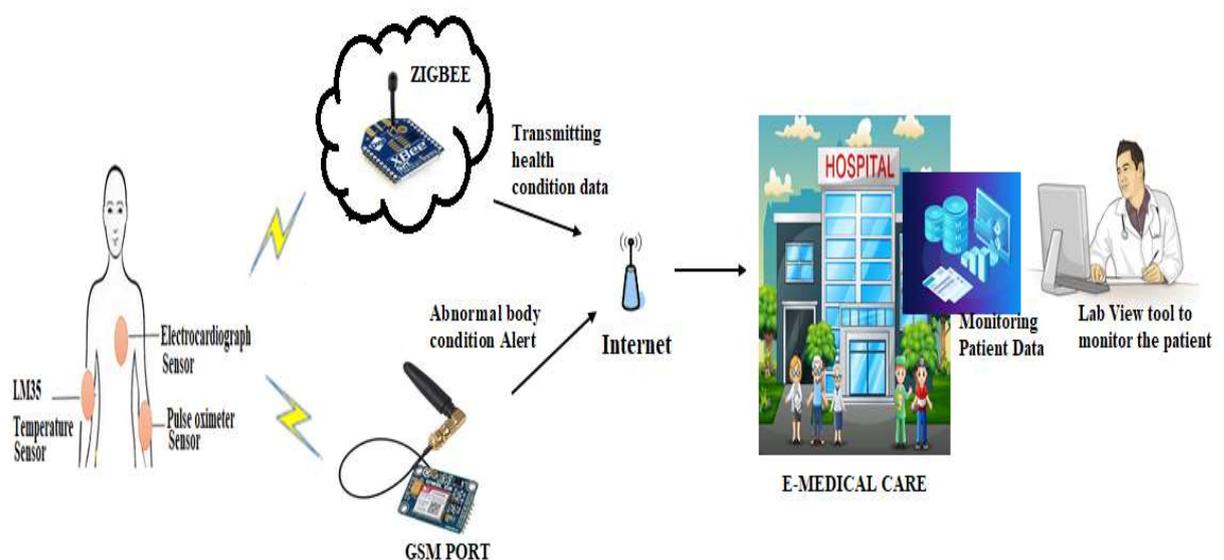


Figure 1: Structure of Real-time Healthcare monitoring using Wireless sensor networks

Figure 1 depicts the overview of proposed System. The framework consists of three sensors heartbeat, temperature and ECG sensors which are wearable by the patient's and the data collected from these sensors are processed by ARM7 LPC2148. The acquired data is sent through ZigBee to the PC which has LabVIEW software operating on it to extract the biological information from patient's body. The input data are managed and presented on LabVIEW by using Data Control panel application and information are also saved instantaneously and offered in a report form. Furthermore, a number of patient's personal data are collected. In emergency circumstances, an alerting note is delivered to healthcare personnel via GSM. The data is then posted on internet with the aim of providing access to obtain patient's records from anywhere at any time by the approved healthcare professionals.

3.3 Requirements

3.3.1 Major Hardware Requirements

1. ZigBee Module



Figure 2: ZigBee Module

XBee with Wire Antenna offers point to multipoint gadget network with ease, providing cost-effective wireless solutions for electronic gadgets. This module permit a consistent and naive communication amongst controllers, computer frameworks with an interface. Communication intervening two end nodes are favourable. This module has been used to both transmitter and receiver section.

2. ARM7LPC2148



Figure 3: ARM7LPC2148 Board

The LPC2148 has 32kB on the SRAM chip and 512kB on the FLASH memory chip. Up to 2kB of endpoint USB RAM is supported by this chip. For almost all applications, this memory is more than enough. 32kB of static RAM that can be used for storing code and data is supported by LPC2148. It is accessible in 8-bit, 16-bit, and 32-bit formats. For many more apps such as sensors, electrical control, mobile application, and much more, LPC2148

is suitable. The LPC is much faster than the Arduino (60 MHz) and power consumption is less compared to Arduino.

3. GSM modem



Figure 4: GSM module

The SIM800LV2.0 GSM/GPRS Module has a built-in regulatory circuit with QUAD-BAND GSM/GPRS module. The module functions by adding both GSM (voice call or SMS) and GPRS features. The advantages of these modules are the 5V voltage serial levels of VCC and TTL, and it can communicate with controllers or another minimum framework with a voltage level of 5V. In case of emergencies, this module is used to alert the care givers if the patient's temperature or pulse rate is abnormal.

4. Wireless biosensors in WSN

- Wireless biosensors persuade the necessities such as easy to wear and achieves clear and unobtrusive continuous monitoring of health, the biosensors are miniaturized, energy efficient and identify biomedical signals such as pulse rate, Hypertension, Respiration rate, ECG and temperature, so that it improves the user's level of comfort.
- For instance, rather than sending raw ECG data from biosensors, feature abstraction can be performed on biosensors and required data will be transferred about an outcome. Additionally wireless networks support the use of bio medical sensors which are characterized by its (i) very low transmit power to coincide with other medical tools. (ii) High data rate to allow implementation with high QoS (Quality of service). (iii) Low cost, low complexity to allow feasibility.

a) Pulse oximeter



Figure 5: Pulse Sensor

The pulse rate is one among the foremost vital signs, primarily for cardiac patients should be promptly monitored. Generally, the pulse rate of a normal person limits from 60 to 100 BPM. However, counting on individual's activity and biological condition, heart rates may vary. This constraint is often utilized with the aim of diagnosing tons of cardiac diseases. A regular pulse rate sensor has a set of LEDs facing with a photo sensing module spots infrared and red light exposed by finger and also it senses the difference in the volume of blood with reference to pulsation and Eventually creates a pulse in the output of photo sensing module. It combines an easy optical pulse sensor with magnification and noise reduction circuit generating quick and straightforward to obtain consistent pulse rate.

b) LM35 Temperature Sensor



Figure 6: LM35 temperature Sensor

Temperature sensors are diversely used in medical devices for health monitoring. LM35 is a combined analog temperature sensors used to estimate human body temperature. In general, Normal person body temperature ranges from 36.1°C or above. This sensor has capacity to measure body temperature in the intervals of - 55°C and 150°C. It omits exterior normalization or clipping to supply predictable accuracies. It also procures minimal self heating and ceases temperature rise more than 0.1°C in atmosphere. LM35 sensor is small and cheap Integrated Circuit yield voltage differs by 10mV in reaction to every °C rise or fall in surrounding environment.

c) Electrocardiograph Module

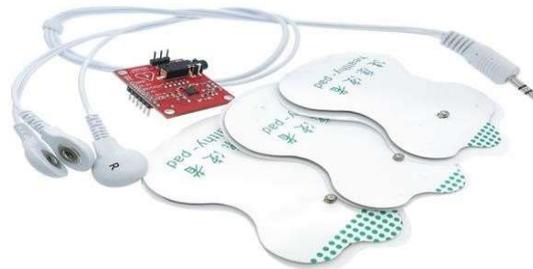


Figure 7: Electrocardiograph probes

The ECG module is cost-effective and it is used to detect the electrical activity generated every time a pulsation occurs. ECG electrodes are placed on necessary parts of the human body, normally on the arms, chest, and legs during an ECG process. The positioning and number of probes on human body parts may vary, but functionality remains the same. These electrical activities are often recorded as an ECG. The ECG records are used to recognize a comprehensive range of cardiac conditions.

Signal	Characteristics
Pulse rate	45– 150 bpm
Blood Pressure	dc – 60 Hz
Temperature	-55°C - 150 °C
Electrocardiograph (ECG)	0.05 – 100 Hz 10 mV (Foetal), 5mV (Adult)

Table 2 : Wearable Sensors Characteristics

3.2.2 Software requirements

1. LabView Software

LabVIEW is a framework design integrating platform and development environment for obtaining, handling, and transmitting biological information. It is user-friendly software that represents a graphic user interface design that can obtain physiological data. The principle of dataflow oversees program execution in a simple way. LabVIEW programs can be effortlessly executed specifically to machine language with the aim of a mainframe can process it. Additionally, the output information created by the LabView and it can be effectively procured. The attainment of data will be carried out

utilizing the National Instrument's Data Acquisition System (DAQ). A huge set of data produced from a range of estimations arising from sensors and data acquisition systems can be modelled and analysed. It offers very strong tools for data acquisition, data analysis, and data visualization. The use of DAQ reduces the complexities such as hardware issues and to fit for more options it can be quickly remodelled and adjusted.

For instance,

- Embedded option embeds the virtual instrument's (VI) front panel so that users can remotely view and control the front panel using a browser.
- The Snapshot option displays a static image of the browser's front panel and it does not permit the browser to interact with the virtual instrument's (VI) controls.
- The Monitor option shows an animated snapshot that is continuously updated and it does not allow the browser to interact with the virtual instrument's (VI) controls. LabVIEW can instantly store patient's biological information in report format, which is a major advantage. LabVIEW provides certain unique features based on the stored information, such as transmitting a message to notify specialists and posting the details on internet as then concerned healthcare professionals can retrieve from any place around the World at one's convenience.

2. XCTU Software

XCTU is compatible with Windows, Mac-OS and Linux and it is open-source, cross-platform application developed to programmers, through a easy user friendly interface, to interrelate with XBee modules. It comprises a tools required by programmer to operate with ZigBee modules. Also these modules can be easily built, programmed and evaluated. It is a convenient programming language to quickly build XBee API modules is XBee API Frame Constructor. The XCTU software is used to manage and configure the multiple XBee modules to communicate wirelessly with each other. It includes comprehensive and complete documentation that can be accessed at any time.

Conclusion

Wearable technology plays an essential role in the healthcare sector as well as in our daily life by providing real-time remote monitoring. In the literature articles, there are other survey studies designed to track several parameters such as Heart rate, blood pressure and temperature. Data obtained from sensors is processed via integrated circuits, and this data is transferred through Bluetooth or Wi-Fi module to the smartphone/PC. Many of the existing frameworks have used wi-fi, which absorbs high power and is often costly, and a few other frameworks have used Bluetooth modules with almost the same properties. However, the candidate wireless technologies are contrasted from these studies, however, where Zigbee demands low power and properties such as high reliability, low complexity, low cost, and greatly improves battery life.

Declarations

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***Conflicts of interest/Competing interests**

- All authors have participated in (a) conception and design, or analysis and interpretation of the data; (b) drafting the article or revising it critically for important intellectual content; and (c) approval of the final version
- This manuscript has not been submitted to, nor is under review at, another journal or other publishing venue.
- The authors have no affiliation with any organization with a direct or indirect financial interest in the subject matter discussed in the manuscript

***Availability of data and material**

Not applicable

***Authors' contributions**

This work is obtaining the information about related works, architecture, hardware components and software.

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