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Remote Continuous Health Monitoring System using Wearable Sensors Networks and IoT

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Abstract: The huge expanding of the more seasoned population, higher caliber of distant medical services and therapy is presently expected in the developing nations. This consideration is particularly vital for the nations with 75% of the older people experiencing ongoing illnesses. Additionally, long haul observing of patients is a test to numerous families in this period of family units. Wireless Sensor Network (WSN) is turning into a promising innovation for different genuine applications. The high level miniature electro-mechanical frameworks (MEMS) with the sensor innovation persistently screen the ailment of a patient that is known as Wireless Body Area Network (WBAN).It can commonly expand over the entire human body and the hubs are associated through a remote correspondence channel. The compound sensor nodes in WBAN are fit for testing, handling, and imparting at least one imperative signs, for example, pulse, oxygen immersion level, action etc. as well as the ecological factors such as humidity, temperature, light and location, etc. of a patient and information transferred to far away using cloud platform. Enhanced wearable devices and cloud access delivers solution to health care field. In this paper, alongside the indispensable boundaries, the fatigue level and ecological boundaries likewise estimated and are sent through fringe interface to a Microcontroller unit (MCU). MCU is answerable for adjusting and investigating the crude information to remove the oxygen immersion, pulse, and temperature data, and afterward diverting the indispensable boundaries into the LoRa and Bluetooth module. The remote Bluetooth and LoRa module communicates these indispensable boundaries to different terminals, for example, cell phones and laptops. Any IoT stage can be utilized to store and recover the information. In light of the qualities got, the sicknesses are analyzed by the specialists from a good ways and caution is shipped off the patient.The test results show that the framework is compelling and dependable for the assortment, transmission, and show of ECG information continuously for the motivation behind tele monitoring of patients with coronary illness

Keywords: Healthcare, Wireless Sensor Networks, Cloud Computing, Body Area Networks, Wearable Devices

1. Introduction

The expression "Web of Things" (IoT) was first utilized in 2009 by Kevin Ashton to allude to organizations of actual gadgets with the ability to obtain information and forward them to an information concentrator for preparing.

In the most recent decade, IoT frameworks have given compelling and important answers for checking and control in an assortment of fields, for example, transportation, Transportation, Agriculture and Medical field. Internet of Things (IoT) innovation gives a skillful and organized way to deal with handle administration liberation parts of medical care as far as portable wellbeing and distant patient observing. IoT creates an extraordinary measure of information that can be handled utilizing distributed computing. However, for realtime distant wellbeing checking applications, the postponement brought about by moving information to the cloud and back to the application is unsuitable. Comparative with this specific circumstance, we proposed the far off patient wellbeing checking in brilliant homes by utilizing the idea of mist figuring at the savvy passage [1]. Worldwide wellbeing which indicates impartial admittance to medical services, especially in distant country creating locales, is described by special difficulties of reasonableness, openness, and accessibility for which quite possibly the most encouraging mechanical intercessions that is arising is the Web of Things (IoT)- based far off wellbeing checking [2]. The environmental risk conveys from the virtual zone concept and provides updated information for different places. Two layers are considered for the correspondence between the IoT hub and server, 4G/5G/WiFi, or LoRa, which can be chosen dependent on ecological requirements. The necessary bandwidth utilization and data

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transfer capacity (BW) are thought about for different occasion situations [3]. The measure of information traded among the gadgets of an IoT framework for physiological boundary checking might be a basic issue and relies upon the degree of information preparing and how it is circulated among framework gadgets. A huge differentiation can be drawn between the trading of crude information that is run of the mill of information logging applications and the situation where some degree of neighborhood handling is requested of IoT network hubs, empowering the trading of qualified estimation data [4].

2. Literature Review

In recent years the researchers have shown interest in Internet of Things (IoT), due to its applications in various research areas. Device to device interconnection, connection between different entities, connection between anything and everything without the limitations parameters such as distance and time have been carried out by IoT technologies [5], [6]. The healthcare applications are predominantly using IoT technology due to the increasing in human lifespan, chronic diseases, elderly people and deterioration in people's health across globally etc. [7]- [8]. The continuous long term monitoring of human vital signs, such as the heart rate (HR), respiration rate (RR), blood pressure (BP), body temperature, etc. could be used for early diagnosis and treatment of chronic diseases which could improve people's health conditions [9]. Also, continuous health monitoring is a needy one for the elderly people because of limited social resources (doctors, nurses, hospital beds, and medical equipment) with the existing medical system comparing with the increasing aging population [10]. The technological advancement of remote communication, installed frameworks and wellbeing offers imaginative options in contrast to clinical consideration, specifically, tele monitoring and tele solution. ECG signal checking is an essential marker in the control of coronary illness. All things considered, one of the fundamental difficulties of far off checking of pulse is the prerequisite of control as per the help given by medical clinic hardware [11].

Security and protection have been a more noteworthy worry throughout some stretch of time because of the delicate idea of the information gathered and sent by the organization. It has been seen that different strategies have been applied to get the information and furnish protection in WBANs however with a tradeoff of execution overhead [12]. In fact, WBAN is a gathering of interconnected, low force, brilliant, and scaled down sensor-hubs, which impart their detected information through a remote medium in or around the human or patient body. It has as of late arose as another pattern and alluring innovation to give such reasonable medical care arrangements. Current advancement in innovation, particularly remote body territory organization (WBAN) got one of the empowering advances that give numerous effective applications in non-clinical or clinical field. WBAN is a correspondence standard improved for low force gadgets and procedure on, in or around the human body, to screen the human medical problems and course the physical or fundamental information from biosensors hubs to the worker for additional investigation [13]-[14].

A significant test for the fate of medical services is to give customized care taking into account a quickly extending medical services framework inside monetary restrictions and an expanding interest for supportability [15]. WBAN which comprises of wearable or implantable sensor hubs, is an innovation that empowers inescapable noticing and conveyance of wellbeing related data and administrations. The radio-empowered implantable clinical gadgets offer a progressive arrangement of uses among which we can highlight exactness drug conveyance, savvy endoscope containers, glucose level spectators and eye pressure distinguishing frameworks.

Gadgets with WBAN are for the most part battery controlled because of affectability and criticality of the information conveyed and took care of by WBAN, dependability turns into a basic issues. WBAN loads a serious level of dependability as it straightforwardly influences the nature of patient noticing. Undetected hazardous conditions can prompt demise. A principle necessity is that the medical services experts get the checked information accurately in crisis circumstances. The significant target is to accomplish a dependable organization with least deferral and most extreme throughput while considering power utilization by diminishing pointless correspondence [16].

3. Overall Architecture of the Developed System

The major concept of the proposed project is to develop a continuous health monitoring of elderly patients from home by using a three-layer sensor system. The main advantage of using this system is wire free, low cost and energy efficient system. Also, it is easy to handle by the elderly people. Fig.1 explains the overall idea of the system to be implemented. It havetwo layers such as layer 1 and 2. The layer 1 consists of temperature sensor, heart rate sensor and the second layer which should measure the environmental parameters.

The sensors associated with this layer are gyroscope, accelerometer and magnetometer. Also, the fatigue level of elderly people is a very important parameter for the assessment of health status. This is considered as a third layer, where the fatigue detection has been carried out by posture detection mechanism. The integrated sensors continuously monitor the heart rate, temperature, also the environmental parameter.

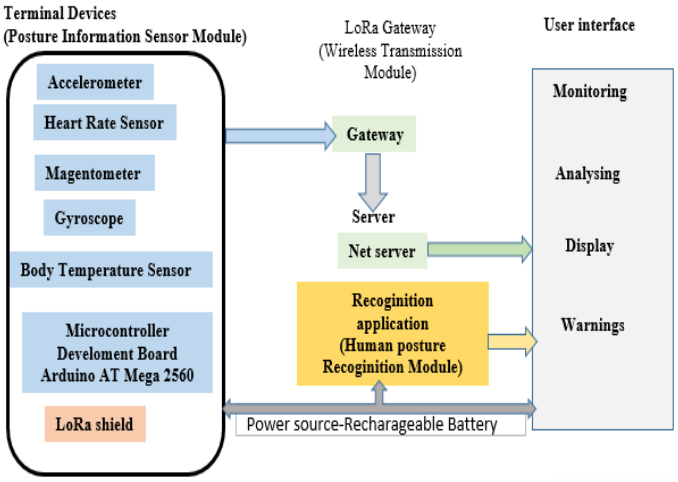

Figure.1. Overall System Architecture of The Proposed Project

The output of the sensors are applied to the analog to digital converter, signal conditioning unit before applied to the Microcontroller Unit (MCU) for analysis. The MCU compares the data acquired with the normal values and it is transmitted to cloud for storage using LoRa module. A mobile application is

developed for viewing the data. In case of any abnormality, it is intimated immediately to the user and physician for quick diagnosis.

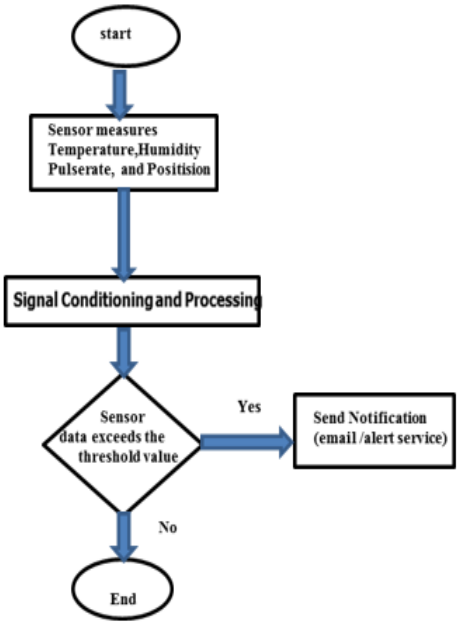

Figure.2. Flowchart of the Proposed System

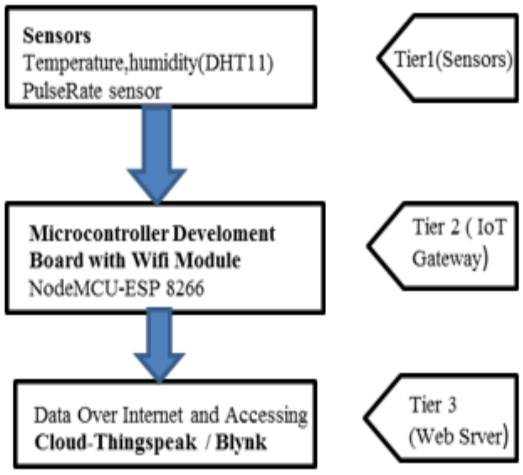

Figure.3. Proposed System Process Diagram

The flow and the process diagrams of the developed project is given in figures 2 and 3 respectively.

The overall system consists of sensor module, data processing and cloud. Pulse sensor is used for monitoring heart rate of the people. The light-absorbing property of hemoglobin is used in the measurement of heart rate. The sensor has two surfaces. The front side of the sensor makes contact with the skin. There is a small round hole in the front surface from where the LED shines into the skin surface. A square shaped ambient light sensor is placed beneath the LED. When the LED emits the light, the sensor reads the reflected light. The light detector produces an electrical signal and this analog signal is converted into a digital signal to measure the heart rate. Heart rate for adults ranges from 60 to 80 BPM at the resting condition. The figure 4 shows the plug and play type biometric pulse rate detecting sensor, which have the +5V or +3.3 V of voltage for normal operating condition, and 4mA of current consumption. Amplification and noise cancellation units are inbuilt in this sensor.

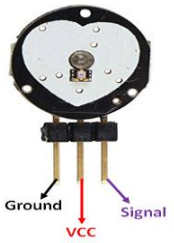

Figure. 4. Pulse Rate Detection Sensor

A linear variable resistive sensor measures temperature variations of the people based on the change in resistance value. The normal human body temperature value is 98.6°F (37°C) as an average one. From the literature review, it can show that the value ranges from 97°F (36.1°C) to 99°F (37.2°C) for "normal" body temperature. The DHT11 sensor is used here to measure Temperature and humidity values. It has negative temperature coefficient to measure temperature and obtained a serial data from 8-bit microcontroller as the values of temperature and humidity. It can be easily interfaced with other microcontrollers. The sensor measures temperature values ranges from 0°C to 50°C and humidity ranges from 20% to 90% with an accuracy of ±1°C and ±1%.

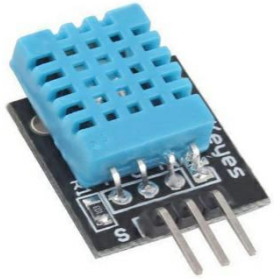

Figure.5. DTH11 Temperature and Humidity Sensor

The humidity component has two electrodes with moisture holding substrate between them. The conductivity of the substrate changes when the humidity of the surrounding changes. The IC should process the change in resistance and it is given to microcontroller unit.

These measured signals are sent to a Microcontroller unit (MCU). The processed data by the MCU redirected the vital parameters into the LoRa module. The LoRa module transmits these vital parameters to cloud and to the host. From these points the stored vital parameters can be accessed by the doctor and further action can be taken by them. In this paper, NodeMCU Esp8266 with Wifi -Internet of Things Development Board is used for practical implementation. It is shown in figure 6.

Figure.6. Node MCU ESP8266

In this paper, Blynk App is used in iOS and Android device, which could be used to build quick interfaces for controlling and monitoring of the developed hardware projects. After downloading the Blynk app, it creates a project dashboard and buttons, sliders, graphs, and other widgets onto the screen are arranged. Also, ThingSpeak is used , which is an open-source Internet of Things application and API to store and retrieve data from things using the HTTP and MQTT protocol over the Internet or via a Local Area Network.

7. Results and Discussion

The proposed system is developed using the sensor units, MCU unit and cloud platform. The developed prototype system is shown in figure 7. It is a wearable band. The developed prototype system performance is evaluated and its result is shown in figure 8. The system performance is compared by applying test over healthy and unhealthy subjects. A pulse rate measured from a normal subject using Think speak is shown in figure 8.

Figure. 7. Wearable Pulse rate wrist band

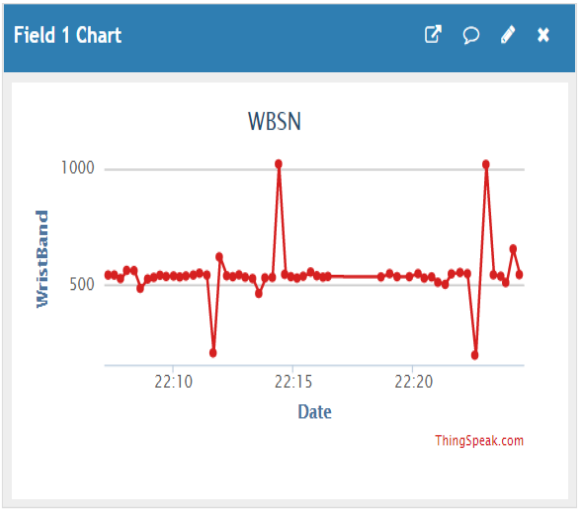

Figure. 8. Pulse rate of the normal subject.

8. Conclusion

In this paper, a continuous smart integrated health monitoring system is designed and developed to monitor the elderly people health condition. It is a low power long range IoT based communication device with a smartphone application. Also, the developed one is a noninvasive device. The developed prototype is applied over different persons with different health conditions and proved that the device provides a proper classification of the subjects according to the measured value. This method provides a high accuracy in differentiating the normal and abnormal condition of the person. This system not only measures the vital parameters, along with that it takes the environmental condition of the elderly person. This keeps the system smarter in providing a better care. Also, the WSN based IoT system consumes minimal power when it is working continuously.

Conflict Of Interest

The authors declare no conflict of interest

Authors Contributions

All authors had approved the final version

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