WEARABLE WIRELESS SENSOR NODES FOR TELEMONITORING OF VITAL BODY PARAMETERS AND HEART ACTIVITY

Sahana R[1], Dr. Vidya. H[2]

[1]*Student, Dept. of Telecommunication Engineering, Dr. Ambedkar Institute of Technology, Karnataka, India*
[2]*Associate Professor, Dept. of Telecommunication Engineering, Dr. Ambedkar Institute of Technology, Karnataka, India*

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Abstract-The technological progress of wireless communication, embedded systems and health equipment offers innovative alternatives to medical care, in particular, the telemonitoring of vital signs such as the ECG signal for heart disease, BP sensor for blood pressure measurement, temperature sensor for body temperature and pulse oximeter for blood oxygen levels. The ECG signal is measured by the sensor node from the human body, which process the signal and detects heartbeats. BP sensor measure the blood pressure, Temperature sensor checks the fever of the patient and the data will be collected over a minute. Pulse oximeter is also called SPo2 sensor, are used to measure the blood oxygen levels. A novel approach for the ECG telemonitoring using Wireless Sensor Node is proposed, where the ECG signal is measured with noise suppression. The acquired signal is used in QRS peaks detection to determine the heart rate. Thanks to a wireless transceiver, the heart rate, blood pressure, body temperature and oxygen levels are transmitted in real-time, which is able to aggregate data via a Cloud on the IoT platform. The experimental results show that the system is effecive and reliable for the ECG measurement, Blood Pressure measurement, Temperature of the body, and Pulse oximeter, processing, transmission, and visualization of information in real-time for the purposed remote monitoring of heart activity, Blood Pressure(BP), Body Temperature(BT),and Blood oxygen saturation (Spo2).

Keywords-Telemonitoring, Internet of things, Electrocardiogram, Temperature sensor, Blood oxygen saturation.

1. Introduction

In the recent years, the continued aging of the world's population and the soaring incidence of chronic diseases require modern and more effective health services. Recently biomedical equipment has seen many technological innovations fulfill this demand for fast and accurate diagnosis and analysis. Numerous intelligent remote monitoring systems are available today, due to the need for remote monitoring of patients with chronic diseases and the elderly. Monitoring the health of patients in their daily routines using wearable wireless biomedical sensors provide the potential to significantly improve the quality of life. Heart rate, blood pressure, and body temperature are key variables to consider for early intervention and long-distance commencement to prevent repeated hospital visits and clinical occurrences. Electrodes are placed on the skin surface of the patient's wrists and legs to measure heart rate during an ECG. Blood pressure combines ECG and photogrammetry methods to constantly monitor systolic and diastolic blood pressure. A thermistor is used to measure body temperature, Literature survey, design methods, experimental results are presented here. The primary goal of the proposed approach is to provide an alternative to the cardiac activity service of remote monitoring of hospital equipment. As a result, this research proposes a wireless, wearable device that can measure, analyze and send information about heart activity to a health center, eliminating the need for patients to go to a health center on a daily basis for consultation or to monitor their heart disorders. During quarantine, a wearable IoT-based device is used to remotely monitor and record vital parameters of patients.

2. Literature survey

Prof. Mr. Absalom E. Ezugwu et.al., "Smart healthcare support for remote patient monitoring during covid-19 quarantine"
Since the outbreak of the novel coronavirus disease (COVID-19) in 2019, social segregation and quarantine have become common policies around the world. Full adoption of the control measures outlined above can prevent frequent consultation visits to the hospital. However, some basic physical needs still require regular monitoring in order to lead a healthy lifestyle. Surprisingly, when Due to recent technology advancements in the Internet of Things (IoT), smart home automation, and healthcare systems, contact-based hospital visits are no longer required. The Smart Home Healthcare Support System (ShHeS) is suggested to accomplish this objective by monitoring patients' health and obtaining prescriptions from doctors while they are at home. Physicians may also establish a diagnosis based on data gathered from the patient remotely. An Android mobile app that interacts with a web-based software has been created to provide a real-time dual link for prospective patients and physicians.

Sensors are incorporated in the system to collect patients' physical health data automatically. In addition, for service innovation and context editing in the home environment, the hyper-analog to context (HAC) distance has been introduced to the existing monitoring framework, resulting in more precise physiological parameter readings and better system performance. Patients may be monitored remotely from their homes using the suggested system, and they can live a more pleasant life by utilizing some features of smart home automation equipment on their phones. One of the study's most significant contributions is that patients with self-loneliness or self-confinement may utilize the new platform to convey symptoms and everyday health issues to doctors through their mobile phones. Despite the fact that there have been 20,026,186 million cases and 734,020 thousand fatalities globally so far, a healthy and happy existence may be attained even in the middle of the 2019 COVID-19 pandemic.

3. Proposed model

The suggested model's block diagram is illustrated in figure1. ECG sensor, temperature sensor, blood pressure sensor, pulse oximeter, also known as Spo2 sensor, raspberry pi, power supply, cloud server, and smart phone are all shown in the block diagram. This paper describes the design and implementation of a portable wireless ECG monitoring sensor, as well as a Blood Pressure (BP) sensor, a Temperature sensor, and a Spo2 & Pulse sensor (MAX30100).

The ECG signal is measured and analyzed by the sensor node in the human body to detect heartbeats. The BPM is the beats per minute (Beats per Minutes) is computed using the heart rate, the blood pressure sensor, and the temperature sensor, all of which are gathered throughout a minute. The MAX30100 sensor is a pulse oximeter (Spo2) sensor, which is used to detect the amount of oxygen in our blood. Because the Raspberry Pi can only read digital data, MCP3800(ADC) is utilized to convert analog data to digital data. The charger provides electricity to the whole system. Once the data is gathered by the Raspberry Pi, it uses SGF (Savitzky-Golay Filtering) and BPF (Band Pass Filter) to smooth the signals and suppress the noise before determining the heart beat. Finally, the data is transmitted to a cloud system that analyzes the values and decides if the heart state is normal or pathological, based on data sheets of various pulse signals. All of the data is transmitted to the cloud. If all of the values are normal, the values will be shown normally; otherwise, data will be sent through the IoT app, allowing the authorities to take care of the patient. The suggested system has been installed and tested effectively and efficiently.

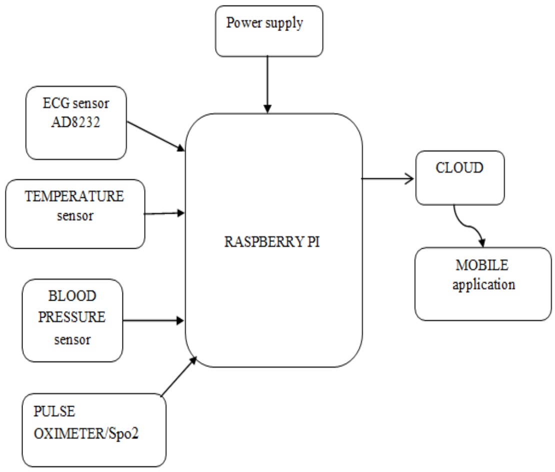

Fig- 1: Block diagram of proposed model

4. Simulation

Python is a popular programming language among programmers owing to its increased efficiency. Because there is no editing step, the edit-test-debug cycle is significantly quicker. Debugging Python programs is simple: a hashing problem is never caused by an error or bad input. When the compiler detects a mistake, it raises an exception. If the program fails to identify an error, the compiler shows a stock trace. It is possible to examine local and global variables, execute arbitrary expressions, create breakpoints, traverse through a line of code at once, and so on using the source level debugger. Python includes a debugger, demonstrating Python's intuitive capabilities. Adding some print statements to the source code, on the other hand, is generally the quickest method to debug a program: a short editing, testing, and debugging cycle makes this simple approach extremely effective. The use of a digital computer to process digital pictures using a computer science method is known as digital image processing. As a subset or field of digital signal processing, digital image processing has many benefits over analog image processing. This enables a wide range of algorithms to be applied to the input data, as well as the correction of issues like noise and distortion. Multi-dimensional systems relate to digital image processing in which pictures are specified in two (or more) dimensions. The development of digital image processing has been influenced by three factors: first, the advancement of computers; second, advances in mathematics (particularly the creation and improvement of discrete mathematical theory); and third, the growing demand for a wide range of applications in the environment, agriculture, military, industry, and medical sciences.

4.1 Uploading to Cloud

The data from the hardware is analyzed and verified by the simulation tool and then uploaded to cloud through URL mentioned in the program. Then the files in cloud updates the data to an application in a smart phone and again update the modified data from an app like whether the heart and body conditions is normal or abnormal. The python language is used for programming the files in the cloud.

4.2 Procedure for App generation

Step 1- Download and install Android studio 4.0 from official site.

Step 2- After downloading the components create new project.
Step 3-Define permissions in Manifest file.
Step 4-Import libraries in gradle file.
Step 5-Write XML code and type cast the variables
Step 6-Now build the apk file from Build/Build bundle/apk/Build Apk(s)

5. Steps involved in python coding

The signals received from the database are processed by SGF (Savitzky-Golay Filter) in the first stage to suppress the high-frequency components. Figure2 shows the DWT based QRS dectection. The signal is sent through the BPF (band-pass filter) to suppress the P and T waves and to further differentiate the QRS regions. The DWT technique is used after BPF treatment to make the QRS areas more visible. The rest of the research focuses on controlling the QRS area shape and identifying areas using custom entry levels. The role of the high-pass filter (HPF) is an algorithm that eliminates the signal baseline deviation that occurs after operations. As a result, the base level of the signal becomes constant. The QRS zones are identified using adaptive threshold determination based on the STD (Standard Deviation) and mean values of the signals in the last part of the research.

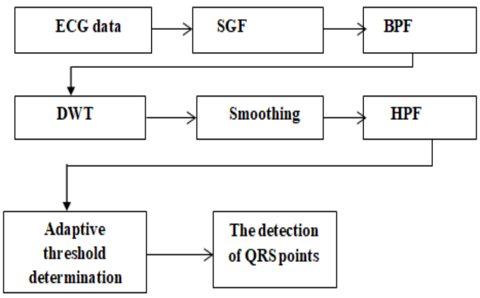

Fig- 2: DWT based QRS detection

6. Implementation and results

A typical ECG consists of a range of P, Q, R, S and T waves, which are repeated 60-120 times per minute and adhere to the specified size and shape criteria. The heart is in a normal sinus rhythm if there are certain conditions. If the patient's heart rate is higher than normal, he is in a severe condition.

The normal range for blood pressure is 90 / 60mmHg to 120 / 80mmHg. Blood pressure of 120/90 mmHg or higher is considered high. Low blood pressure is defined as a reading of 90/60 mmHg or less.
Normal body temperature is 30 C (30 to 30 C). According to specific "research", "normal" body temperature can vary from 28 C to 30 C. A temperature above 30 C indicates that you have a fever caused by an infection or illness.
Blood oxygen saturation (SpO2) is an important property that can be easily measured using photogrammetry (PPG) and pulse oximetry techniques. PPG technology allows to obtain different waveforms of blood vessels, which can then be used to determine the oxygen saturation of the blood using two wavelengths (usually 660 nm and 905 nm). When hemoglobin binds with oxygen, its absorption spectrum changes. It is possible to measure the amount of oxygen carried by blood cells using the principles of oximetry (usually 95-100 percent). This test helps to detect undiagnosed changes in patient health such as oxygen (80%), which indicates hypoxia and leads to insufficient oxygen delivery to the human body. When the patient is anemic, it is difficult to measure the oxygen saturation of the blood.
After that, all the data is transferred to the cloud. If all values are normal, the values are displayed correctly; Otherwise, the app will send an alert to the concerned authorities to take care of patient.

6.1 Data collection part

Figure 3 depicts the hardware model. The system is connected with the help of local host such as WI-FI, which includes the raspberry pi. The ADC converts the analog ECG signals into digital signal. ECG signal determines the heart disorders either it is normal or abnormal. The raspberry pi collects all the data from sensors and (MCP3008)ADC and transfers it to the cloud computing system. The smartphone phone app displays the data of heart and vital functions.

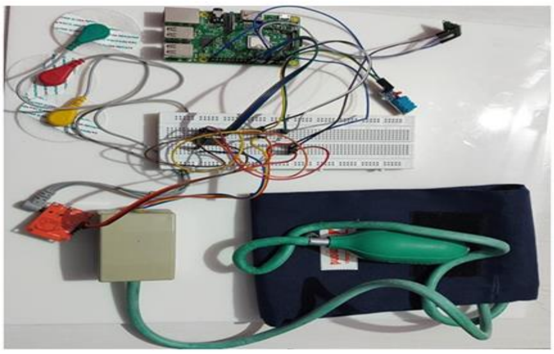

Fig- 3: Hardware model

6.2 VNC Viewer(virtual network computing)

Step 1- First connect the hardware as shown in the below and give power supply through USB cable.

Step 2- Switch Wi-Fi hotspot on in the mobile where app is installed and connect to the laptop. Make sure that the mobile and laptop have the same local host.
Step 3- Enable the VNC viewer shown in figure4.

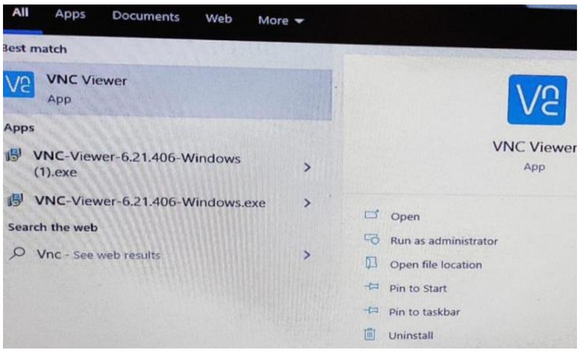

Fig- 4: VNC viewer window

Step 4- Select the IP address shown in figure5.

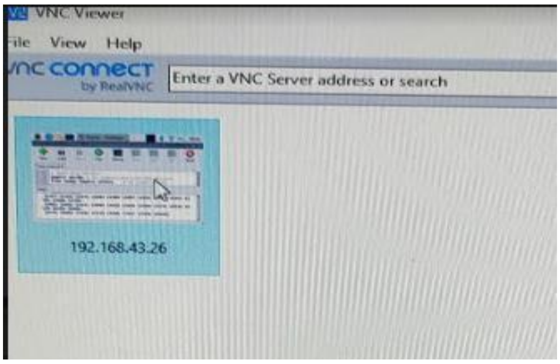

Fig- 5: Selection of respective IP address

Step 5-Enter the username and password. shown in figure6.

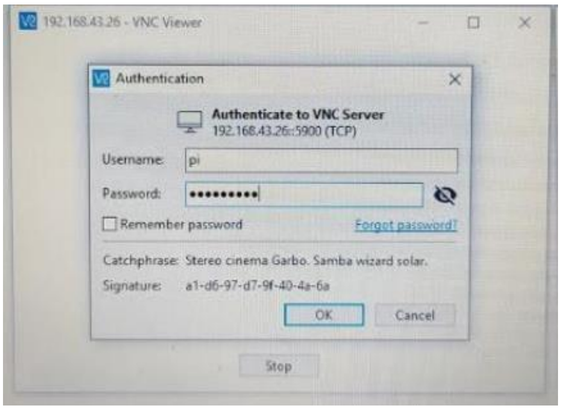

Fig- 6: VNC viewer authentication window

Step 6- Now run the VNC viewer and see the output in the shell which displays health condition shown in figure7.

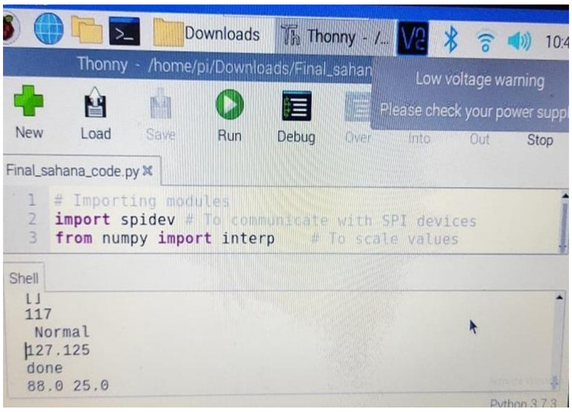

Fig- 7: VNC viewer output window

Step 7- Same thing will update in the mobile App through cloud.

The QRS complex begins with Q, small downward deflection, then large upward deflection, peak (R) and finally downward S wave, as shown in figure.8 This QRS complex shows depolarization and ventricular contraction.

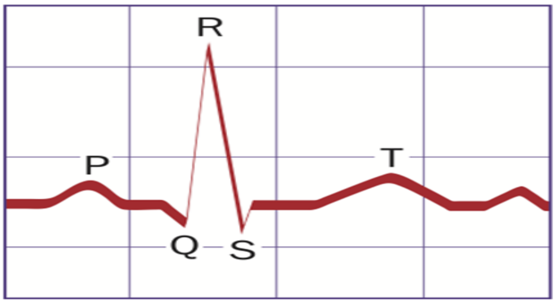

Fig-8: QRS complex

Ventricular depolarization is represented by the QRS complex comprising waves Q, R, and S. Despite the fact that ECG leads do not include these three waves, the existence of a "QRS complex" is referred to as a "QRS complex." The typical QRS complex in lead V1, for example, does not only include the Q, R, and S waves, but also the combination of R and S waves, which is referred to as the QRS complex for this lead.

The graph shown in figure 8 is the normal ECG graph which consists of PQ, QRS and ST segments. In this we concentrating only on the QRS segment to detect the heartbeat of the patient or human body thus by suppressing the other segments as shown in figure.8.1

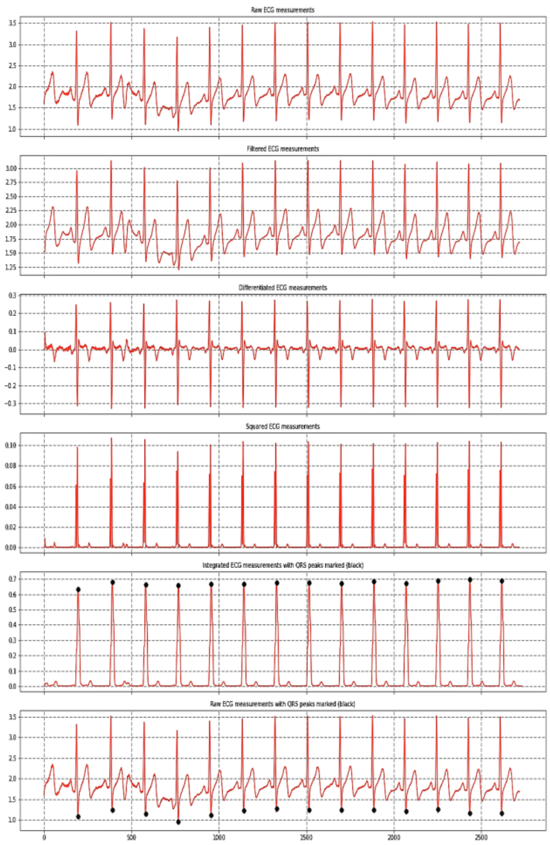

Fig- 8.1: Output graph

7. Conclusions

Due to the lack of adequate facilities and very high costs, the incidence of chronic diseases in the elderly population has become a big problem. People living in rural areas far from medical facilities face a more serious scenario because delay in diagnosis and treatment can lead to death. Most of these problems can be solved with timely diagnosis and treatment. Wireless communications and technological advances have opened the door to real-time Wearable sensor-based healthcare monitoring systems, a real-time cardiac monitor for heart patients in distant places was suggested. The Android mobile device and web interface are built on a set of wearable sensors. This paper describes the design and implementation of a portable wireless ECG monitoring sensor, a blood pressure (BP) sensor, a temperature sensor, and a Spo2 & Pulse sensor (MAX30100). This technique has been enhanced, opening the way for a new generation of flexible, dynamic cardiac activity monitoring and critical parameters, while also guaranteeing the safety of patients and health-care providers by resolving the following limitations:

- Preventing hospital overcrowding by offering automated and rapid diagnosis Heart rate may be monitored remotely by health experts. And it's manageable.
- As much as possible, reduce the number of visits to the hospital for consultation or to monitor cardiac activity and vital parameters.
- I may eliminate manual recording of the patient's ECG state and handwritten reporting by updating the ECG data in real time on the IoT remote monitoring platform.

The findings achieved are satisfactory in terms of real-time constraints, information dependability, and simplicity of use.

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