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CARDIO VASCULAR ALERTING SYSTEM FOR POST – OP CABG PATIENTS

Anandha Kumar R[1], Thamotharan M[2], Kamalesh Kumar P S [3], Selva Sindhuja R[4], Pavithra R[5]

[1,2,3,4,5] Department of BME Hindusthan College of Engineering and Technology Coimbatore, India

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Abstract - *Our approach gives the perfect solution to the issues that the patient experiencing post-op coronary artery bypass graft. Cardiovascular disease affects the blood vessel and the heart, and this may lead disease like the heart attack, arrhythmia, cardiomyopathy, coronary artery disease, the heart failure, rheumatic heart diseases, congenital heart disease, and an Aorta disease syndrome etc. As a result, this may lead to coronary artery bypass surgery. For our proposed smart system to detect dysrhythmia using ST Wave for post-op Coronary artery bypass operated patients. The main purpose of this project is to monitor health parameters like blood pressure, stress and pulse will be monitored through various sensor. Those sensors are used along with EKG in this system. If the system detected any abnormalities, it will directly call to nurses. When any of the sensed values exceeds the threshold level then an alarm will turn on. Our proposed system will also reduce the work of nurses in order to monitoring patients.*

***Key Words*: Cardiovascular, Dysrhythmia, ST wave, EKG, CABG, Alarm.**

1. INTRODUCTION

Heart is the most important organ of circulatory system in the human body, as they possess pumping of the blood all over to the body. One may undergo coronary artery bypass surgery because of poor blood flow to the heart in the people who are suffering by severe coronary artery disease (CAD). During CABG treatment, a healthy artery from another part of the body is grafted to the blocked or part of embolus in the coronary artery. This new passage enroute the oxygen-rich blood around the blockage to the cardiac muscle, and it resumes more active lifestyle. Arrhythmia is an important portion, and if there is no timely treatment, acute arrhythmic symptoms may cause high death rate. Even for some arrhythmias that are not looming life-threatening, patients may need medical care or attention for preventing future health deterioration. Therefore, continuous ECG monitoring is needed by patients and even by normal people with uncomfortable heart feelings. Most doctor's choice for continuous ECG monitoring is the Holter monitor, it usually records patient's ECG data for 24 to 48 hours, but the Holter monitor system cannot perform diagnosis in real time and only the data of recorded period is analysed, if there were severe [1]Arrhythmic heart beats happening during recording or Arrhythmic heart beats happen outside the recorded episode, patients cannot get timely warning or medical care, so continuous ECG monitoring in real time is needed and wearable ECG sensors. This unwanted heart attack and sudden death can be prevented by early detection and timely treatment of arrhythmia which will reduce the heart attack in people and also prevent the loss of life.

2. EXISTING AND PROPOSED SOLUTION

2.1 Being a problem

After CABG surgery, the patient moved to Cardio-Thoracic unit, where the patient is continuously monitored in the ratio of 2:1 which is Nurse to patient. Patient monitoring systems is the only one which is used to monitoring the grafted patients.

2.2 Proposed result

This device consists of bodily sensor related to microcontroller, code has been written with Arduino IDE, and the microcontroller is interfaced with ECG sensor and pulse sensor. ESP32 microcontroller has a total number of 30 pins & there are 25 pins for input & output, it can operate upto, 2.4GHZ, the maximum current each port can sink or source is around 240 mA. When contact is made with patient, ECG sensor start sensing ECG waveform from patient. This device mainly focus on detecting the elevation of ST- segment. The normal interval between S&T segment are upto, 0.1mV. If there is any increase in ST elevation or depression than the normal range, the counter will start count. The count from counter will be compared on timely basis (here we are comparing for each hour) with the standard values that are defined in Code. If the count increases beyond the normal range, the buzzer starts alarming, whose frequency depends on the intensity of Abnormalities. This helps the healthcare provider to handle the abnormalities prior to any health complications. We also included the pulse sensor, which serves dual purpose in our project. The first one is to monitor pulse rate and the second is based on pulse rate we can scale the stress or pain in patient due to after effects of Surgery or drug administration , which will help to identify complications during their unconscious state.[1]

3. DESIGN AND ARCHITECTURE

In this paper, the author describes the workflow of the cardiovascular alerting system. The system comprises of mainly three units. Processing unit, Rectifier unit and

Sensing unit. The rectifier components used are, Transformer, AC-DC conversion, Filter circuit, Regulator 7812 and Regulator 7805. The block diagram Chart-1 illustrates the following,

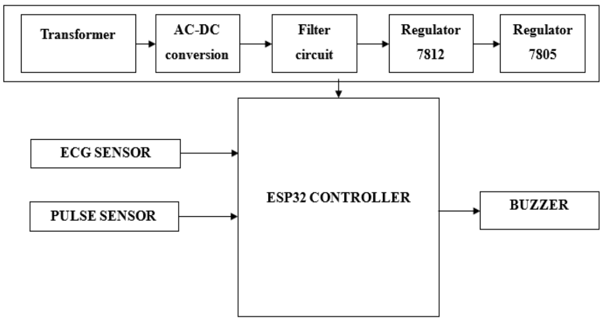

Chart -1: Block Diagram

The working flow of the components illustrated in Chart- 2,

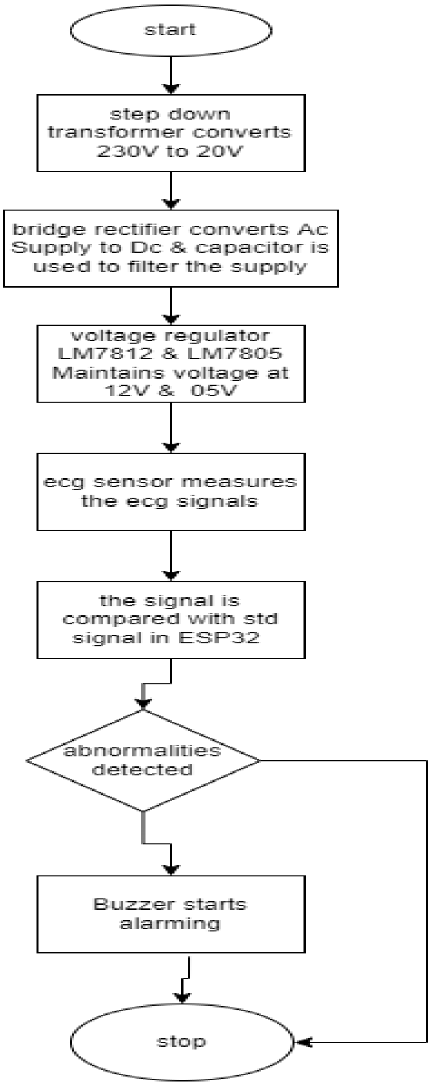

Chart -2: Flow Chart

4. MAIN COMPONENTS

4.1 ESP32 Controller

ESP32 is a combination of cost efficient and power efficient on a chip microcontroller which is integrated Wi-Fi and dual-mode Bluetooth. The ESP32 series comes on either a Tensilica Xtensa LX6 microprocessor in both dual-core and single-core variations, Xtensa LX7 dual-core microprocessor or a single-core RISC-V microprocessor and it includes built-in antenna switches, RF balun, power amplifier, low-noise receive amplifier, filters, and power-management modules. ESP32 module is created and developed by Espressif Systems, which is a Shanghai-based Chinese company, and it is manufactured by TSMC using their 40 nm technology. It is a successor to the ESP8266 microcontroller. Their features are, Xtensa dual-core 32-bit LX6 microprocessor, it operates at 160 or 240 MHz and performing at up to 600 DMIPS. Wireless connectivity descriptions are, Wi-Fi: 802.11 b/g/n. Bluetooth: v4.2 BR/EDR and BLE it shares the radio with Wi-Fi. The Peripheral interfaces are, 34 × programmable GPIO s 12-bit SAR ADC upto 18 channels. 2 × 8-bit DAC s. 10 × touch sensors capacitive sensing GPIOs. 4 × SPI, 2 × I^2S interfaces, 2 × I^2C interfaces, 3 × UART. SD/SDIO/CE-ATA/MMC/eMMC host controller and SDIO/SPI slave controller. Ethernet MAC interface with dedicated DMA and planned IEEE 1588 Precision Time Protocol support.

Fig -1: ESP32 Controller

4.2 Sensor Units

- ECG Sensor: Traditionally, ECG paper is separated into 1mm squares.[5] Ten blocks normally equal 1 mV vertically, and the paper speed is usually 25mm/s horizontally, therefore one block equals 0.04s (or 40ms). It's worth noting that we also have "large blocks" that are 5mm on each side. Always check the calibration voltage on the right of the ECG, and paper speed. The following Image Fig-2 shows the normal 1mV calibration spike:

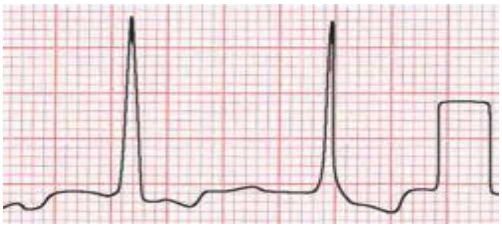

Fig-2: Normal 1mV calibration spike

It's important to note that if the calibration signal isn't "squared off," the ECG tracing is either over-damped or under-damped, and shouldn't be trusted. It's simple to calculate heart rate when you know the paper speed. It's also useful to have a rapid method of estimating the rate, and one such method is as follows, 1) keep the following numbers in mind: 300, 150, 100, 75, 60, 50. 2) locate an R wave that intersects a 'large block' marker. 3) Count the number of huge blocks between the current R wave and the next R wave. A normal heart rate has traditionally been considered to be between 60 and 100 beats per minute, however it's probably more reasonable to re-adjust these parameters to 50 to 90 beats per minute. Sinus tachycardia is defined as a heart rate of more than 90 beats per minute, whereas bradycardia is defined as a heart rate of fewer than 50 beats per minute. It's important to consider the clinical context: a rate of 85 in a highly trained athlete could indicate a significant tachycardia, especially if their resting rate is 32 beats per minute! It's likewise a bad idea to try to regulate low rates aggressively in the presence of good perfusion and outstanding organ performance

Fig-3: ECG Sensor

- Max 10300 sensor: The MAX30100 is a sensor that combines pulse oximetry and a heart rate monitor. It detects pulse oximetry and heart rate signals using two LEDs, a photodetector, improved optics, and low-noise analogue signal processing. The MAX30100 uses 1.8V and 3.3V power supplies, and it may be turned down by software with very little standby current, allowing the power supply to be connected at all times. The MAX30100 is a full pulse oximetry and heartrate sensor system solution designed for wearable devices with high demands. The ambient light cancellation [4] (ALC), 16-bit sigma delta ADC, and unique discrete time filter make up the SpO2 subsystem in the MAX30100. The SpO2 ADC is a 16-bit resolution continuous time oversampling sigma delta converter. The ADC output data rate can be set anywhere between 50Hz and 1 kHz. A patented discrete time filter in the MAX30100 rejects 50Hz/60Hz interference as well as low-frequency residual ambient noise. Temperature Sensor. MAX30100 includes an on-chip temperature sensor for (optionally) calibrating the SpO2 subsystem's temperature dependence. The wavelength of the IR LED has little effect on the SpO2 algorithm, but the wavelength of the red LED is important for accurate data interpretation. The temperature sensor data can be utilized to compensate for changes in ambient temperature and compensate for the SpO2 inaccuracy. To produce LED pulses for SpO2 and HR measurements, the MAX30100 includes red and IR LED drivers. With the suitable supply voltage, the LED current can be controlled from 0mA to 50mA (typical only). Based on application situations, the LED pulse width can be adjusted from 200s to 1.6ms to improve measurement accuracy and power consumption.

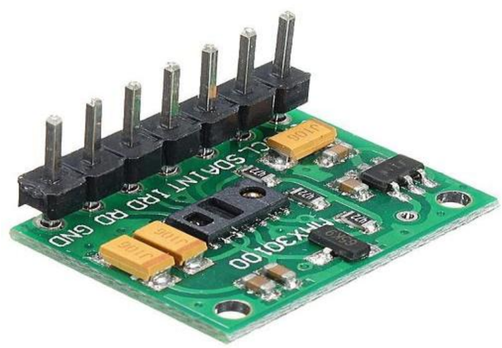

Fig-4: Max 10300 sensor

5. Working

When the power supply turned on, the step-down transformer in the product converts the 230V to 20 V AC supply, which then converted into DC supply by Bridge Rectifier. The voltage Regulator LM7812 & LM7805 used to regulate voltage at 12V & 5V respectively. The ECG signal from patient is measured by three limb lead ECG sensor, the signal then passes to ESP32 microcontroller, where the signal is compared to the standard signal. The ST segment from real time signal is checked for elevation over the period of time. The counter in the system starts counting if it detects any abnormalities in ST segment. If the count exceeds the range, the buzzers start to give alarm signal. This help health care monitor to assess the patient before it getting worse. The stress level of the patient during Drug administration and other medications can be measured by the using the pulse sensor by measuring pulse rate.

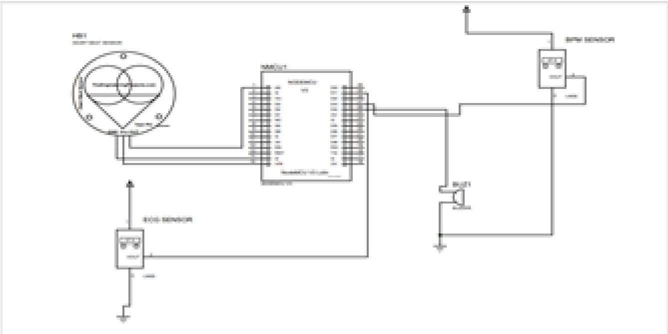

Fig-5: Circuit Diagram of CV alerting system

6. Experimental Setup

Experimental setup for our system as shown in Fig.8 consisting of sensors with its accessories like pads and sensors cable, ESP32, and number of sensors and Buzzer has been shown in figure. All the connections between sensors and ESP32 board can be clearly seen

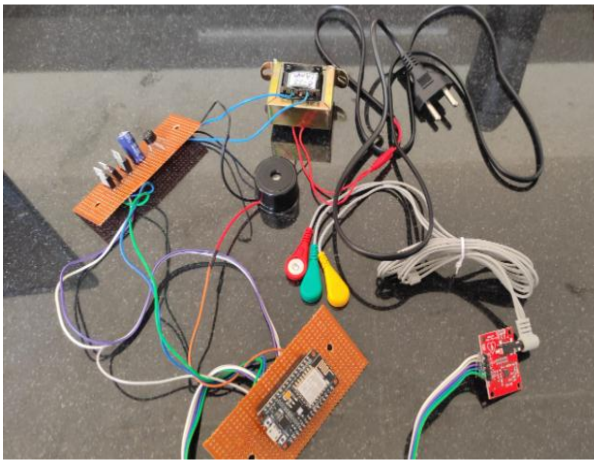

Fig-6: Experimental Setup

7. RESULT AND CONCLUSION

This device is quite simple and serves as an effective system by monitoring the risky parameters after the CABG surgery, which ultimately results in preventing mild heart attack, stress management, and some heart problems like myocardial infraction and arrhythmias. These kinds of equipment are more essential for the people and as an engineer it is different sense of technologies into the world.

8. Future Scope

The future scope of this project targets to integrating IoT technology for making ease to monitoring patients. Connecting IoT devices helpful in monitoring patient's parameters like abnormal sweat using sweat sensors and also helpful to doctors to get analysis of patient's circulatory system behavior from cloud database. The main development in future is that, if any patient undergoes any serious abnormalities in heart, this system immediately sends alerts to respective health center as well as patient's close relatives. By this patient life can be saved by earlier response.

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