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THE DEVELOPMENT OF AN IOT-BASED HEART RATE MONITOR

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Abstract- To prevent suicide and heart-related mortality, a wireless gadget that monitors heart disease patients and suicide watch lists is required. This research proposes a portable and wireless system that can track and send heart rate and blood oxygen levels (SP_{02}) to a remote location using GSM technology. The heart rate sensor is made up of a photoplethysmography (PPG) sensor, which uses optical principles to measure changes in blood volume. A pulse oximetry sensor that detects blood oxygen saturation levels is built into the oximeter monitor. For the convenience of the user, these sensors are incorporated into a small, wearable gadget. The oximeter probe is in direct touch with a patient's body, and the measurements are taken by the microcontroller analog pin zero and calibrated using C++ code that is programmed into the ATMEGA328P microcontroller using an Arduino UNO programmer. The readings are monitored using the Blynk app, which is configured with the sensors to read data and it is connected to a Wi-Fi module. Whenever the sensor detects an increase in analog pin voltage, readings are produced and transmitted in order to understanding the pulse rate and oxygen saturation level which is crucial. The GSM module's telephone number is programmed with a code that allows the patient's position to be requested at any time. The code is sent as a text message to the SIM inside the module, and the location of the patient is returned as a text message to the end user. This wireless system was able to successfully track and send heart rate and blood oxygen level wirelessly.

Keywords: heart rate, IOT, monitor, photoplethysmography, sensor

INTRODUCTION

The frequency of heart-beats per minute is referred to as the heart rate. Heartbeat varies according to age group. A typical adult's resting heart rate ranges between 72 and 76 beats per minute (bpm) for those who are 18 years of age and older. When engaging in cardiovascular exercise, most people experience an increase in their heart rate. The illness known as bradycardia is characterized by a quick pulse that is typically below the normal quick pulse rate, and tachycardia is characterized by a quick pulse that is typically above the normal quick pulse rate [1]. Recent research has shown that the major cause of mortality in 2017 was cardiovascular disease (CVD) [2]. The latest study has also indicated an increase in the number of deaths from depression and heart attacks. There have been situations where people have passed away while alone at home. Utilizing the victim's heart rate, a remote wireless monitoring device can be used to address such issues. Without needing to visit a patient, observation of a patient remotely technology permits patients beyond hospitals [1]. If a remote monitoring cardiac device was worn and an emergency alert could be issued right away to the emergency units at hospitals nearby, some heart attack and suicide deaths may essentially be avoided [3]. Doctors and nurses face challenges in monitoring patients' health conditions remotely. Traditional monitoring devices, only available in hospitals, are not user-friendly and uncomfortable. It is crucial for doctors and family members to have a portable device to monitor patients when they are not present. Body temperature is a vital indicator of health, as it measures. The capacity of the body to produce and eliminate heat. Normal body temperature depends on the location and activity level of the person. A wireless heart rate monitor is a wrist-mounted gadget that detects heartbeats and enables medical professionals to wirelessly track it. It has a microprocessor that tracks heart rate per minute and transmits the information to a doctor over a wireless communication connection. For precise position in an emergency, the device also has a GPS module. Utilizing a conventional analog into digital converter and a GSM modem, the heartbeat data is transformed into digital data for wireless transmission as SMS messages [4]. Modern heart rate monitors track the ECG and compute parameters using a microprocessor. These monitors typically have a chest strap transmitter and a wrist-worn receiver or mobile phone that can identify anomalies in blood pressure and heart rate that might cause heart attacks [5]. Optical heart rate monitors gauge blood flow through veins and tissues to calculate heart rate based on light return. When blood flow dynamics, such pulse rate and volume, vary, the device scatters light. The gadget is located using GPS communication, and Nano Tracker transmits position information in real-time to the IoT Cloud platform through the 2G mobile network. The device has data on longitude, latitude, speed, date, time, and battery voltage and can be adjusted and diagnosed through USB or SMS. This study aims to build a wireless wearable heart monitoring device with an emergency alerting system.

LITERATURE REVIEW

According to research, there are many various tools available in hospitals to monitor internal body changes.However, many of them have limitations on upkeep, price, size, and mobility. This human heart is a complex organ located on the left side of the chest, consisting of four distinct chambers. It supplies oxygenated and deoxygenated blood to the body, with the heart chambers separated by interatrial and interventricular septa. It operates through an intrinsic electrophysiological system, with cells from two heart fields dominating the left and right ventricles [6]. Measurements of the heartbeat and body temperature are essential for determining health and fitness during doctor visits or physicals. The strength and health of the cardiovascular system are indicated by heart rate, which measures the contractions and expansions of the heart. Adults typically have heart rates between 60 and 100 BPM. The whole state of health may be impacted by abnormal heartbeats. When engaging in aerobic activity, the heart rate rises; after exercising, it returns to normal [1]. In the modern world, cardiovascular disease is the main cause of death. Cardio vascular disease is a general term for a group of illnesses that affect the blood arteries that surround the heart. Heart attack, agina, congestive heart failure, coronary artery disease, and arterial hardening are among the several medical disorders listed in the study [6]. An ECG is a painless, non-invasive test that records heart signals in order to find heart issues, see activity, and keep track of heart health. It is usually carried out at medical offices, clinics, hospitals, and private gadgets like smartwatches. Body signals generated by the central nervous system are distorted by analog signals from the ECG [7]. A microcontroller is a low-cost, self-sufficient single integrated circuit microprocessor. In specialized control systems for things like washing machines, phones, microwaves, cars, and weaponry. A central CPU, input/output ports, memory, an internal clock, and peripheral devices are common features of microcontrollers. Microcontrollers, which range in size from 8 to 32 bits, are produced and sold by over two dozen businesses. Several well-known manufacturers are Intel, Zilog, Motorola, Atmel, Parallax, and Microchip [8]. A wireless distributed data acquisition system was presented for long-term, synchronized patient health monitoring. In order to collect data from various monitors and synchronize it with preexisting information on the telemedical server, the system uses a personal digital assistant (PDA) as a mobile gateway. Evaluation of the impacts of demanding military training is made possible by the system's usage of low-power microcontrollers and a conventional 900 MHz wireless link [9]. A wireless biosensor and smart phone-based individualized cardiac monitoring system. When a heart patient is in danger, the prototype analyzes real-time sensor and environmental data and notifies ambulances and caregivers. It sends sensor data to a hospital for remote monitoring by cardiologists or nurses. Programs for rehabilitation follow patients' progress and offer guidance or assurance [5].The sensor measurements are acquired and transferred.

MATERIALS AND METHODS

This section describes a customized cardiac surveillance device that makes use of wireless biosensors and smartphones. The prototype analyzes when a heart patient is in danger, alerts ambulances, and caretakers by analyzing real-time sensor and ambient data. It sends sensor data to a hospital so that clinicians or cardiac specialists may observe patients there remotely. Figure 1 shows how rehabilitation programs keep tabs on patients' development and offer guidance or support. The AVR microprocessor is chosen for this study after taking into account a number of considerations.

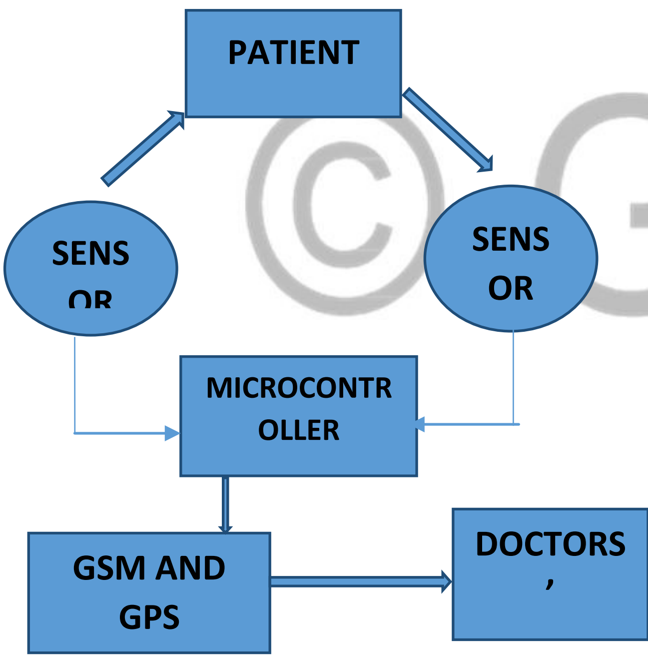

FIG. 1. BLOCK DIAGRAM OF PROPOSED METHOD

A. Control Unit

This model necessitates an indicator that aids in identifying the smallest possible amount of inputs or outputs in which microcontroller must have be selected , as well as the degree of necessity of a built-in conventional electronic converter component.

B. Working Register

Utilizing a single byte register known as the Working register, the majority of AVR Microcontroller Unit instructions are written. Typically, any operations affecting values in the File Registers involve the Working register. When using a pair of numbers in numeric or logical computations, either of the pair of variables is always placed into the Working register at the start of the instruction. Following completion of instruction, that result is typically maintained in the Functioning register.

C. ATMEGA328P Pin out

A wide variety of features and factions are available in the midrange family of microcontrollers, there are only so many pins, and not all functionalities are accessible at once. The ATMEGA328P standard 28 pin dual inline package is depicted below. Every pin has several purposes, as you can see. Pin 5, for instance, a pin that can be used as an input as well as output connection.

D. Power Supply Stage

The circuit and its modified version can be powered by a controlled 9V and 5V/50mA power source, which is displayed. The output of the rectifier is filtered by Capacitor C1. A fixed positive voltage regulator for 5V is called U1 (7805). When the battery's output is linked to the 7805's input, a regulated, steady 5V is produced at the device's output; SW1 is the principal ON/OFF switch. Generating power and a 50Hz supply from a battery source is is 9V.

$$maximum\ voltage, V_t = V_{rms} \times \sqrt{2} \tag{1}$$

$$V_t = 9\sqrt{2} = 12.7V$$

$$Supply\ frequency, f = \frac{1}{period\ (T)} = 50Hz \tag{2}$$

$$Period, T = \frac{1}{f} = \frac{1}{50} = 0.02s = 20ms \tag{3}$$

In both positive and negative cycles, engaged in the method of rectification experience an overall voltage drop, or V_d.

$$V_d = 2V_{BE}[V_{BE} = 0.7V\ for\ a\ SD] \tag{4}$$

$$V_d = 2 \times 0.7V = 1.4V$$

APV value, $V_{LM} = (V_m - 2V_{BE})V$ (5)

$V_{LM} = (12.7 - 1.4)V$

$V_{LM} = 11.3V$

Change in peak voltage value over the discharge period, $\delta V = V_{LM} - V_{dc}$ (6)
$V_{dc} = 10V$

Given the voltage sensor regulator's specifications for the input, the filter battery should not decrease below 6V.

$\delta V = (11.3 - 10.0) = 1.3V$
Time shift during the release duration, t=10ms
The maximum predicted overall current usage for this design is 600 mA. In order to get the filter capacitor's value, follow these steps:

$$C = \frac{500mA \times 10ms}{1.3V} = 385\mu F$$

The capacitor value, that approximates the predicted value and suggests a value of 470µF, was picked to offer an emergency buffer.

E. GSM Module

The SIM800L module features TTL-level serial, power supply, and antenna interfaces, providing a comprehensive Quad-band GSM/GPRS LGA solution. It is small and lightweight, supporting quad-band 850/900/1800/1900 MHz, transmits voice, SMS, and data with little power, and measures 15.8*17.8*2.4 mm. It enables cost reductions and a quick time-to-market while supporting Bluetooth, FM, and integrated AT.

F. Construction

This research passed through the design, analysis, implementation, construction, and testing. Figure 2 shows the soldering circuits on Vero-boards which includes the power supply and microcontroller sections. These were coupled and eventually put in a plastic casing as casing as shown in fig. 3. The construction of a plastic casing had perforations and vents for cooling purpose.

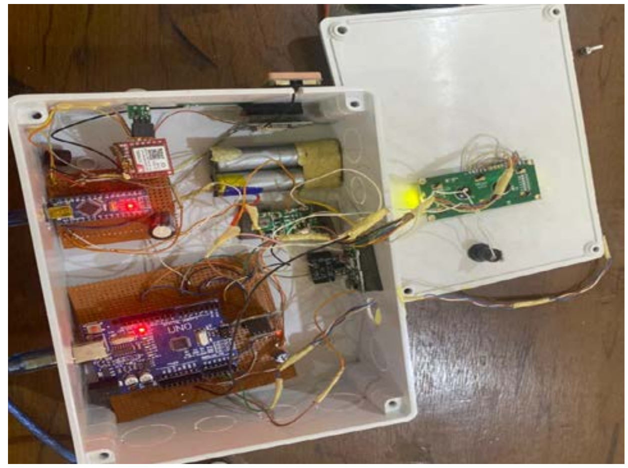

FIG. 2. CONSTRUCTION BEFORE BEING COVERED

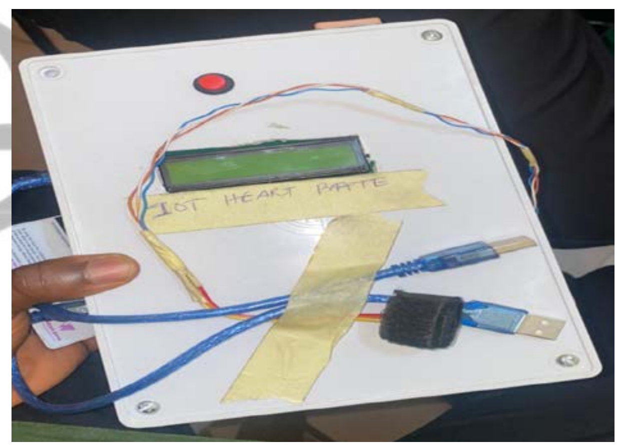

FIG. 3. CONSTRUCTION AFTER BEING COVERED

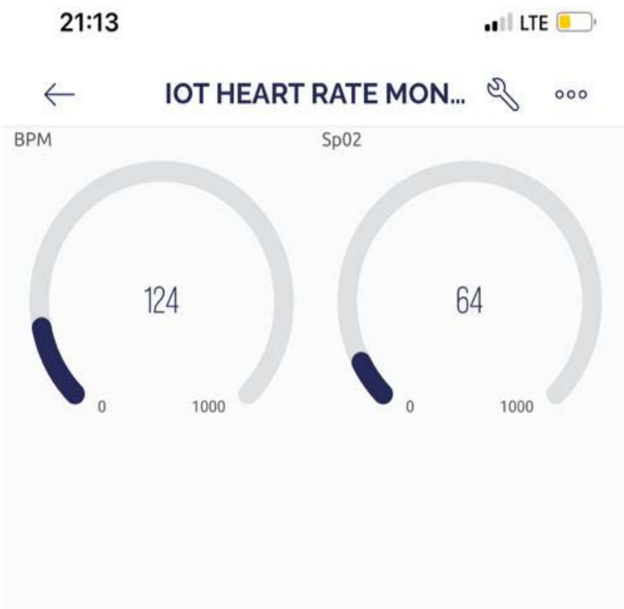

FIG. 4. IOT HEART RATE MONITORING

The system was rigorously tested on patients and healthy individuals, achieving the same results as measured by physicians. A validity report was prepared, and data from cell phones and LCD displays was captured. The prototype was successfully implemented, demonstrating its effectiveness. Fig.4. demonstrates how the Blynk app is used to monitor one's health. If the mobile device has a quick reception, the SP02 reading and heart rate in beats per minute are obtained instantly.

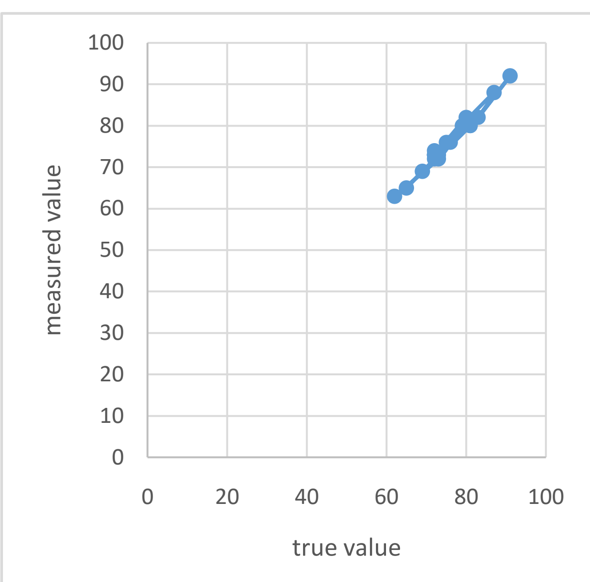

FIG. 5. GRAPH OF THE RELATIONSHIP BETWEEN TRUE AND MEASURED VALUE

Fig. 5. shows the graph displays the relationship between manufactured heart rate readings (true value) and measured values (measured value), indicating minimal error, and indicating system accuracy. Figure 6shows the SMS sent to the mobile phone of the physician while testing, the location is gotten by calling the mobile inserted in the sim and the location of the device would be sent instantly.

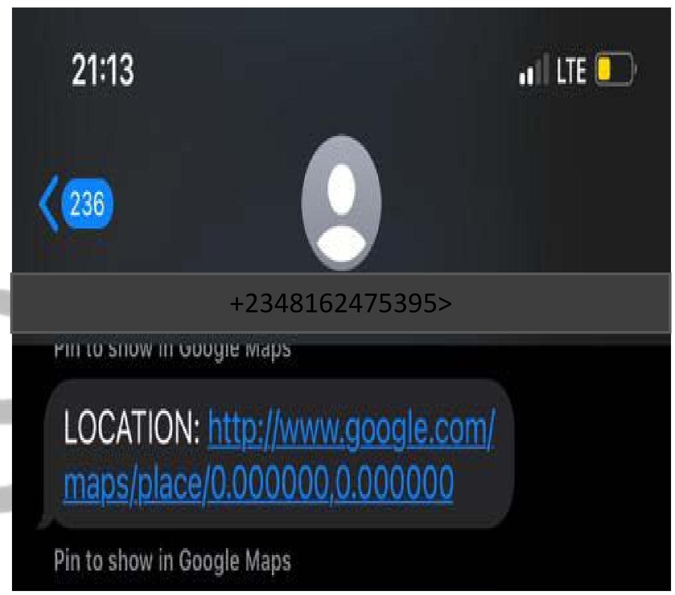

FIG. 6: TEXT MESSAGE OF THE LOCATION OF THE DEVICE

CONCLUSION

The portable and wireless system was implemented with a number of elements, including affordability, economical, durable, and easily accessible parts and materials, upon evaluation, the system's performance complied with the design requirements. Performance can be affected by the soldering's quality and the components placement in the Vero board. If inadequate soldered, it can lead to the circuit developing. The system is malfunctioning due to an early dry connection. Furthermore, if logic components are soldered adjacent to components that radiate heat, overheating could occur, which could affect how well the system functions as a whole. The quality of the components, handling, usage, and casing, could also have an impact on performance. In the case of a system breakdown, upkeep and repairs will be easy for the user to perform and this is inexpensive. Furthermore, this system can be applied in a number of contexts, including agriculture, labs, and irrigation systems.

RECOMMENDATION

Utilizing integrated circuits with higher integration scales to reduce circuitry and provide authentication to less privileged individuals, such as visually impaired individuals, can be addressed in future work.

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