Health Monitoring and Alert System using Voice over Internet Protocol (VoIP)

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Abstract

The majority of the senior residents are regularly disregarded and are powerless in the midst of health-related crises. The current frameworks can help in keeping track of the condition yet do not have an automated alerting framework that can alert the concerned clinical specialists over long distances. Likewise, they are wired, which can meddle with the patient's movements. Wearable and wireless gadgets are present in the market, yet again their major drawbacks are being significantly expensive and an absence of automated alerting framework. The gadgets that have both wellbeings checking and alerting frameworks are simply exorbitant for ordinary people. To deal with this issue, we have thought of a prospective health alert system. The framework comprises a heartbeat sensor that will continuously monitor the pulse of the user. If the pulse rate deviates from the normal range, it will be detected by the Node MCU. In order to avoid a false alarm for healthcare services, the Node MCU will send an alert to the user using a buzzer in order to get confirmation from the user. The user will respond using the user input buttons, and the system will act accordingly. The location will be fetched from the GPS sensor, and healthcare services and relatives would be alerted about the user's condition and his location using VoIP calls.

1. INTRODUCTION

The health monitoring and alert system focuses on developing a device that enhances the ability of an individual to protect the health of their friends and family. [1]Monitoring refers to the action of observing signs and symptoms of a disease, a condition, or one or more medical parameters over a period of time. It can be carried out by continuous measurement of parameters like pulse, blood pressure, respiratory rate, etc. by using a medical monitor or by performing laboratory tests.

Different sorts of frameworks for health monitoring are available in the market. However, the majority of the frameworks do not have an automated framework for sending alerts to healthcare services in case of emergency. Likewise, they are very expensive and are not affordable for common people. Even the best devices for health monitoring like ECG machines can only be used on bed-ridden patients. Also, as they are wired devices, they obstruct the patient's movements. [2]

The major drawbacks of existing devices that are wearable and wireless are that they are too expensive for a common man, and they also lack an automated alerting system. [3]

Cardiac arrest, also known as a heart attack, occurs when the heart experiences a decrease in function all of a sudden, typically due to lack of blood flow. Like any other muscle in the body, the heart is a muscle that requires oxygen and blood to work. [4]

A normal heart rate for any person is between 60 and 100 beats per minute. During a heart attack, a person's pulse may become slower, that is, bradycardic or faster, known as tachycardic, depending on the type of heart attack they're experiencing. [5]

There are a number of symptoms that occur during a heart attack. Some of the visible symptoms of heart attack are breathlessness, profuse sweating, sudden body temperature change, cardiac arrhythmia, etc.

However, these symptoms may not necessarily occur during a heart attack, such as in the case of silent heart attacks, wherein the victim is unaware that he/she has a heart attack due to an absence of any of the recognizable symptoms of a heart attack. Even if this is the case, monitoring still plays an important role in saving lives. [6]

Common symptoms of heart attack are:

- Pain in the chest, arm, neck, and back
- Light-headedness
- Shortness of breath
- Dizziness
- Nausea
- An abrupt cold sweat

Specific risk factors for cardiac arrest include smoking,

chronic inflammation, obesity, physical inactivity, high blood pressure, and family history. []

Cardiac arrest can be life-threatening. The earlier someone receives treatment, the greater the chances of their survival. Hence, proper monitoring and alerting system are required to save the lives of the patients.

2. PROPOSED SYSTEM

The proposed system suggests a health alert system that will continuously monitor the pulse of the user and will inform the relatives of the user and healthcare services in case of emergencies. It uses a microcontroller device along with sensors for monitoring the body parameters and uses voice over internet protocol (VoIP) calls for alerting the healthcare services and relatives in case of emergencies.

2.1. System Architecture

The proposed system comprises a microcontroller device called Node MCU. The framework consists of two sensors: the pulse sensor and the GPS sensor. The pulse sensor uses the principle of PPG and measures the pulse rate in BPM. The GPS sensor monitors the location of the user. The entire circuit of the Node MCU is provided with a 6 V power supply from a button-cell battery. All components, including the battery, are mounted on a wearable frame.

2.2. Components

2.2.1. Pulse Sensor

The pulse sensor is a sensor based on the principle of PPG,

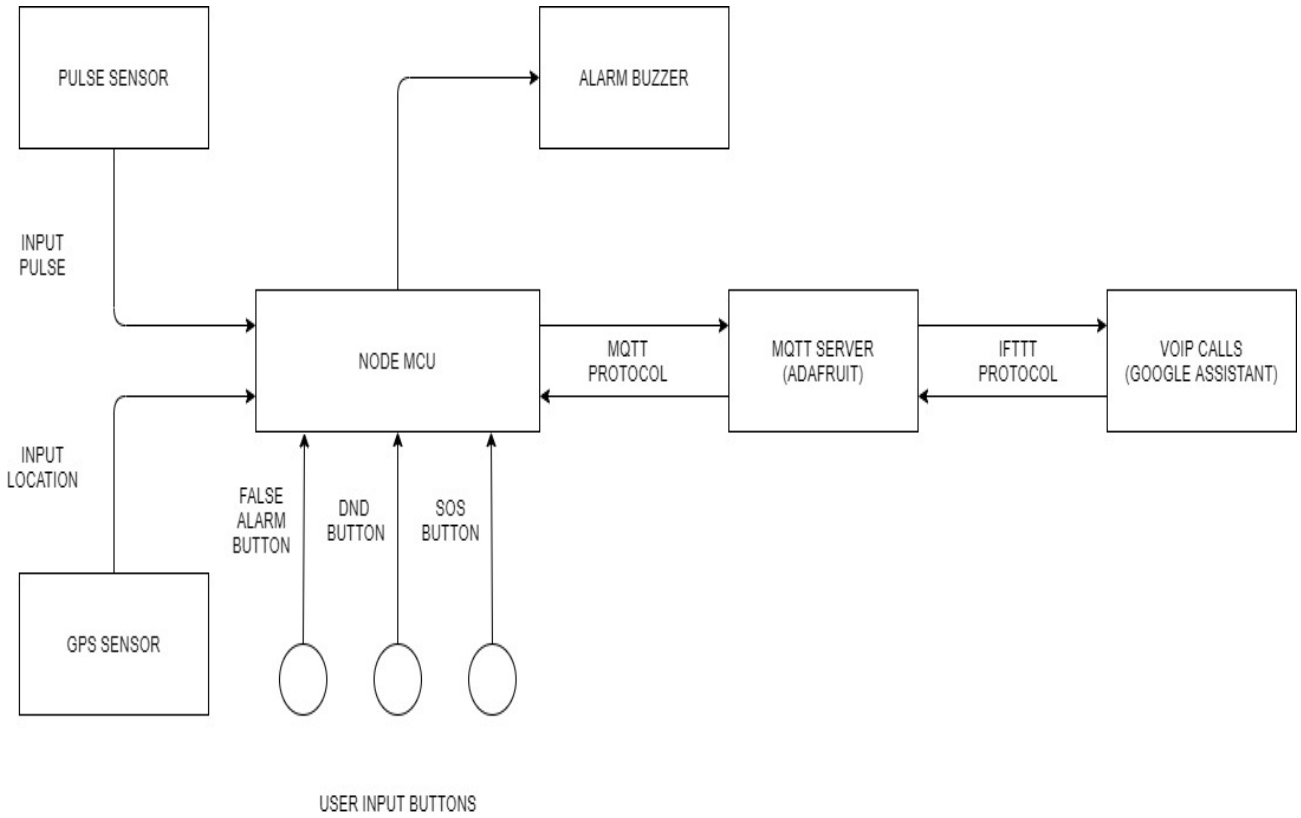

Figure 1: Block diagram

Figure 2: Pulse sensor [10]

Figure 3: GPS sensor [11]

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Figure 4: Node MCU [12]

Figure 5: Alarm buzzer [13]

which is used to measure heart rate. It is used for monitoring the pulse of the user. [8]

2.2.2. GPS Sensor

The GPS sensors are receivers with antennas that use a satellite-based navigation system with a network of 24 satellites in orbit around the earth to provide position, velocity, and timing information. It is used to provide the location of a user while sending alerts. [9]

2.2.3. Node MCU

Node MCU is a system on chip microcontroller device which provides an open-source IoT platform. It acts as a processing unit in the system. The Node MCU takes input parameters from the sensors and constantly monitors them. It has Wifi connectivity, which is used to send alerts if the sensor readings have reached emergency levels.

2.2.4. Alarm Buzzer

Whenever the pulse rate reaches the emergency levels, Node MCU will send an alert will to the user. This alert is indicated by the alarm buzzer.

2.2.5. False Alarm Button

A false alarm button is introduced into the framework. Whenever the pulse rate reaches the emergency levels, an alert will be sent to the user through the alarm buzzer. The system will wait for the response of the user. If the user feels perfectly fine, then he/she can press the false alarm button to cancel sending alerts to relatives and healthcare services.

2.2.6. DND Button

Many times, the users are busy or attending an important occasion wherein they do not want the system to send alerts through alarm buzzers. DND feature allows the user to temporarily shut down the system. DND mode can be activated using the DND button and can be deactivated using the same button.

2.2.7. SOS Button

In many cases, it is possible that the user is having visible symptoms of having a heart attack, but there is no major change in the pulse values. Also, in cases like a silent heart attack, it is diffi cult to detect cardiac arrests or heart attacks as there may not be any significant change in the parameters being monitored. An SOS feature is provided in the system, which bypasses the conventional pathway and sends alerts to relatives and healthcare services.

3. WORKING

The Node MCU receives data from the pulse sensor and continuously monitors it. If the pulse rate deviates from the normal range, it will be detected by the Node MCU. The system will inform the user about the deviation of pulse rate from normal range through alarm buzzer. The system will wait for the response of the user and act accordingly.

The system provides a set of three user input buttons. They are false alarm button, DND button, and SOS button.

In order to avoid sending false alerts to relatives and healthcare services, a false alarm button is incorporated into the system. Whenever the user receives an alert from the system through an alarm buzzer, the false alarm button can be used if the user is fine and doesn't find any apparent signs of a heart attack. This will cancel the alerts. If the user does not press a false alarm button within one minute after receiving an alert from the alarm buzzer, the alert will be sent to the user's relatives and healthcare services, respectively.

For the convenience of users, an additional feature called DND mode is introduced into the system. This feature allows the users to temporarily shut down the system for any important occasions where they do not want the system to send alerts. The user can press the DND button and activate the DND mode and can press the DND button again to deactivate the DND mode.

In cases like sensor damage or silent heart attack, it is difficult to detect cardiac arrests or heart attacks as there may not be any significant change in the parameters being monitored. An SOS feature is provided in the system, which bypasses the conventional pathway and sends alerts to relatives and healthcare services.

The alert consists of the patient's name and location, wherein the location is fetched from the GPS sensor. The alerts will be sent via calls and text messages using VoIP.

4. RESULTS AND DISCUSSION

There are not many devices that are produced for keeping track of the condition of the user just as sending alerts to the healthcare services if necessary. The existing devices

are not wireless and thus meddle with the movements of the user. Our system eliminates this drawback as it is wireless and wearable, and in this way, it does not meddle with the portability of the patient. Also, it is cost-effective and affordable for the common man, which is one of the greatest advantages of this framework.

At present, the framework was not tested on the field with actual heart patients. Tests completed under simulated emergency conditions demonstrated that the framework worked as expected in most cases.

5. CONCLUSION

Nowadays, there are many cases of cardiovascular emergencies in both the elderly and young people. Therefore, there is an increasing demand for wearable health monitoring devices that do not meddle with the patient's movements.

The system monitors the heart rate of the patient, and health alerts will be sent to relatives and healthcare services when it reaches emergency levels using VoIP calls. The goal of the framework is to produce a wearable device that can monitor the condition of the user while not affecting the mobility of the user at affordable prices. The data of previously recorded heart attacks are considered as a base for defining normal and emergency conditions for the user. This data can be obtained from the hospital databases.

There are various types of cardiovascular diseases which include minor heart attacks, sudden cardiac arrests, silent heart attacks, etc. wherein in most of the cases, the patients are not aware of the fact that they are having a heart attack. The measurement of medical parameters may not be that helpful for alerting relatives and healthcare services in such emergency cases. Even the maximum accuracy of ECG machines for monitoring heart rate is approximately 92%. Since the human body parameters keep changing constantly, it is hard to make an ideal framework that can accomplish 100% efficiency.

The goal of our system is to help the patients in case of all cardiovascular diseases, which can be detected by constant monitoring of certain human body parameters. Although the system may not have achieved 100% accuracy, it is still a versatile device that can detect any forms of cardiovascular emergencies and alert healthcare services. With further improvements and development, the system can also be responsible for detecting all other types of cardiovascular diseases and make a truly versatile and adaptable framework.

6. SCOPE FOR FUTURE IMPROVEMENTS

With evolution and enhancement in sensors and transducers, more efficient sensors are available in the market, which can be incorporated in the framework. The frame design can be improved to become more attractive and user-friendly. Printed circuit boards (PCBs) and customized thin wires can be used to further enhance the framework by reducing external wiring. Big data can be incorporated into the framework for better analysis of the user's condition.

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