Cardiac Emergency Detection System with Automatic Ambulance Alert

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***Abstract* - This project presents a prototype health monitoring and disease detection system using a Raspberry Pi 4 Model B as the main processing unit. The system integrates a heartbeat sensor and a DS18B20 temperature sensor to measure vital health parameters. A USB web camera is used for disease detection based on image analysis, while a push button allows mode selection for different detection operations. An LCD is employed to display sensor readings and system status. When abnormal health parameters are detected, a buzzer generates an alert, and a GSM module sends an SMS notification to the ambulance driver. The system is powered by a regulated 5V power supply that distributes power to all components. This prototype demonstrates an integrated approach for basic health monitoring and preliminary disease detection.**

Keywords: Raspberry Pi, Cardiac Emergency Detection, Heartbeat Sensor, Body Temperature Monitoring, IoT Healthcare, GSM Alert System

I INTRODUCTION

The issue of medical response within a given time period of medical emergencies is a significant challenge in the modern society as more and more cardiac and physiological incidences are taking place at homes, places, and isolated places. Despite the various health monitoring devices, it is not very easy to respond to an emergency situation in a timely manner due to delays in detection, continuous monitoring as well as relying on human attention. The conventional medical monitoring devices involve the constant oversight of the medical personnel and the wearable devices and manual reporting systems depend on the patient to raise an alarm, which is not always practical when the patient is in a critical state. The intelligent health monitoring solutions are a significant research field lately as embedded systems, sensor technologies, and communication networks have been developed rapidly. Embedded systems like the Raspberry Pi can be used to acquire, process, and transmit physiological data in real-time, and therefore, can be adopted to process and display such data on continuous health-monitoring purposes. Vital parameter sensors like those of heart rate and body temperature give early warnings of body abnormal conditions and thus emergencies are detected early enough. These systems are further enriched by communication modules that allow real-time relay of alert messages to the medical services. Most of the existing systems have health monitoring and emergency notification processes that are not operated together and therefore they are not so effective in case of critical situations. The camera based observation systems need human attention and even the manual alert systems need the user to seek the assistance. Such restrictions impose loopholes in quick medical care particularly where the patient loses consciousness or is unable to release an alert. Hence the demand of an automated and integrated health monitoring system, which can recognize the abnormal condition of the health and trigger an emergency communication without the involvement of a human being is a high demand. The presented Cardiac Emergency Detection System based on Raspberry Pi mitigates these issues by integrating the constant monitoring of vital signs, visual examination, and automatic warning into one platform. The system will contain a heartbeat and temperature sensor and a camera to monitor the state of the patient with the GSM module helping to send an emergency message to ambulance immediately in case abnormal values are observed. The system will help to increase the response time, provide a better patient safety level and decrease the threat of deadly outcomes in the cases of medical emergency because of the constant monitoring and the real-time notification shown.

II LITTERATURE SURVEY

A wearable sensor based health monitoring system discussed by Pantelopoulos and Bourbakis was developed (2010) to allow continuous monitoring of the physiological attributes like heart rate and body temperature. The system was aimed at an early-stage detection of abnormal health conditions with the embedded sensors and the wireless communication. It supplied the correct health monitoring but the big hindrance was that it had no provision of an inbuilt emergency alert for emergency medical response.

A pervasive healthcare monitoring framework is a proposal by Varshney (2007) that would utilize the wireless communication technologies to transmit the medical data in real time. The system was used to monitor patient vitals and do health monitoring of patients at a distance. Nevertheless, it was dependent on network connections to a large extent where reliability was compromised in places with a weak connection.

The system proposed by Islam et al. (2015) is a healthcare architecture based on an Internet of Things and comprising real-time health monitoring on a cloud platform along with sensors and communication modules. Their system enabled incessant gathering and relay of vital parameters to be analyzed by the medical professionals. Its primary weakness was that it relied on cloud infrastructure, which added to latency and cost of operation.

The article by Mohan et al. (2017) presents the design of a real-time heart monitoring and alert device based on the IoT technology. The machine was able to check the heart rate and send alarms when cardiac anomalies were observed. Despite offering quick response, the system could only go as far as the consumption of power and lack of sensor integration.

To monitor the deterioration of patients, Clifton et al. (2012) developed a predictive health system that integrates the wearable sensor data with clinical measurements to assess the health of the patients. The system enhanced prompt detection of medical emergencies. It however demanded sophisticated data analysis and hospital-scale infrastructure and so was not applicable to low cost applications.

Khandoker et al. (2012) suggested a physiological signal identification system based on continuous monitoring of the heart-rate and temperature of a person in healthcare services. The system was not as precise in the automatic means of relaysing an emergency situation, yet it was good at identifying abnormal conditions.

Malasinghe et al. (2019) proposed a remote patient monitoring system based on wearable sensors, which collect vital signs with an IoT-based remote patient monitoring system. The system allowed the day-round monitoring of health and doctor access remotely. The weakness was that the alert system was not very automated in case of emergencies.

Baig et al. (2017) conducted a review of mobile healthcare system integrating physiological sensor and wireless communication to respond to emergencies in medical care support. These systems enhanced patient monitoring and access to data although they had problems in terms of data security and reliability.

The research by Al-Emran et al. (2020) suggested an IoT and wearable sensors-based health care framework to monitor the conditions and recognize an emergency situation in real-time. The system had a good implementation of sensors and communication modules. Nevertheless, its operation was reliant on the consistent internet and cloud connectivity.

Gubbi et al. (2013) proposed a generic IoT architecture that can be used to support sensor-based health applications and real-time data delivery. The framework was scalable and also offered remote monitoring, however, it demanded high network availability and integration of the complex system.

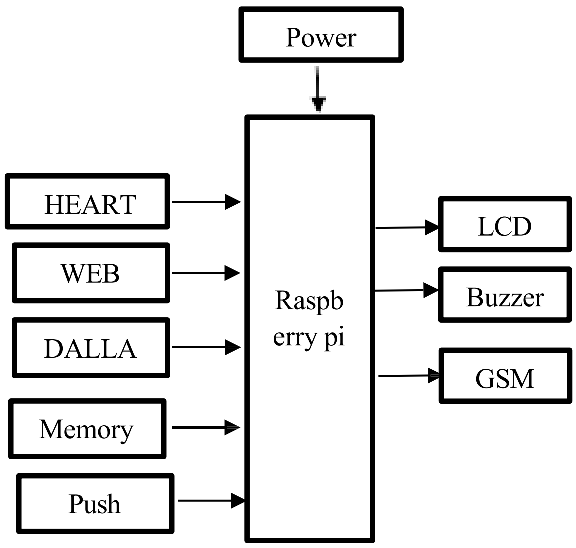
III PROPOSED SYSTEM

It is suggested that such a system should help in delivering patients suffering abnormal physiological conditions with timely medical assistance without necessarily having to be supervised by a human being. The central processing unit of the system is the Raspberry Pi 4 Model B. The DS18B20 temperature sensor and the heartbeat sensor are connected to the Raspberry Pi and are continuously used to monitor the vital parameters of the health of the patient. These sensors give real time readings that are processed to either tell whether the case of the patient is healthy or not. The system has an inbuilt USB web camera to allow visual observation of the patient. The camera has real-time images that can be utilized in simple observation of the disease, physical condition. It has a push button that allows messages to choose sensor-based monitoring mode or the camera-based detection mode. The heart rate, body temperature, and the current state of the system is displayed on the LCD, allowing localization of the condition of the patient. In case of abnormal values like irregular heart rate or high temperature is sensed, the system recognizes that maybe one has a potential emergency state. At this point, a buzzer is sent into operation to attract attention of others. At the same time, the GSM module sends an emergency SMS to the ambulance driver that would update him about the condition of the patient. This will guarantee that medical help is sought as soon as possible without having to press the alert manually. Controlled 5V power supply is used to supply constant power to all the components of a system such as the Raspberry Pi, sensors, GSM module, camera, LCD, and buzzer. This synchronized activity of sensing, processing, display, and wireless communication helps the system to give constant monitoring and emergency addictions. The system is 24/7, hence tendency of detecting any abnormality in vital signs is detected early enough before it becomes critical. The sensor data obtained are simultaneously served as inputs to the Raspberry Pi to enable rapid decision-making and adequate emergency detection. The camera monitoring can be used to be visually assured of the conditions of the patient that may assist the medical staff upon alert receipt. The system has a communication based on GSM which allows it to operate even when there is no availability of internet and this fact makes it fit to be used both in a rural and urban setting. The small and portable size of the system results in easy implementation in households, healthcare facilities, ambulances, and distant care centers. Generally, the offered system enhances patient safety through the minimization of response time and offers an automatic way to notify about the medical emergency.

IV PROBLEM STATEMENT

Irrespective of the growing access of health-care equipment and health information, instances of unexpectedly cardiac and physiological crises are on the increase, particularly in the domestic setting, in the community, and in remote localities. A high count of patients does not receive medical help on time since health issues related to abnormalities are not detected early enough and also because of lack of constant checks. The current medical monitoring devices are either through human observation, hospital based (equipment) or wearable devices that cannot be used because the patient must actively request assistance, which is not possible when unconscious or in extreme distress. Majority of the existing systems do not have an entirely automated process of identifying abnormal vital signs, and producing emergency alerts in real time. The lack of twenty-four hours control and the immediate transfer of the alert predises the patients to severe health risks and may result in lethal consequences. Thus, the necessity to implement a stable and independent health monitoring system capable of monitoring essential parameters and detecting some abnormal conditions in real-time and informing medical services is high to guarantee a possible emergency response and enhanced patient safety.

V BLOCK DIAGRAM



VI METHODOLOGY

The ultimate aim of the suggested methodology will be to create an independent health monitoring and emergency alert mechanism, which will be able to constantly monitor the vital parameters of the patient and react instantly to abnormal conditions. The platform architecture is developed based on Raspberry Pi 4 Model B that manages the sensing, processing, and communication functions. Its hardware configuration will consist of a heartbeat sensor, to measure the pulse rate, and a DS18B20 temperature sensor to take the body temperature readings, as well as a USB camera to provide access to real-time performance so that the user can have a basic view of the patient. A controlled supply of power is adopted to maintain a stable operation of all parts. It is built on the Raspberry Pi python environment, and the programs are coded in such a way that they read sensor data continuously and assess the available values against the predetermined levels of safety thresholds. The data relayed by the heart rate and temperature is processed in real time so that it can be established whether the patient is under normal or abnormal conditions. As long as the measured values are above the safe limits, the system occurs as a possible medical emergency. Live picture of the patient is captured by using the USB camera which can be used to visually check the condition of the patient. Various functioning modes can be chosen with the use of a push button, i.e. sensor-based monitoring and camera-based observation. The LCD module has the data of the current heart rate, body temperature and system status, which is used to give local feedback regarding the health state of the patient. Whenever an abnormal condition is taken note of the buzzer is automatically turned on to draw the attention of other people nearby. Meanwhile, the GSM module delivers an emergency SMS message to the ambulance driver that the patient needs some medical care. The ability to make a dual alert mechanism makes certain that not only a local but also a remote notification is made, minimizing the response time. The system provides real-time access to sensor measurements and down states, and with their constant recording, one can observe the dynamics of the patient or evaluate his/her health condition rather swiftly. The flow of information aids in detection of warning signs before the condition turns out to be dire. Flexible data management and valid control of the system is made possible by the use of a microcomputer-based platform. Going to the extent of testing in varying operating conditions is done to ensure that the system is a true and resourceful one. Calibration of the sensor and tuning of the threshold is done to reduce false alarms and to increase detection capabilities. The outcome of the test is the adjustments to increase the stability of the systems and the speed of their response. The proposed methodology will guarantee patient safety through reliable emergency detection and quick medical help with the assistance of continuous monitoring, automated decision-making, and communication in real-time.

VII EXPERIMENT RESULTS

It was proposed to test the Cardiac Emergency Detection System to ensure that it was able to diagnose anomalous health conditions and issue emergency warnings in real time. The system was also able to measure the heart rate and body temperature in real time with the help of heartbeat sensor and the DS18B20 temperature sensor. By determining the values that were beyond prescribed safe limits, the system automatically detected the condition as abnormal and the alert mechanism went off. The abnormal condition happened to be detected and the buzzer was activated immediately to give a warning locally. Meanwhile, the GSM module was able to relay an SMS message to the ambulance driver with the emergency data. This ensured the performance of the wireless and the efficiency of the automatic generation of an alert. All the test conditions were properly reflected in the LCD display that provided an opportunity to observe in real-time the vital signs of the patient with a sensor. The USB camera offered operator real-time visual control over the patient, which allowed the visual check of the physical status. The images acquired after the alarm was raised justified the emergency situation after confirmation was made. The mode selection push button functioned well and the system could change between sensor-based monitoring and camera-based observation without problem. The repeated tests were carried out under varying physiological conditions to test the accuracy of the system and the response speed. The system was also able to give timely alerts as it responded within a short time once abnormal parameters have been observed. Continuous sensing, visual observation, and the GSM-grounded communications guaranteed the reliability of the functioning in case of emergency situations. When the system was left to operate over long periods of time, it did not encounter notable communication and sensory failures. The regulation of power supply facilitated the continuous operation of the Raspberry Pi, sensors, GSM module and the camera. This stability is critical in the case of continuing health monitoring applications where any break down can result in critical danger. The experimental results prove the system is deployable in the real-life setting including homes, clinics, and ambulances to make basic health monitoring and emergencies alert. The system under consideration helps decrease the reliance on human input and increases the likelihood of accessing timely medical care. In general, the system proved to be reliable, speedy in reaction and responding to emergency messages.

VIII FUTURE SCOPE

In the current health care setting, constant health check-ups and speedy emergency services and response have been gaining more emphasis following the increasing cases of cardiac and physiological crisis. Even though the suggested health monitoring system, which involves the use of a Raspberry Pi, offers a good solution within the means of simple vital-sign monitoring and emergency alerts, there is broad potential to improve and expand in most aspects. This can be improved by adding to the embedded system and communication technologies to allow more accuracy, greater coverage, and greater reliability in the future. The introduction of more biomedical sensors like ECG, blood oxygen (SpO 2) and blood pressure sensors could be considered as one of the possible improvements because they allow the cardiac and health conditions to be analyzed more closely. More sophisticated solutions of data processing and machine learning are also possible to strengthen the accuracy of detecting abnormal cases and decrease the number of false alerts. Better interpretation of complex physiological patterns by sensor fusion methods and adaptive threshold mechanisms can also be implemented. It is also crucial that communication capabilities are developed with the help of IoT and cloud connectivity. The connectivity of the system to a cloud based platform will result in patient information being stored, analysed and accessed remotely by the doctors and healthcare providers. This would allow real-time health monitoring,

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medical history management, and remote diagnosing of a patient, and thus increase the effectiveness of the system both in home and hospital. Enhancements to this system should include the use of mobile applications that enable the caregivers, family and doctors to engage alerts, real-time sensor and patient-related information wherever they are. This will make medical decision making fast and will enhance coordination of patients and medical practitioners in case of an emergency. Moreover, voltage control and usage of energy-even consuming elements can extend the working hours of the system in order to be more appropriate in the long-term monitoring as it needs to be continuous. Through these improvements, the intended system will be transformed into a well-developed smart healthcare platform that can provide effective monitoring, health risks early detection, and emergency response, which will eventually lead to patient safety and quality of care.

IX CONCLUSION

The creation of the Raspberry Pi-based Cardiac Emergency Detection System is one of the major attributes of enhancing real-time monitoring of health and emergency healthcare response. The proposed system offers a proactive approach to identifying abnormal physiological conditions with continuous monitoring of the heart rate and body temperature measurements and integrating the computer-generated measurements with visual testing and automatic alarming. When sensing, processing, and wireless communication are incorporated within a system, then the system will be able to recognize the occurrence of an emergency situation and take some action without the assistance of a human being. The latter addition of a GSM module to transmit SMSs instantly and a buzzer to provide local notifications will guarantee that any medical services as well as the nearby individuals will be notified automatically and in real-time in the case of a severe health incident. The USB camera continues to improve the system with real-time visual data information, which facilitates validation of the patient through the camera. Such a combined effort enhances situational awareness and allows to decrease response time, which is critical during cardiac and medical emergencies. The proposed system can be deployed in any location, whether at a home, a clinic, ambulance, and remote healthcare settings because it is compact, cost effective and also flexible. Its modularity can be easily expanded by adding sensors and other communication technologies in future. The system helps to make the healthcare support system reliable and more secure in case of emergency by allowing constant monitoring and automatic alerts. In general, the Cardiac Emergency Detection System shows how embedded and IoT-based systems can transform the provision of healthcare. The implementation of this type of system will be crucial in minimizing the risk associated with medical care, increasing patient lives and delivering life-saving service in emergency cases with further enhancement and large-scale application.

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