

## SMS-based heart attack detection system

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**Abstract.** Internet of Things (IoT) is described as a network of computer devices and things which can transfer data to each other. Considering the scenario, continuous monitoring of health is most important to manage emergency situations. A person's heartbeat, or Beats Per Minute (BPM), is one of the most crucial aspects of their health. The heartbeat was previously exclusively measured in clinics and hospitals, but they have recently made their way into mobile applications. So, for monitoring a person's Heart Rate (HR) and Oxygen saturation levels (SpO<sub>2</sub>) (works as an oximeter) MAX30102 sensor is used. The data is collected and transmitted by a patch circuit. The aim of this work is to monitor heartbeat and oxygen levels of a person and alert through a notification message if either of them are above or below required level. The levels are also displayed on the mobile app which is designed using Kodular. If the heartbeat level of a person crosses a certain threshold value, the microcontroller displays an alert message on the app and also sends an alert SMS notification to the contacts of family members and concerned medical authorities.

### 1 Introduction

The Internet of Things (IoT) refers to the interconnected network of physical objects (such as sensors or devices) that are able to exchange data and communicate with each other and other systems over the internet or other networks. These objects, which may be digital or mechanical, have the ability to send and receive information automatically, without the need for human or computer intervention. The concept of IoT was first coined in 1999 by Kevin Ashton. The history of the concept dates all the way back to 1832, when an electromagnetic telegraph was invented. Through the transmission of electrical signals, two machines can communicate directly. The true origin of the internet can be traced all the way back to the 1960s. The first IoT device was developed in the 1980s by students at Carnegie Mellon University. It was a system that allowed users to connect to a Coca Cola vending machine on campus through a network to check if it was out of Coca Cola. The machine was equipped

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with microswitches to measure the number of coke cans and the temperature. In 1990, John Romkey was the first person to connect a toaster to the Internet. A year later, students at the University of Cambridge used a web camera to check the availability of coffee in their computer lab. They created a program that took pictures of the coffee pot every 12 minutes and sent them to computers so that everyone could see if there was coffee or not. This was the first prototype of a web camera. These days, more than 27 billion devices are connected to the IoT. In the future, it can exceed 100 billion devices.

Myocardial Infarction, sometimes known as MI, is the medical term for heart attack. A person who is suffering from heart attack or myocardial infarction will experience pain in their chest and other body areas. An individual's life can be saved by recognizing early symptoms of a heart attack and receiving immediate care. Cardiac arrest, in which the heart entirely stops beating, is different from a heart attack. Without treatment, a heart attack can progress to cardiac arrest, making both medical emergencies. A person's heart rate is one of the crucial aspects to know how the health of that person is. Heart attacks can be fatal, so it's important to recognize the warning signs as soon as possible so that you can call for help. The symptoms of heart attack are a sensation of heaviness or crushing in the chest, or combination of pressure, tightness, pain. Pain which spreads to either neck, arms, jaw or back. A sensation like indigestion or heartburn. Nausea, few vomiting, feeling too sweaty, feeling dizzy and anxiety. It may also include Hypoxemia which is low oxygen levels in blood, Pulmonary Edema which means accumulation of fluid in and around the lungs, and Cardiogenic Shock which means the sudden drop of blood pressure. The order and length of the symptoms may vary; they may last for several days or appear and disappear quickly. Sometimes the symptoms of heart attack are different for men and women. Like women experiencing upper body pain, having sleep disturbances etc.

Heart attacks are most commonly caused by Coronary Heart Disease (CHD). CHD is a disorder where cholesterol deposits block the main blood channels that supply the heart with blood, the coronary arteries. They are referred to as plaques. One of the plaques ruptures (bursts) prior to a heart attack, which results in the formation of a blood clot at the location of the rupture. A heart attack could result from the clot obstructing the heart's blood flow. Chance of getting CHD rises as a result of Smoking, High Blood Pressure, taking a high cholesterol diet, being obese, having diabetes etc. The less common causes are Hypoxia i.e lack of oxygen and drugs like cocaine which narrow the arteries.

Due to the increase in health issues in the modern world, personal health monitoring is thought to be of utmost importance. The general health is being severely impacted by the increasingly stressed lifestyle. Coming to heart attacks many heart patients are dying either on their way to hospital or before reaching the hospital. According to the stats most cardiac patients are beyond the age of 50. Out of these, single residents make up around 75% of the patients. These patients' biggest issue is that they are all by themselves. Nobody was available to perform CPR on them or transport them to the closest hospital. It further states the importance of health monitoring systems.

The cost of seeing a doctor has skyrocketed due to the long wait times at hospitals and the growing number of patients, which is particularly hurting those people who cannot afford the fee or who do not have serious illnesses but find out they have it only after paying a substantial fee to the doctor. Researchers and surveys frequently show that the majority of significant health problems are caused by disregard for small health problems. The majority of these problems can be resolved simply by following a healthy diet, regular exercise, and sleep patterns.

## 2 Proposed Method

The proposed method involved a stepwise approach. Initially, the required libraries for sensor data reading and processing were installed in the Arduino IDE. This facilitated the connection with the MAX30102 sensor via an ESP32 to obtain heart rate and oxygen level readings. The subsequent stage focused on connecting Google Firebase with the Arduino for storing and managing the collected health data. The Firebase real-time database was created, and the API key and secret key were integrated into the Arduino code to enable data transfer. A Kodular app was then developed to display the health data retrieved from Firebase. This app was linked to Firebase by specifying the Firebase URL in the Kodular's Firebase Token section. Finally, the system's alert messaging module was designed to send notifications, including the patient's live location, to their relatives and medical authorities using components such as labels, text boxes, activity starters, location sensors, and Firebase databases. This method ensured the seamless flow of health data from the sensor to the end users, enabling real-time health monitoring and alerting [1].

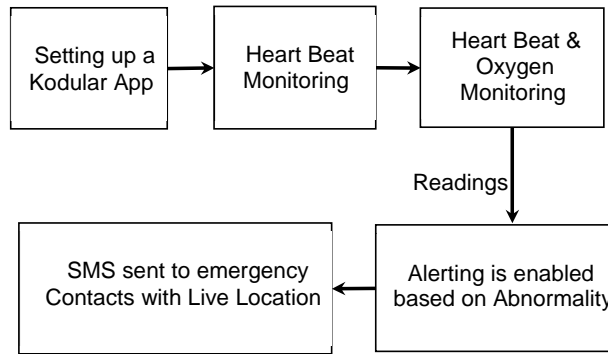


Fig. 1(a). Block Diagram of the Proposed Method

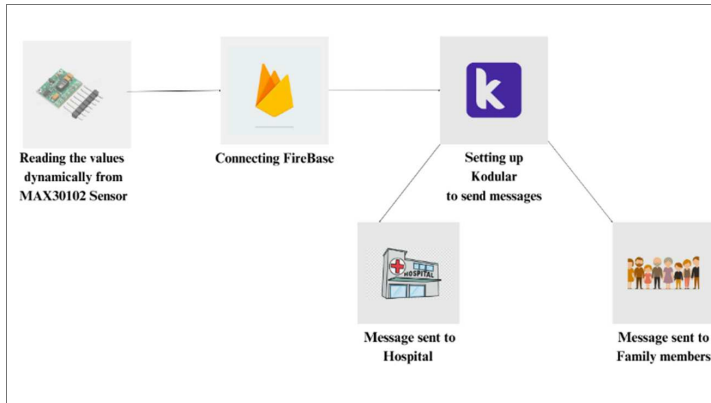


Fig. 1(b). Connectivity Diagram

Figure 1(a) shows the block diagram of the proposed system. The detailed explanation of the architecture diagram is as follows.

- The process begins with the creation of a Kodular app, where the user interface and functionalities are designed.
- The Kodular app is configured to establish a connection with the Firebase database, enabling real-time data retrieval and storage.
- The heart rate monitoring module is initiated, collecting heart rate data from the MAX30102 sensor connected to an ESP32 microcontroller.
- Simultaneously, the system is set to monitor both heart rate and oxygen levels.
- If abnormal readings are detected during monitoring, the Alerting System is activated.
- An alert message is generated and sent out to predefined recipients, including family members and doctors.
- The message includes vital information and the patient's live location, ensuring prompt and effective response to critical health conditions.
- This system provides continuous heart rate and oxygen level monitoring, ensuring the well-being of the user by alerting relevant parties in case of abnormal readings.

Figure 1(b) illustrates the connectivity diagram. There are four modules in the proposed work. They are,

1. Reading values from the Sensor
2. Connecting Firebase
3. Setting up the Kodular App
4. Sending alert messages

### 2.1 Reading values from the Sensor

By using MAX30102 sensor connected with esp32, the heart beat levels and oxygen level readings are taken, using ArduinoIDE. Along with installing Arduino IDE, some libraries should be installed. Components required for this module are as follows: (a) Wifi module, (b) Firebase Arduino Client Library for ESP32, (c) Firebase ESP32 Client and (d) SparkFun MAX3010x Pulse Sensor library. Wifi Module: Enables network connection using Arduino Wifi shield. Firebase Arduino Client Library for ESP8266 and ESP32: Supports all the firebase related products such as real time database, cloud firestore database, Firebase Storage etc. It also supports other Arduinodevices using client interfaces such as Wi-Fi Client, GSMClient.

Firebase ESP32 Client: The entire Firebase Arduino client library that supports CRUD (create, read, update, delete) and Stream operations is quick, secure, and trustworthy. SparkFun MAX3010x Pulse and proximity Sensor Library: An Arduino Library for the particle sensor and MAX30102 Pulse Ox sensor. This library enables the Arduinoto take the readings of the heart beat and oxygen saturation levels of the patient.

### 2.2 Connecting Firebase

Google firebase is connected with Arduino IDE for storing the readings of heart Beat levels and oxygen levels of the patient. Basically, Firebase is a Backend-As-A-Service (BAAS) app development platform which offers services such as real-time database, cloud storage, authentication, crash reporting, analytics, etc [2]. It is created using Google's framework. In the paper, the real-time database is used. Google Firebase is connected with an Arduino to take the readings of heart beat and oxygen saturation levels of the patients and transfer them over Google Firebase. Components required for this module are as follows: Google Firebase and Arduino code for connecting Firebase

### 2.3 Setting up the Kodular App

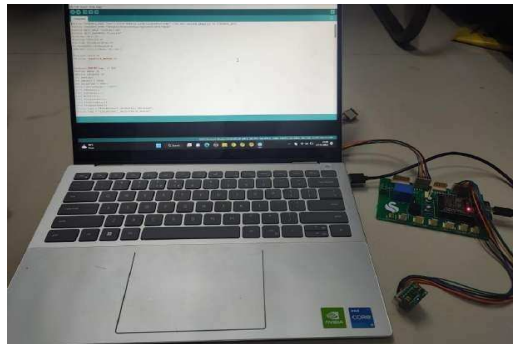
An application is set up to display the readings of heartbeat and oxygen levels, using Kodular. For connecting with firebase, the URL of the firebase has to be copy pasted at the Firebase token section in the Kodular [3]. Kodular is a free online toolkit for creating mobile applications. It primarily offers an online drag-and-drop platform for developing Android apps, allowing anyone to build any kind of app without writing a single line of code [4]. Components used in this module, (a) Kodular Companion and (b) Mobile

### 2.4 Sending alert Messages

An alert notification message including the live location of the patient is sent to the relatives of the patient and medical authorities. The following are the components used in Kodular for sending the alert message(s): Labels, Text box, Activity Starter, Location sensor, and Firebase.

## 3 Experimental Results and Discussions

It is a highly integrated and highly sensitive pulse oximeter and heart rate sensor used to incorporate live heart-rate data. It can be used with microcontrollers such as Arduino, ESP32 etc. It can be used with wearables such as fitness trackers, sports watch. The MAX30100 sensor is connected to the microcontroller of ESP32 and the readings of the patient are taken using the sensor. Figure 2 illustrates the Hardware setup of the proposed work. With the MAX30100 sensor, the heart beat and oxygen saturation levels of the patient can be taken. The dynamic readings from the sensor are used as the data in this application.



**Fig. 2.** Hardware Setup.

The data read from the sensors is first stored in a real-time database in Google Firebase, shown in Figure 3, through which mobile application is operated and data is transferred from the database to the mobile application wirelessly over the internet. The outputs of the code are displayed in the firebase which is shown below.

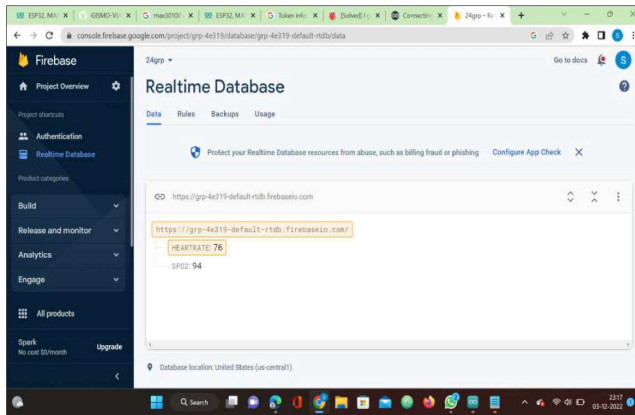


Fig. 3. The readings are stored in the real-time database

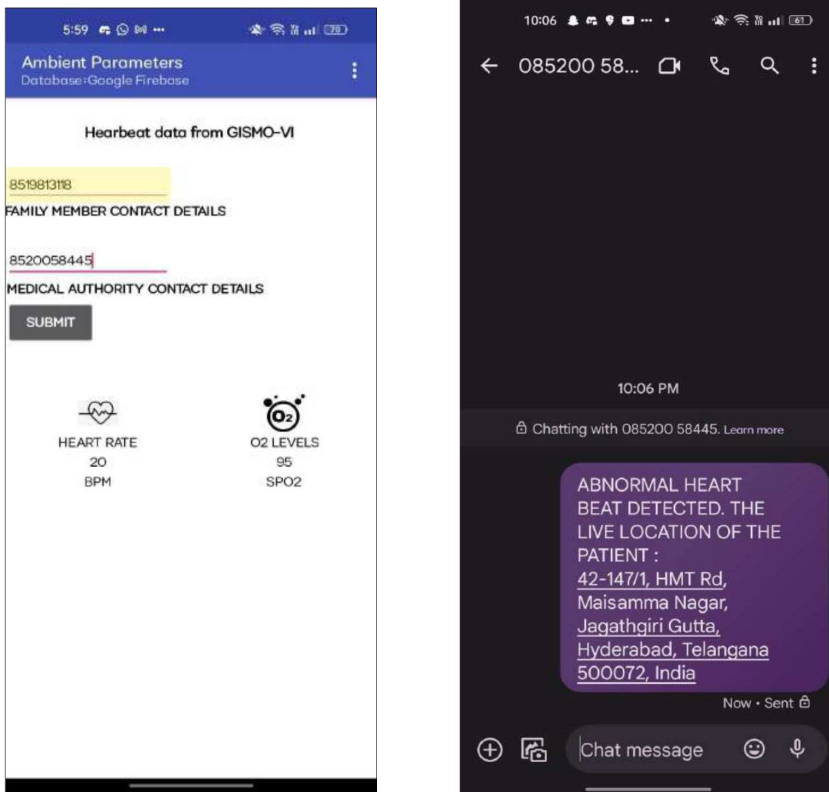


Fig. 4. Final Version of the application interface and the sending of alert messages.

The Kodular application shows the output to the user in their device as follows. A Kodular App is designed to take the input of contact details of the family members and medical authority. And the heartbeat levels and oxygen saturation levels of the patient are displayed on the app. By clicking the submit button, the contact details which are provided by the user are stored. Whenever the heartbeat levels become abnormal ( $< 60$  or  $> 100$ ), the app will send a text message to the contacts which are given by the user. Figure 4 represents the frontend view of the application which is designed using Kodular.

#### 4 Conclusion and Future Enhancements

Centuries ago, people died mostly due to wars, epidemics, low standards of living, poor maintenance and low-level medical care. But as time changes chronic diseases, accidents, heart attack, etc became global leading causes of death [5]. Due to the increase in health issues in the modern world, personal health monitoring is thought to be of utmost importance. General health is being severely impacted by the increasingly stressed lifestyle. The cost of seeing a doctor has skyrocketed due to the long wait times at hospitals and the growing number of patients, which is particularly hurting those people who cannot afford the fee or who do not have serious illnesses but find out they have it only after paying a substantial fee to the doctor. According to researchers some of the health issues can be solved by following a healthy diet, having a proper sleep, by regular exercising (brisk walking) and checking a few parameters such as Blood pressure, BMP, SpO2 levels etc. The paper aims to monitor the heart rate and the oxygen levels of a person through MAX30102 sensor and alert when either of them are above or below required level and the values are also displayed on the mobile app using Kodular platform. If the readings cross a certain threshold value, the microcontroller displays an alert message on the App [6].

The app also sends an alert notification to the contacts of family members and medical authorities. As it is a known fact that early symptoms of heart attack are reduced oxygen levels and abnormal heart rate. When the readings are abnormal and alert an alert notification will be sent to the concerned family members and medical authorities through an app which is designed using Kodular. The system also sends the live location of the patient to the family members and concerned medical authorities through the App. The paper helps elderly people and heart patients who experience cardiac issues. ~~Optimizing~~ **Optimizing** to future enhancements, Utilizing the paper's framework and design the paper can be expanded into new heights through IoT. The temperature sensor BMP280 can be integrated into the paper as sudden temperature drop or sudden temperature rise are one of the symptoms of heart attack. Paper ensures accuracy by testing MAX30102 sensor, patch circuit, and communication for precise health measurements under diverse scenarios. Thorough evaluation includes patch circuit and communication testing, ensuring the system responds accurately to varied health thresholds with timely notifications. System undergoes testing with diverse demographics, accounting for environmental factors and user mobility to demonstrate reliability and accuracy in real-world conditions.

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