DEVELOPING SMART SYSTEM FOR MANAGING HEART PATIENTS' CRISES

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Research Journal Specific Education

Faculty of Specific Education

Mansoura University

ISSUE NO. 67, MAY , 2022

مجلة بحوث التربية النوعية - جامعة المنصورة

العدد السابع والستون - مايو ٢٠٢٢

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*M. A. E. Sheta** *R. A. E. El-Adly*** *A. E. E. ElAlfi****

Abstract:

The purpose of this study is to present an effective system model for tracking and monitoring patient vital data in order to deliver timely medical services and manage cardiac patient crises. The data will be acquired via sensors and compared to a preset threshold. The proposed system is based on pulse rate, so in the event of an emergency, a sound alert would be launched for the patient, and the GSM module would transmit these patients' records to a web server, where they are kept in a database, and SMS is sent to the hospital phone, so the patient may communicate in real time via a web browser and SMS message.

Keywords

Arduino, GPS, Google Map, GSM, Heart Rate, Pulse Sensor

INTRODUCTION

An irregular cardiac rhythm can occur at any moment and in any location without warning, causing health problems such as lightheadedness, racing of the heart, or dizziness. If a strange coronary heart beat closes for a long time, it might affect one coronary heart's feature and even cause death in some circumstances [1].

Therefore, heartbeat rate refers to the number of heartbeats per unit of time, which is often stated in beats per minute (bpm). Adults with a healthy heart rate have a heart rate of 60 to 100 bpm [2].

This means that arrhythmia is a condition in which the heart rate in adults is more than 100 beats per minute, resulting in an abnormal pulse rate environment. Adults with a heart rate of fewer than 60 beats per minute are said to have bradycardia [3].

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The Photoplethysmography signal can readily identify heart rate.(PPG) is a non-invasive optical technique for detecting changes in blood volume in blood capillaries that involves lighting the skin with an infrared light source and using a photodiode to measure variations in light intensity reflected or passing through the skin tissue [4].

GPS stands for Global Positioning System, and it is a satellite-based navigation system that employs the geographic coordinates system to pinpoint the precise location of a GPS module. The latitudes and longitudes are included in the GPS coordinates [5].

The GPS is used to locate the patient, and the map is followed to locate the nearest hospital. Once the location has been determined, the patient record is transmitted to the nearest hospital [6].

The doctor must be aware of the patient's physical and physiological state in order to make the best decisions possible regarding medicine administration and transportation. As a result, communication between the ambulance crew, the patient, and the monitoring station is required [7]. Thus, it monitors physical parameters such as heartbeat and sends the data to the nearest hospital through a web server and SMS message [8].

A GSM modem is a specific form of modem that accepts a SIM card and functions on a mobile operator's subscription, such as a mobile phone. GSM (Global system for mobile) uses a manner known as circuit switching. This method of communication lets in a route to be installed amongst devices [9].

RELATED WORK

Had developed a mobile device based on the PPG technique that measures heart rate using a pulse sensor, an Arduino Uno board, and an ATmega328p microcontroller. The technology can track heart rate, identify missed heartbeats caused by premature ventricular contractions (PVCs), and show the data on a Liquid Crystal Display (LCD). The heart rate and missing beat data are then serially transmitted to an ESP 8266 Wi Fi module, which uses the Message Queuing Telemetry Transmission (MQTT) protocol to post the data to a website [10].

Had introduced a prototype for a low-cost HRM device was demonstrated. The gadget is user-friendly, portable, long-lasting, and cost-effective. The HRM gadget is effective and simple to operate. This gadget has the potential to be employed in both clinical and non-clinical settings. Individual users can also utilise it with ease. Using the HMS capabilities given by this system, the gadget might potentially be used as a monitoring instrument [11].

Had developed a wireless pulse rate and temperature monitoring device based on an ATmega328 microcontroller has been created (arduino uno).and the patient may be observed in real time from afar. Both readings are shown on the LCD monitor. The measured data is transmitted from the remote via wireless technology. [12].

Had developed a patient health monitoring system based on IOT (Internet of Things). The doctor will be able to examine the patient's health state online.So that a doctor may provide essential therapy to a patient remotely and provide advice to the patient remotely [13].

Had aimed to monitor heart rate using a pulse sensor and the data was saved on a server for later use. The http protocol is used to send the data to the server and the individual can use Wi-Fi hot spot settings to connect to it via their Android phone [14].

Had suggested a method for detecting cardiac arrhythmias by measuring the time between each heartbeat (IBI), arrhythmia may be recognized using the knowledge gathered from the literature study. The rate of change of IBI may be investigated by using the IBI values obtained and constructing a graph. It was discovered that when the heart rate varies, so does the IBI, which may be used to identify whether arrhythmia is present. The ESP8266 Wi-Fi module for IoT and the PPG sensor were used to detect atrial fibrillation by continuously monitoring PPG signal data [15].

Had investigated how to make a low-cost, portable heart-rate counting system using a microcontroller for monitoring heart health. An IR finger-tip sensor was used to obtain the cardiac pulse [16].

Had proposed an effective system that would track, trace and monitor the vital readings of the patient in order to provide effective medical services in a timely manner. The data will be acquired using the sensors and compared to a specified limit. The study concentrates on heart rate, body temperature, and therefore in the event of an emergency, an SMS will be sent to the doctors mobile phone containing measured values and position [17].

A technology that monitors your heart rate and body temperature wirelessly has been implemented that is able to keep track of your heart rate and read the patient body temperature at any time, At any moment, healthcare practitioners may monitor and diagnose their patients using a laptop, they can easily keep an eye on their patients from their desk, which is very useful in an emergency [18].

Had developed an IoT device, where the exact GPS coordinates of the patients are sent to the server through Doctors and hospital workers may also follow the patient's exact position and serve him using the server's web interface and Google Maps [19].

Had presented a built-in smart gadget that constantly examines the health of patients, The pulse rate, skin temperature, and saline liquid level of patients are all monitored by this device. This smart gadget alerts physicians or caregivers if any of the aforementioned metrics surpass the threshold value and orders remedial steps to preserve patients' lives [20].

The PROPOSED SYSTEM

The proposed system is designed to provide an effective method for tracking and monitoring patient vital data in order to provide timely medical services. The data will be recorded and compared to a predetermined threshold with the use of sensors. The proposed system focuses on heartbeat rate and launches a sound alarm for the patient and posts a request to the server containing the serial id, measured values for heart rate, and the patient's current location to the nearest hospital. It also sends an SMS message to the nearest hospital, the SMS containing the pulse rate, the current location of the patient, and a URL website for the hospital. The proposed system has three main stages: measuring heart rate, getting the current location, and sending and receiving notifications via web server and mobile phone. The block diagram of the proposed system as shown in figure (1).

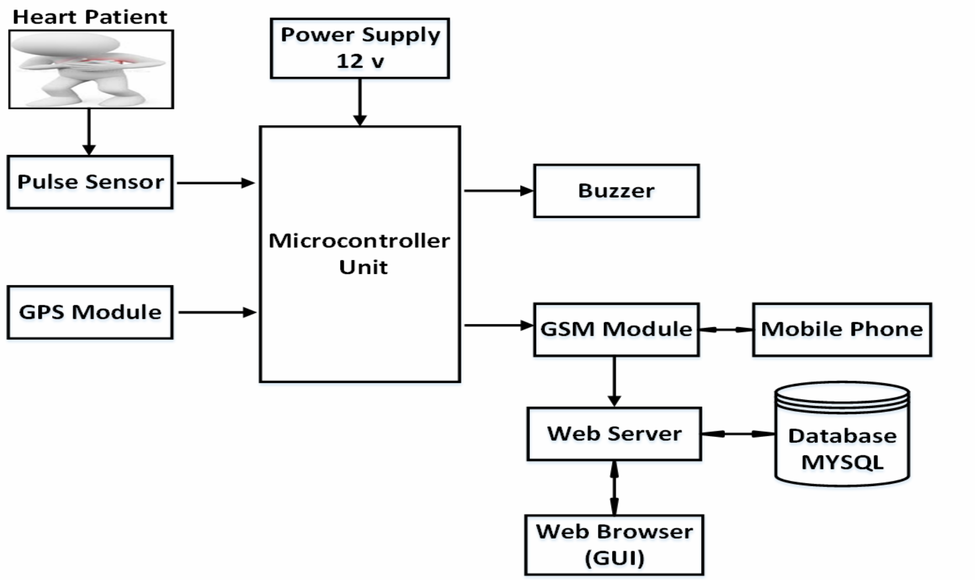


Fig.1. Block diagram of proposed system.

The proposed system has three main stages:

1. Measuring heart rate for patient using pulse sensor.
2. Getting the current location for patient using GPS module.
3. Sending and receiving notifications via web server and SMS via mobile phone using GSM module. The flow chart for the proposed system as shown in figure (2).

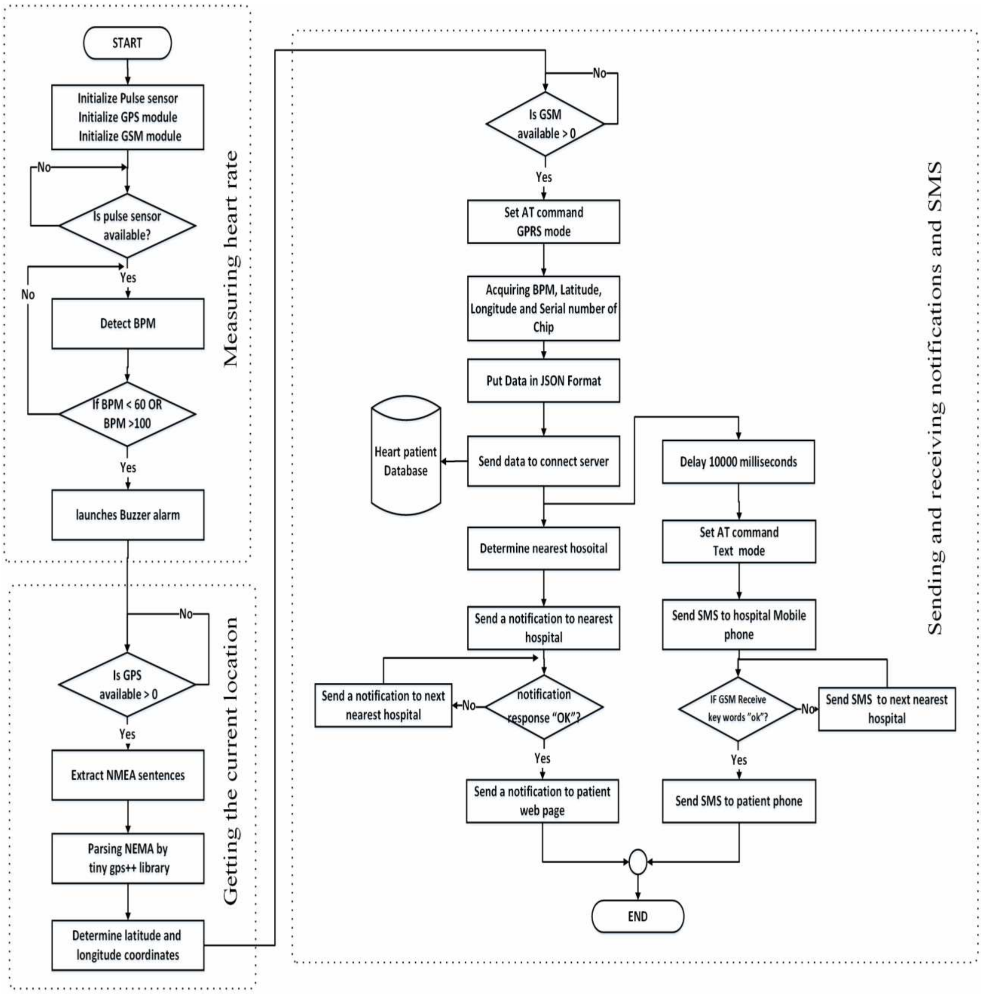
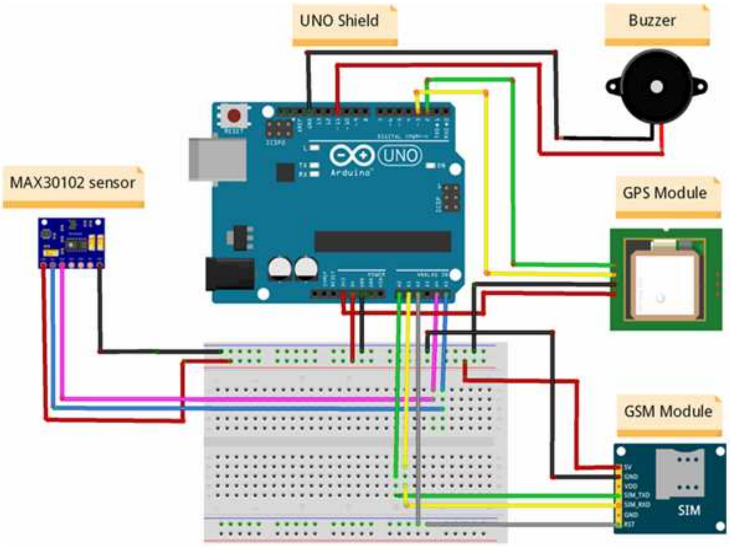


Fig.2. Flow chart of the proposed system.

The heart rate monitoring system has five components, the circuit diagram of the heart rate monitoring system as shown in figure (3).

- **Pulse rate sensor:** It is used to determine the heart rate of a patient.
- **Buzzer sensor:** It is used to sound an alarm for the patient in the event of a disturbance in the heartbeat.
- **GPS module:** It is used to get the patient's coordinates.

- **GSM module:** It is used to send the measured data from the patient through a web server and SMS message.
- **Arduino shield:** It is used to connect and control for all component connect to.



Module Pin	Arduino Pin
Pulse Sensor	
VCC	5V
GND	GND
SCL	A4
SDA	A5
Buzzer Sensor	
Signal	Pin 11
GND	GND
GPS Module	
RX	Pin 2
TX	Pin 3
VCC	3.3V
GND	GND
GSM Module	
RT	A1
TX	A0
VCC	5V
GND	GND
REST	A3

Fig.3. Circuit diagram of the heart rate monitoring system.

3.1 Measure of heart rate

The aim of this stage is to measure the heart rate of the patient and detect a heart attack in them by putting sensors on one of their fingers or at any spot on their body where the heart rate can be measured. This stage is based on the Arduino Uno microcontroller, the max30102 sensor and the buzzer alarm. Schematic for measure of heart rate as shown in figure (4).

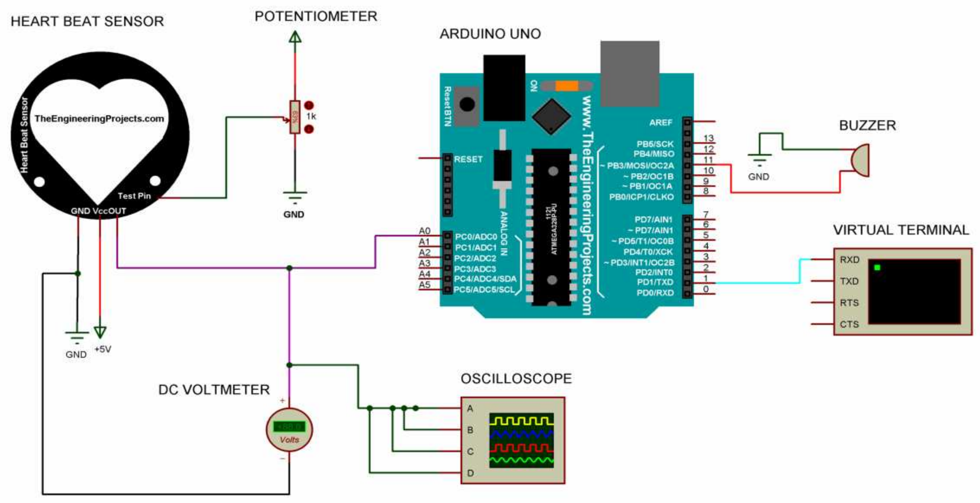


Fig.4. Schematic for measure heart rate.

The patient's heart rate is read at this stage using a pulse rate sensor. The max30102 sensor as shown in figure (5).

Fig .5. Max30102 sensor.

The specifications of the pulse sensor are:

- In an LED reflective solution, a heart rate monitor and a pulse oximeter biosensor are combined.
- 14-Pin Optical Module, 5.6mm x 3.3mm x 1.55mm.
- Integrated Cover Glass for Optimal and Reliable Performance.
- Connection to the output signal (I2C).
- Power-saving features include programmable sample rate and LED current.
- Low power heart rate monitor (<1mW).
- Ample Sample Rates.
- Operating Temperature Range: -40°C to +85°C.
- Otherwise, the operational voltage is in the +5V range.

The sensor has two leds, one of which emits red light and the other infrared light. Infrared light is all that is required to compute the pulse rate.

Photoplethysmography (PPG Signal) is used to power this sensor. The PPG signal is a non-surgical technique for determining relative changes in the volume of blood in the blood vessels near the skin's surface [21].

There are two parts to A PPG signal consists of two parts: an AC part and a DC part. The AC component of the PPG signal is acquired when light travels through arterial blood and is pulsatile. Light is absorbed by blood in veins, bones, and tissues. causes the DC component, or non-pulsatile part. This signal provides vital data such as variability of heart rate, blood pressure, and respiration [22].

Heart rate value extracted from the max30102 sensor used in the proposed system as shown in figure (6).

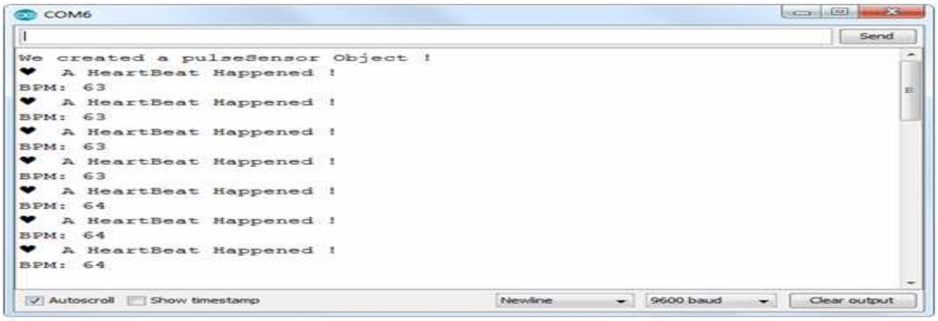


Fig.6. Heart rate value extracted from pulse sensor.

The peak to peak interval (PPI), heart-rate variability (HRV) and heart-rate (BPM) are calculated using equations [23].

$$PPI = \frac{1}{sample\ rate} \sum_{i=1}^{n} (p_{i+1} - p_i) * 1000 \qquad (1)$$

$$HRV = \frac{1}{N} \sum_{i=1}^{n} PPI_i \qquad (2)$$

$$HBR = \frac{1}{HRV} * 60000 \qquad (3)$$

Where:

N: the number of point peaks

i : the value of each peak position.

Once the heart rate value is obtained from the PPG Signal, the specified threshold is applied; its value varies between 60 and 100 bpm [2].

If the value of the heart rate is in the permissible range, then there is no response from the proposed system, and if the value of the heart rate is higher or lower than the threshold, there isa transition to the second stage.

3.2 Getting the current location

The aim of this stage is to determine the current location of the patient. This stage is based on the Arduino uno microcontroller and the GPS Neo 6m Module. The schematic for this stage as shown in figure (7).

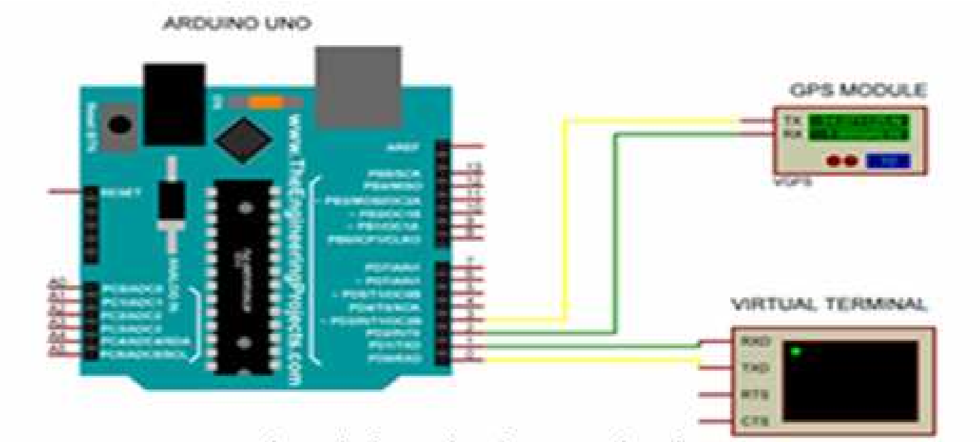


Fig.7. Schematic for getting the current location.

The patient's GPS coordinates will be the data to be gathered. The Global Positioning System (GPS) is a system of satellites orbiting in space that transmits precise and error-free locations. It's significant since it has the capability of determining position in three dimensions: longitude dimensions, altitude dimensions, and latitude dimensions.

Patient coordinates are extracted using the GPS Neo 6m Module. GPS Neo 6m Module as shown in figure (8).

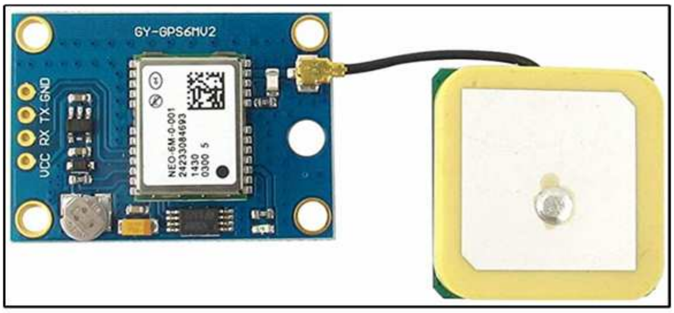


Fig.8.GPS Neo 6m Module.

The specifications of GPS module are:

- GPS module receiver that requires a power supply between 2.7 and 3.6 volts.
- It has four interfaces: UART, USB, SPI, DDC, as well as an antenna supply and supervisor, when given with the proper external components .
- It also features a time pulse, an RTC crystal, three configuration pins, and anti-jamming technologies.
- It's a u-blox 6 50-channel positioning system with over 2 million effective correlators.
- An EEPROM for saving settings is a crucial feature, as is the 25x25 ceramic antenna.

The GPS Neo 6m Module extracts GPS data in the form of NMEA sentences (National Marine Electronics Association).

NMEA clauses provide specifications that describe the interaction between various electronic equipment. This standard allows computers and other marine equipment to communicate with marine electronic devices. The connection to the GPS receiver is also defined in this specification. NMEA data is understood by the vast majority of computer systems that provide real-time location and navigation data. This NMEA data contains the complete location, speed, and time information that is processed by the GPS receiver. Each NMEA statement must begin with “$ and be no longer than 80 characters, including line endings. The data portions of these statements are separated by commas [24]. The following table (1) shows GPS NMEA sentences.

After getting the GPS NMEA Sentences from the GPS unit utilised in the current stage, an analysis is performed on these sentences using the TinyGPS++ Library to determine the patient's current location.

Table 1. GPS NMEA sentences extracted from prosed system.

S. NO.	Sentence	Description	Value of Proposed System
1	$GPGGA	Global Positioning System Fix Data.	014522.00,3102.70957,N,03124.27719,E,1,05,3.61,19.3,M,17.5,M,,*67
2	$GPGLL	Geographic position, latitude/ longitude.	3102.70957,N,03124.27719,E,014522.00,A,A*6B
3	$GPGSA	GPS DOP and active satellites.	A,3,19,20,17,05,30,,,,,,,,4.76,3.61,3.10*0B
4	$GPGSV	GPS Satellites in view.	3,1,12,05,16,228,16,07,00,101,,12,07,238,20,13,83,259,21*79
5	$GPRMC	Recommended minimum specific GPS/Transit data.	014523.00,A,3102.71121,N,03124.27632,E,6.922,337.86,260621,,,A*6A
6	$GPVTG	Track made good and ground speed.	337.86,T,,M,6.922,N,12.819,K,A*08

TinyGPS++ is an Arduino library for processing NMEA data streams, which is provided by GPS modules. It is the direct inheritor of TinyGPS. The library contains methods for quickly and easily obtaining time, location, date, speed, course, and altitude from GPS devices. The library can extract all of the data from the two most popular NMEA statements, $GPGGA and $GPRMC.

The Encode () In order for TinyGPS++ to work, this function is utilised to channel characters from the GPS module on a regular basis. Flow chart for extracted coordinate from GPS as shown in figure (9).

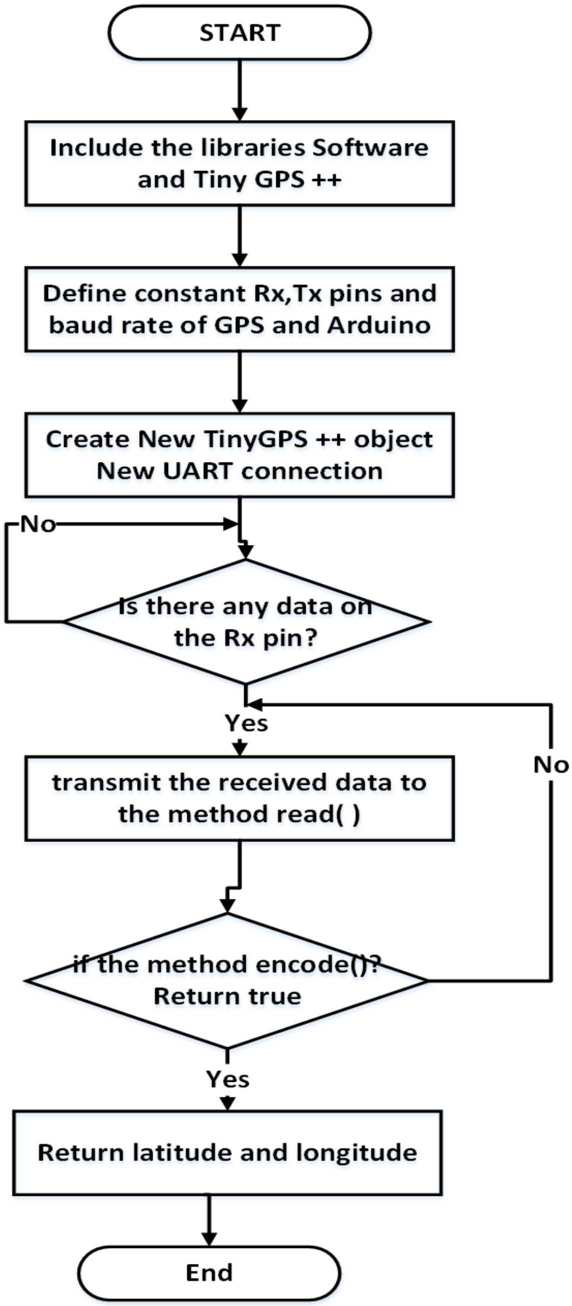


Fig.9. flow chart for extracted coordinate from GPS.

3.3 Sending and receiving data via server

After determining the patient's heart rate using the Max30102 sensor and extracting the patient's coordinates using the GPS 6M Module, it sends a post request as a JOSN object to the server. The JOSN object contains information such as BPM, latitude, longitude and serial number of the chip for each patient. The process of sending data to the connected server as shown in figure (10).

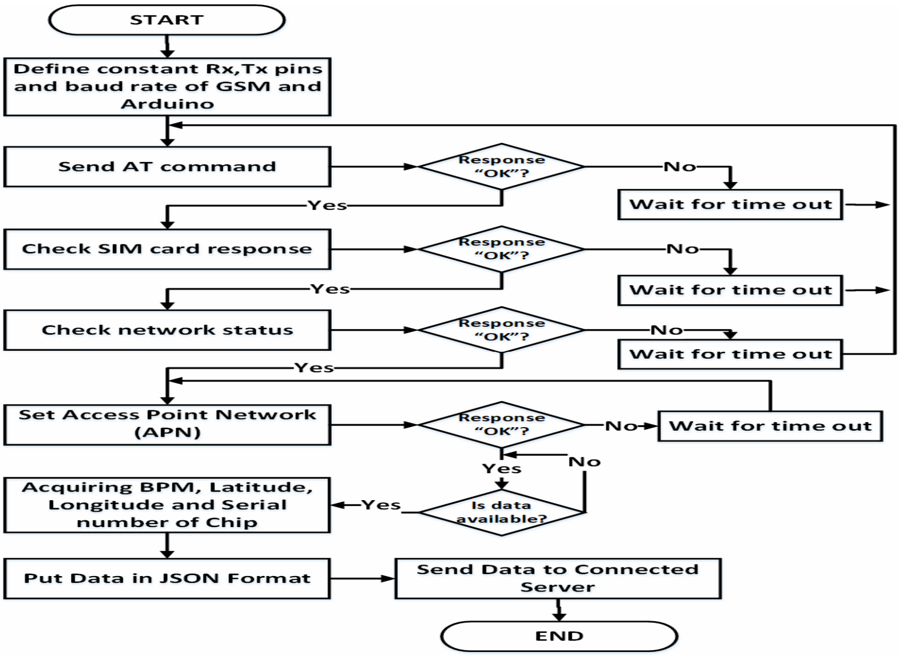


Fig. 10. Flow chart for sending data to a connected server

The data is received from the connected server, then the key value is extracted from the JSON object, the nearest hospital to the patient is determined based on the hospital data stored in the database, and finally, a notification is sent to the nearest hospital. The flow chart for receiving data from a connected server as shown in figure (11).

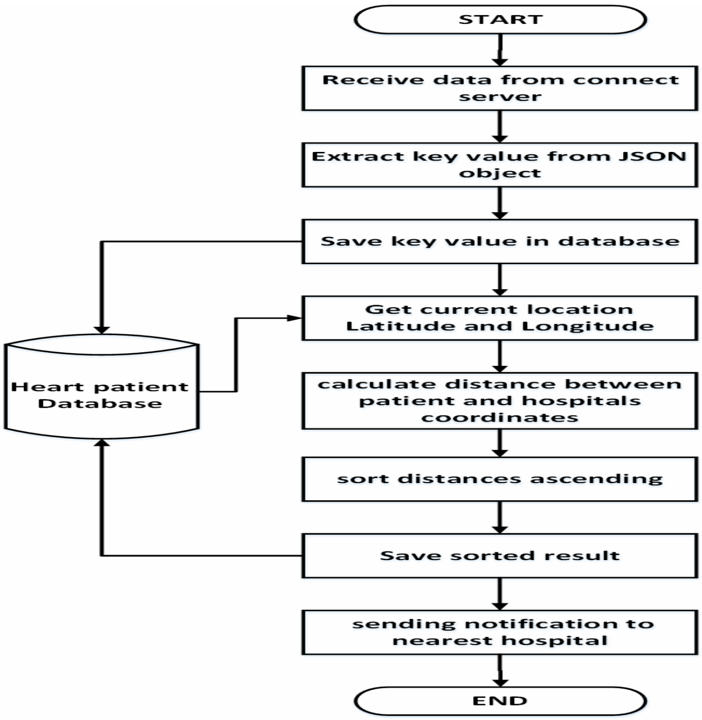


Fig.11. Receiving data from connected server.

The notification contains the patient's name, heart rate, time of heart attack, and serial ID of the patient's device. Based on the serial ID of the patient's device, a query is made about the personal and vital data for the patient stored in the database.

After the request is sent to the server, the SMS is sent to the mobile of the nearest hospital with a delay time of 10,000 milliseconds. The message sent contains the pulse rate, the current location of the patient, and the URL of the hospital. If the response from the hospital was with the keyword "OK", a short text message was sent to the patient's mobile in the name of the hospital that received his request, and in case the hospital refused the request by sending the keyword "No", The first message is sent to the next nearest hospital, and the patient's crisis management is handled in this way until the request is accepted. The flow chart for sending and receiving SMS as shown in figure (12).

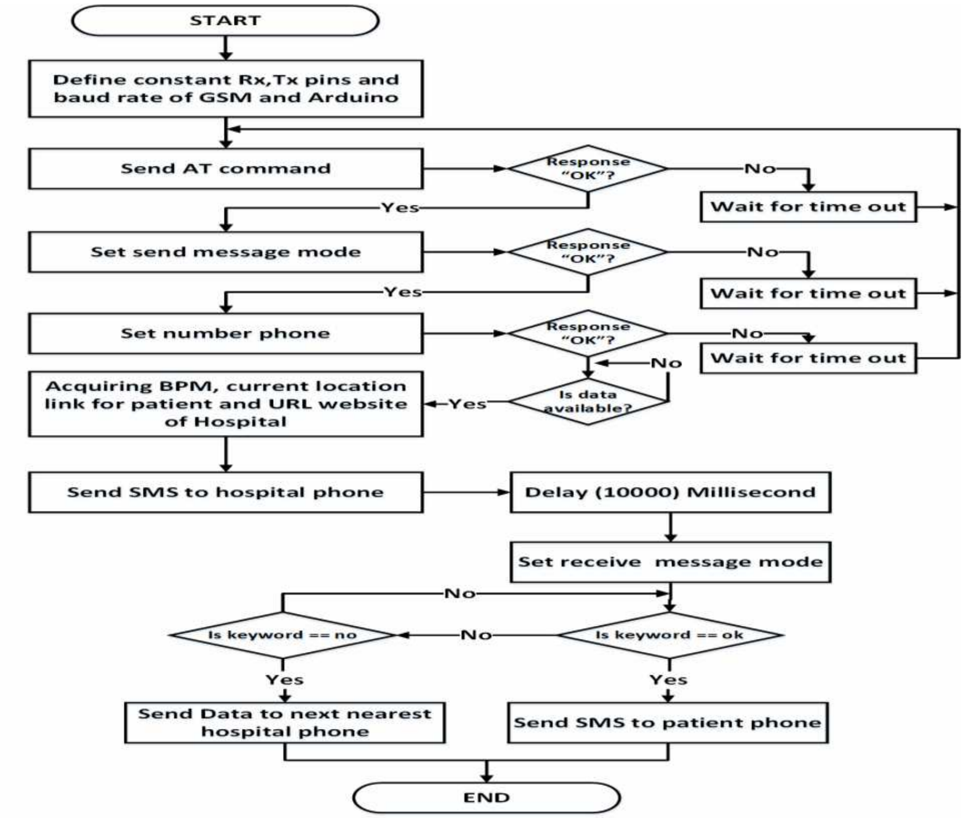


Fig. 12. Flow chart for sending and receiving SMS

The distance is calculated by the following equation [25] and the following table (2) shows hospitals' coordinates and calculates the distance to the nearest hospital.

$$d = 2r \arcsin \sqrt{\sin^2\left(\frac{\varphi 2 - \varphi 1}{2}\right) + \cos(\varphi 1).\cos(\emptyset 2).\sin^2\left(\frac{\psi 2 - \psi 1}{2}\right)} \qquad (4)$$

Where :

d : the Distance (km). r : the earth's radius, which is 6371 (km).

φ : the Latitude. ψ : the Longitude.

Table 2. Hospitals coordinate and calculate distance to nearest hospital.				
NO	**Hospital**	**Latitude**	**Longitude**	**D**
1	Mujamma Al-Eman	31.039922	31.385667	**0.59**
2	Arab Hospital	31.035842	31.392044	**0.97**
3	AlziraeiaynHospital	31.033270	31.395031	**1.29**
4	Glory Hospital	31.029488	31.398085	**1.69**
5	DELTA Hospital	31.042821	31.364752	**1.80**
6	Alqima Altakhasusi	31.032727	31.362846	**1.83**
7	Gezira International	31.045231	31.365543	**1.87**
8	Alraja Alsaalih	31.038118	31.361908	**1.91**
9	Noor AL-iman	31.051361	31.404860	**2.80**
10	Al Khair Hospital	31.051935	31.407021	**3.00**

This stage is based on the Arduino uno microcontroller and the GSM SIM800L Module. Schematic for sending data to a connected server as shown in figure (13).

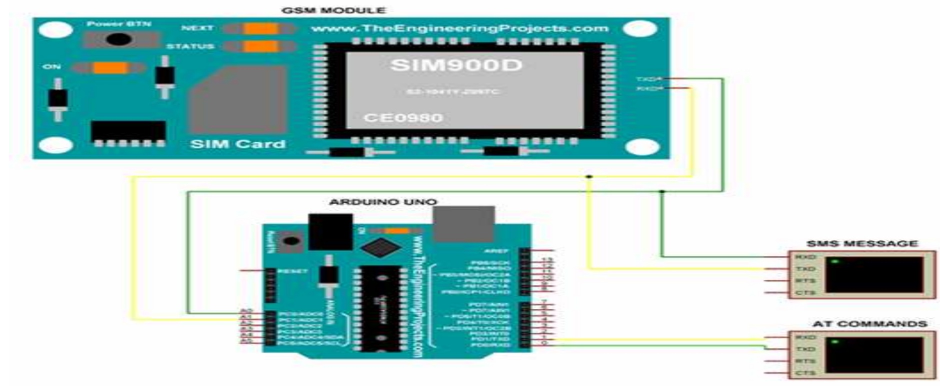


Fig.13. Schematic For sending data to connected server.

A post request will be sent at this stage using the GSM SIM800L Module. The GSM SIM800L Module as shown in figure (14).

Fig.14. GSM SIM800L Module.

The Technique GSM refers to the Global System for Mobile Communications. The European Telecommunications Standards Institute (ETSI) created it. The A SIM800L cellular module is a tiny cellular module. It allows you to make and receive phone calls as well as send and receive SMS. The main characteristic of the GSM Sim800L is its tiny size and affordable price.

The specifications of the GSM SIM800L Module are:

- Voltage range: 3.8 to 4.2.
- Power consumption: sleep mode < 2.0mA, idle mode < 7.0mA.
- Module dimensions are 25 x 23 cm.
- The temperature range of -40 to + 85 ° C.
- Micro-SIM is the type of SIM card that may be used and AT instructions are used as the interface.
- Frequencies supported 850/950/ 1800/1900 MHz .

The AT Command is used to operate this GSM SIM800L Module. AT commands are GSM modem control instructions. Every command begins with the letters "AT." AT serves as a prefix, indicating the GSM modem at the start of the command line. The AT commands are used in the proposed system to send data to the connected server are shows in Table (3).

Table 3. AT Commands.

AT Commands	**Description**
AT	Check the status of the modem
AT+HTTPINIT	Start HTTP service
AT+HTTPTERM	Stop HTTP Service
AT+HTTPPARA	Set HTTP Parameters value
AT+HTTPACTION	HTTP Method Action
AT+HTTPHEAD	Read the HTTP Header Information of Server Response
AT+HTTPREAD	Read the response information of HTTP Server
AT+HTTPDATA	Input HTTP Data

Chapter 4: APPLICATIONS AND RESULTS

The main part of the proposed system is alerts the patient if there is an abnormality in the heart rate and transmitting the information obtained from the patient by using Pulse sensor, getting the current location of the patient and recommending the nearest hospitals to the patient and finally notification sent to the nearest hospital the implementation of the proposed system as shown in figure (15).

Fig.15. Implementation of the proposed system.

The nearest hospital received a distress notification from the proposed device for patient, it contains the patient's name, heart rate and time of heart attack as shown in figure (16).

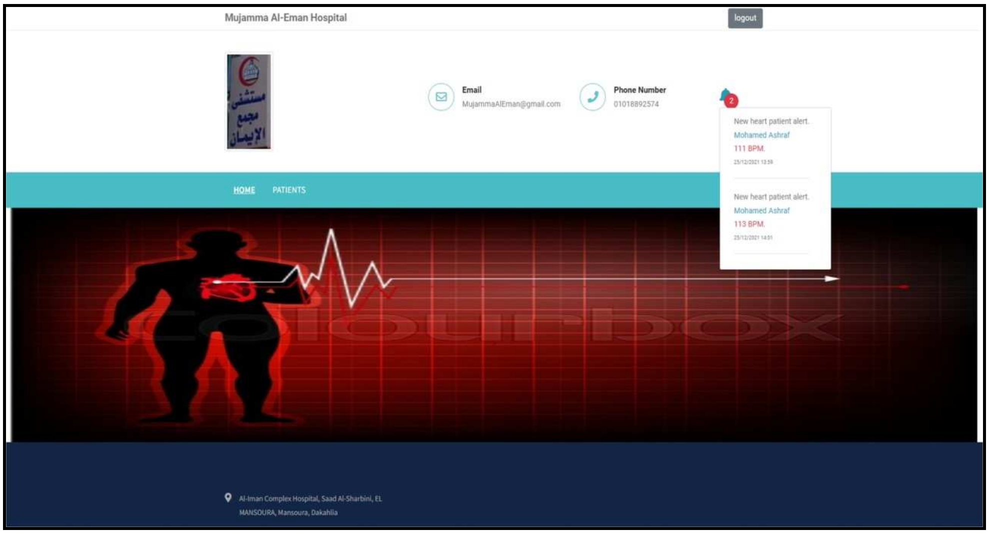


Fig.16. nearest hospital received notification on the webpage.

To confirm the response to the distress request, a notification page is entered that contains the patient’s personal , vital information, as well as his current location and navigation through directions on Google maps, medical file is also created for the patient in this hospital received the distress request as shown in figure (17,18).

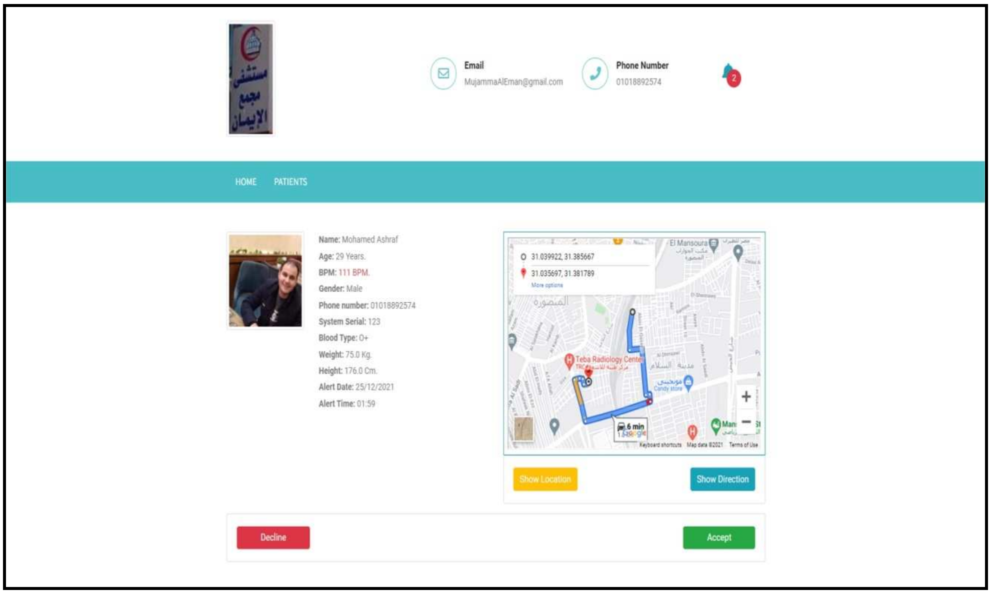


Fig.17. webpage of confirm response to distress request.

Fig.18. The patient's medical file.

If the nearest hospital is not ready to receive the patient, send notification is automatically to the next hospital in terms of the closest distance as shown in figure (19).

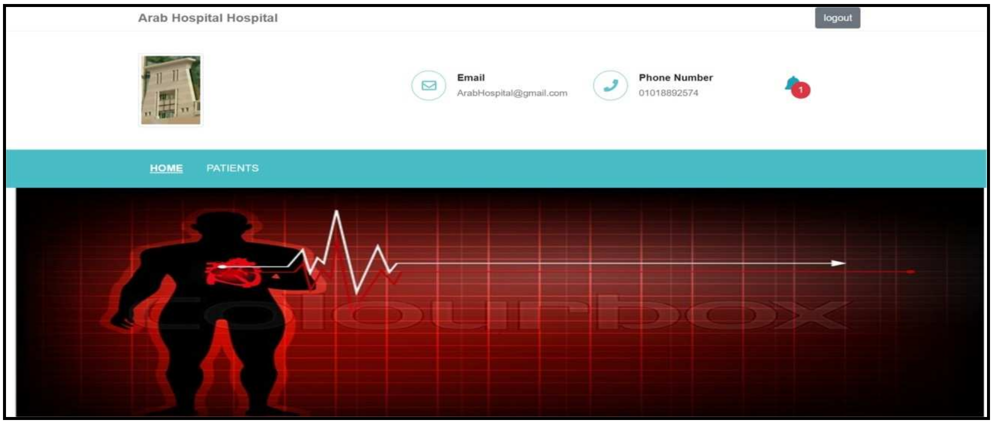


Fig. 19. Next nearest hospital.

In the case of receiving a patient for the first time in the hospital, a form is prepared for him that contains personal and vital information, in addition to the serial number ID used in the process of querying the patient's information and displaying his medical file for all hospitals that receive a notification from the patient's device as shown in figure (20).

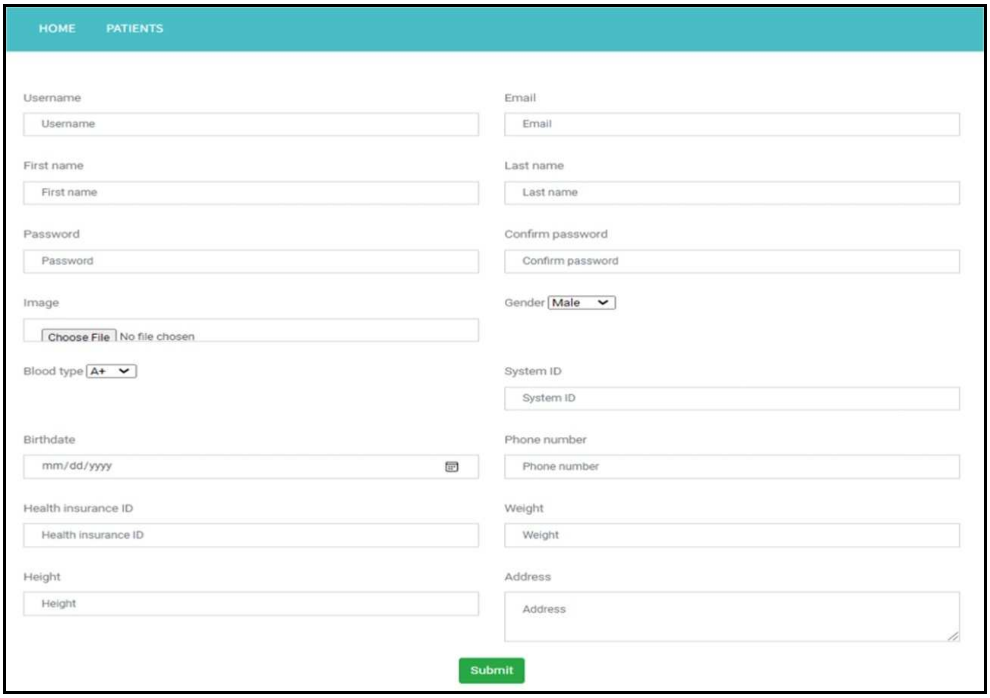


Fig.20. patient data registration form.

After sending a notification to the nearest hospital, and its approval of this request, a notification will be sent to the patient's web page, including: the name of the hospital that was received, heart rate, and the time and date of the hospital's approval of the request as shown in figure(21).

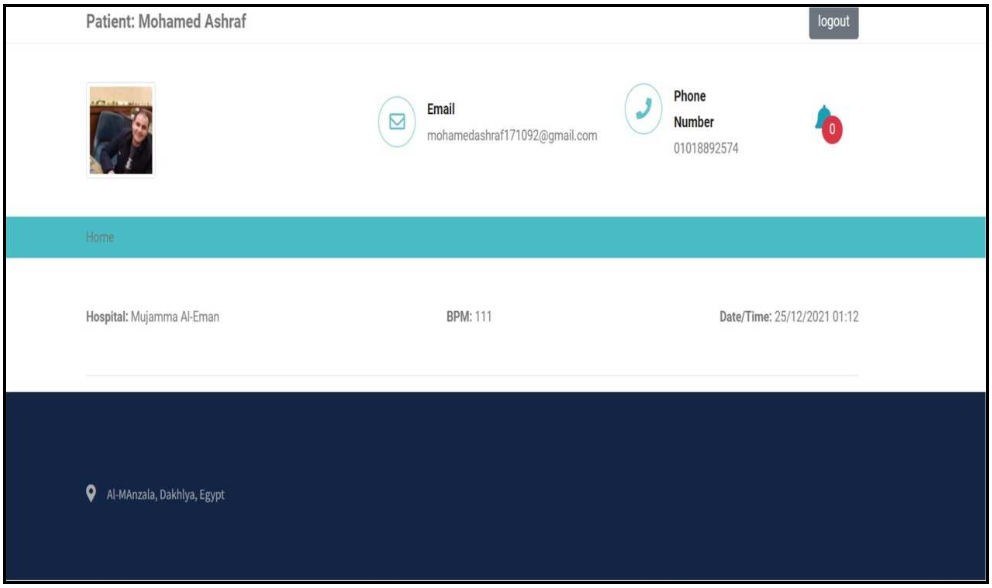


Fig:21. Web page for patient.

The phone nearest hospital received a SMS from the proposed device for patient; it contains the pulse rate, the current location of the patient, and a URL website for the hospital as shown in figure (22).

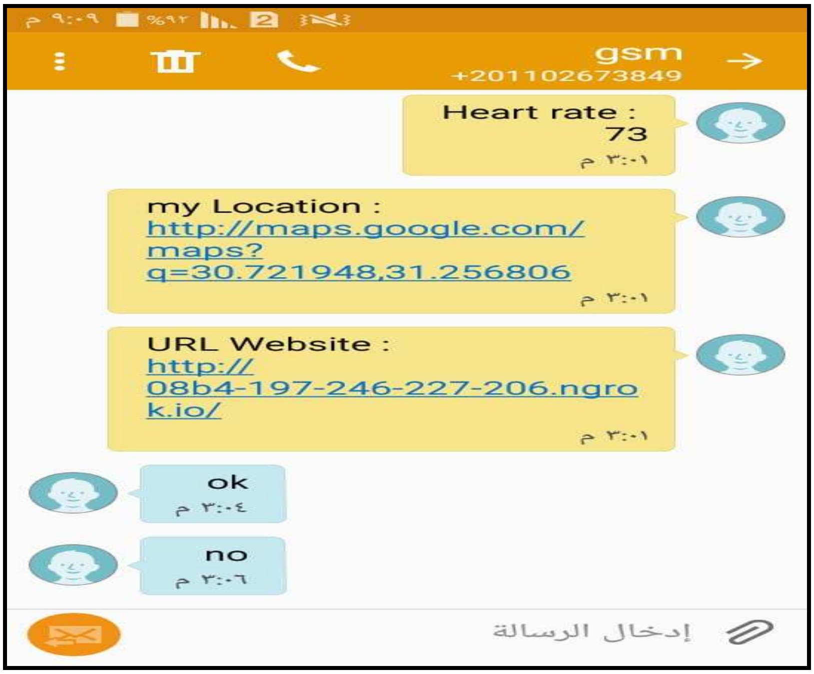


Fig:22. Send SMS to the nearest hospital phone.

If the hospital responded with the keyword "OK," a brief text message was sent to the patient's mobile phone informing him of the hospital that had received his request; if the hospital responded with the keyword "No," the initial message was routed to the next closest hospital as shown in figure (23).

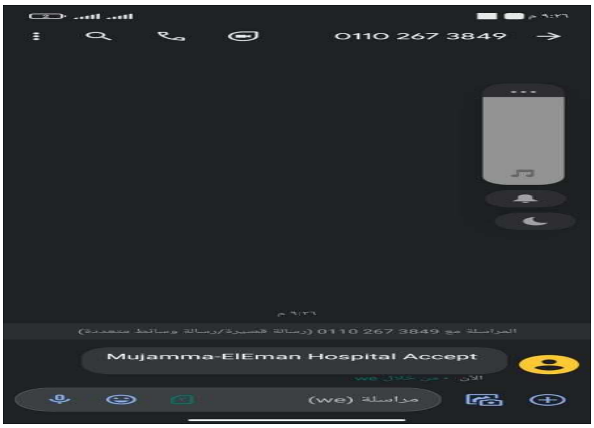


Fig:23. Send SMS to the patient phone.

Two individuals had their heart rates measured. The highest and minimum error percentages were determined from these values, and they were found to be 3.7 percent and 1.2 percent, respectively. Table (4) shows the test results and figure(24).

Table 4. Error Percentage of the Heart Rate measurement.

Subject No.	**Gender**	**Heart Rate using sensor (in BPM)**	**Heart Rate Manual Measurement (in BPM)**	**Error percentage (%)**
1	M	66	67	**1.5**
1	M	72	74	**2.7**
1	M	69	71	**2.8**
1	M	78	79	**1.2**
1	M	75	74	**1.3**
1	M	82	83	**1.2**
1	M	73	75	**2.6**
1	M	75	76	**1.3**
1	M	72	74	**2.7**
1	M	81	79	**2.5**
2	F	65	67	**2.9**
2	F	63	65	**3.7**
2	F	80	78	**2.5**
2	F	76	75	**1.3**
2	F	71	73	**2.7**
2	F	85	88	**3.4**
2	F	84	81	**3.7**
2	F	80	81	**1.2**
2	F	72	70	**2.8**
2	F	69	71	**2.8**

The Error Percentage of the Heart Rate Measurement:

$$= \frac{\text{Heart Rate Manual Measurement} - \text{Heart Rate Using Sensor}}{\text{Heart Rate Manual Measurement}} * 100 \qquad (5)$$

$$\text{Minimum Error Percentage} = \frac{83 - 82}{83} * 100 = 1.2\ \%$$

$$\text{Maximum Error Percentage} = \frac{81 - 84}{81} * 100 = 3.7\ \%$$

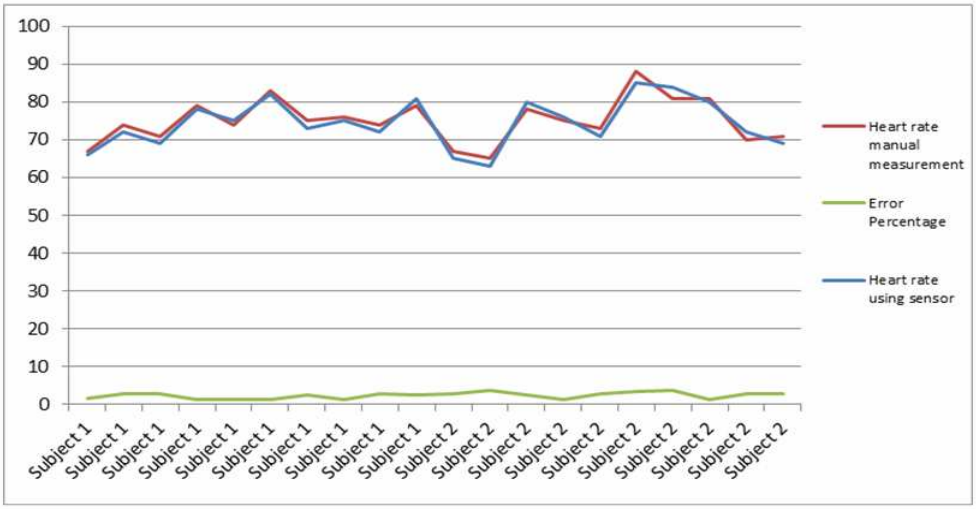


Fig. 24. Heart rate using sensor, manual measurement and error ratio for pulse sensor

The accuracy of the coordinates provided by the GPS Module was measured by comparing the coordinates provided by the GPS module to the real coordinates provided by Google Map and noting the distance difference.

The GPS module (Neo-6m GPS) used has a stated accuracy of 0.50m, and measurement of coordinate accuracy is calculated using the following equation [26]. Table (5) presents the results obtained and figure (25).

$$\text{Position Accuracy (\%)} = 100\% - \frac{\text{Actual Variation} - \text{Stated Variation}}{\text{Actual Variation}} * 100 \qquad (6)$$

Table 5. Measuring the Accuracy of the Coordinates.

Position	Actual Coordinates (Latitude, Longitude)	GPS Module Coordinates (Latitude, Longitude)	Variation in Distance (m)	Percentage Accuracy (%)
1	31.051361,31.404860	31.051365, 31.404863	0.52	96.1
2	31.051935,31.407021	31.051935, 31.407028	0.57	87.7
3	31.035842,31.392044	31.035847,31.392044	0.55	90.9
4	31.033270,31.395031	31.033266,31.395035	0.56	89.3
5	31.029488,31.398085	31.029484,31.398082	0.53	94.3
6	31.039922,31.385667	31.039924,31.385662	0.52	96.1

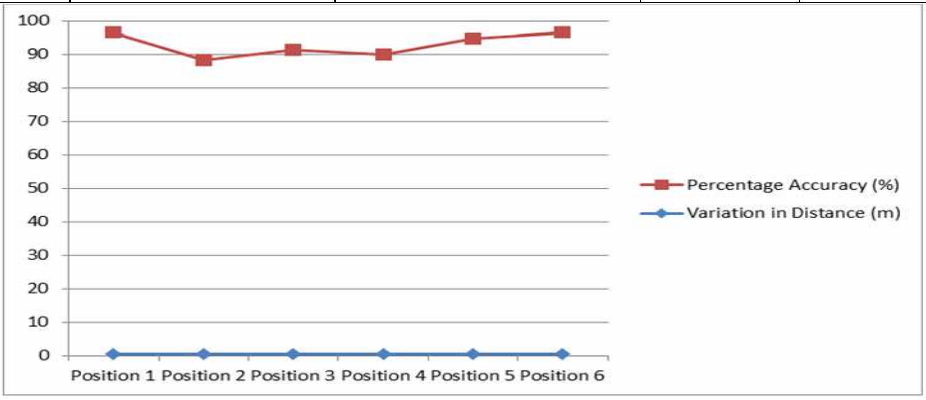


Fig. 25. Variations in Distance and Percentage for Accuracy GPS Coordinates.

Chapter 5: CONCLUSIONS AND FUTURE WORK

This paper proposes a smart system for managing the crises of heart patients based on the proposed techniques. Sensors are used by patients to identify cardiac problems. The device begins monitoring As soon as the patient's heart rate exceeds a specified threshold, the system works to alert the patient, determine the current location of the patient, and determine the nearest hospital, and then notifications are sent via web server which contains the value of the heart rate, location of the patient, and serial ID of the chip for the patient to the nearest hospital. Results could be amended in future work by applying the proposed system to various parameters such as temperature rate and ECG rate. The system can be developed to work on mobiles and tablets.

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تطوير نظام ذكي لإدارة أزمات مرضى القلب

الملخص العربي:

الغرض من هذه الدراسة هو تقديم نموذج نظام فعال لتتبع ومراقبة البيانات الحيوية للمريض من أجل تقديم الخدمات الطبية في الوقت المناسب وإدارة أزمات مرضى القلب. سيتم الحصول على البيانات عبر أجهزة الاستشعار ومقارنتها بحد معين مسبقاً. يعتمد النظام المقترح على معدل النبض ، لذلك في حالة الطوارئ ، سيتم إطلاق تنبيه صوتي للمريض ، وستقوم وحدة GSM بنقل سجلات هؤلاء المرضى إلى خادم ويب ، حيث يتم حفظها في قاعدة بيانات ، ويتم إرسال الرسائل النصية القصيرة إلى هاتف المستشفى ، بحيث يمكن للمريض التواصل في الوقت الفعلي عبر متصفح الويب ورسالة نصية قصيرة SMS.

الكلمات المفتاحيه

أردوينو ، نظام التموضع العالمى ، خرائط جوجل ، النظام العالمى للاتصات المتنقلة ، معدل ضربات القلب ، مستشعر النبض<