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Elderly People's Life Saving Assistant (EPLSA) using IoT

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Abstract—Heart attack is one of the main causes of death nowadays especially for elderly people since it can strike anytime and anywhere. This project aims to build a smart assistant system that can predict the possibility of heart attack occurrence depending on the heartbeat rate before it happens for an elderly person wherever he/she is, and send a message to an elderly's relative or a specialist informing him/her that the elderly might have a possible heart attack along with the geometric location in order to try to save the elderly's life on time. In our system, a pulse sensor was attached to an Arduino microcontroller with ESP8266 NodeMCU as a Wi-Fi module to measure the heartbeat rate (BPM), if the heartbeat is either too low or too high, a message will be sent to a specified mobile, warning its owner of a possible heart attack. When the message arrives to the specified mobile, the owner will open an Android application named EPLSA. Through this application, he/she can send a request to the microcontroller asking for the geometric location. The microcontroller replies with the values of the latitude and longitude of the elderly's location which can be viewed on Google maps too.

Keywords-Heart attack; Heartbeat rate; Beats per Minuit; BPM; Pulse sensor; NodeMCU; ESP8266; Arduino; IoT; Arduino-IDE.

I. INTRODUCTION

The term Internet of Things (IoT) is defined as the ability to connect different "things" in a network and was first introduced by Kevin Ashton in 1999. It includes connecting different computing devices like digital and/or mechanical machines, people, animals and other objects in-order to transfer data over a network. It aims to extend the benefits of the Internet with remote control ability, data sharing and constant connectivity by using an embedded sensor to collect data [5]. All these "things" are connected via a Network. IoT can be helpful in so many applications. One application is the one presented in our work.

Our work presents a method that can help detecting a possible heart attack occurrence. Heart attack is one of the main causes of death nowadays. It can strike anytime, anywhere and at any age too. Despite this fact, we targeted the elderly people of age 60 and above who leave their homes regularly.

Many elderly people have to leave home for many reasons; work, walking, visit ... etc. Many times they are alone, and their relatives may not know their exact location. So the aim was to design a smart heart attack detector that can predict the signs of a heart attack, and sends a message to a trustworthy relative or police or emergency room along with the geometric location for the elderly in order to try to save his/her life on time – if possible.

A Normal resting heart rate ranges from 60 to 100 beats per minute (BPM) for a normal person. If BPM goes below 50, this condition is known as Bradycardia, whereas, if BPM goes above 100, it is called Tachycardia. Although the slow heart rate is not always dangerous for elderly people, it may cause symptoms as fainting, dizziness, lightheadedness and fatigue and sometimes organ damage may result [13][14][15].

Depending on these facts, we have attached a pulse sensor to a microcontroller that the elderly takes with him/her wherever he/she goes. The sensor keeps reading the signals from the elderly's body and counts the heartbeat rate. If the heartbeat rate exceeds either of the two predefined limits, then the assistant predicts that a possible heart attack could happen, and it sends a message to a relative/specialist mobile informing him/her that the elderly is having a possible heart attack. The relative/specialist will immediately open an Android application and ask the microcontroller to send the geometric location of the elderly. The relative/specialist can also view the location by opening the Google maps from the application as well.

Moreover, three LEDs were added to the circuit to inform the elderly himself that something wrong is happening.

II. RELATED WORK

Researches with different methods have been developed to discuss the issue of health monitoring over IoT. We list some of them here.

This paper describes a technique of measuring the heart rate through a fingertip and shows the heartbeat on LCD as well as displaying the results over the net using local and global servers. In this system the data were collected via fingerprint sensor through Arduino board then transferred on both Global and local servers. The local server was created by html page, whereas, the global one is connected via Thingspeak site, which is a good platform for storing and analyzing data through Wi-Fi module [1].

This paper provides a heartbeat monitoring and heart attack detection system using IoT. As soon as the patient heartbeat goes above a certain limit, the system sends an alert to the controller which then transmits this over the internet and alerts the doctors and/or concerned users. The system also displays the live heart rate of the patient whenever the user logs on for monitoring. Thus, the concerned ones may monitor heart and get an alert of heart attack of the patient immediately from anywhere and the person can be saved on time [2].

This paper developed a system that measures and detects the patient's heartbeat and body temperature then sends the data through wireless sensors. Also, LCD has been used to display the calculated human heartbeat rate. The sensing data was continuously collected in a database in order to be used to inform the patient of any unseen problems and will be displayed by a specialist to provide better aid [3].

This paper implements a heart rate monitoring and heart attack recognition system using IoT. The hardware with android application will be carried by the patient. The user may set the high and low-level of heartbeat limits, after that the system can start monitoring the patient's heartbeat. When the heartbeat readings go above or below the limit, the system will send an alert about high or low heartbeat and about chances of heart attack and transmit them over internet using Wi-Fi module [4].

III. ELDERLY PEOPLE LIFE SAVING ASSISTANT (EPLSA) IMPLEMENTATION

This section lists the Hardware and Software components used in our project in detail:

A. Pulse Sensor

A Pulse sensor – which is shown in figure 1, is an electronic device that is used to measure the heart rate by using a LED and a LDR. To detect a pulse, the LED passes light and the LDR measures the intensity of light received. Whenever the heart pumps blood, more light is absorbed by increased blood cells causing the intensity of light received on the LDR to decrease and its resistance value to increase. This variation in resistance is converted into voltage variation using an OP-AMP [6][11].

Figure 1. Pulse Sensor.

B. NodeMCU

The Wi-Fi module in our project is the NodeMCU, which is shown in figure 2. NodeMCU is an open source platform that includes a firmware that runs on the ESP8266 Wi-Fi SoC from Espressif Systems. Its hardware is based on the ESP-12 module [10].

NodeMCU is connected to the Internet via the elderly mobile as the host, and is given a static IP address.

Figure 2. Node MCU.

C. IFTTT.com web Site

Inorder to allow the hardware circuit to send a message to the relative/specialist mobile, we have created an account using the website IFTTT.com [7]. "*If This Then That*" (IFTTT) is a free web-based service to create *applets* which are defined as a chain of simple conditional statements. The applet is triggered by changes that occur within other web services, such as Gmail or Facebook or many other services [8].

The hardware circuit will send the message to the site, and then the site will send it to the specified mobile. The IFTTT application must be installed and running at the backstage of the specified mobile. Figure 3 shows the process.

Figure 3. Sending a message from the circuit to Mobile via IFTTT.com.

D. Arduino UNO

The Arduino UNO is an open-source microcontroller board based on ATmega328P microcontroller and developed by Arduino.cc. The board has 14 digital pins and 6 analog pins used for input and output operations. The board is programmed with Arduino-IDE [12]. Figure 5 shows the board.

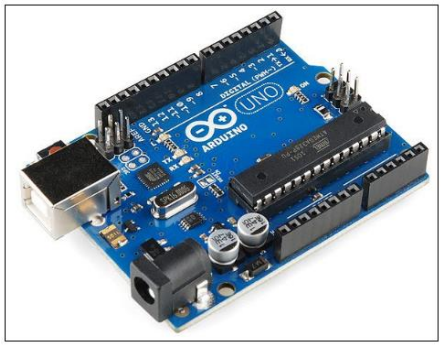

Figure 5. Arduino UNO board.

E. EPLSA Android Application

EPLSA Android application was designed using the MIT app inventor 2. App Inventor is an open-source web application with online development environment provided by Google and maintained by the Massachusetts Institute of Technology (MIT). It allows users to create applications for Android OS 2.3 ("Gingerbread") or higher [18]. App Inventor uses a graphical interface, which allows users to drag-and-drop visual objects to create an application. Moreover, MIT App Inventor allows people to store data on Google's firebase [9]. However, App Inventor is only available for the Android platform, the process of developing it for iOS is currently in progress [16][17].

EPLSA application contains one screen with three main buttons as shown in Figure 4. The buttons are:

- Button "*Connect with the Elderly Assistant*" which establishes a connection with the microcontroller using its IP address. When the button is clicked, the latitude and longitude of the location are displayed on screen.
- Button "*Show Location on Google Maps*" which takes the values of the longitude and latitude, opens the Google map and shows the location on the map.
- Button "*Clear Data*" which resets the values of the longitude and latitude.

Figure 4. EPLSA application Main Screen.

IV. METHODOLOGY

The hardware circuit was given a static IP address and was connected to the internet via the elderly's mobile. A pulse sensor was attached to the circuit along with three LEDs – for visual result displaying. The elderly is supposed to take the hardware circuit with him/her wherever he/she goes. Figure 6 shows the hardware circuit.

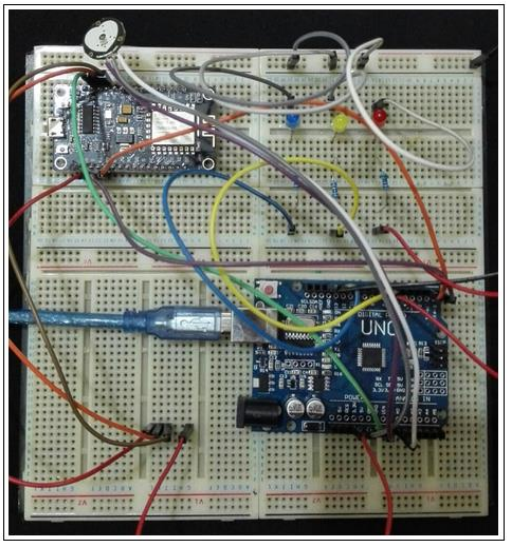

Figure 6. The Hardware Circuit.

The pulse sensor was attached to pin A0 of the Arduino Uno microcontroller. Pulse sensor keeps reading the elderly's heart status and calculates the heartbeat rate (BPM) and sends it to the microcontroller.

The microcontroller checks if the value that has been read from the pulse sensor is within a specified range which was determined by maximum and minimum limits. We have used 100 as the maximum limit, and 50 as the minimum limit according to [13].

If the value is within the range, then the heart rate is normal and nothing is done. Otherwise, if it is greater than the maximum limit, or lower than the minimum one, then a possible heart attack is detected.

A red LED which was attached to pin 7 of the microcontroller will be ON when the sensor reads a value greater than 100, whereas, a blue LED which was attached to pin 12 will be ON when the sensor reads a value less than 50. The yellow LED is attached to pin 8 and is ON when the heartbeat rate is within the normal range.

LEDs were used to inform the elderly himself about his/her heart rate situation. If the yellow LED is ON, then the heartbeat rate is in normal range and nothing is to be worried about. If the red LED is ON, then the heart rate is higher than the allowable maximum value (Tachycardia). If the blue LED is ON, then the heart rate is lower than the allowable minimum value (Bradycardia).

Meanwhile, the microcontroller sends a message to a specified mobile (Emergency room, police or a trustworthy relative of the elderly) informing him/her that the elderly is possibly having a heart attack and needs help.

The message – actually, is sent to the IFTTT.com website, and the website sends it to the specified mobile. Inorder to deliver the message to the specified mobile, the IFTTT application must be installed on that mobile and must be running at the backstage.

When the message arrives, the specialist/relative will open the application EPLSA and he/she must press the button "***Connect with the Elderly Assistant***" first. Clicking on this button allows the mobile to send a request to the elderly's assistant (the microcontroller) asking it to send the latitude and longitude of the elderly's location. The returned values will appear on screen allowing the specialist/relative to determine the exact location of the elderly.

Viewing the values of the latitude and longitude as pure digits on screen is not well understood for most of the people who prefer using Google Maps and depend on it to determine locations and directions, a button "***Show Location on Google Maps***" was added to the application. When the user clicks on this button, the values read for latitude and longitude in the first step will be taken and viewed on Google maps to show the location of the elderly.

Button "***Clear Data***" – when pressed, will rest the values for latitude and longitude to null and clear the screen for purposes of restarting the values received from the microcontroller.

Figure 7 shows the block diagram and the connections between the project components.

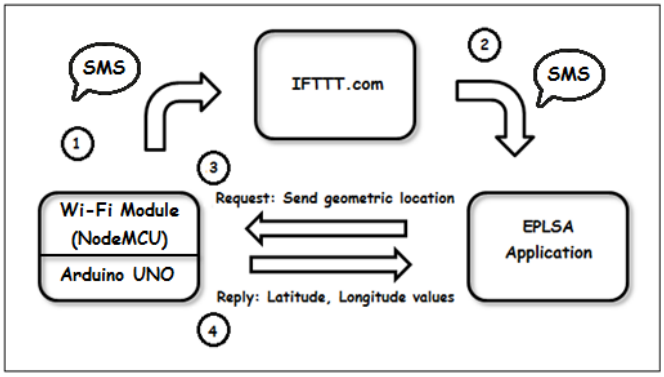

Figure 7. Block Diagram of the whole system.

V. RESULTS

In this section, we present the results we achieved by displaying screenshots of our execution results.

Figure 8 shows the message that was sent to the mobile when a possible heart attack was detected.

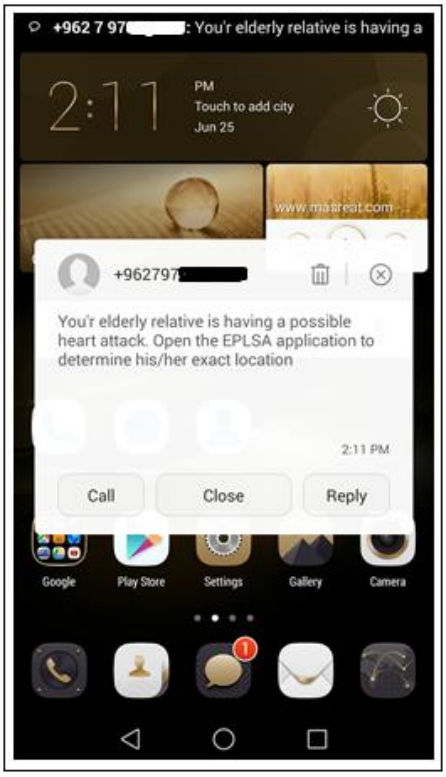

Figure 8. The arrived message.

Figure 9 shows the application screen when the button "***Connect with the Elderly Assistant***" is pressed and the returned values for latitude and longitude.

Figure 10 shows the location on Google maps.

Figure 9. The received values of the latitude and longitude.

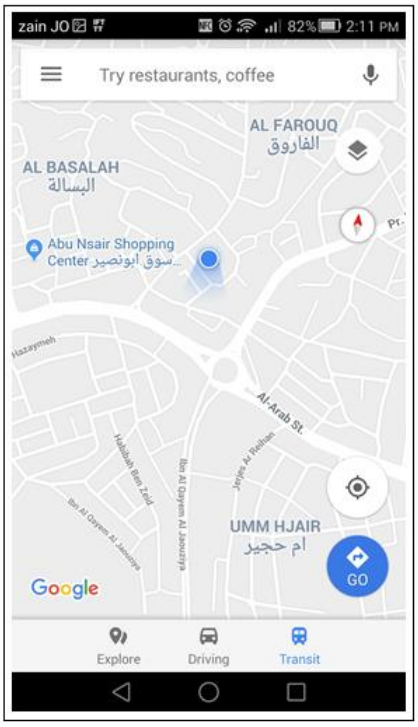

Figure 10. Location shown on Google Maps.

VI. CONCLUSION

Using IoT, this paper presents a method to assist elderly people detecting if they are having a possible heart attack by collecting the data related to the patient's heart rate via a pulse sensor.

This sensor is always ON and keeps reading the heartbeat rate (BPM) and checks if they are within a specified range or not. If the BPM exceeds certain limits, the microcontroller will send a message to a trustee's mobile. When the message arrives, the person opens an Android application (EPLSA application) that is installed in the mobile and sends a request to the microcontroller asking for the values of the latitude and longitude of the elderly's location. The microcontroller replies with these values. The values will appear on the application screen. Moreover, the application can connect to the Google maps application on the phone and show the location on the map.

The project can further be enhanced by establishing a database for all the elderly people and connecting it with the emergency room and the police directly.

Also the application can be extended to iOS platform in the future.

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