REAL-TIME LOCATION TRACKER FOR CRITICAL HEALTH PATIENTS USING ARDUINO

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Abstract–Internet of things (IOT), it is the technology which helps in communication between circuits, machines and different types of devices. This feature has applications in medical industry to benefit technologies behind IOT, such as sensors, actuators and hardware support. In health care sector it is very crucial to know the location of the patient at the time of emergency, so that the required services can be made available at right place and time. This can be solved using GPS coordinates. A prototype can be developed to locate the exact gps co-ordinates of the patients to the server. One can track the exact location of the patient using web interface on the server and Google maps. The prototype can be developed using GSM module, Arduino and GPS module. To make a low cost gps tracker, different IOT platforms, different IOT tools, sensors, different programming libraries, APIs usages, server hosting and needed AT commands with website interface are implemented and discussed in detail.

IndexTerms–
Internetofthings(IOT),Arduino,GPSmodule, GSMmodule,healthcare.

I. INTRODUCTION

In the last few years, with related advances in IOT has started to develop, many technological achievements have great impact on society, science and medicine. Researchers have developed new technologies for remote health monitoring. IOT technology has a layered architecture where the first layer acts as a sensing data, the second processes the data in required form. The third layer defines different high- end protocols and interfacing logic that helps in sending data. The data is sent to server where different channels on server receives different data from different applications. To build an IOT based system, one has to understand the different layer functions. Arduino is available in different shapes and sizes; it can be used as per application needs. The cloud is used to receive GPS coordinates, for that a website is designed. the website fetches the coordinates from cloud and by using Google map API, the live location of patient can be displayed on google map. The developed model also will be able to read parameters like temperature, humidity, heart beat rate and many such parameters. It should also be able to sense glucose level and voice out if the level is low.

II. LITERATURESURVEY

A. ARDUINO

Arduino is an open-source electronic platform. It is based on easy to use hardware and software. Arduino boards are able to read inputs like turning on light of sensor, finger on button or a twitter message and turn it into outputs like activating a motor, turning on LED and so on. Arduino is designed to make electronics more accessible. Arduino code is written in C/C++. Arduino hardware is easy and Arduino IDE is very much simple. Code written is easier to comprehend. To facilitate the proper working of IOT system, Arduino comes with an ATMEGA microcontroller that processes the data. Arduino acts as brain of system by processing data from sensor. The platform is readily available. ESP-8266 WiFi module is required to establish communication between Arduino and cloud platform.

B. GSM MODULE

It is a hardware device that uses GSM telephone technology to provide data link to remote

network. It is identical to an ordinary mobile phone requiring SIM. GSM Module is part of an embedded system. It is a customized Global System for Mobile communication (GSM). This module is able to receive serial data from radiation monitoring and transmits the data as text to the required person. It is an international standard for mobile telephones. A GSM Modem is a wireless modem. It is designed for communication over GSM network. It requires a sim card to activate communication with network. AT command is used to instruct mobile phone or GSM module to send SMS. Here we have used SIM800L, which is a miniature GSM modem. For GSM to connect with internet Ground of Arduino must be connected with GSM. GSM module's RX and TX pin is connected with Arduino's D3 and D2 pin respectively. GSM compresses and digitizes data. It then sends it down a channel with two other streams of user data., each in its own time slot.

C. GPS MODULE

Global Positioning System (GPS) Module is set up to feed position data to Arduino board over a serial connection. Several libraries are available to turn raw data into useful information. It is a satellite-based navigation system. This system is freely accessible to anyone with GPS receiver and unobstructed line of sight to at least four satellites. The receiver calculates its position by timing precisely the signals sent by GPS satellites. The GPS receiver gets a signal from each satellite. The satellite transmits the exact time signals are sent. By subtracting the time, the signal was transmitted from time it was received, GPS can tell how far it is from each satellite. To calculate the time GPS signals took to arrive, receiver needs to know the time very accurately. If receiver is only able to get signals from three satellites, position can still be obtained but it will not be accurate. Antenna is connected to GPS module using RF cable.

D. SENSORS FOR ARDUINO

Sensors are devices that convert physical quantity into electrical quantity. In this paper we have used temperature sensor, pulse rate sensor, ultrasonic sensor, oximeter, ultrasonic sensor and Humidity sensor to read values from the patient body and get basic medical report. The data is displayed on LCD display. These sensors acts as eyes, ears, nose of any electrical equipment which senses parameters in outside world and give readings to microcontroller. The signals from sensors are computed in microncontroller and is displayed on LCD. Here for temperature we have used LM35 sensor, for humidity DHT11 sensor, for pulse rate we have used pulse rate sensor. To detect the glucose level in container we have used ultrasonic sensor. To detect the oxygen level in blood we have used Max30100 oxi meter. It is important to select the sensors need in our project beforehand.

III. METHADOLOGY

In the proposed system the temperature sensor, Humidity sensor, Glucose level sensor, Heartbeat sensor and Spo2 sensors areused.Thisallsensorsareinterfacedwithmicroco ntroller.Oncedevice will get power on, all sensor will get activated. Sensor will start the reading information from human body. Once any emergency will occur, that will be detected by sensor and microcontroller [6].In the proposed system Arduino IDE Microcontroller is used. The micro controller reads the coordinate for live location and it will send to IOT server.Esp8366 module we are using here for IOT part. The data can be seen from anywhere in the world using IOT device. LCD interface is used for user. User will able to see all information also on LCD Display. GSM module sends a message to the guardian and doctor in case of any emergency.

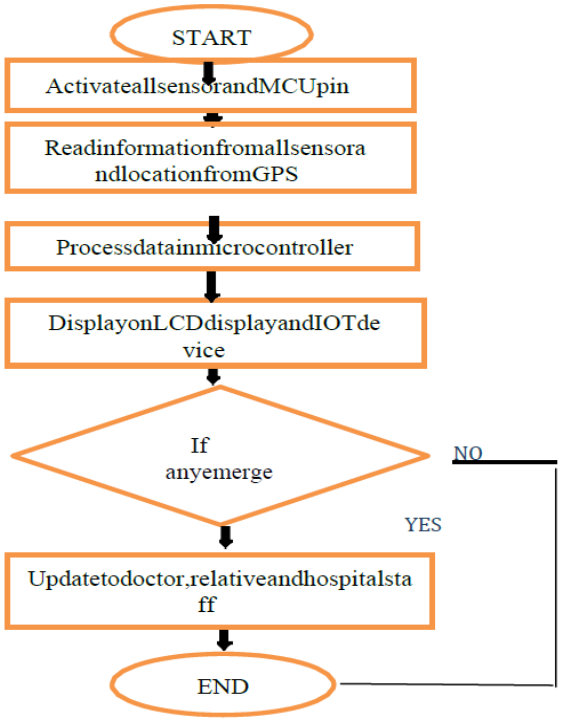

Fig.1:Flowchart

Figure 1 shows the flow chart of the proposed idea. When the device is turned on, all sensors and MCU pin is activated. The information is read from all sensors and the location is fetched from GPS. The data is processed in the microcontroller. The information read from the sensors and the location is displayed on LCD display and also updated in IOT cloud account. If there is any emergency based on the set parameters the information is updated to doctor, relative or hospital staff. If there is no emergency the process is ended.

IV. BLOCK DIAGRAM

Figure 2 shows that the microcontroller is placed at the center and the sensors of temperature, glucose, heart beat and Spo2 is connected to the microcontroller. The input and output pins of GPS and GSM module is also connected to the micro controller. The LCD display is connected to microcontroller to see the information. IOT module stores the data which can be seen in cloud account.

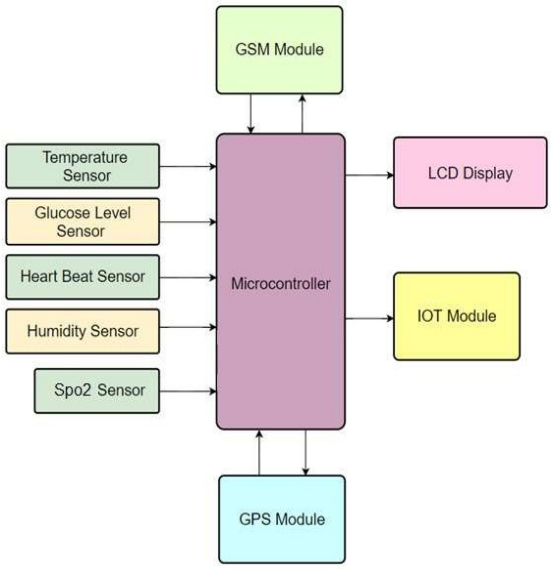

Fig.2:Block diagram of proposed model

V. HARDWARE IMPLEMENTATION

- Esp8266wifi

ESP8266 is a WIFI SOC (system on a chip) chip device. It is a highly integrated chip designed to provide full internet connectivity in a small package.ESP8266 can be used as an external WIFI module, using the standard AT Command set Firm ware by connecting it to any microcontroller using the serial UART, or directly serve as a WIFI-enabled micro controller, by programming a new firm ware using the provided SDK

Fig.3:Esp8266wifi

- GPS Module

Global Positioning System (GPS) is a satellite-based system that uses satellites and ground stations to measure and compute its position on Earth. GPS is also known as Navigation System with Time and Ranging (NAVSTAR) GPS. GPS receiver needs to receive data from at least 4 satellites for accuracy purpose. GPS receiver does not transmit any information to the satellites. This GPS receiver is used in many applications like smartphones, Cabs, Medical, electronics circuit. Fleet management etc. GPS receiver module gives output in standard (National Marine Electronics Association) NMEA string format. It provides output serially on Tx pin with default 9600 Baud rate. This NMEA string output

START from GPS receiver contains different parameters separated by commas like longitude, latitude, altitude, time etc. Each string starts with '$' and ends with carriage return/line feed sequence..It provides output serially on Txpin with default 9600 Baud rate. This NMEA string output from GPS receiver contains different parameters separated by commas like longitude, latitude, altitude, time etc. Each string starts with '$'and ends with carriage return/line feed sequence.

Fig.4:GPSModule

- GSM Module

A GSM module or a GPRS module is shown in figure 3.3.It is a chip or circuit that will be used to establish communication between a mobile device or a computing machine and a GSM

or GPRS system. The modem (modulator-demodulator) is a critical part here.

Fig.5GSMModule

Global System for Mobile communication (GSM) is digital cellular system used for mobile devices. It is an international standard for mobile which is widely used for long distance communication There are various GSM modules available in market like SIM900, SIM700, SIM800, SIM808, SIM5320 etc.

SIM900A module allows users to send/receive data over GPRS, send/receive SMS and make/receive voice calls. The GSM/GPRS module uses USART communication to communicate with microcontroller or PC terminal. AT commands are used to configure the module in different modes and to perform various functions like calling, posting data to a site, etc.

- LCD Display 16X2

The term LCD stands for liquid crystal display. It is one kind of electronic display module used in an extensive range of applications like various circuits & devices like any prototype, circuits, mobile phones, calculators, computers, TV sets, etc. These displays are mainly preferred for multi-segment light-emitting diodes and seven segments. The main benefits of using this module are inexpensive; simply programmable, animations, and there are no limitations for displaying custom characters, special and even animations, etc. The LCD display is shown in figure.

Fig.6 LCD Display

- Registers o fLCD

A 16×2 LCD has two registers like data register and command register. The RS (register select) is mainly used to change from one register to another. When the register set is ‘0’, then it is known as command register. Similarly, when the register set is ‘1’, then it is known as data register.

- Command Register

The main function of the command register is to store the instructions of command which are given to the display. So that predefined tasks can be performed such as clearing the display, initializing, set the cursor place, and display control. Here commands processing can occur within the register.

- Data Register

The main function of the data register is to store the information which is to be exhibited on the LCD screen. Here, the ASCII value of the character is the information which is to be exhibited on the screen of LCD. Whenever we send the information to LCD, it transmits to the data register, and then the process will be starting there. When register set =1, then the data register will be selected..

- LM35 Temperature Sensor

The LM35 is an integrated circuit sensor that can be used to measure temperature with an electrical output proportional to the temperature (in °C). It can measure temperature more accurately than a using a thermistor. The sensor circuitry is sealed and not subject to oxidation. The LM35 generates a higher output voltage than thermocouples and may not require that the output voltage be amplified. The LM35 has an output voltage that is proportional to the Celsius temperature. The scale factor is .01V/°C. The LM35 sensor is shown in figure.

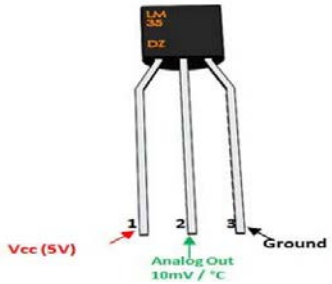

Fig.7 LM35Temperature Sensor

The LM35 does not require any external calibration or trimming and maintains an accuracy of +/-0.4°C at room temperature and +/-0.8°C on a range of 0°C to +100°C.Another important characteristic of the LM35 is that it draws only 60 micro amps from its supply and possesses a low self-heating capability. The

LM35 comes in many different packages such as TO-92 plastic transistor-like package, T0-46 metal can transistor-like package,8- lead surface mount SO-8 small outline package

- MAX 30100 Oximeter

MAX30100 is an integrated pulse oximeter sensor solution. It's an optical sensor that derives its readings from emitting two wavelengths of light from two LEDs a red and an infrared one, then measuring the absorbance of pulsing blood through a photo detector.. This particular LED color combination is optimized for reading the data through the tip of one's finger. It is fully configurable through software registers and the digital output data is stored in a 16-deep FIFO within the device. The MAX30100 Oximeter is shown in figure.

Fig.8 MAX30100 Oximeter

The pulse oximetry subsystem in MAX30100 consists of ambient light cancellation (ALC), 16-bit sigma delta ADC, and proprietary discrete time filter. It has an ultra-low-power operation which makes it ideal for battery operated systems. MAX30100 operates on a supply in the range of 1.8 to 3.3V. It can be used in wearable devices, fitness assistant devices, medical monitoring devices, etc. The MAX30100 operates from 1.8V and 3.3V power supplies and can be powered down through software with negligible standby current, permitting the power supply to remain connected at all times..

- Pulse Rate Sensor

Monitoring heart rate is very important for athletes, patients as it determines the condition of the heart (just heart rate). There are many ways to measure heart rate and the most precise one is using an Electrocardiography. But the easier way to monitor the heart rate is to use a Heartbeat Sensor. It comes in different shapes and sizes and allows an instant way to measure the heartbeat. The sensor has two sides, on one side the LED is placed along with an ambient light sensor and on the other side we have some circuitry. This circuitry is responsible for the amplification and noise cancellation work. The LED on the front side of the sensor is placed over a vein in our human body. This can either be your Fingertip or you ear tips, but it should be placed directly on top of a vein. Figure 3.7 shows the pulse rate sensor.

Fig.9 Pulse rate sensor

Now the LED emits light which will fall on the vein directly. The veins will have blood flow inside them only when the heart is pumping, so if we monitor the flow of blood, we can monitor the heart beats as well. If the flow of blood is detected then the ambient light sensor will pick up lighter since they will be reflecting ted by the blood, this minor change in received light is analyzed over time to determine our heart beats.

- Humidity Sensor

The level of humidity affects various physical, chemical and biological processes. In industrial applications, humidity can affect the business cost of the products, circuits, motor, Transformer, health and safety of the employees. So, in semiconductor industries and control system industries measurement of humidity is very important. Humidity measurement determines the amount of moisture present in the gas that can be a mixture of water vapor, nitrogen, argon or pure gas etc.

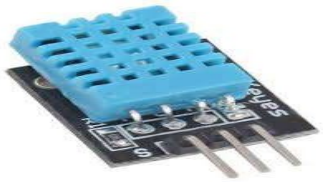

Fig.10 DHT11 sensor

DHT11 is a single wire digital humidity sensor, which gives relative humidity in percentage. DHT11 is a single wire digital humidity which provides humidity serially. DHT11 sensor provides humidity value in percentage in relative humidity (20 to 90% RH) DHT11 sensor uses resistive humidity measurement component.

- Ultrasonic Sensor

The HC-SR04 ultrasonic sensor uses SONAR to determine the distance of an object just like the bats do. It offers excellent non-contact range

detection with high accuracy and stable readings in an easy-to-use package from 2 cm to 400 cm or 1" to 13 feet. Figure shows the HC-SR04 sensor.

Fig.11 HC-SR04 sensor

- ISD 1820 Voice Recorder Module

The ISD1820 Voice Recorder Module is based on the ISD1820 IC, which is a single chip Voice recorder IC for single message record and playback. I am not sure about the availability of only the IC but it is frequently found in the module with all the necessary components and circuitry.

A major feature of the ISD1820 Voice Recorder Module is that is can store the messages in its non-volatile memory and can be configured to store messages of length between 8 Seconds to 20 Seconds.

The ISD1820 Voice Recorder Module used in this project is shown below. As you can see, there are a lot of components on the board that help the ISD1820 IC in recording and playback.

Fig.12:ISD1820Voice recorder module

VI. WORKING AND RESULTS

Temperature sensor, Glucose level sensor, Heartbeat sensor, humidity sensor and Spo2 sensor are interfaced with pin of microcontroller. LCD display connected with digital GPIO pin. LCD interface required four data pin, RS pin and enable pin. Once microcontroller will start the execution of program, all sensor read signal from human body. IOT module is interfaced with TX and RX pin of microcontroller. GPS module also required TX and RX pin. GPS module working on serial communication. GSM module is used to send a message in the case of emergency. The GSM module doesn't require any internet connection to send the message. It is required to create an account in the IOT cloud where the result of the information read is stored and displayed in excel sheet. The results in IOT cloud is displayed in the form of graph. The message is sent to the doctor, relative and the hospital staff if the parameters matches the emergency conditions. The signals of the sensor is sent to microcontroller and there the signals are computed and displayed in the LCD display in digital form. The GSM module contains the numbers of the doctor, relative of the patient and hospital. The GPS module is used to know the location of the patient to make it easy for the hospital staff to give necessary medical aid as soon as possible. In this project, a system or device is being developed for real time location tracking for critical health patients. In this system different type of sensors are interfaced for different parameter of human body. GPS location finder is interfaced with microcontroller serial pin. All sensor will read the different parameter and signal from body. Based on that parameter of body, the sensor will send information to microcontroller.

Esp88266 microcontroller is heart of the project implementation. This is 28 pin IC and its very powerful microcontroller. It's working on 5 Volt DC supply. The code is written in embedded c language. By using this code, it is possible to convert sensor signal into meaningful data. Based on over threshold value the emergency condition will activate and microcontroller will get current location address using GPRS module. This information will be sent to specified mobile number. For sending SMS a GSM Module is interfaced with microcontroller. Additionally, we are interfacing a LCD also, so with that we will display the all sensor value information on LCD screen. This system we are making it compact in size and it will be helpful for critical patient.

Fig13: Completed model

VII. APPLICATIONS

The patient's health is monitored and updated in the cloud account. The information can be accessed from anywhere and anytime. The device tracks the live location of the project in

emergency. Not only the human's health monitoring and tracking is done, it is also done for animals. The body parameters are sensed automatically and device is easy to use and doesn't require professional's guidance. The record of many patients can be seen or recorded in the same cloud account. The doctors or hospital staff can access records of many patients in a single cloud account.

VIII. ADVANTAGES

The advantages of this IOT device is that it is an automatic system used for different conditions. It also has many sensors for monitoring health. The basic medical test report can be obtained through this device. This device is easy to use by the patient and doesn't require another person's help or guidance. This device is more reliable. Less maintenance is required. It is a cost-effective system, if the devices are manufactured in bulk the cost of each device reduces. The manpower is not required. The manpower can be used elsewhere for some other useful purposes. The time for doing the basic medical examination is saved as we get the basic medical test report through the sensors.

IX. CONCLUSION

The prototype developed is simple to use. When the finger is placed, the sensor collects information and are displayed on LCD. The doctors can get basic medical report using this model in less time. The results can be viewed in cloud account to get the average results of the patients. After collecting the data, if the parameters indicate emergency then it updates the staff or guardian through SMS. If the glucose level is low in the container, the voice module which we have used voices out that the glucose level is low. The voice command can be given in local languages too. As for the power supply, it can be given through power banks also in case of travelling or other conditions. In case of emergency, this model sends the medical report as well as the location of the patient for easy tracking, so that the medical aid can be given at the earliest.

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