Design and Implementation of Accident Alert System using Bluetooth Low Energy Technology

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Abstract: *In the Modern world, the frequency of the road accidents has been increasing exponentially. India accounts for 1.5 people killed and more than 4.5 crippled annually which is the highest number of accidents globally. In a day around 1214 accidents happens across India in which 25% accounts for two-wheelers. In short six two-wheelers die every hour. For Four Wheelers there are lot of technologies and support systems that could be used for protection of the persons in it like air-bags but for two wheeler nothing so far. Accident alert system aims to sends out location of the accident zone to the nearby help center so that ambulance. The system includes Vibration sensor, Heart beat rate sensor and Bluetooth module. The system uses Bluetooth Low Energy (BLE) to communicate with mobile which in turn sends out the location to respective health care center.*

Keywords: Global Positioning System, Bluetooth Low Energy.

1. Introduction

The numbers of the accident in India is increasing proportionally with the population rate. In India a total of 4, 37,396 accidents were recorded in 2019, resulting in 1, 54,732 deaths. There are many reasons for the accident in which two-wheelers contribute a huge part. The Major reason for the death of the accident victims in India is found to be late response of emergency services and a false fear or superstition among people of false accusation and dragging into cases. There is lack of system to raise an alert and intimating exact location of accidents. Lives of many people are under immense risk due to the lack of proper emergency facilities in our country. The Accident alert system identifies the occurring of the accident with the help of piezoelectric vibration sensor and Heart pulse rate sensor and transfers the data using Bluetooth Low Energy and the mobile phone. The phone and the device is connected through Bluetooth. The device sends the location to the respective local emergency centre through the internet.

The System is placed inside the helmet of two-wheelers and the product is customizable as per the person's interest. The system contains information like Customer & Vehicle Identity Number and location details like Latitudes and Longitudes and the family contact information. The location will be shared to the nearby ambulance from the help centre. The device contains ESP-32 which is a controller with in-build Wi-Fi module and a

Bluetooth. The Flow chart of the system is show in the following figure 1. The chart states the flow of the information.

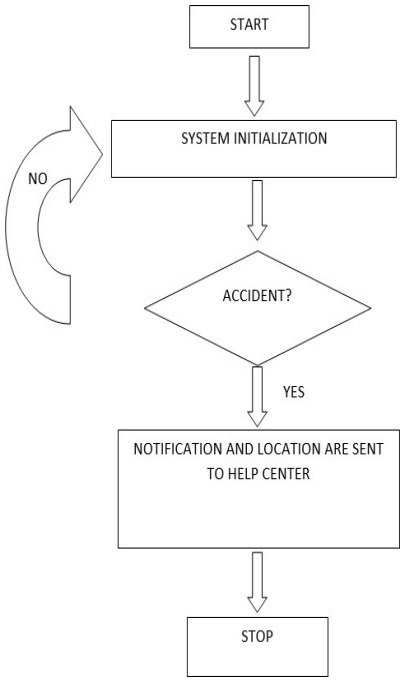

Figure 1. System Flow Chart

2. Hardware Description

The network architecture of the system is explained below in the figure 2. The sensors inbuilt in the helmet send the signal to the controller in case of accident and in turn the controller sends signal to the mobile phone through Bluetooth which will connected to each other.

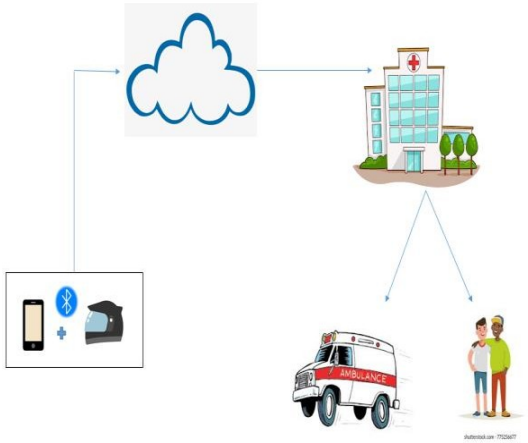

Figure 2. Network Architecture of the system

Node MCU ESP32:

Node MCU is an open source platform which is being offered for low-cost. It initially included ESP8266 Wi-Fi integrated System on Chip based on the ESP-12. Later ESP-32 was added.
The Firmware is built on the Espressif Non-OS SDK for ESP8266. Lua scripting language is used in this firmware . It is based on the eLua project. The Firmware is built on the Espressif Non-OS SDK for ESP8266. It uses many open source projects, such as SPIFFS and lua-cjson. The users need to select the modules based on the need for their projects, due to resource constraints and build a firmware tailored to their needs. Recently Support for the 32-bit ESP32 has been added.

The Features of the ESP32 are as follows,

- Memory – 520 KB SRAM
- Bluetooth: V4.2 BR/EDR and BLE
- Wi-Fi: 802.11 b/g/n
- Ultra Low power (ULP) co-processor
- 12 bit SAR ADC up to 18 channels
- Internal low-dropout regulator
- 2* I^2C , 2*I^2S, 3*UART interfaces
- 10 GPIOs
- CPU: Xtensa dual core (or single core) 32-bit LX6 microprocessor, operating at 160 or 240 MHz and performing at up to 600 DMIPS
- TX/RX, up to 8 channels
- SD/SDIO/CE-ATA,MMC/eMMC host controller
- SDIO/SPI slave controller
- Robust Design - ESP 32 can operate in a temperature range of -40^{o}C to +125^{o}C.
- High Level of Integration – ESP 32 has in-built FR balun, Antenna switches, Power Amplifier, power management modules, Low-noise amplifier and Filters.
- Hybrid Wi-Fi & Bluetooth- It acts a standalone system or as a slave device to the host.

Piezoelectric Vibration Sensor:

The principle of piezoelectric effect is used in the piezoelectric vibration sensor in order to measure changes in pressure, strain and force and converts it into electrical signals. The strain sensitivity of the piezoelectric is found to be 5.0 V/ με.

A Piezoelectric material has three operational modes namely,
Transverse effect – The charges on the x-axis are displaced by the force applied on the y-axis (neutral), perpendicular to the line of force. The amount of charge (Q_x) depends on the dimensions of the piezoelectric as below,

$$Q_x=d_{xy}F_yb/a$$

Longitudinal effect - The applied force is directly proportional to the amount of charge irrespective of size and shape of piezoelectric. The resultant charge is given as,

$$Q_x=d_{xx}F_xn$$

Shear effect – The applied force is directly proportional to the amount of charge which will be applied at right angle and it is independent of size and shape of element. The charge can be given by,

$$Q_x=2d_{xx}F_xn$$

The Piezoelectric vibration sensor returns the analog value as electric signal voltage. The features of the sensor are Flexible PVDF Piezo Polymer film, wide dynamic range, laminated for higher voltage output.

Heart rate Sensor:

The Heart rate sensor is an optical sensor used to measure pulse waves. A pulse wave is the one which changes in the volume of the blood vessel that occur when the heart pumps blood. To minimize the effect of ambient light such as infrared and red rays, an optimized optical filter is adopted in the sensor block. A low power optical heart rate monitoring without need for external circuitry is achieved by low brightness low VF LEDs. In addition, leveraging optical sensor technology cultivated over many years allowed ROHM to significantly increase the sensitivity of the sensor block.

3. System Operation

The Operation and technology used in this system are listed and described as follows.

Bluetooth Low Energy (BLE):

Bluetooth Low Energy (BLE) is also called as Bluetooth Smart. Now-a-days everything becoming Bluetooth smart like smart bands, head phones, watches etc. Similarly Bluetooth smart has been used in the accident alert system. It is a power conserving type of Bluetooth. Its primary application is short range communication of small quantity of data in a low bandwidth. It remains in sleep mode constantly when a connection is not initiated, which makes it to consume very much less power approximately 100 times less than Bluetooth.

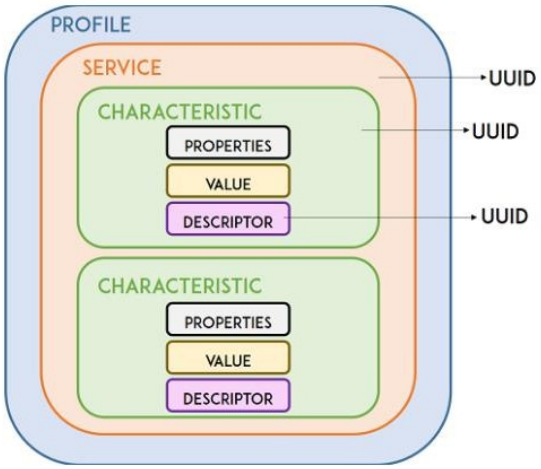

Figure 3. GATT Hierarchical Diagram

BLE supports point-to-point, broadcast and mesh network communication modes, whereas it is optimized for short burst data transmission. The frequency band is of 2.4 GHz ISM band and has 40 channels with 2MHz spacing in which 3 advertising channels and 37 data channels. In BLE there are two devices namely, Client and Server. In this system Node MCU ESP-32 acts as client and mobile phone acts as server and point to point communication mode is being used.

Generic attributes which is commonly called as GATT is used to send and receive standard messages. The service has a UUID which stands for Universally Unique Identifier. It is a unique 128 bit i.e., 16 bytes number. The characteristic of BLE has two attributes namely characteristic declaration and the characteristic number.

Working:

The device which contains Node MCU ESP32, Piezoelectric vibration sensor and heart rate sensor is integrated with the helmet. A mobile phone application will be provided for the user. While he wears the helmet the mobile application should be connected through BLE. The mobile application contains some additional features like Safe-driving mode which can hold off the calls during the driving. In case of accident, a huge amount of vibration will be sensed on the piezoelectric vibration sensor and there will be a variation of heart pulse due to the shock of accident it may be lower than usual or higher than usual which is depended on the physical and health condition of the user. Once the signal has been triggered from the microcontroller the mobile application will sends the current location of the user to the nearby help centres like 108 control room in Tamilnadu. The user also gets an alarm in the device regarding the fact that location and distress call and he/she got one minute to use the kill switch in case he/she doesn't require the emergency service. If the kill switch is not activated the location will be shared to nearby ambulance service by the regional help centre. In case they didn't get opportunity to activate the kill switch in given time of one minute and they feel that emergency service is not needed' he/she can cancel the entire distress call via the mobile application.

4. Results

The system can detect the accidents and able to sends the location. For demonstration of the model Blynk app has been used as the server and the location has been received.

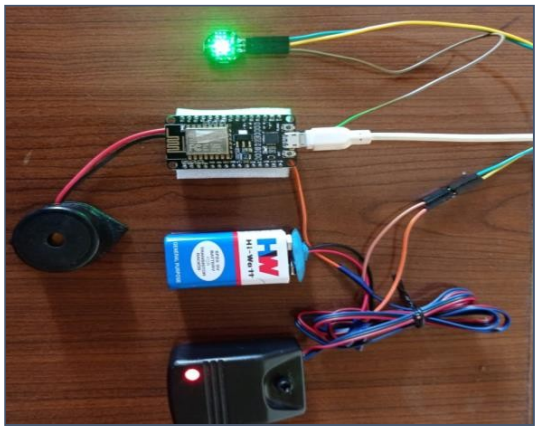

Figure 4. Onboard Prototype

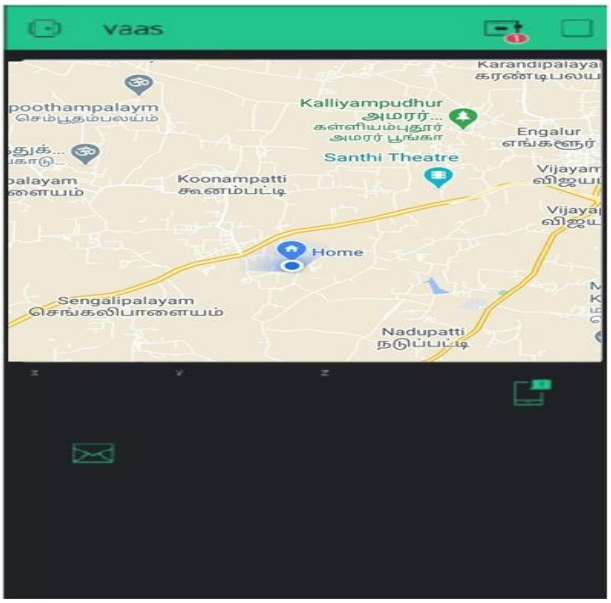

Figure 4. Output Screen on Blynk App

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