Automatic Vehicle Accident Detection and Healthcare Unit Notification using IoT Technology with ESP32

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Abstract

In developing countries the whopping increase in population has indirectly contributed in rapid motorization and extensive growth of vehicles. Due to this, the road accidents have become unavoidable that is causing a high rate of fatalities and severe injuries. The drastic influence of modern technologies has significantly played the vital role in preventing accidents by automizing the vehicle and making it completely smart. This paper mainly discuss about the system which is developed using IoT technology with the integration of ESP32 Microcontroller, Smart Sensors, GPS, GSM and Blynk Application to detect accident and to send immediate notification to the nearby healthcare centers and emergency contacts for the rescue operation.

Keywords: IoT, ESP32 Microcontroller, Smart Sensors, GPS, GSM, Blynk Application

Introduction

At the current moment, the number of accident cases is emerging in an exceedingly rapid rate. Considering every minute, every hour and every day there is extremely high count of accident cases that occurs worldwide. Some accidents are minor while some are fatal which usually occurs in an unpredictable manner. In certain circumstances when there is any occurrence of an accident, if information is not clocked in to the nearby healthcare centres in time or if there is no access to the sudden emergency services or first aid might lead to the loss of life which is tragic. By taking into account all these issues there is an absolute necessity to develop a system which can scrutinize the condition and operate in an effective way to overcome the time lag between the occurrence of an accident and availability of medical services. The foremost purpose of this project is to develop a system using IoT technology which is effective enough to avoid the accidents by considering different aspects, also to detect and inform the relevant emergency centers and concerned people so as to rectify the situation without any further ado. This can be accomplished with the usage of smart sensors by integrating it with ESP32 microcontroller enclosed in the vehicle. These sensors trigger at the occurrence time of accident. The GPS and GSM modules are utilized for the notification purpose which determines the location of the accident spot and accordingly informs the nearby hospitals and concerned

family members. In this project an open source application called Blynk is used which is mainly designed for the IoT projects where the information can be accessed via mobile.

Literature Survey

[1] In this paper, the authors have proposed a prototype of automatic accident triggering system for a car by adapting IoT technology. Accelerometer and GPS sensors are utilized from where the signal is sent to the cloud. The signal indicates the severity of the accident and the GPS location. The notification is sent to cell phones using Twilio and the GPS location can be accessed on ThingSpeak by anyone with the login credentials. By obtaining the GPS coordinates, ambulance can reach the scene immediately. A quicker and rapid tracking is also implemented for the felons who decide to flee after causing the accident.

[2] This paper explains about the system which uses IoT frame work integrated along with the smart sensors and a microcontroller which are pre-programmed into the vehicle that can be activated at the time of an accident. This device is designed in such a manner that it alerts the respective authorities about an accident only if the passengers have been seriously injured. This device detects accidents on time and triggers the immediate notification; GPS and GSM are enabled in order to seek the location details and to send an urgent message to the registered numbers. It is also designed to track the health of the driver by embedding heart rate sensor to the seat-belt.

[3] In this work, a prototype is designed for the auto-detection of number of accidents on the road with the help of VANET (Vehicle Ad-hoc Network) methodology and Internet of Things. The VANET app will be able to review the intensity of the accident and the severity of an emergency with the help of mechanical and medical sensing devices. During such event of emergency situation a message is sent to the nearest hospital, as the central server finds the location of the nearest emergency centers.

[4] This paper discusses about the cost-effective system which is developed to auto detect accidents using IoT technology. On the account of occurrence of an accident, the data information is immediately sent to the web server and the SMS is instantly sent to the acquaintances of the victim and the concerned authorities. Load cell GPS, GSM, Wi-Fi module and microcontroller are interfaced in the system. This system is proposed in a manner such that it can be implemented as smart accident detection and rescue system for a large vehicle populated cities.

[5] The paper mainly explain about the implementation of IoT based smart helmet called 'Konnect' to detect and report the accidents. This system mainly depends on the cellular devices data of the drivers and is mainly developed to ensure the higher safety for motorists. The system is built with the sensors, Wi-Fi enabled processor and cloud computing infrastructures. The processor monitors the erratic variations continuously by communicating with the accelerator values. Whenever accident occurs, the required details are sent to the emergency contacts with the help of cloud based service and the location is tracked through GPS.

[6] In this paper, a system has been proposed to avoid accident hazards efficiently using technologies like V2V communication, smart sensing, mobile edge computing, etc. This system mainly focuses on two wheelers. It also provides a mechanism to identify whether the person riding the bike has a valid license or not through RFID reader. Raspberry Pi is used as a microcontroller which is further interfaced

with different sensors. This system avoids accidents by monitoring certain condition like red light detection, validation of license, drink and drive cases and many more and make sure of the vehicle and driver's safety.

[7] This paper majorly deals with the implementation of diagnosis system for the improved safety using IoT technology. The proposed system mainly monitors the parameters like alcohol content, head light system, level of coolant and status of the seat belt. The data from these parameters are stored with the help of local storing methods and later transferred to the central sever where all the records are stored. If any of these parameters exceeds its limitations then the warning is triggered and driving pattern faults are informed to the driver. This system is designed such that it is user friendly, vehicles friendly and more cost efficient.

[8] This paper explains about the system which detects accident swiftly and notify to the emergency centers. It examines the intelligent and fastest route for the ambulance to reach the accident detected destination by utilizing IoT technology. Thus by adapting IoT technology's framework, it can diminish the lag by applying RF advancements which can control the movement of signals. It also makes use of cloud storage for storing all sort of data and details of nearest hospitals and current traffic conditions.

[9] In this paper, the prototype is proposed using IoT technology. The author has considered the factors like fire detection and collision. Arduino Uno microcontroller is used in the model to control the entire system. The MQ135 sensor is utilized to detect the smoke along with a fire sensor module DFR0076. In addition, GSM SIM800L module is used to provide information to the security agency. The system built efficiently works in detection of accidents.

[10] This paper presents an IoT based automatic accident detection and classification system using the fusion of Smartphone's built-in and connected sensors to detect as well as report the type of accident. The status of accidents considered in this system is collision, rollover, fall-off, and no accident. The machine learning models involving the techniques of Naïve Bayes, Gaussian Mixture Model and Decision tree are compared to select the best classification model. The physical parameters of the movement of vehicle are considered which are speed, absolute linear acceleration, change-in-altitude, pitch and roll. These parameters are used to test and train each candidate. This proposed system frequently works whether there is accident or not. In case of accident, it informs predefined emergency services and family members.

Proposed System

The prototype system which has been developed detects the accident instantly and informs the concerned people and authorities. In this prototype model, ESP32 microcontroller is considered as the core of the overall system. It is basically considered as it is low power on-chip microcontroller which has in built Wi-Fi and Bluetooth module. In addition to this it is battery friendly. The different sensors are interfaced to ESP32 which detects the various aspects of the vehicle functioning and drivers condition while driving in order to ensure maximum safety. The different cases considered in this prototype system are:

(1) If the vehicle gets bumped and there is sudden reduction in speed where the vehicle becomes static then the case is tested for the presence or absence of person.
(2) The occurrence of any obstacles near the vehicle is determined.

(3) The tilting of the vehicle during the occurrence of accident is determined.

(4) In case if the driver is drunk then the system is designed to send the pre-notification or warning to drive safely.

The sensors considered in this system are IR sensor, Ultrasonic sensor, Accelerometer and MQ-3 gas sensor. These sensors flow of information is controlled by ESP32. IR sensor is installed for the detection purpose of presence or absence of person on the vehicle seat at the occurrence time of an accident. Ultrasonic sensor is used for the detection of any sort of obstacles that might come in contact with the vehicle. Accelerometer ADXL335 is incorporated for the accurate measurement of acceleration. The acceleration is measured in three axes which are X, Y and Z directions. Positive and negative acceleration are measured by X and Y axes respectively. The angle of turnover of the device is measured by Z axis. MQ-3 gas sensor is installed to detect the alcohol status. The system is designed in such a way that if it comes to the notice that driver is drunk then the pre-notification or warning is sent to the driver to drive slowly and safely. Along with these sensors the GPS and GSM modules are incorporated to detect the vehicle location and for sending the notifications to the related people and authorities respectively. A mobile application called Blynk is used where all the sensor data is integrated to the Blynk server. Blynk is mainly an open source application which has been designed to deal with IoT projects. It enables the communication between the system and the server where the information can be stored and obtained when required. The mobile application is installed where the developed system is integrated to the Blynk server for monitoring and control purpose. ESP32 is connected to the Blynk server through Wi-Fi. Whenever the accident occurs the sensors trigger warning in the form of output messages which is displayed on the Blynk server, also the location of the vehicle can be accessed on the Blynk server. The immediate alert about the accident and the location spot is sent to the emergency contacts through GSM. The block diagram of the proposed system is shown in the below figure.
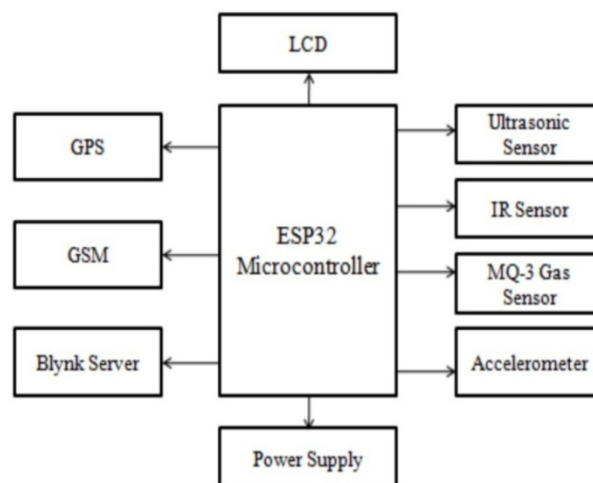

Figure 1: Block Diagram of the Proposed System

Implementation

A prototype model is implemented by incorporating ESP32 microcontroller and various sensors. ESP32 has inbuilt Wi-Fi module. The considered Ultrasonic, IR, Accelerometer (ADXL335), MQ-3 Gas sensors are connected to the microcontroller. GPS and GSM modules are also interfaced. Blynk mobile

application is installed, after the installation account is created and logged in with the login credentials. This application is compatible for both android and iOS devices. A project is created in the app by choosing the appropriate hardware model. In this system ESP32 Dev board is considered. Auth token is generated which is unique identifier required in order to connect the selected hardware to the smartphone. The system is connected to the Blynk with the connection mode Wi-Fi. The application contains various widgets and these widgets are added according to the requirement. When the power supply is provided to the system it starts to operate. As soon as the system is in 'ON' mode it is simultaneously connected to the Blynk application through Wi-Fi. During the operating time of the system the information starts flowing through the sensors. The sensors detect the various conditions and based on that it triggers warning which is displayed manually on LCD. When the accident occurs the GPS locates the coordinates and the exact location of the vehicle is determined. This information is obtained on Blynk server. With the help of server the location of the accident is sent to the concerned authorities so that the quick medical aid can be provided. Also the emergency contact numbers are fed to the system such that whenever the accident occurs the information, condition and the location are sent to the concerned family members or friends.
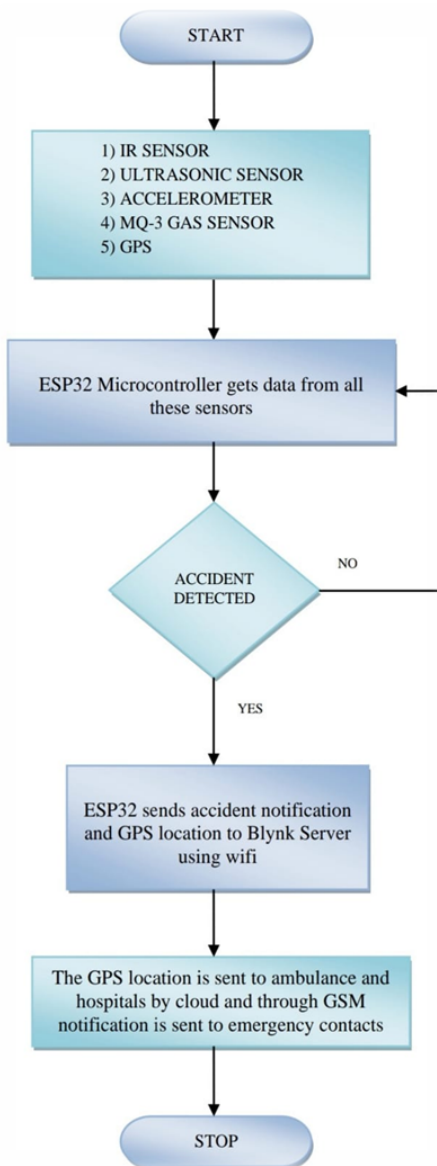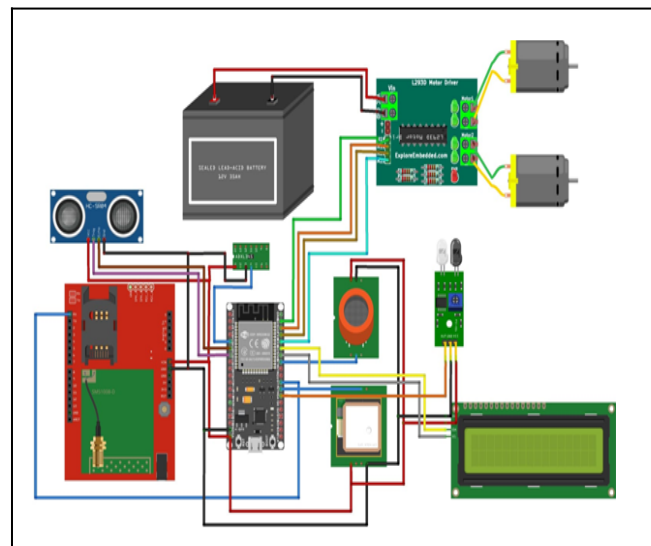

Figure 3: Circuit Diagram of Hardware Implementation

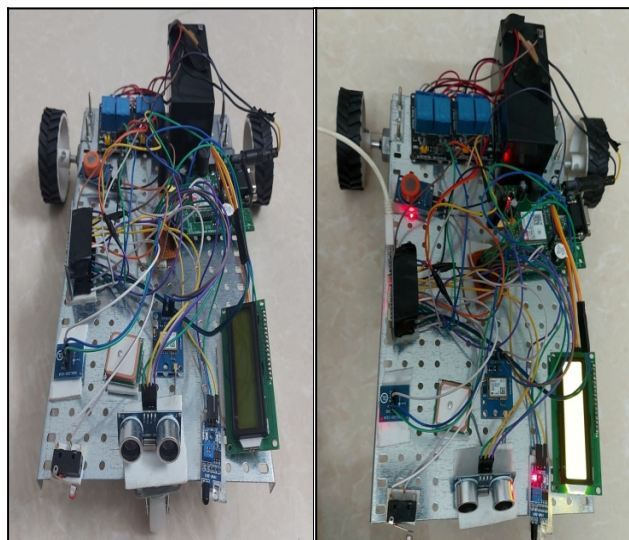Figure 2: Flowchart of the Proposed System

Figure 4: Implemented Prototype Model

Results

A prototype model of automatic accident detection and notification is completely built. Subsequently, the required output is achieved by testing all the sensors for the various input conditions. The coding is written and executed in Arduino IDE platform. The coding is written according to the considered cases of the project. The different threshold values of sensors are considered. According to these values the cases are tested. Presence or absence of a person is determined by the IR sensor. Any sort of obstacles or disturbance within the threshold value of distance greater than 2 and less than 15 is been determined by the Ultrasonic sensor. MQ-3 gas sensor senses the alcohol status for the threshold value greater than 3000 and accordingly it is designed to the pre notify the driver in the form of text message and sound alarm warning to drive cautiously. For the threshold value of greater than 2100, the tilting of the vehicle in different directions at the the time of accident is determined by using 3 axis accelerometer. With the help of GPS exact location of the vehicle is tracked down. Through Blynk application the vehicle conditions are monitored and the information is obtained constantly. The Blynk server sends the location details to nearby emergency centers. The GSM aids in sending immediate SMS and location link of the vehicle to the emergency contacts. This proposed system is very reliable, cost efficient and user friendly.

Conclusion

There are enormous developments happening around the globe every new day. IoT is one of the current blooming technologies. The system developed using IoT technology can yield the results in more structured and coherent manner. The road accidents are occurring in an extreme level. When an accident occurs, the important thing which matters the most is person's life. Usually in many cases due to the delay in obtaining the information of the accident and also because of lack of aid there is a chance of loss of life which is horrifying. In order to overcome such situations a prototype of IoT based automatic vehicle accident detection and healthcare unit notification is successfully built and subsequently the output is obtained for the considered cases. This IoT based project helps in detecting the accidents for certain conditions and determines the vehicle location that is the accident spot and it immediately sends the emergency notification to the nearby healthcare centers and concerned family members. The similar system which is more efficient can be included during the manufacturing phase of vehicles to avoid and monitor accidents in real life.

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