

IOT Based Vehicle Surveillance And Crash Detection System

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Abstract—One of the leading causes of fatalities worldwide is road accidents, many of which happen due to delayed response authorities due to either poor response time or lack of a proper real time monitoring/reporting tool for emergencies. This paper presents the design of a vehicle monitoring/crash detection system based on "IoT concepts" whereby there is no manual intervention by either the driver or passengers at any time. In order to achieve this objective, MEMS accelerometer sensor will be used to continuously monitor/detect changes in rate of acceleration whenever a crash occurs. The Arduino UNO shall be used as a processing unit to process incoming data from the sensor and control the other devices. Upon confirmation of an accident occurrence, the GPS module will obtain accurate location information of the event and that information will then be sent via the GSM module, through SMS messages, to a preprogrammed list of emergency contacts including family members, hospitals and/or other rescue services. There are two feedback devices included in the project, a 16×2 LCD display and buzzer, which shall relay real time information to the user. The entire circuitry will be powered by a 5V DC regulated power supply and a 12V adapter will be used to power the auxiliary modules. The experimental testing of the system has confirmed that this system will accurately detect crash events and generate alert messages with

Index Terms—IoT, Vehicle Surveillance, Crash Detection, MEMS Accelerometer, GPS Module, GSM Module, Arduino UNO, Accident Alert System, Intelligent Transportation.

I. INTRODUCTION

In the past few years, there have been many improvements in technologies related to modes of transport, yet still road crashes are one of the key concerns on a global scale, resulting in thousands of fatalities each year. According to the World Health Organization, an estimated 1.35 million people are killed in road traffic accidents per year, with millions more suffering injuries resulting in them being physically disabled for up to their entire lifetimes. There is a very good chance that any number of those deaths could have been avoided had the ambulance assistance arrived as quickly as possible in the best location.

Currently, with the majority of people unable to get assistance due to their potential injury or being inside the vehicle, or having witnesses who might see the accident taking place but not able to assist right away in some cases due to their remote location having connectivity problems, any delay in responding to the accident has the potential to be a life/death situation for the accident victims.

The technologies of the IoT have a very good opportunity to fix the problem. With sensory functionality, communications capability, and processing power, vehicles could develop autonomous systems that would detect a collision on its own and initiate the appropriate emergency response without any human involvement.

The solution designed in this project utilizes various mature embedded and wireless communication technologies. A MEMS accelerometer sensor is used to identify any sudden acceleration within the vehicle, signalling the occurrence of a crash. The Arduino UNO microcontroller then analyses this information and executes further operations. The GPS sensor locates the current position of the car, while the GSM sensor sends out a

warning text to predetermined emergency contacts. Additional features such as an LCD screen and buzzer aid in delivering onboard alerts. for future innovations in secure healthcare informatics.

II. LITERATURE SURVEY

The automated reporting of a traffic accident was first developed by Ramani et al. [1]. Their method was to use a vibration sensor to detect the event, and then to utilize a GPS module to obtain the vehicle's location. A message was then sent to the emergency services using a GSM network. The one limitation to this method was that it relied on a single vibration sensor; hence, the accuracy of detecting a true accident versus normal road vibrations was limited.

In a similar vein, Hannan and Hussain [2] also developed a vehicle accident detection and alerting mechanism. Their approach was to combine GPS for location detection using the GSM network to send an alert message once an accident was detected, with the primary goal being to reduce the amount of time required to send the alert message after detection. They proved that real-time alert messaging for accident incidents was indeed possible, but issues revolving around the accuracy of the sensors and prevention of false alarms were not given an adequate amount of consideration.

Kiran and Rao [3] performed an assessment of the ability to use MEMS accelerometers to detect changes in acceleration occurring when a collision occurs. They currently found that MEMS-based solutions exhibited superior sensitivity.

III. EXISTING MODELS AND LIMITATIONS

However, most existing systems used for detecting collisions in vehicles operate based on a common principle. The collision detector, in most cases a shock or vibration sensor, detects any potential impact from outside and once its value surpasses a certain predefined threshold, the GPS unit is activated to obtain the present coordinates of the vehicle before the GSM unit sends out an SMS message to pre-configured contacts.

Despite the usefulness of the above approach when tested in laboratories, there are a number of shortcomings associated with it that hinder its real-world implementation in current models. The first of these concerns the method used by some systems whereby the threshold values are set for determining whether a collision took place or not. This approach fails to distinguish between a collision and road bumps encountered on highways.

The second limitation found in the current technology involves the lack of in-car feedback systems. The lack of either display or auditory feedback indicates that there is no indication for vehicle occupants to know when an alarm has been raised and help is being sought. In addition, there could be unnecessary panic or even the attempt to initiate secondary actions that could worsen the situation.

The third deficiency in previous versions of the device is the lack of power regulation in the system. Voltage fluctuations can affect the accuracy of the information obtained by the sensors and the transmission of signals between modules.

IV. PROPOSED SYSTEM

The suggested IoT-enabled vehicle surveillance and accident detection system will be capable of automatically detecting instances of crashes in vehicles and immediately providing accurate location-based alerts to emergency contacts based on predetermined conditions without necessitating manual intervention from the occupants inside the car. The hardware for the proposed solution will be based around the use of the Arduino UNO board as its primary controller.

A. System Architecture

A MEMS accelerometer will constantly be monitored through the Arduino in order to determine whether a crash has occurred based on the vehicle's movement on more than one axis. The MEMS accelerometer detects acceleration values for each of the X, Y, and Z planes. The sum total of these values will then result in the calculation of the magnitude of acceleration. In the case where the latter exceeds the threshold, a crash event is said to occur.

After this occurs, the GPS module will receive the geographical location of the car in the form of latitude and longitude data. This information will be used as part of an alert message to be sent through the GSM module to the cell phone numbers of the preprogrammed emergency contacts. The 16x2 LCD gives constant feedback on the status of the system, the data from the sensors, and the

confirmatory alert signal to everyone around or within the vehicle. An alerting sound produced by the buzzer comes into effect right after the detection of a crash. The whole system operates under a regulated power supply of 5V with the 12V, 1A adapter giving an extra voltage to the GSM and GPS.

B. Block Diagram of System

The master controller in the form of the Arduino UNO takes inputs from both the MEMS accelerometer and GPS modules. The output modules include the GSM module for sending alerts remotely, LCD for local display of the alert, and the buzzer for making an alerting sound.

Block Diagram

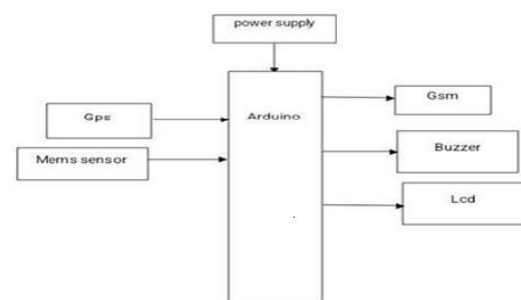


Fig1.0: - Block diagram of system

V. HARDWARE AND SOFTWARE COMPONENTS

A. Arduino UNO

The Arduino Uno is a programmable hardware platform that is based on open source and uses 8-bit microcontroller AVR called ATmega328P with a clock rate of 16 MHz. There are 14 digital pins used for input and output purposes from these 6 are PWM enabled pins and 6 analog input pins. It offers 32 KB of flash memory, 2 KB of SRAM, and 1 KB of EEPROM. The use of its TX and RX pins allows serial communication, and power can be provided either by means of USB interface or an external power supply adapter.

B. MEMS Accelerometer Sensor

MEMS Accelerometer is a small and highly accurate inertia-based sensor that can measure acceleration along several axes at once. The ADXL345, the particular accelerometer in use for this project, has the ability to sense the acceleration along the X, Y, and Z axes and communicate with the Arduino using the I²C or SPI communication protocol. It provides users with flexibility in selecting a measurement range and allows the detection of acceleration with high precision, which is necessary for determining whether a collision occurred or it is just another motion of the vehicle.

C. GPS Module (NEO-6M)

The NEO-6M GPS module employs satellite trilateration in order to determine the actual geographical coordinates of the car at any given point in time. It picks up signals from various satellites, computes the distance between itself and the satellites using the time taken for signal reception, and then transmits the coordinate data in NMEA format using the serial Tx pin of the module in default mode at 9600 bps. The \$GPGGA string obtained from the output includes data such as latitude, longitude, altitude, and time.

D. GSM Module (SIM800L)

SIM800L GSM Module runs on the frequency bands of 850, 900, 1800, and 1900 MHz and can transmit and receive SMS. This module needs a SIM card for connecting to the cellular network and communicates with the microcontroller using AT Commands over serial communication protocol. As soon as there is any crash event detected by the Arduino, it sends a command to this GSM module that transmits an SMS with the location coordinates of the vehicle to the emergency contact list.

E. 16×2 LCD Display

The 16×2 LCD screen shows two lines of alphanumeric characters with 16 characters on each line. The LCD screen works either in 4-bit or 8-bit mode of interface and uses digital I/O pins of the microcontroller. In the given model, the 16×2 LCD is used for the presentation of system status, sensor data, and confirmation about the sending of alerts.

F. Buzzer

The buzzer is a piezoelectric audio signalling component rated at 6V DC with an operating range of 4V to 8V. It is activated by the Arduino upon crash detection and produces a continuous audible tone at approximately 2300 Hz. This immediate in-vehicle alert is useful in situations where conscious occupants need rapid notification that an emergency alert has been triggered.

G. Power Supply

This project utilizes a controlled 5V power supply obtained from a 12V, 1A power adapter using a 7805 IC voltage regulator circuit. The voltage is step-down by the transformer, then converted into pulsating direct current by the bridge rectifier, and is further filtered with capacitors for the voltage to be stabilized into 5V, which will provide power to the Arduino and its accessories. For the GSM and GPS modules, which operate on higher power requirements, they are connected to the 12V power adapter output.

H. Software Platform

The Arduino IDE, which is a cross-platform integrated development environment that runs on Java, is utilized for the coding of the system. The firmware is developed in Embedded C and is responsible for handling the following

functions: Accelerometer polling; GPS information interpretation; GSM command execution; LCD display control; and Buzzer. In order to interface with the GPS and GSM modules, software serial library is utilized.

VI. RESULT AND DISCUSSION

The test results for the assembled prototype included testing of its performance in terms of reliability of crash detection and timely alerts transmission in stationary and crashing conditions. The MEMS accelerometer was set to the threshold values, distinguishing the real crashes from vibrations resulting from potholes or speed bumps during usual driving conditions.

The system performed adequately in all cases and was capable of detecting crashes and sending alerts within a two to three second range. In the conditions of open sky, the GPS module received location data within 30 to 60 seconds and determined the location within three-to-five-meter radius. The GSM module took from five to eight seconds to send SMS containing the location of the car to all pre-defined contacts.

The status of the LCD screen corresponded accurately to the state of the device and its operations. Thus, it showed crash occurred, alert sent, and the correct location. The buzzer instantly turned on after a crash. False positives were not observed in the tests of potholes and normal braking.

Comparisons with existing similar systems indicate that the proposed design offers competitive detection accuracy, faster alert dispatch, and the added benefit of multi-modal in-vehicle notification through both display and audio output. The use of a regulated power supply further enhanced operational stability across all test conditions.

VII. CONCLUSION

This paper has described the designing, implementation, and testing process of an Internet-of-Things based Vehicle Surveillance and Crash Detection system that offers complete automation for accident detection and emergency notification. Through the incorporation of components such as a MEMS accelerometer, an Arduino UNO board, a GPS module, a GSM module, an LCD screen, and a buzzer, the system has been developed to overcome the problem of delay in emergency services that has been leading to fatalities from road accidents in many places.

The experimental outcomes have shown that the proposed system is reliable in detecting crash events and sending location-based messages with minimal delay to concerned persons through SMS. There are no false alarms when the system undergoes simulation tests under normal driving situations, which means that the calibration technique for setting up the threshold values is very efficient.

Further developments will involve incorporating cloud computing technology to analyse data collected after

accidents, including fall-detection functionality for motorcycle riders and the creation of an Android app that will show an emergency contact real-time location of the accident scene. Other improvements can be made by extending the system with a rollover detector and other sensors for monitoring the health status of drivers.

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