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Research Article

Vehicle Collision detection and Remote Alarm Device using Arduino

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Abstract

Vehicle accidents are one of the leading causes of fatalities. Because of not getting help on time, poor emergency facilities, people lose their lives. This project deals with the optimum solution to this drawback. An automatic alarm device for vehicle accidents is introduced in this paper. The vehicular module is used to detect vehicle accident. An accelerometer can be used in a car alarm application so that dangerous driving can be detected. It can be used as a crash or rollover detector of the vehicle during and after a crash. With signals from an accelerometer, a severe accident can be recognized. The vehicular module can search for the accident spot and then send the basic information to first aid center and police station within few seconds covering geographical coordinates where the accident had taken place. By means of satellite navigation system, first aid rescuers, police too can accurately locate the place so that they can save the injured people as soon as possible. This paper provides the following contributions to detecting vehicle accidents via ATMEGA 16 controller. Here it is seen how AVR controller, accelerometer, GSM connections, and GPS can be used to provide situational awareness.

Keywords: *vehicle accident, MEMS, accelerometer, GSM, GPS, alarm device, vehicle tracking*

1. Introduction

The rapid development of economic construction and people's living standard continues to improve. As well as road vehicle accident take place frequently which caused huge losses of life and property to the country and people. Traffic has become an important event in the national interest. Poor emergency incident is a major cause for the high number of traffic fatalities and the death rate in our country [Wang Wei and Fan Hanbo et al, 2011]. A number of technological and sociological improvements have helped reduce traffic fatalities during the past decade, e.g., each 1% increase in seatbelt usage is estimated to save 136 lives [Cohen and L. Einav et al, 2003]. Advanced life saving measures, such as electronic stability control, also show significant promise for reducing injuries, e.g., crash analysis studies have shown that approximately 34% of fatal traffic accidents could have been prevented with the use of electronic stability control [A. Lie, C. Tingvall, M. Krafft, and A. Kullgren et al, 2006]. Moreover, each minute that an injured crash victim does not receive emergency medical care can make a large difference in their survival rate, e.g., analysis shows that reducing accident response time by one minute correlates to a six percent difference in the number of lives saved [W. Evanco et al, 1996]. This module provides information about the accident to the hospital and police station. As a result sudden help public life may save and the traffic jams are reduced. To improve the level of supervision and management for cargo transport vehicles, especially trucks carrying coal it is important to develop transport vehicles remote monitoring module [Saurabh S. Chakole, Vivek R. Kapur and Y.A.Suryawanshi et al, 2013]. This design is a system which can detect accidents in significantly less time and sends the information to hospitals with the help of GPS, the time and angle in which a vehicle accident had occurred. In this work, MEMS accelerometer and GPS tracking system is developed for accidental monitoring. In the incident of accident, this wireless device will send mobile phone short massage indicating the position of vehicle by GPS system to family, affiliate, emergency medical service and nearest hospital so that they can provide ambulance and treatment for the patients. An effective approach for reducing traffic fatalities, therefore, is to reduce the time between when an accident occurs and when first responders, such as medical personnel, are dispatched to the scene of the accident. Automatic collision notifi- cation systems use sensors embedded in a car to determine when an accident has occurred. These systems immediately dispatch emergency medical personnel to serious accidents. Eliminating the time between accident occurrence and first responder dispatch reduces fatalities by 6% [S. Rauscher, G. Messner, P. Baur, J. Augenstein, K. Digges, E. Perdeck, G. Bahouth, and O. Pieske et al, 2009].

A Switch is also provided in order to terminate the sending of a message in rare case where there is no casualty, this can save the precious time of the medical rescue team. When the accident occurs the alert message is sent automatically to the rescue team and to the police station. The message is sent through the GSM module and the location of the accident is detected with the help of the

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GPS module. The accident can be detected precisely with the help of both Micro electro mechanical system (MEMS) sensor and vibration sensor. The angle of the rolls over of the car can also be known by the message through the MEMS sensor. This application provides the optimum solution to poor emergency facilities provided to the roads accidents in the most feasible way [Varsha Gaud and V. Padmja et al, 2012].

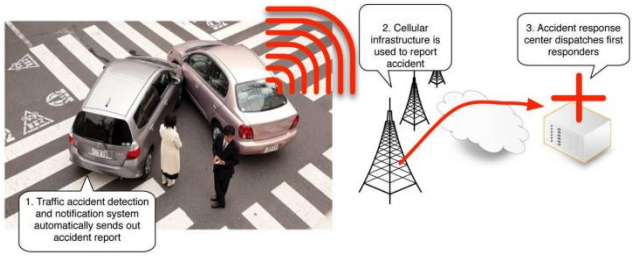

Fig.1 A Vehicle based Accident Detection and Notification System

Key features of this design include:

a. Vehicle real-time monitoring by sending "its" information regarding position (longitude, latitude), time, angle to the monitoring station and to the user/owners mobile that should help them to get medical help if accident or the theft occurs.
b. User/owner has an access to get real-time position of a vehicle in real time.

Also in case of theft vehicle should be stop at the same time where this system is ported on the mobile vehicle.

2. Literature Survey

In literature, a number of approaches to provide security and safety through moni- toring the vehicle's real time precise positioning and information using different tech- nologies have been proposed. A good survey of using GPS, GSM and GIS has been provided in [Ioan Lita, Ion Bogdan Cioc, Daniel Alexandru Visan et al, 2006] and [Mrs.RamyaKulandaivel, P.Ponmalar, B.Geetha, G.Saranya et al, 2012]. The general mechanism is to provide the real time geograph- ical position of a vehicle using GPS receiver and send this information to GSM center through configurable software, this is all done by the monitoring center which is working as a control unit that is connected not only by an optical cable but also connected wirelessly through TCP/IP protocols. The monitoring center distributes the data to the client in an understandable format and it also stores the travelling records and displays the real time information about vehicle on electronic map through GIS system [Ioan Lita, Ion Bogdan Cioc, Daniel Alexandru Visan et al, 2006]. Another approach is that vehicle terminal includes a GPS receiver which extracts information about position through GPS satellites and sends it through GSM network and to the control center which reads the information, process it through GIS management system and saves it in the data base system and on user demand displays it on electronic map via MapX tool [Mrs.RamyaKulandaivel, P.Ponmalar, B.Geetha, G.Saranya et al, 2012].

A different approach is proposed by integrating GPS and GSM/GPRS transmission technologies .The basic idea is to localize the vehicle system by receiving the real time position of the vehicle through GPS and send the information through GSM module via SMS service with an added feature of GPRS transmission to the monitoring center through usage of internet [M.AL-Rousan, A. R. AI-Ali and K. Darwish et al, 2004]. Using AT89S52, this project has been designed. It used EEPROM to store the phone numbers.

3. System Architecture

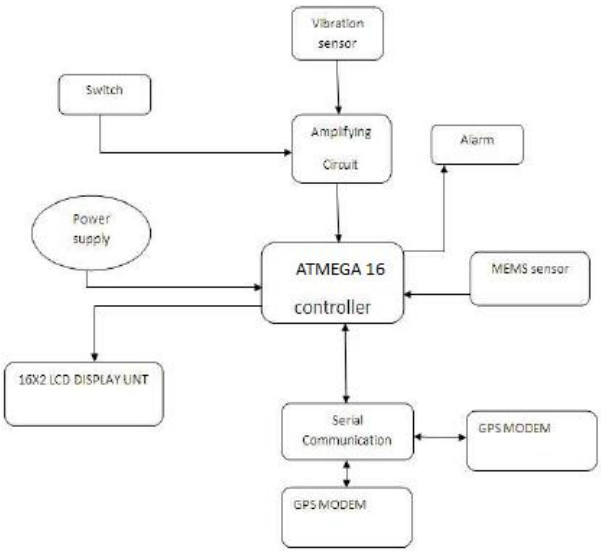

Fig.2 Block diagram of Vehicular Monitoring and Remote Alarm Device using Arduino

The complete block diagram is as shows in figure 2.The vehicular system [VS] includes hardware that consists of an ATMEGA 16 microcontroller, Accelerometer, GPS module, GSM module, l6x2 LCD, and vibration sensor. The whole VS works on a 5V or 9V dc regulated power supply. The GPS receiver module interfaced with USART of ATMEGA 16 provides speed and location information. Whenever the accident occurs the vibrations are sensed by the vibration sensor and these signals are given to the controller through the amplifying circuit. If incase there is an rolls over of the car the angle of the rolls over is detected by the Micro electro mechanical system(MEMS) sensor and it is given as the input to the controller for further processing. As and when the input is received by the controller, the buzzer (alarm) is ON and the message is sent to the rescue team with the help of the GSM module. The rescue team reaches the site of the accident with the help of the location given in the message. An LCD display is provided to get the display of the tasks carried out. In some conditions where there are no casualties or when there is no need of the medical facility to the person, then the messaging can be terminated with the help of the switch provided in order to avoid wasting the valuable time of the medical rescue team. The GSM and GPS modules are interfaced to the Arduino controller using serial communication. All the components are interfaced precisely so that the accident detection and alert message

sending are fully automated, so that the warning time is reduced significantly.

3.1 GSM Module

Global System for Mobile communications (GSM) is the almost popular wireless standard for mobile phones in the world. GSM module allows transmission of Short message service (SMS) in TEXT mode and PDU mode. The proposed design uses SIM 300 GSM module in text mode. This design uses SIM300 GSM module that provide 900/1800/1900MHz Tri-band for VOICE, SMS, DATA, and FAX. This module operates on AT command over TTL interface. AT command is an abbreviation for Attention command that is recognized by GSM Module. This abbreviation is always used to start a command line to be send from TE (Terminal Equipment) to TA (Terminal Adaptor). The information contains information position (longitude, latitude). The module is configured at 9600 baud rate.

3.2 GPS Module

The Global Positioning System (GPS) is a space-based radio navigation system that provides reliable positioning, navigation, and timing services to users on a continuous worldwide basis -- freely available to all. . For anyone with a GPS receiver, the system will provide location and time. GPS provides accurate location and time information for an unlimited number of people in all weather, day and night, anywhere in the world. The GPS is made up of three parts

1. Satellites which are orbiting the Earth.
2. Control and monitoring stations on the Earth.
3. The GPS receivers owned by the users.

3.2.1 GPS Receiver

- Location, speed, direction, and time are determined by GPS receivers.
- To locate the receiver in 3D space three satellite signals are necessary.
- For time accuracy 4 th satellite is used.
- Position is calculated with in sub centimeter scale.

The role of GPS in this project is to track the vehicle for every 5 minutes and position of vehicle is sent to mobile.

3.3 Accelerometer

An accelerometer measures acceleration. Acceleration is a measure of how quickly speed changes. Accelerometer sensor is used to measure static (earth Gravity) or dynamic acceleration in all three axes, forward/backward, left/right and up/down. The output of accelerometer provides 1.65V to 3.3V in positive direction and in negative direction the voltage drop from 1.65V to 0V. It is in analogue form with three different output voltages each representing X, Y and Z direction of motion. Accelerometer is used in this design for the collision detection. The maximum output voltage of accelerator module is 3.3V that is a CMOS voltage of the processor. Accelerometers operate on the piezoelectric principal: a crystal generates a low voltage or charge when stressed as for example during compression. (The Greek root word “piezein” means “to squeeze”.) Motion in the axial direction stresses the crystal due to the inertial force of the mass and produces a signal proportional to acceleration of that mass. This small acceleration signal can be amplified for acceleration measurements or converted (electronically integrated) within the sensor into a velocity or displacement signal.

3.4 Vibration Sensor

The three parameters representing motion detected by vibration monitors are displacement, velocity, and acceleration. These parameters can be measured by a variety of motion sensors and are mathematically related (displacement is the first derivative of velocity and velocity is the first derivative of acceleration). Selection of a sensor proportional to displacement, velocity or acceleration depends on the frequencies of interest and the signal levels involved. Eddy current probes are non contact sensors primarily used to measure shaft vibration, shaft/rotor position and clearance. Also referred to as displacement probes, eddy current probes are typically applied on machines utilizing sleeve/journal bearings. As compared to accelerometers, velocity sensors have lower sensitivity to high frequency vibrations. The mechanical design of the velocity sensor; an iron core moving within a coil in a limited magnetic field, no clipping of the generated signal occurs, but smooth saturation.

3.5 Control Unit

The ATmega16 is a low-power CMOS 8-bit microcontroller based on the AVR enhanced RISC architecture. By executing powerful instructions in a single clock cycle, the ATmega16 achieves throughputs approaching 1 MIPS per MHz allowing the system designed to optimize power consumption versus processing speed. Control unit receives information from accelerometer, vibration sensor, GPS module and send it to rescue system and police station with the help of GSM.

4. System Software Design

The development environment for the system software is Proteus 7.8 with the C program language been used. The Flow Chart of the system is shown in the figure 2. It shows the system is initialized on power ON. When the system is detected to be abnormal, it is confirmed that the accident has occurred. The vibration/acceleration of the vehicle is detected to confirm the cause of the accident. As soon as the accident is detected the buzzer (alarm) is ON. The switch is scanned first; if it is a minor accident then the switch is ON so that messaging is terminated. If it is a major accident, the switch remains OFF and the message is sent automatically to the rescue team after the

location is detected by the GPS.

The Flow Chart of the system is shown in the figure 3. It shows the system is initialized on power ON. When the system is detected to be abnormal, it is confirmed that the accident has occurred. The vibration/acceleration of the vehicle is detected to confirm the cause of the accident.
As soon as the accident is detected the buzzer (alarm) is ON. The switch is scanned first; if it is a minor accident then the switch is ON so that messaging is terminated. If it is a major accident, the switch remains OFF and the message is sent automatically to the rescue team after the location is detected by the GPS.

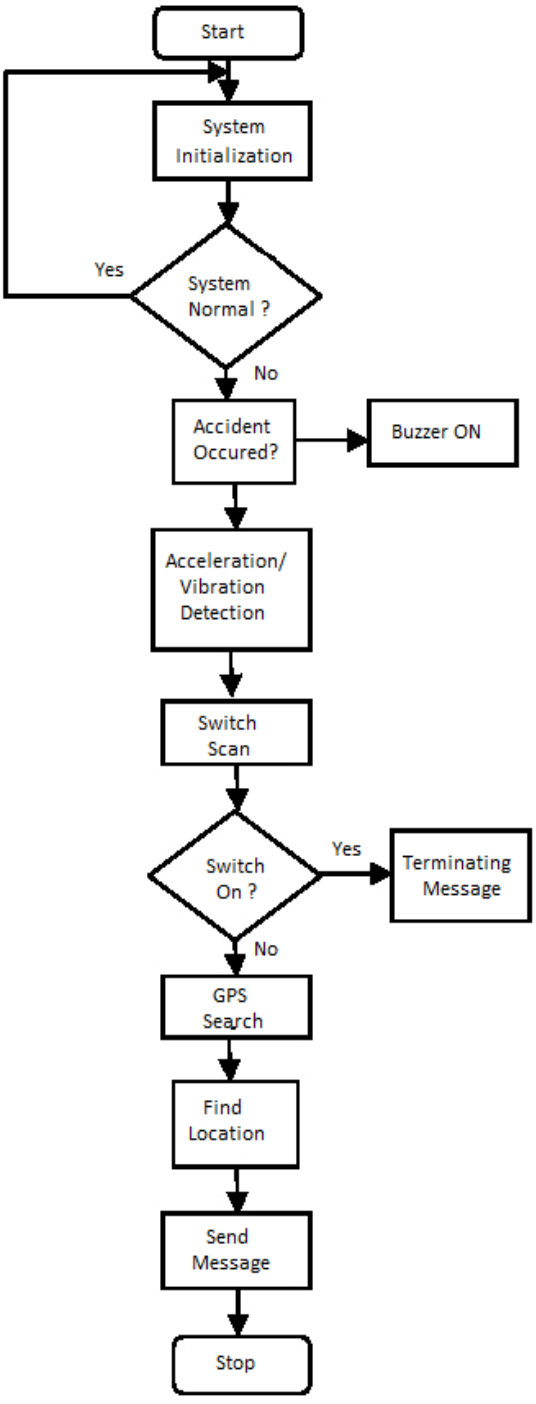

Fig.3 Flow chart of Vehicular Monitoring and Remote Alarm Device using Arduino

5. Working of System

Whenever accident occurs MEMS and vibration sensor detects and sends the signals to microcontroller, by using GPS we will get particular locations where accident has occurred, then GSM sends message to authorized members. Switch is provided in case of minor accidents.

Fig.4 Working of the system

6. Future Scope

1. System can be interfaced with Vehicle airbag system that prevents vehicle occupants from striking interior objects such as steering wheel or window.
2. This can also be developed by interconnecting a camera to the Controller module that takes the photograph of accident spot.

Conclusion

With the advent of science and technology in every walk of life the importance of vehicle safety has increased and the main priority is being given to reduce the alarming time when an accident occur, so that the wounded lives can be attended in lesser time by the rescue team. This paper provides the design which has the advantages of low cost, portability, small size and easy expansibility. The platform of the system is Arduino along with MEMS, Vibration sensor; GPS and GSM, interfacing which shortens the alarm time to a large extent and locate the site of accident accurately. This system can overcome the problems of lack of automated system for accident location detection. Consequently, the time for searching the location is reduced and the person can be treated as soon as possible which will save many lives. This system will have broad application prospects as it integrates the positioning systems and the network of medical based services.

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