

Abstract

Now a days, Most of the accidents on the roads are caused by driver faults, inattention and low performance. The proposed system aims at developing Safety system for accidental monitoring of vehicle based on ARM 11. Modern vehicles are equipped with many sensors and ARM11 plays a significant role in handling the entire communication between the sensors. In this work, the hardware's structure, the interface circuit, along with the ultrasonic distance measurement system, Speed sensor and GPS tracking system were studied to measure speed and distance between vehicles. When the distance is less and speed is more than safety value, the buzzer will alarm and the results of measurement will be displayed on ARM 11. The system can be applied to the collision avoidance control system on vehicle. Similarly GPS system is used to track location of vehicle. The system is compact and easy to install in vehicle. The system can be tested in real world applications using vehicle.

Keywords: GSM Modem, GPS module, Ultrasonic sensor, Speed Sensor.

Introduction

Active safety is seen as the viable solution necessary to reduce vehicle accidents. The vehicle accident is a major public problem in many countries, particularly in India. Despite awareness campaigns this problem is still increasing due to driver faults, inattention and low performance [1]. Increasing stress levels in drivers, along with their ability to multi task with infotainment systems cause the drivers to deviate their attention from the primary task of driving. Hence much emphasis is being given to occupant safety.

Although several research groups and major vehicle manufacturers have developed safety devices to protect drivers from accidental injuries. But it is difficult to implement good safety device for the vehicle using a single parameter [2]. Alternatively, intelligence schemes such as collision avoidance and location tracking have recently been devised to minimize the possibility of accident by using Ultrasonic system and GPS tracking system.

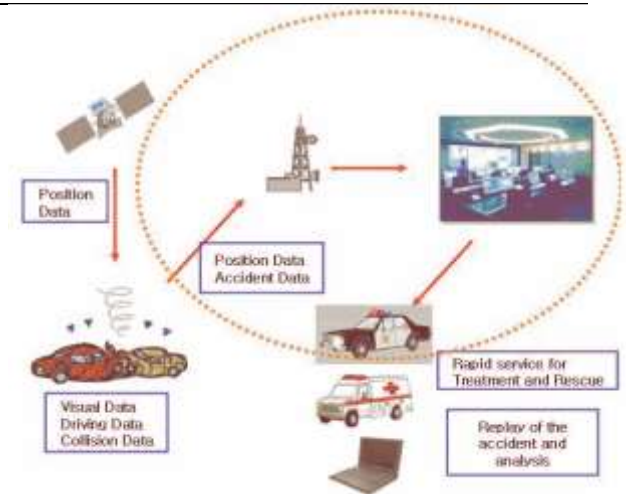


Fig.1. Concept of Safety System

There is a wide range of systems developed to increase safety of vehicles themselves by making them more stable and reliable. Therefore, the complete solution for reduction of road accidents is only possible by making the vehicles 'aware' of the driving context and the driver status. The proposed system aims at developing active safety system for accidental monitoring based on ARM11. In order to reach this aim, the objectives are set as follows:

- Development of safety system for Pre accident detection
- Intelligent system for analyzing alertness of Driver and inform to control room
- Tracking of vehicle, measuring distance between ego and leading vehicle to prevent accident

With the development of automotive industry, traffic load was increasing, and automotive safe driving issues were paid more and more attention [3], including collision avoidance control. Ultrasonic has good orientation and penetration, and has a certain ability to adapt to the environment. So, ultrasonic distance measurement system used in vehicle to avoid collision was feasible.

Ultrasound sensors are very versatile in distance measurement. They are also providing the cheapest solutions. Ultrasound waves are useful for both the air and underwater [1]. The main task of ultrasonic distance measurement is transmitting and receiving ultrasonic, and the processing of signal received by ultrasonic receiving circuit.

GPS module which is used for location tracking, communicated with 27 satellites to obtain geographic information. ARM 11 receives data from GPS module operated at refresh rate of 1Hz with UART interface. The data is decoded from GPRMC package using NMEA protocol, GPRMC or minimum recommended data consisting of basic GPS parameters including latitude (north or south), longitude (east or west), ground speed, current date and time, course over ground and magnetic variation.

A. The Principle of Ultrasonic Distance Measurement

Ultrasonic transducer uses the physical characteristics and various other effects of ultrasound of a specific frequency. It may transmit or receive the ultrasonic signal of a particular strength. These are available in piezoelectric or electromagnetic versions. The piezoelectric type is generally preferred due to its lower cost and simplicity to use [5].

The Ultrasonic wave propagation velocity in the air is approximately 340 m/s at 15°C of air or atmospheric temperature, the same as sonic velocity. To be precise, the ultrasound velocity is governed by the medium and its temperature; hence the velocity of ultrasound in the air is taken as 343 m/s. Because the travel distance is very short, the travel time is little affected by temperature. It takes approximately

29.15μsec for the ultrasound to propagate waves through 1cm distance; therefore it is possible to have 1cm resolution in the system.

The sound waves with frequency higher than 20 kHz is called ultrasonic. In addition to the characteristics of sound waves (such as reflection, refraction and diffraction), ultrasonic has the characteristics of centralized direction, good penetration, and small amplitude [5,7]. Therefore, ultrasonic has a great advantage on real-time, accuracy, non destructiveness, and so on. The ultrasonic which frequency is around 40 kHz has the best transmission efficiency. So, the frequency of the driver signal for the ultrasonic emitter used in this design is 40 kHz.

B. The Principle of GPS Tracking System

The Global Positioning System (GPS), usually means a GPS receiver, the only fully-functional satellite navigation system. More than two dozen GPS satellites are in medium Earth orbit, transmitting signals allowing GPS receivers to determine the receiver's location, speed and direction [6].

Each of these 3,000 to 4,000 pound solar-powered satellites circles the globe at about 12,000 miles (19,300 km), making two complete rotations every day. The orbits are arranged so that at anytime, anywhere on Earth, there are at least four satellites "visible" in the sky. Positioning System (GPS) is actually a constellation of 27 Earth-orbiting satellites (24 in operation and three extras in case one fails).

All satellites transmit on (1575.42 +/-10) MHz (L1) frequency, with C/A(Course/Acquisition) coded 1023 kHz data and the system receiver works on this signal. The U.S. military developed and implemented this satellite network as a military navigation system, but soon opened it up to everybody else. A GPS receiver's job is to locate four or more of these satellites, figure out the distance to each, and use this information to deduce its own location. This operation is based on a simple mathematical principle called *trilateration*.

So the GPS receiver has to know two things:

- The location of at least three satellites above it
- The distance between the receiver and each of those satellites

The GPS receiver figures both of these things out by analyzing high-frequency, low-power radio signals

from the GPS satellites. Better units have multiple receivers, so they can pick up signals from several satellites simultaneously. Radio waves being electromagnetic energy travel at the speed of light (about 186,000 miles per second, 300,000 km per second in a vacuum). The receiver can figure out the distance and time required for the signal to arrive.

Hence, Active safety system is the concept in which with the help of ultrasonic sensor, GPS module and ARM 11, possibility of accidents can be reduced [4].

System implementation

- A. Hardware- Ultrasonic Distance
Measurement circuit
B.



Fig. 2. Ultrasonic Transmitter and Receiver Circuit

In this paper, we describe such a measurement system which uses ultrasonic transmitter and receiver units mounted at a small distance between them.

Transmitter part contains two, 555 timer, AND gate (4081) and inverter IC (4049)

555(1) generates pulses with frequency 40KHz. Actually, ultrasonic transmitters are available with two frequencies 20KHz and 40KHz. 20KHz is typically not used as it fits within the voice band, it will be difficult to separate out voice noise from actual ultrasonic waves. Therefore the choice is 40 KHz.

Presently our target is to get waves from the other vehicle as well reflected waves. In that case, instead of continuous transmission of the waves, we will transmit it for very short duration; typically referred to as *BURST* signal. The burst of the signal will be transmitted for short duration. After that there will be silent period. The period is actually response time, i.e. waiting for reflected waves. If waves are reflected back, there is obstacle. To generate the burst we will require one for 555 IC with Less ON time and more OFF time. 555(1) generates 40 KHz signal.

$$\text{Equation is } 0.69 (R_a + 2R_b) C \quad (1)$$

$$\text{Select } C = 0.01 \mu\text{F}$$

$$1/40 \text{ KHz} = 0.69 (R_a + 2R_b) 0.01 \times 10 \quad (2)$$

This will give $R_a = R_b = 1.1 \text{ K}\Omega$
[Approximately]

In 555 normally ON time is more and OFF time is less. Therefore we will invert the output of second 555 timer. 555(2) will generate such LOW frequency pulses. The speed of the ultrasonic wave is 330m/sec. If we take range for reflected wave as 1m; the time required will be 1/330. It is equal to 3msec. For to-fro journey time required will be 6msec.

We will add some margin; i.e. $1.5 \times 6\text{msec} = 9\text{msec}$. Better to take it as 10msec. This time is response time once the wave is transmitted. Time to transmit the wave is 1/10 of 10msec, i.e. 1msec.

Finally we require ON time - 1 m sec and OFF time - 10 m sec. As mentioned 555 gives more ON time and less off time, therefore,

OFF time - 1 m sec and ON time - 10 m sec

$$11\text{msec} = 0.69 (R_a + 2R_b) C \quad (3)$$

Calculate the values taking $C = 0.1 \mu\text{F}$

Finally, output of the 555(2) is inverted using 4049 IC. We have specifically selected CMOS IC so that we can operate at higher voltage levels i.e. 12V/15V. Output of 555(1) and Output of Inverter is ANDed together to get BURST signal. During ON time (1msec) we get 40 KHz pulses. For 10msec, we get LOW logic continuously. Within 1msec there will 40 pulses of 40 KHz frequency.

Now we are left with 5 inverters in the chip. Ultrasonic transducer operates on Piezoelectric principle [10] i.e. apply electrical signal and convert it to mechanical movement. In transducer, there is HORN kind structure that vibrates at 40 KHz frequency. The waves will be transmitted in air medium. The principle is fairly same as that of loud speaker.

To transmit the waves, we do transmit it with high power. Power means typically current quantity. Therefore inverters are used as buffer device (Boost the current). The final output of the inverter is fed to ultrasonic transmitter. The waves will be now transmitted.

C. Software- GPS receiver Module



Fig.3. GPS System Overview

GPS receivers are used for navigation, positioning, time dissemination, and other research. Receiver displays real time data, which is speed and position. To store this data it is transferred to RAM of ARM 11[8]. It is then transferred to PC using RS 232 protocol [10].

Here, HoluxGM-83 GPS module is used because of its high performance. It is the cheapest module in its class. Also it's a compact module and having Independent operation board. It has direct communication interface with computer and it Supports NMEA0183 v2.2 data protocol [6, 9].

This GPS module having following specifications:

- Receiver: 20 Channel , L1, Frequency, C/A Code,
- Accuracy: 10m without SA; 100m with SA
- Velocity: 0.6m/s
- Acquisition time: Better than 60 seconds
- Position update rate: Once per second
- Input Power: 9 to 18V DC
- Interface: 2 x RS 232C Port
- Output: NMEA 0183

This module has High speed signal acquisition using 1920 time / frequency search channels.It Built-in WAAS/EGNOS Demodulator.It has Low power consumption and Push-To-Fix mode.Also having an Optional Rechargeable battery for memory and RTC backup and for fast Time to First Fix (TTFF)[9].

1) Software Implementation:

This GPS allows 2 types of Programming i.e. Units Programming and NMEA Programming. We are using "NMEA Programming". Example of sentence:

\$GPGGA,1229.487,3723.2475,N,12158.3416,W,1,07,1.0,9.0,M,0000*1

TABLE I Identification String of NMEA Programming

Name	Byte	Definition	Description
Start byte	1	:	Start symbol of data package
Data package ID	1	0~9	Package ID is repeated from 0 to 9
System password	3	000~999	System Password
Terminal ID	4	0000~9999	Terminal ID
Position data	19	E00000000 0~ E18000000 0	E means east longitude, which is from 000° and 00.0000 min. to 180°and 00.0000 min.
UTC	6	Hhmmss	Greenwich Time (hour, minute, second)
Upload time rate	3	001~255(003)	Upload time interval = basic upload time / upload time rate
Alarm information	4	Xxxx	0 means OK; 1 means alarm
Stop byte	1	#	Stop symbol of data package

The NMEA standard is proprietary and expensive. The settable parameters and options available for setting in NMEA Programming are as follows:

In the MAIN MENU screen of the GPS, choice '2' is NMEA Programming, So the user presses numerical key 2.

On selecting the choice 2 on the main menu, the NMEA Programming String is displayed as shown below:

- a) The settable parameters and options available for setting in NMEA Programming are as follows:

TABLE II Different Parameters Used in NMEA Programming

Parameter	Purpose
NMEA STRING	One or more than one of the 10 strings
FREQUENCY	0 to 59 secs. Options-time between 2 successive strings
STATUS	Enable/Disable Options
REQUEST	Once/ Continuous Options

- b) On selecting the choice 2 on the main menu, the NMEA Programming String is displayed as shown below:

NMEA PROGRAMMING
NMEA: GPZDA
FREQUENCY: 0
STATUS: ENABLE
REQUEST: ONCE

<ENT> to transmit <ESC> to return to the previous screen <UP ARROW> to scroll the options for item in the same field <DOWN ARROW> to move to the next field

D. Software Integration of GSM Modem

GSM is a Digital cellular network or wireless network. Over 200 GSM networks are operational in 160 countries around the world. The service will ultimately have more than 400 base stations for the palm-sized handsets that are being made by Ericsson, Motorola, and Nokia. GSM provides a high degree of security. GSM users can send and receive data, at rates up to 9600 bps. This data is used to transmit the vehicle position information.

Mobile phone is easy to use and It is less expensive. Here, Sony Ericsson mobile handset model no. T610 is used. Communication Link: 900/1800 MHz GSM modem. The S.E. T610 module can be driven via the serial interfacing using the set of standard AT commands. 8 simultaneous calls on the same 200 kHz wide communication band at speeds up to 9.6kb/s. It uses a bi-directional SMS for up to 160 byte.

- a) Select AT commands required for SMS transmission are as follows:

AT+CSCA Set the SMS center address. Mobile-originated messages transmitted through this service center.

AT+CMGS Send short message to the SMS center

AT+CMGR Read one message from the SIM card storage

AT+CMGD Delete a message from the SIM card storage

AT+CMGF Select format for incoming and outgoing messages: zero for PDU mode, one for Text mode

AT+CSMP Set additional parameters for Text mode messages

- b) How to use Microsoft Hyper Terminal to send AT commands to a Mobile phone or GSM Modem

AT
OK
AT+CMGF=1
OK
AT+CMGW="+85291234567"
>A simple demo of SMS text messaging
+CMGW:1
OK
AT+CMSS=1
+CMSS:20
OK

E. Project Specifications

- a) Vehicle Tracking System Specifications

Tracking Accuracy : 15 m..
Communication Link: 900/1800 MHz GSM modem.
Position Update Rate: User Programmable (15sec to 24hr)

- b) Hardware Specifications

Operating Voltage: 12V–28V DC. Standard 12V automotive battery ideally suited.
Power consumption: Peak Power Consumption: 3W.
Standby Power Consumption: Less than 250mW.
Operating Temperature range: -10 to +55 degrees C.

Results

The Experiments were done for the Hardware testing of Ultrasonic circuit and software implementation of GPS, GSM Module. The results of experiment for Ultrasonic circuit were seen on CRO and it gave the same output as shown in fig. Similarly, GPS module was tested and ARM 11 can be able to send GPS data periodically to the control station. Also it should be able to respond to commands issued to it via the GSM link and support GPS data logging feature. The information is sent to control station within 15 seconds.

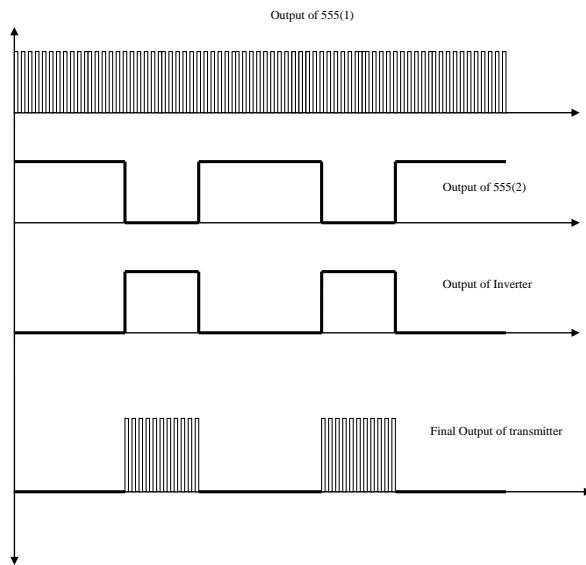


Fig.4. Hardware testing Results of Ultrasonic Circuit

Conclusion

This Advance Safety System is used minimize the rate of accidents and improves the performance of vehicle. This System can be implemented in any vehicle. ARM 11 is used because of its higher speed and to low cost. The device can be able to send GPS data and Sensor's output periodically with high speed. The system can be tested in real world application using vehicles. Embedded- C language has been used for the software implementation of this System. ARM11 analysis performed for longer-term time windows give an opportunity to develop human-centric systems which are capable of recognizing the context/maneuver and detecting distraction/abnormalities. Multimodal features can be used to prevent vehicle accidents. In our future work, the proposed model will be improved and several driver behavior, performance and characteristics will be linked.

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