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Accident Avoidance System using CAN

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Abstract

Advancement in technologies to have a great vehicular experience safety system is very essential in automobiles. Accident can occur anywhere anytime hence there is a need to save human lives from an accident by detecting a mishap before it happens. As traffic hazards and road accidents are increasing day by day it causes huge loss of life and property because of the poor emergency facilities. The paper is aimed in advancements in cars for making it more interactive and intelligent for avoiding accidents on roads. As an improvement to safety systems a multi-sensor, control Area Network (CAN) based system is interfaced with Engine Control Unit (ECU) using ARM-7 microcontroller. In order to prevent from accidents different sensors are used to observe fatigue levels of driver, pulse rate, alcohol level, obstacle detection and also sudden collisions. Global positioning system, GSM and CAN technologies for faster communications make the system completely reliable, safe, and stable and it attains the expected result of real-time analysis of data very effectively to provide a safer drive.

Keywords: Accident, Automobile, CAN, Embedded Systems, Electronic, Sensor, Global Positioning System, GSM

1. Introduction

Safety and comfort are essential things during the design of an automobile. As the no. of vehicles are increasing, the rate of accidents are also increasing day by day. Therefore manufacturers necessarily require a monitoring system in the vehicle that helps to avoid accidents and to prevent the life of driver. The main purpose of an accident avoidance system is to reduce the chances of collision and continuous monitoring of the health parameters of driver and also the vehicle environment. Speeding, drunk driving, sudden fall of pulse rate and seat belt adjustments all lead to accidents. Mostly accidents occur due to driver's carelessness and also the cases of drunken driving. If there is a sudden fall in the pulse rate, the driver may become unconscious. Alcohol detection, heart pulse rate monitoring systems, obstacle detection and early collision detection are used to reduce the frequency of accidents. In this paper we proposed a low cost, efficient system that can help in monitoring sensor data. This device is basically based on ARM-7 TDMI system which is the heart of this project that controls all heartbeat sensor, vibration detection sensor, alcohol detection sensor, ultrasonic sensor are used. These sensed data are transferred to the controller in the form of packet frames and by using GSM/GPS and public mobile network services all the information can be transferred to web server and mobile phone.

Many systems are developed for sensor monitoring. Nowadays automobile companies are offering an inbuilt safety system. A real-time online safety prototype for controlling the speed of vehicle uses ARM microcontroller[1]. A report of Myanmar road accident shows accident causes[2]. An Arduino board based system works on hall-effect magnetic wheel revolution sensing. It is connected with main PIC microcontroller and Personal Computer. Real time result was displayed on C#. Graphical User Interface is exported to Microsoft Excel report[3]. A Raspberry-pi based system is based on image processing uses edge

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detection technique for tracking collision of vehicle[4]. A system with distance measurement is developed that continuously captures near by vehicles and using ultrasonic calculates the minimum distance for collision and alert the driver[5]. Field of obstacle detection has led to immense progress in the interaction between primary assurance systems and primary–secondary safety systems[6]. Three technologies used for large-range vehicle observation are computer vision[7], radar[8,9] and laser-scanner[10,11]. Use of multi sensors enhances the chances of understanding. To reduce deficiencies of sensors, numerous algorithms were proposed[12–14]. X-by-Wire system uses a low-level control layer for vehicle control[15,16]. One algorithm uses the vehicle dynamics for avoiding two vehicular accident[17], the information provided by a laser-scanner sensor in case of hazardous situation[18]. EEG, EKG-ECG based advanced system are still in research to develop highly efficient systems[19,20].

Here a system is proposed which automatically controls the speed of vehicle and stops engine when it requires to avoid collision.

The rest part of the paper is framed as follows-

Section 2 highlights the system requirements. Section 3 deals with proposed system. Section 4 provides results and future scopes and Section 5 gives conclusion.

2. System Requirements

To obtain the desired results we require a system which is reliable, secure and also efficient. The system requires compact package of hardware and software. It must fulfil the necessary qualities such as real-time continuous monitoring and exact statistic series. It needs to store the data to record the performance level. It provides 24/7 access and exact location map interface. It must support mobility and less power consumption.

2.1 Hardware Architecture

Proposed system uses sensors such asvibration sensor, alcohol detection sensor, ultrasonic, IR sensor, heartbeat detection sensor. This acquired analog data is transferred to the ARM Board which is the main controller of the system. The CAN controller connected with the ARM board in addition with SPI using UART ports, is interfaced with GPS/GSM modules. The components are as follows-

2.1.1 ARM7 TDMI

ARM7 TDMI is an advance RISC machine. It is a general purpose 32 bit microprocessor. It provides great help in embedded applications and developments. ARM board is a combination of FPGA and ASIC automation, reduces risks of SoC designs. It has not only high performance-32 bit ARM instruction set but high code density-16 bit Thumb reduce instruction set. It has 512k Flash memory and 32k+8k RAM Data memory. Figure 1 shows the ARM board with all pin configurations. This Von Neumann Load/Store architecture has characteristic single address and data bus for data and instruction. It contains 40-pin GPIO header, 2 USB connection ports, a click-in micro SD slot that inserts the card neatly into the board, a power jack and a reset button. It supports JTAG debugging, serial port communication ISP, low noise power input.

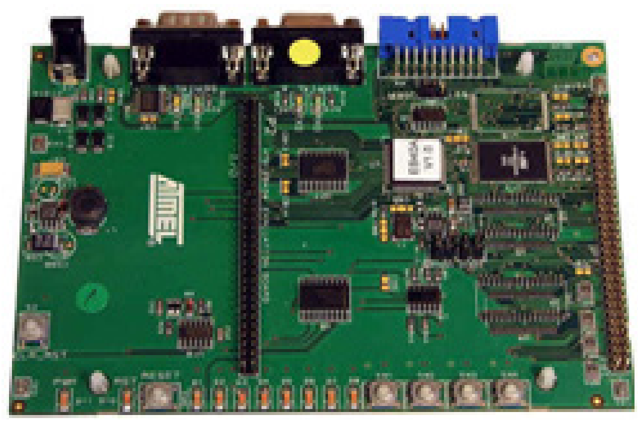

Figure 1. ARM7 TDMI board.

2.1.2 Sensors

2.1.2.1 Heart Beat Sensor

It monitors the pulse rate of driver. The Sensor senses the light level transmitted through the vascular tissue of the fingertip or the ear lobe and the corresponding variations in light intensities that occurs as the blood volume changes in the tissue. The sensor consists of a LED and a photodiode. When tissue is illuminated, some of the light is absorbed by the blood and the transmitted or the reflected light is received by the light detector. The detector output is in the form of electrical signal and is proportional to the heart beat rate.

2.1.2.2 Vibration Sensor

It is used to observe the collision of vehicle which is sensed due to vibration and shocks during accident. The piezoelectric sensor is used for flex, touch, vibration and shock measurement. Whenever a structure moves, it experiences acceleration. A piezoelectric shock sensor, in turn, can generate a charge when physically accelerated.

2.1.2.3 IR sensor

Infrared sensor emits to observe surrounding aspects. It is used for obstacle detection. An IR sensor measures the heat of an object and detects the motion as well. Usually in the infrared spectrum, all the objects radiate some form of thermal radiations. When IR light falls on the photo-diode, the resistances and these output voltages change in proportion to the magnitude of the IR light received.

2.1.2.4 Alcohol detection sensor

Drowsiness of driver can causes mishap evasion that can be a reason of death. MQ3 sensor with breath analyser is used here to check the liquor level.

2.1.2.5 Ultrasonic sensor

It is used to detect the distances from obstacles thy collision can be avoided. It is based on the echolocation process. Transmitted sound waves bounced back and retrieved with some time difference that helps to calculate the distance.

2.1.3 GPS Module

The Global Positioning System (GPS) is a space based satellite navigation system that provides location and time information in all weather conditions, anywhere on or near the earth where there is an unobstructed line of sight to four or more GPS satellites. A GPS receiver calculates its position by precisely timing the signals sent by GPS satellites high above the Earth.

In Figure 2 GPS data payload frame shows longitude and latitude it helps to detect exact location of vehicle including date and time.

It uses the ranging technique to determine the location of vehicle. GPS module has POT ceramic antenna that enables GPS navigations to track the object with high sensitivity. TTL serial protocol is used to communicate with microcontroller.

2.1.4 GSM Module

Global system for mobile communication service is used for transmission of the sensor and location value over a 2G or 3G cellular services of public network. Here we used SIM900 GSM module. It supports TCP/IP features such as FTP, E-mail, SMS, SMTP. It uses RS-232 to communicate with ARM board.

2.1.5 Control Area Network

Controller Area Network (CAN) is introduced by Robert Bosch. It is a multi-master asynchronous, serial communication protocol that is used to connect actuators and sensors, electronic control modules in the automotive and industrial applications. CAN is a single wire peer to peer communication network. All nodes have equal priority. When a CAN device is ready to transmit data, it checks the bus status if the bus is busy it writes a CAN frame for the network. The transmitted CAN frame neither contains address of transmitting node nor next receiving nodes but an unique arbitration ID depend on which each node of the network decides to accept CAN frame. If at the same time many nodes try to transmit onto the CAN bus according to the priority highest priority gets the access first. In Figure 3. CAN frame structure

Unit id	**server IP address**	**port#**	**Time**	**Date**
Latitude	**Longitude**	**Collision status**	-	-

Figure 2. Data payload.

Start of frame	Arbitration field	Control field	Data Field	CRC	ACK	End of frame

Figure 3. CAN data frame.

is shown, it supports 8-12 bits data field with arbitrary and CRC bits to protect the data.

Features of CAN controller

- Implements CAN V2.0B at 1Mb/s (ISO11898-1).
- Masks and filters to filter out unwanted messages.
- Two receive buffers and Three transmit buffers.
- High speed SPI™ interface (10 MHz) Low voltage operation (2.7 V – 5.5 V).
- One shot mode to ensure a message transmission is only attempted once.
- Start-of-Frame (SOF) signal pin to detect CAN start-of-frame.
- Data byte filtering of the first two data bytes.

2.1.6 CAN Transceiver

The CAN transceiver follows ISO-11898-2 AND ISO11898-5 standard physical layer requirement. It has two tasks:

Receiving: It acquires signals from the bus to signal levels that the CAN Controller demands and it has protective circuitry that save the CAN Controller.

Sending: It converts the transmit-bit signal retrieved from the CAN Controller into a signal which has sent onto the bus.

2.2 Software Requirements

Here ARM7 TDMI controller works with different software such as Keil, Flash magic and needs proper Ethernet connection using DHCP server that provides the IP address on which our system works. It uses embedded system programing to execute the program.

2.2.1 KEIL

Keil is a serial console, it provides Integrated Development Environment (IDE) for microprocessors. It is a free and open-sourceterminal emulator and network file transfer application. It helps in different embedded application by translating high level language source code to object code. It has project manager, simulator, debugger, cross compiler, assembler, linker. It supports user for easy program execution for the systems.

3. Proposed System

An automobile needs a safety system. In the proposed system ARM7 TDMI is used. This microcontroller is interfaced with sensors, GSM, GPS and CAN controller and transceivers. This system is employed in the vehicle. All the sensors are attached with the steering of vehicle and connected to the power switch. Fig 4 shows block diagram of system. When power is given to the system all sensors get activated, driver needs to breath out in the breath analyser that has alcohol detection sensor. In Figure 5 alcohol sensor checks the alcohol level in the body, if the alcohol level is above the threshold then controller stops the ignition system. Heart beat sensor's clip can be attached to finger or earlobe of driver and it monitors the pulse rate of driver continuously if the pulse rate is abnormal then engine automatically slows down. Figure 6 has pulse rate monitoring system shows vehicle control during abnormal condition. When SMS is received by owner, ignition can be stopped by giving an interrupt message. IR sensor detects obstacles on the way that can cause accidents. It observes the lane change of the vehicle. Ultrasonic sensor is used to measure the distance between the two vehicles, if this distance is less than a certain range than it sends a warning message on dashboard. All the sensor values display on display board LCD according to the priority assigned to sensor by CAN. Vibration sensor has assigned highest priority, it is used to sense the collision, when car is hit or collide with any other vehicle or other obstacle than GSM interfaced with

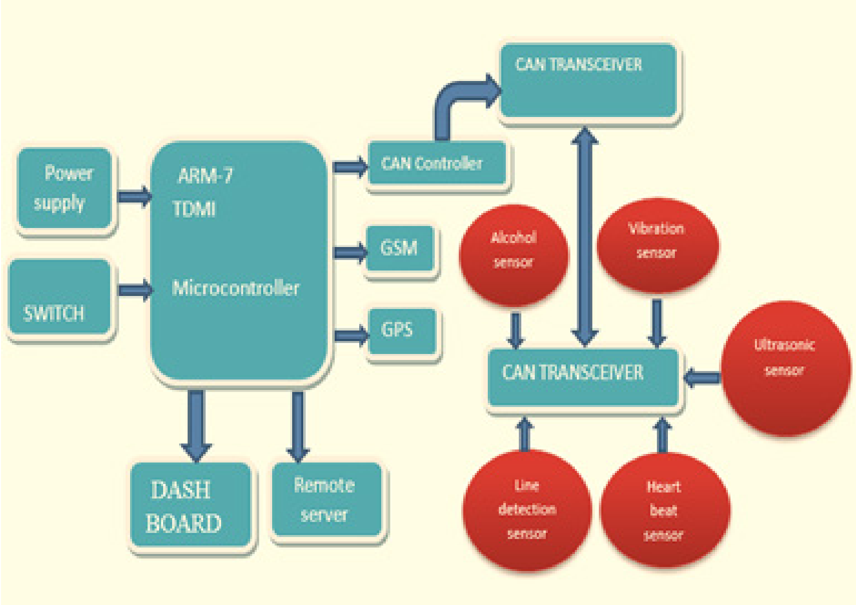

Figure 4. Block diagram.

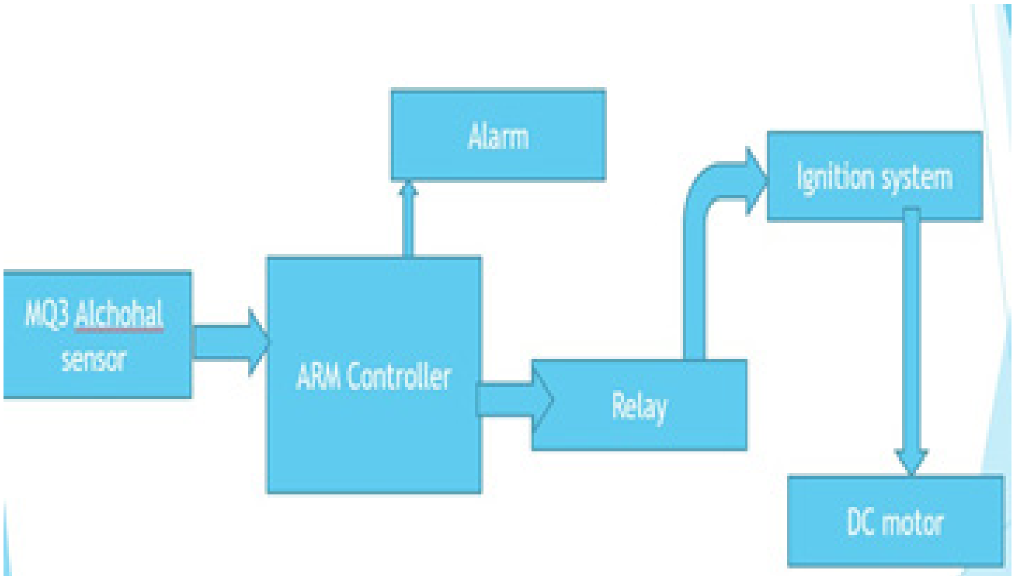

Figure 5. Alcohol sensor.

microcontroller gets activated and it sends the message to hospital or pre recorded number on the GSM.

Sensor values are recorded in form of a data log that can be transferred to a server, from where manufacture can collect the data for future advancement perspective.

Here CAN controller is used to provide the priority to tasks of sensors and to enhance the quality of transmission using CAN transceiver. CAN has high speed rate of 1MB/sec and for industrial application 3.2Mb/sec is used. Hence this system helps to reduce the accident chances.

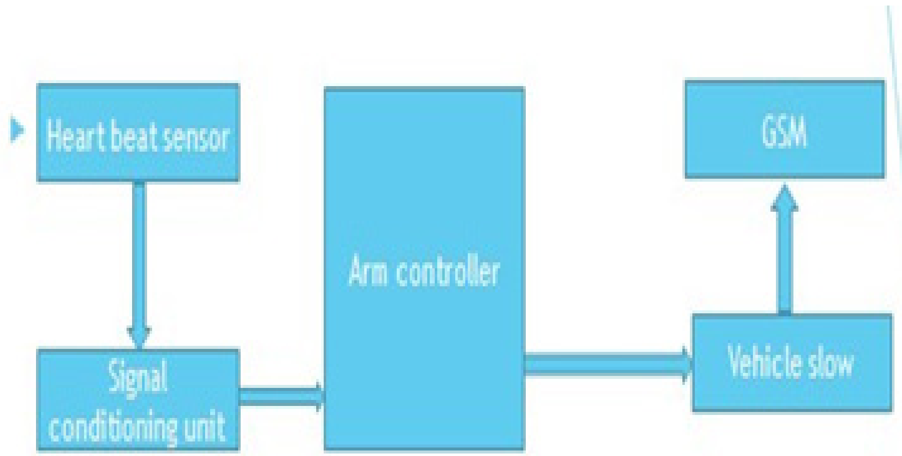

Figure 6. Pulse rate sensor.

4. Experimented Results

Proposed idea is tested with ARM7 TDMI. At different time instants sensor gives different values. Microcontroller responds very fast with the help of CAN controller. System sends the information about the accident or collision to the respected place through SMS. And controls vehicle in case of drunken drive or for abnormal pulse rate. Figure 7 shows multi-sensor hardware arrangement with CAN bus.

When shock, vibrations, alcohol is observed in the vehicle or any distant obstacle is detected with which collision can be possible, warning messages display on the dash board and SMS also delivered to the owner for prevention. Figure 8 shows sensors outputs.

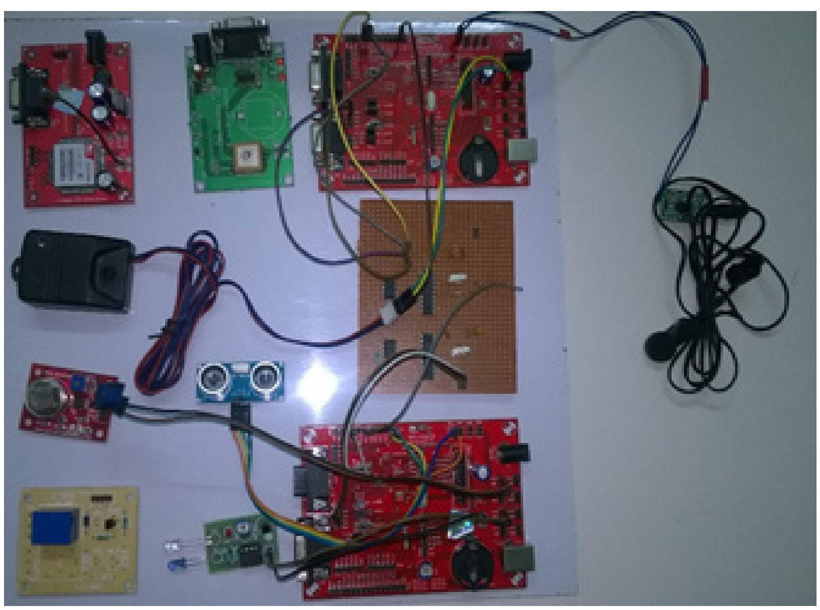

Figure 7. Basic circuit.

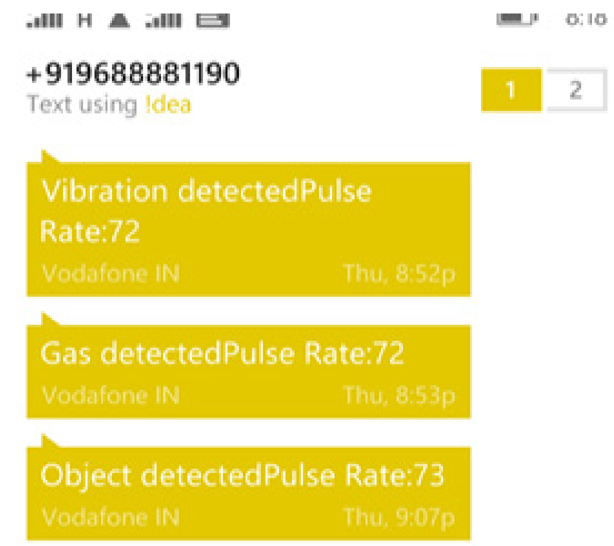

Figure 8. Sensor outputs.

Figure 9 shows the cordinates of vehicle. If any time vehicle collide with any obstacle, vibration sensor gets activated and detects vehicles exact location using GPS and sends the cordinates of location through SMS to the owner.

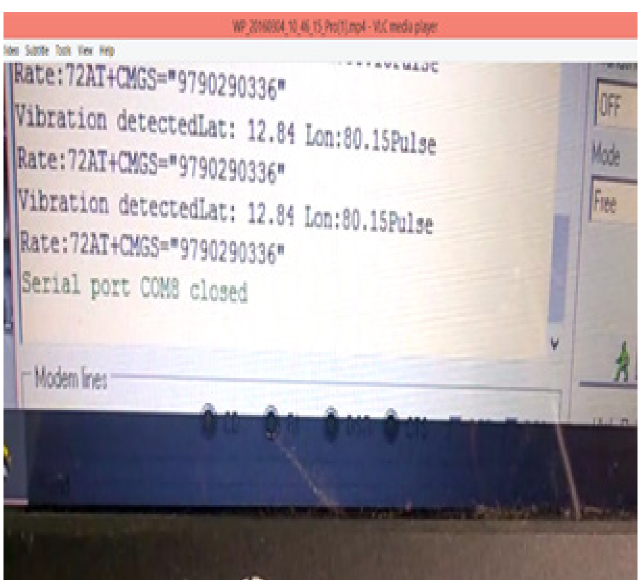

Figure 9. Vehicle location detection.

5. Conclusion

In this paper a sensor based accident avoidance system has been proposed. Design is developed using wireless system. System is designed, implemented and tested for vehicle safety. Many works have to be done to improve the performance such as power consumption during detection of sensors. The result and analysis of this practical experiment shows expected output and guaranteeing safety of driver and obstacles such as pedestrians, other vehicles and health monitoring. It supports a cost effective system to provide modest, flexible and compact single Soc. This design has many more future possibilities to make safety system more advance and efficient.

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