

**International Journal of Innovative Research in Science,
Engineering and Technology**

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Special Issue 6, May 2015

Design of a New Intelligent Vehicle System using Multifarious Sensors with Microcontroller

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ABSTRACT: There are large number of road accidents occur due to a loss of control on vehicle by the driver. And other factors are also influencing the road accidents such as (i) loss of friction between tire and road, (ii) loss of control in steering and (iii) obstacles crossed in front of the vehicle. Many of these accidents could be avoided by embedding Advanced Driver Assistance Systems (ADAS) in a vehicle. Motivated by the above fact, this paper introduces a method to combine ultrasonic sensor, yaw rate sensor, and steering angle sensor into the ADAS to reduce the road accidents. The above mentioned sensors are embedded and can be controlled using Peripheral Interface Controller (PIC) micro controller. By incorporating all the devices in this ADAS, most of the accidents can be prevented and also can save the human lives. This configuration simulated using Proteus software and to be tested using hardware for real time implementation.

KEYWORDS: Advanced Driver assistance Systems, Objects in front of the vehicle Steering fault, Tire-Road friction.

I. INTRODUCTION

Many traffic-safety related investigations claim that there is a correlation between the road condition and the number of accidents. An internal study at Volvo Cars claim that 15 % of all accidents occur owing to low tire-to-road friction. This is to be avoided by introducing many systems like Anti-lock Brake Systems (ABSs), collision avoidance systems, Advanced Driver Assistance Systems (ADAS). Among these systems ADAS is mainly used in this paper to reduce the road accidents. For that, ADAS is utilising the combination of three sensors like ultrasonic sensor, yaw rate sensor, and steering angle sensor. The above mentioned sensors are used to detect (i) The obstacles crossed in front of the vehicle (ii) Friction between the tire and road (iii) Steering fault respectively. The combination of three sensors which are controlled by one PIC microcontroller is producing an appropriate and effective result compared to the other systems.

This paper organised as follows. Section I describes the road friction and their related work, section II describes the car accidents caused by steering fault, section III describes the vehicle accidents due to obstacles crossed in front of the vehicle, section IV explains the Proposed system, section V explains an experimental results, section VI deals with the conclusion.

A. Road Friction

Friction is defined as the force between two objects as they move over one another such as the surface and car's tire which it is travelling on. Two types of friction: (1) Static (2) kinetic

An object can move from one surface to another surface static friction is required. To keep the object in motion kinetic force is required. When a car moving the tires does not need great force to keep moving. This value is known as the friction coefficient, it is used to shows how much "stickiness" is between the two objects. The frictional force is

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measured as the friction coefficient multiplied by the normal force. The normal force is defined as the force of the bottom surface (like road) pushing up on the other object (like car) as the first object (car tires) pushes down on it.

When the wind gets up there is more chance of falling trees, branches and rubble on the roads. It is very difficult to avoid. Around 7% of accidents caused by improper maintenance of road. It is also dangerous and can puncture car tyres, and also cause further serious damage to car wheels.

In existing method, a Stochastic Model Predictive Control (SMPC) approach is used to model the driver steering skill [1], which effectively incorporates the random variations in the road friction and roughness. This method is then used to generate a steering command by minimization of a cost function, including the lateral path error and ease of driver control.

Changsun Ahn *et al* [2] described two methods based on the peak aligning torque and non linear least square approach to estimate the road friction coefficient. This paper utilize steering system, simple vehicle lateral dynamics and front tire dynamics.

J. Dakhllallah *et al* [4] described Extended Kalman Filter is used to measure vehicle's current status as well as road/tire interaction forces. Using longitudinal and lateral vehicle velocity sideslip angle can be estimated. From this, friction coefficient and the sideslip angle estimated and compared with the real measurements. The drawback of this system is, it can be used for four wheel vehicles only.

B. Vehicle accidents due to obstacles in front of the vehicle

Car accidents occurs when a vehicle collides with another vehicle, animal, other stationary object or utility pole. And also it results injury, vehicle damage, death and property damage.

Vehicle design, speed of operation, road design, road environment, driver skill and/or impairment, and driver behaviour, these factors contribute to the risk of collision. Worldwide, motor vehicle collisions lead to death and disability as well as financial costs to both society and the individuals involved.

O.M.H.Rehman *et al* [5] described a novel alert messages dissemination protocol based on vehicular ad hoc networks (VANETs) have strong potential in the reduction of high speed road traffic accidents. In an emergency situation alert messages can convey the warning messages to the vehicles. In this paper two protocols were used. First protocol is used to reduce the traffic accidents by providing a simulated evaluation of chain crash scenarios. Second protocol perform initial alert messages broadcasting in case of multiple cars collision.

C. Car accidents caused by steering fault

Actual steering failure is quite rare but would be very dangerous if it occurred while travelling on a busy road. Loss of Power steering failure is one of the main steering failure. If a hydraulic pipe is damaged, power steering could be lost gradually.

Another one steering defect is the mechanical steering linkage. If this occurs, the vehicle should stop otherwise slow down the vehicle and then skid to a halt, it is very safe. If steering failure does occur, try to remain calm and try to regain control of the car quickly to avoid a car accident.

S.D.Cairano *et al* [7] described Model Predictive Control (MPC) strategy used to coordinate the system which consists of active front steering and differential braking and piecewise affine (PWA) approximation used to

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defined the tire force characteristics. In a hybrid MPC strategy the PWA system is used as prediction model. Finally this paper tests high performance of the controller in different low friction surfaces.

II. PROPOSED SYSTEM

The proposed Advanced Driver Assistance System includes more features like detection of tire-road friction, steering movement and obstacles in front of the vehicle. Separate sensors are used for this purpose. All the sensors are monitored by microcontroller and also it is used to provide an intimation to the driver by alert system.

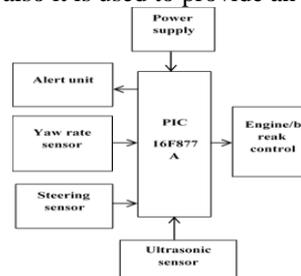


Fig. 1. Architecture of proposed system

System Architecture

The block diagram of proposed system is illustrated in fig. 1.

Working

This proposed system has many parts mainly PIC microcontroller act as a heart of this device. The sensors are connected to the microcontroller. If any sensor is in active state, they will give the intimation to the microcontroller. The microcontroller controls the break or engine. 12v power supply is given to the microcontroller.

Every block of proposed system is explained as below.

A. Microcontroller

A microcontroller is a small computer on a single integrated circuit consisting of a relatively simple CPU combined with support functions such as a crystal oscillator, timers, and watch dog timer, serial and analog I/O etc. There are many types of microcontroller, this paper uses PIC microcontroller for controlling the entire system.

B. PIC 16F877 Microcontroller

Peripheral Interface Controllers (PIC) is one of the advanced microcontrollers which is developed by microchip technologies. These controllers are more advanced than normal microcontroller like INTEL 8051.

PIC 16F877 is one of the most advanced microcontroller from Microchip. Because of its low price, wide range of applications, high quality, and ease of availability, this controller is widely used for experimental and modern applications. Main feature of this microcontroller is, it can be reprogrammable. The entire system controlled by this micro controller. All the sensors connected to the micro controller, based on the information given by the sensor the controller controls the vehicle. Power supply is 12v to the micro controller.

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C. Ultrasonic Sensor

This ultrasonic distance sensor provides stable and accurate distance measurements from 2cm to 450cm. It has an accuracy of 2mm and focus of less than 15 degrees. This sensor uses ultrasonic sound to measure distance just like bats and dolphins do. Ultrasonic sound has such a high pitch that humans cannot hear it. This particular sensor sends out an ultrasonic sound that has a frequency of about 40 kHz. Ultrasonic sensor has two main parts: a transducer that is used to create an ultrasonic sound and another one is used to listens for its echo. This sensor used to detect the object in front of the vehicle while the vehicle moving I any object is detected, it gives information to the controller unit. The controller unit controls the break or engine. Here, ultrasonic HC –sr04 sensor used for distance measurement up to 6m.

D. Yaw Rate Sensor

When the vehicle is moving, sometimes there is a loss of friction between the tire and road. In that time, yaw rate sensor is used to detect the vehicle's angular velocity around its vertical axis. If there is a friction between the tire and road, the sensor will transmit the information to the controller. Controller controls the break or engine. Here, Infinite G-35 yaw rate sensor is used for friction measurement.

E. Steering Sensor

Steering sensor is mounted on the steering shaft. It is mainly used to measure angle of steering wheel. Loss of control on steering can be estimated using this sensor. If any steering fault occurs, steering sensor intimates the micro controller and the controller control the break or engine.

III. EXPERIMENTAL RESULTS

The intelligent ADAS system is simulated using proteus ISIS-7 software. Proteus is design software developed by Lab center Electronics for electronic circuit simulation, PCB design and schematic capture. Its simplicity and user friendly design made it popular among electronics fanciers. Proteus is commonly used for digital simulations such as microprocessors and microcontrollers. As per the proposed system explained in section III, the devices are connected using Proteus software shown in figure2.

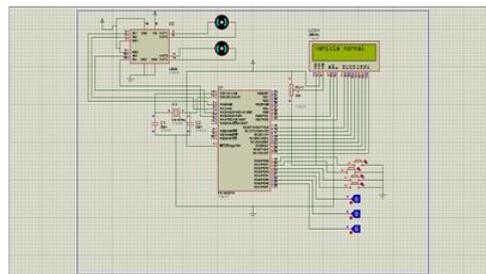


Fig. 2. Initial configuration

In the simulation, if steering angle sensor is in active state, the simulation is used to display the information to the driver like steering fault, engine stop through LCD, which is shown in figure 3.

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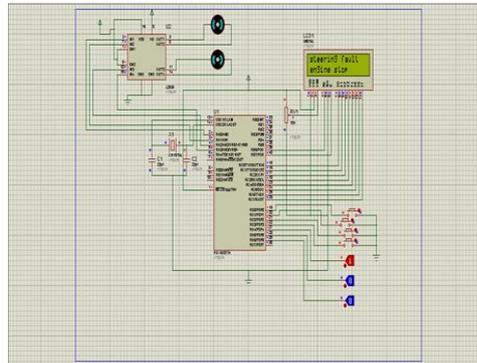


Fig. 3. Active state of steering angle sensor

If ultrasonic sensor is in active state means, the simulation is used to intimate the driver by sending an alert message through LCD. The alert message contains 'obstacle detected, engine stop'. This activity shown in figure 4.

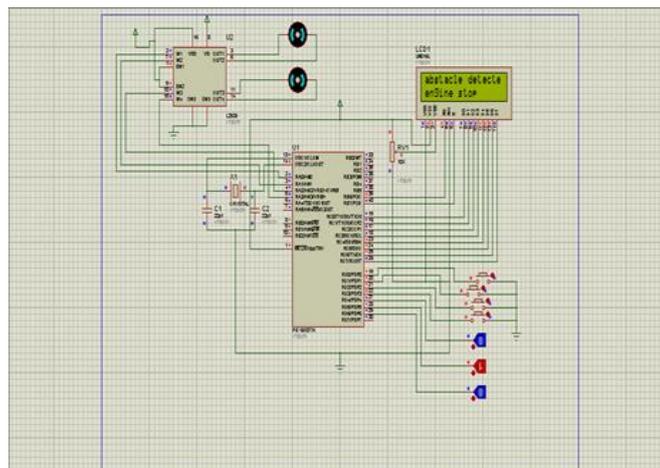


Fig. 4. Active state of Ultrasonic sensor

Finally, yaw rate sensor is in active state means, 'road friction, engine stop' message is displayed on the LCD screen. The activation of yaw rate sensor is shown in figure 5.

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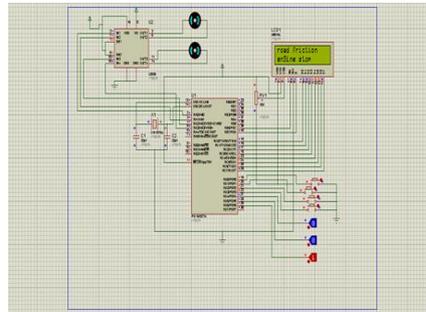


Fig. 5. Active state of Yaw rate sensor

After the simulation the respective program is embedded in to the microcontroller IC PIC16F877A using PIC programmer kit. The crystal oscillator of 20MHz frequency is connected to the microcontroller to generate required clock cycles. Microcontroller needs a power supply of 12V which is provided by means of battery. Hardware implementation is shown in figure 6.

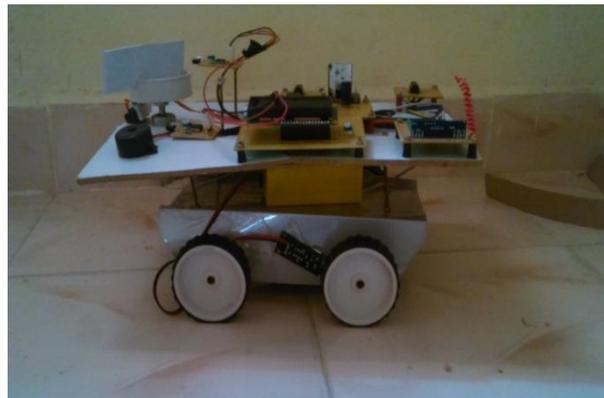


Fig. 6.a. Hardware implementation



Fig. 6.b. Hardware implementation

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IV. CONCLUSION

In general, there are many road accidents caused by road friction, steering fault and obstacles crossed in front of the vehicle. In order to minimize the road accidents this paper implements an Intelligent ADAS to detect tire-road friction information, obstacle crossed in front of the vehicle and abnormal steering conditions during normal driving. This system is simulated successfully by using Proteus and also implemented using hardware. From the simulation result, this system effectively detects the abnormal factors such as tire road friction, obstacles in front of the vehicle, steering condition to avoid road accidents.

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