*International Conference on Mechanical, Industrial and Materials Engineering 2015 (ICMIME2015)*
*11-13 December, 2015, RUET, Rajshahi, Bangladesh*

***Paper ID: AM-22***

# Identification of the location of any obstacle ahead of a running vehicle in a foggy and drowsy environment

Efat A. Haque[1], Jannatul J. Juthy[2] and Nirendra N. Mustafi[3]
[1,2,3]Department of Mechanical Engineering
Rajshahi University of Engineering & Technology, Rajshahi-6204, Bangladesh.
haque.efat@gmail.com

## Abstract

*The number of vehicle is increasing very fast worldwide and hence the occurrence of accidents is just following the trend. Many people are dying or becoming disabled in road accidents every day. Particularly in developing countries like Bangladesh, the scenario is really alarming. To decrease such unwanted road accidents is a declared target of modern Intelligent Transportation Systems. This paper illustrates a simpler approach to the avoidance of vehicle-vehicle collisions in a foggy and drowsy weather conditions. An intelligent system is planned to be developed using suitable sensors, named a Collision Warning System (CWS) for the drivers. The system will alert the driver in case of an impending collision to prevent or mitigate the crash. Ultrasonic sensors are selected to be used here, which can detect obstacles in a foggy and drowsy environment ahead of any running vehicle, and which can perform equally at day and night time in sensing the location of obstacles. The main purpose is of this work thus to design the systems and to test them in reality. The minimum distance that has to be maintained between vehicles in order to prevent an accident is determined by two second rule which is used worldwide. Whenever any obstacle or vehicle appears in front of the vehicle, the sensor will sense it and a speaker will alert the driver about its presence and let him know about an approximate location of the obstacle. The driver will then take the necessary safety measures to avoid the collision and will save the precious lives.*

Key Words: Vehicle, Collision, Obstacle detection, Intelligent Transportation System, Ultrasonic sensor.

## 1. Introduction

In the modern era, road accident has become a burning issue worldwide. Day by day the rate of occurrence of road accident is increasing rapidly. Being a populated country, the rate of occurrences of road accidents in Bangladesh is really alarming. Despite of taking different measures by the government, the rate is not reduced appreciably due to the careless driving by the drivers. According to the Bangladesh Police Headquarters (FIR) report BRTA publishes statistical data on road accident every year. Table 1 presents such statistical data for years 2007-2014 [11]. It is said that the prevention is better than cure. Detecting an obstacle ahead of any vehicle can avoid the collision and thus can save human lives. To execute this, an advanced precise obstacle detection aptitude is needed. Vehicles on road may face human, animals, or any obstacle ahead of them and the estimation of the distance is done by the drivers own eyes which may lead to an accident eventually. This paper intends to find a technique to reduce the rate of occurrences of road accidents by installing a kit that helps the driver to detect the location of the obstacles ahead of the vehicle accurately. It's a technology based collision decreasing process and quite practical. This system will help the driver to remain alert about the vehicle coming

**Table 1.** Statistical data on road accident [11]

| Year | Total accidents | Death | Injured | Total casualties |
|---|---|---|---|---|
| 2007 | 4869 | 3749 | 3273 | 7022 |
| 2008 | 4427 | 3765 | 3284 | 7049 |
| 2009 | 3381 | 2958 | 2686 | 5644 |
| 2010 | 2827 | 2646 | 1803 | 4449 |
| 2011 | 2667 | 2546 | 1641 | 4187 |
| 2012 | 2636 | 2538 | 2134 | 4672 |
| 2013 | 2029 | 1957 | 1396 | 3353 |
| 2014 | 2027 | 2067 | 1535 | 3602 |

from the opposite end. Many efforts have been tested to design such an intelligent system for vehicles application published in the literature. An intelligent over speeding sensor was used to sense obstacle to reduce crash between two wheelers. The sensor used in [1] was able to work at speed above 25 kmph. S.P. Bhumkar presented a model at [2] to avoid accident by detecting the symptoms of fatigue of driver and control the speed the vehicle accordingly. In [3, 5] a passive Infra Red sensor was used for detecting obstacles. When the system in [3] was unable to avoid accident, the location was tracked by using GSM (Global System for Mobile Communication). Several vision based vehicle detection systems were reviewed in [4]. Pre-crash detection system was designed by Md. Maminul Islam at [6] using IR sensor. It also contained relay to protect the car from battery ignition and buzzer for making noise to inform the surrounded people when accident occurred. Sungji Han presented a vision based vehicle detection system was developed and decided whether that the obstacle is vehicle or non-vehicle [7]. Ultrasonic and Infra Red sensor were used simultaneously in paper [8] and properties of surface are calculated according to Phong Illumination Model. The main function of Phong model is to estimate the reflectance properties of any surface illuminated from the points on a surface. The aim of this paper is to design and develop a reliable, efficient and realistic detecting process to detect the obstacles for reducing road crush. The ultrasonic sensor is used here as it is very cheap and efficient to use in daylight and in any situation of weather, even in rainy and foggy weather when the driver might not be able to see obstacle within in two meter ahead of the vehicle. Then this arrangement will let the driver know about the almost exact location of any obstacle within 11 meter. This sensor provides precise data about the location of obstacles that are reliable enough to resist road accident in case of low speed vehicles. The voice alert keeps the driver alert and alertness of driver act as the main key to avoid road accident. This arrangement may be a life saver in practical field of application avoiding road accident on the highway.

## 2. Estimation of safe distance for stopping the distance

When a driver observes any other vehicle coming from the opposite side he needs some time to think and move his feet to accelerator for braking paddle. Stopping distance is the sum of the reaction distance and braking distance.

$$D= V^2/2\mu g$$

This equation implies stopping distance but in this case it's independent of driver's reaction time. Here, co-efficient of friction $\mu$ is varied with the condition of road surface. For normal surface $\mu$ is normally 0.8 and for wet surface it's 0.4 to 0.5.This paper also considers two second rule to avoid accident to alert the driver if any vehicle comes inside the safe distance. Two second rule is used worldwide to run the vehicles on the highway to maintain safe distance. According to this rule the driver has to stay two seconds behind of a vehicle running ahead of driver's vehicle. This rule is applicable for any type of vehicle for any speed. The driver has to face difficulties to measure the exact safe distance to maintain while driving. Two second rule solves this problem and lets the driver to observe how much the vehicle in front is moving forward in two second. These calculated data for stopping distance and safe distance according to two second rule are shown in Table 2.

**Table 2.** Data for stopping distance [10] and safe distance [12]

| S.no. | Speed (km/h) | Stopping distance (good surface) M | Stopping distance (wet surface) m | Safe distance (m) |
|---|---|---|---|---|
| 1 | 80 | 31 | 63 | 44.44 |
| 2 | 70 | 24 | 48 | 38.88 |
| 3 | 60 | 17 | 35 | 33.2 |
| 4 | 50 | 12 | 24 | 27.76 |
| 5 | 40 | 7 | 15 | 22.22 |
| 6 | 30 | 4 | 8 | 16.66 |
| 7 | 20 | 2 | 4 | 11.1 |
| 8 | 10 | 0.5 | 1 | 5.54 |

## 3. Methodology

At first an ultrasonic sensor is selected for this project of suitable range to use on a medium speed (20 to 30km/h) vehicle. The circuit is designed in PROTEUS design suit and program is written in Bascom AVR. Then all the necessary components are set into a PCB board according to the circuit diagram. After that audio sounds that tell about the measured distance are recorded in an Mp3 player and attached with the system. This will give an audio signal whenever the sensor senses any obstacle on the road. Finally after completing all the set up, the system is tested practically. Thus the desired kit is ready to install in any vehicle.

### Block diagram of the system

The block diagram of the proposed system is presented in Fig.1.This diagram makes it possible to understand the whole procedure at a glance. A microcontroller controls the entire arrangement. Distance is measured by the sensor and this is displayed on the LCD screen by the help of microcontroller. The opto-couplers are used here for switching. Audio track is played according to distance shown in the LCD display. At the same time the driver hears the sound with the help of a speaker.

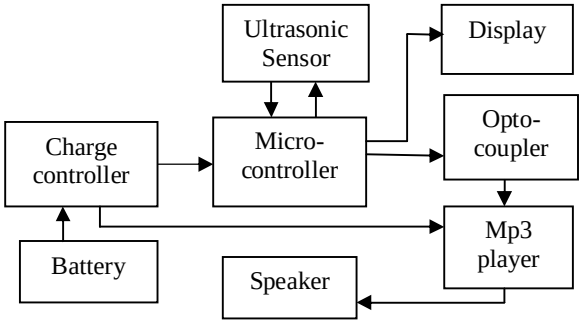


**Fig. 1.** Block diagram of the proposed system

### Hardware description

Microcontroller ATmega32 acts as the brain of this project. It's an 8-bit microcontroller which is highly flexible and cost effective. Microcontroller with advanced RISC architecture consisting 32x8 general purpose working resisters. It consists high endurance non- volatile memory segments with 32kbytes of in-system self programmable memory which is flash program type and 1024bytes EEPROM. It's operated on 2, 7V-5.5V (ATmega32L) and 4.5V-5.5V (ATmega32). It consumes 1.1mA in active mode and 0.35mA in idle mode and less than 1μA in power down mode. Fig. 2 shows the pin configuration of ATmega32.

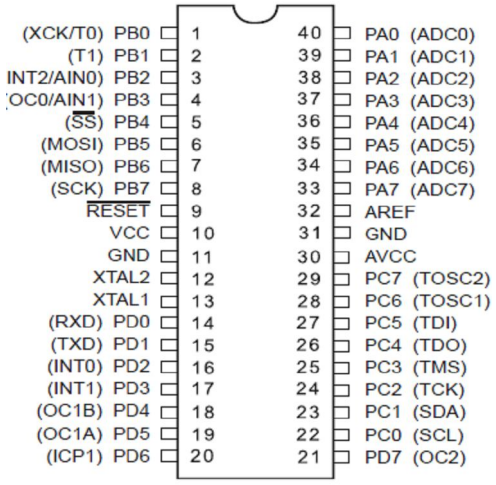


**Fig. 2.** Pin configuration of the microcontroller ATmega32 [9]

In this project an ultrasonic sensor US020 is used for measuring distance. The sensing range of this module is 11m. The static current of it is 3 mA. DC 5V power supply is needed to run it. This sensor emanates sound waves of high frequency which propagates at regular interval in the air. When this waves smack an obstacle, they are returned back as eco. For calculating the distance time interval between emitting the signal and receiving eco is measured by the microcontroller. Two regulators IC (Integrated circuit) 7805 and 7806 are used in this project .The main purpose of these regulator ICs are to carry on the accurate voltage from the power supply. In a circuit, the quantity of voltage from the source may swing and that's why fixed voltage supply may not be possible to maintain. This IC has three pins. Among them first one is input pin and third number is output pin. The name of middle pin is ground pin. The electronics semiconductor device named Opto-coupler PC817 is used here for transferring electrical signal within circuits. Through an optical transmission path it mainly connects two electrical detach circuits to keep them electrically isolated. Opto coupler can transfer electrical signal either digital or analogue. Along with microprocessor opto-coupler can be used for switching, signal isolation, pc communication and many other applications. In this project the opto-couplers are used for switching.

## 4. Experimental setup

Fig.3 represents the overall system arrangement. This circuit includes one ultrasonic sensor for detecting obstacles, one microcontroller ATmega32 to control the system, one LCD to show the measured distance and one Mp3 to give sound alert. An obstacle was kept at one meter distance, no.1 LED blinks, then the LCD displayed the measured distance as "1 met" and audio track from the Mp3 player is played accordingly. This procedure continues till the ultrasonic sensor gets any obstacle within the definite range of it.

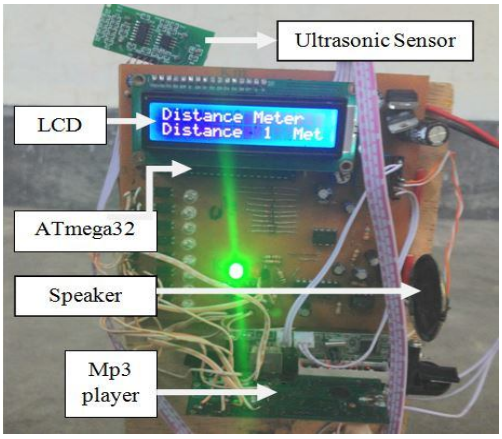


**Fig. 3.** Experimental setup of the system

The constructed circuit consists of one microcontroller ATmega32, one ultrasonic sensor, one LCD display (16*2), two regulator ICs, one charge controller, twenty two capacitors, and ten opto-couplers PC817. The entire circuit receives power to run from the vehicle battery via charge controller. The AN7805 is used to control the charge to the circuit and the AN7806 to the audio amplifier. The microcontroller contains the program to run the system. The program is written in Bascom AVR. At first all the pins used in this system are declared and mentioned which are for input and which are for output signal. Then the LCD part is described which controls the vision in the LCD monitor. After that the entire loop is described and according to the loop the pins become activate and inactive. The ultrasonic sensor throws a pulse of 40 kHz with the transmitter of the sensor, and then the receiver receives the eco of the transmitted ultrasound. The output of ultrasonic sensor is fed into the microcontroller as pulse in signal. The LCD monitor gets signal from the microcontroller and illustrate the distance measured by the sensor. The opto-couplers get signal from the microcontroller and work accordingly. When any obstacle is at 1 meter distance the first output pin of microcontroller becomes active while other pins remain inactive. Then the opto-coupler works and passes the signal to the Mp3 player where the 1$^{st}$ audio track is played and speaker make some sound which is amplified so that the driver of the vehicle can hear it. In the same procedure if the sensor senses any obstacle at 2 meter distance the 2$^{nd}$ pin becomes active and the first pin gets inactive so as the other pins on the microcontroller. Then 2$^{nd}$ audio track is played. The system works in the same way till the obstacle is within 11 meter. The circuit diagram of the system is shown in Fig. 4.

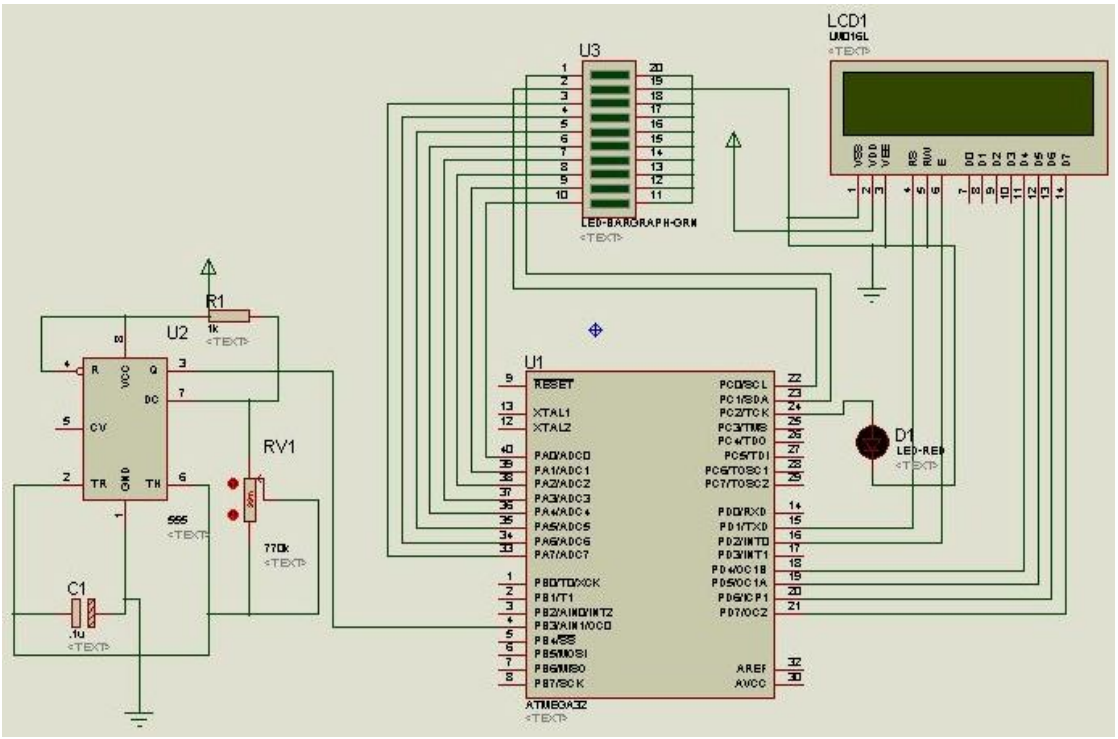


**Fig. 4.** Circuit diagram of the system

## 5. Results and discussion

At first the circuit was tested in stationary condition and then applied to a running vehicle. The constructed circuit performs well in both situations. The experimental data for stationary condition are accumulated in the Table 3. Deviations between the actual and displayed distance were noted during the tests. This is presented in the last column of the Table 3.

**Table 3.** Experimental data for stationary condition

| S.no. | Actual distance (m) | Measured distance (m) | % Error |
|---|---|---|---|
| 1 | 0.95 | 1 | 5.26 |
| 2 | 1.94 | 2 | 3.09 |
| 3 | 2.93 | 3 | 2.38 |
| 4 | 3.87 | 4 | 3.35 |
| 5 | 4.85 | 5 | 3.09 |
| 6 | 5.62 | 6 | 6.76 |
| 7 | 6.67 | 7 | 4.94 |
| 8 | 7.58 | 8 | 5.54 |
| 9 | 8.74 | 9 | 2.97 |
| 10 | 9.71 | 10 | 2.98 |
| 11 | 10.65 | 11 | 3.28 |

Fig. 5 shows the deviation between actual distance and measured distance graphically. The sensing range of ultrasonic sensor depends on some physical parameters such as temperature, external noise, shape of the surface and density or consistency of the material, humidity etc. By the effect of these factors measured values were deviated from the actual values in Table 3.

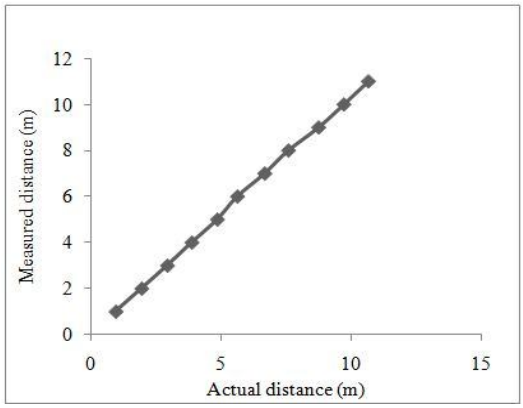


**Fig. 5.** Deviation between actual and measured distance

The results when the system was attached to a running vehicle are shown in Table 4. Fig.6 interprets the sensitivity of the system as a function of vehicle speed. It shows that the sensitivity decreased as the vehicle's speed increases.

**Table 4.** Experimental data for running condition

| S.no | Speed (km/h) | Sensing range (m) |
|---|---|---|
| 1 | 0 | 11 |
| 2 | 10 | 11 |
| 3 | 20 | 11 |
| 4 | 25 | 10 |
| 5 | 30 | 9 |
| 6 | 40 | 8 |
| 7 | 50 | 3 |

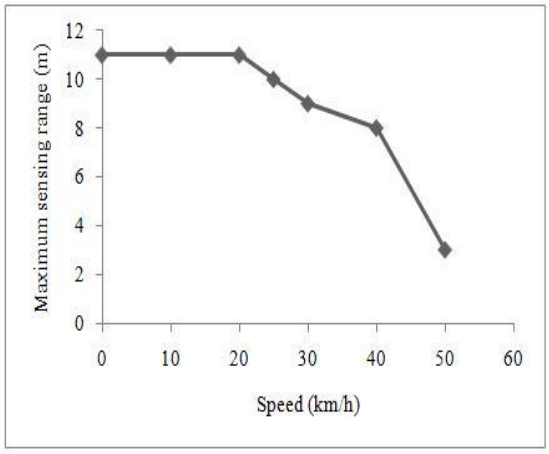


**Fig. 6.** Functionality of the system as a function of vehicle speed

After the system being applied on a running vehicle at a high speed, some errors took place in sensing obstacle at a long distance. It's been observed that the ultrasonic sensor used here can measure at its maximum range at 0-20 km/h and after that its sensing range decreases gradually.

## 6. Conclusions

After testing practically, it's confirmed that this project may be applied in vehicles running at low speed due to the range of the ultrasonic sensor used in this study. This system is applied to a local vehicle which normally

runs at a speed of 20 km/h – 30 km/h at busy roads. Considering safe distance and stopping distance, it's been seen that this system works successfully up to speed 20 km/h. In case of stopping distance the system works up to 45 km/h normal road surface and 35 km/h on wet road surface. Considering the speed of that vehicle, it's seen that this system is applicable for those types of vehicles which run at that speed on the highways. For further application on high speed vehicle, the sensor must be replaced with higher range ultrasonic sensor. The total cost of this project is approximately $35.32. This is quite economical to apply this system in practical field.

## 7. Future works

The limitations of the proposed system can be improved further in the following ways:

- High range ultrasonic sensor or possibly its amplification can be used so that it performs well for vehicles at high speeds.
- Despite of using the proposed system in a vehicle, a driver may not respond quickly in taking measures to avoid clashes. In this situation Auto Drive of the vehicle for a while after sensing the obstacle in front of it is quite important. That's why an Auto Drive system can be designed and integrated with this system to improve its reliability.

## 8. References


[1] Sonali.N, Maheswari.R, "An Intelligent Obstacle and Over Speeding Sensor to Prevent Dashing of Motorcycles", *International Journal of Soft Computing and Artificial Intelligence*, Vol.1, No.1, pp. 14-17, 2013.

[2] S.P. Bhumkar, V.V. Deotare, R.V.Babar, "Accident Avoidance and Detection on Highways", *International Journal of Engineering Trends and Technology*, Vol.3, No.2, pp. 247-252, 2012.

[3] Md.Khaled Hossain, Sayed Samial Haq, "Detection of Car Pre-Crash with Human, Avoidance System & Localizing through GSM", *International Journal of Scientific and Research Publications*, Vol.3, No.7, pp. 1-7, 2013.

[4] Zehang Sun, George Bebis, Ronald Miller, "On-Road Vehicle Detection: A Review'', *IEEE Transactions on Pattern Analysis and Machine Intelligence*, Vol.28, No.5, pp. 694-711, 2006.

[5] G. Benet, F. Blanes, J.E. Simo, P.Perez, "Using Infrared Sensors for Distance Measurement in Mobile Robots", *Robotics and Autonomous Systems*, Vol.40, No.4, pp. 255-266, 2002.

[6] Md. Maminul Islam, Md. Rabiul Hasan, Imran Chowdhury, Md. Towhid Chowdhury., "Internet of Car: Accident Sensing, Indication and Safety with Alert System", *American Journal of Engineering Research (AJER)*, Vol.2, No.10, pp. 92-99, 2013.

[7] Sungji Han, Youngjoon Han and Hernsoo Hahn, **"**Vehicle Detection Method using Haar-like Feature on Real Time System", *World Academy of Science, Engineering and Technology*, Vol.3, No. 11, pp. 375-379, 2009.

[8] Tarek Mohammad, "Using Ultrasonic and Infrared Sensors for Distance Measurement", *World Academy of Science, Engineering and Technology*, Vol.3, No.3, pp. 269-274, 2009.

[9] Atmega32 datasheet available at http://www.alldatasheet.com/datasheet-pdf/pdf/77378/ATMEL/ATMEGA32.html access in 9-15-2015.

[10] Vehicle stopping distance calculator available at http://www.csgnetwork.com/stopdistcalc.html access in 10-28-2015.

[11] Bangladesh Road Transport Authority- Road Safety available at http://www.brta.gov.bd/index.php/road-safety access in 9-15-2015.

[12] Two-second rule - Wikipedia, the free encyclopedia available at https://en.wikipedia.org/wiki/Two-second_rule access in 9-15-2015.