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SENSORS BASED VEHICLE CROWED SENSING IN BAD WEATHER CONDITIONS

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ABSTRACT

Bad weather and road traffic accidents are the main causes of vehicle losses and deaths. The degree of severity may be influenced by a number of factors. Various methods and techniques were tested with different distances, conditions and speed, to recognize the reaction of drivers in changing visibility in fog. On the basis of various types of fog generated on artificial and camera images, new algorithms have been proposed in recent studies for visibility improvement techniques. The core thing should be the development of operational fog detection and alarming system, with respect to speed and headway. Although the Advanced camera based driving assistance systems have the functionality in relieving the driver but they have drawbacks in terms of image quality, computation, working at night and with bad weather conditions. The proposed research contributes by analyzing existing work, detecting bad weather by measuring visibility distance, detecting moving or stationary vehicle on road in fog and providing alert to drivers in danger distance between vehicles and other objects using sensors.

Keywords: crowed sensing, fog, ultrasonic sensor, traffic congestion, bad weather.

INTRODUCTION

Crowed sensing, referred to as moveable crowd sensing, is a method where a number of individuals with mobile devices able to sense the objects, compute results, share data and obtain information to compute, analyse, map, approximate and predict any process.

Traffic congestion is a situation in transport that is characterized by slower and increased vehicles queuing. Traffic jamming on urban road networks has increased to a large extent in the recent past. When traffic demand is great enough, the communication between vehicles slows the speed of the traffic flow this results in some jamming.

Various problems like heavy traffic congestion and accidents have occurred on roads due to increase in number of vehicles. Due to these problems, the lives of peoples become in danger and also a lot of time is wasted. Bad weather conditions include fog, smog, smoke heavy rain and night time driving. It affects the daily life in many ways. Road accidents happen mostly due to poor weather conditions. Keeping vehicle distance is very difficult at the time of driving in poor weather conditions.

Every year hundreds of human beings get killed in vehicle collisions. A mainstream of these accidents take place when the visibility is low due to fog. Fog has affected many human activities like travelling and shipping. According to a survey, 10% of the traffic accident occur at night time and 3% accidents happen due to fog. Different countries like England, USA, India and Pakistan are facing fog problems. Pakistan is facing climate changes and one of them is fog. Complete record of accidents and number of people killed in accidents from 2009 to 2020 [1] is presented in Table-1.

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Table-1. Traffic accidents report.

Year	Total number of accidents	Accident		Persons		Total number of vehicles involved
		Fatal	Non-Fatal	Killed	Injured	
PAKISTAN						
2009-10	9747	4378	5369	5280	11173	10496
2010-11	9723	4280	5443	5271	11383	10822
2011-12	9140	3966	5174	4758	10145	9986
2012-13 *	8988	3884	5104	4719	9710	9876
2013-14*	8359	3500	4859	4348	9777	9423
2014-15*	7865	3214	4651	3954	9661	8949
2015-16*	9100	3591	5509	4448	11544	10636
2016-17*	9582	4036	5546	5047	12696	11317
2017-18	11121	4829	6292	5948	14489	13134
2018-19	10779	4878	5901	5932	13219	12908
2019-20	9701	4403	5298	5436	12317	12894
PUNJAB						
2009-10	5344	2590	2754	3083	5856	5344
2010-11	5420	2591	2829	3167	5809	5420
2011-12	4990	2361	2629	2888	5071	4990
2012-13	4587	2213	2374	2692	4515	4587
2013-14	3696	1717	1979	2145	3941	3696
2014-15	3054	1435	1619	1750	3652	3054
2015-16	3288	1576	1712	2053	4550	3288
2016-17	3819	1989	1830	2494	5231	3819
2017-18	5093	2708	2385	3371	6772	5093
2018-19	4823	2808	2015	3423	5916	4823
2019-20	4294	2471	1823	3102	5746	5498
SINDH						
2009-10	1465	883	582	1031	1261	1580
2010-11	1270	758	512	927	1071	1541
2011-12	1054	681	373	756	681	1121
2012-13	935	582	353	696	637	960
2013-14	945	613	332	791	893	1103
2014-15	881	583	298	771	863	1029
2015-16	924	634	290	749	754	1144
2016-17	880	608	272	786	970	1009
2017-18	848	586	262	802	838	1015
2018-19	972	620	352	725	829	1142
2019-20	858	572	286	741	741	1026
KHYBER PAKHTUNKHWA						
2009-10	2559	712	1847	921	3560	3128
2010-11	2722	773	1949	986	4153	3479
2011-12	2772	785	1987	953	3913	3501
2012-13	2968	846	2122	1059	4016	3736
2013-14	3120	877	2243	1033	4257	3934
2014-15	3399	942	2457	1137	4524	4260
2015-16	4287	1083	3204	1299	5527	5490
2016-17	4256	1103	3153	1317	5804	5736
2017-18	4425	1119	3306	1295	6093	6052
2018-19	4337	1097	3240	1318	5798	6062
2019-20	3891	997	2894	1186	5069	5487
BALOCHISTAN						
2009-10	379	193	186	245	496	444
2010-11	311	158	153	191	350	382
2011-12	324	139	185	161	480	374
2012-13	297	136	161	163	362	381
2013-14	342	173	169	247	480	434
2014-15	315	147	168	178	440	389
2015-16	357	178	179	207	504	470
2016-17	401	209	192	321	567	537
2017-18	496	259	237	313	624	715
2018-19	409	226	183	330	542	642
2019-20	469	252	217	289	640	694
ISLAMABAD						
2012-13	201	107	94	109	180	212
2013-14	256	120	136	132	206	256
2014-15	216	107	109	118	182	217
2015-16	244	120	124	140	209	244
2016-17	226	127	99	129	124	216
2017-18	259	157	102	167	162	259
2018-19	238	127	111	136	134	239
2019-20	189	111	78	118	121	189

*- Islamabad Included.

Source: Provincial Police Department (Crime Branch)& Islamabad.

Table-1. Yearly traffic accidents in Pakistan.

According to media reports from India, 11,090 people were killed in fog related incidents in 2017. The killing percentage was 100% greater with respect to 2014. In 2014, deaths due to fog were 5,886 and in 2015, 7665 people were killed in fog related accidents. In 2016, death rate increased by 20%. During the month of December and January, North India was among the highest number of accidents due to fog [2].

The objective of this research is to explore the factors which are affecting the travelling system. Fog is severe problem while travelling on roads. Accident location can be mapped based on based traffic accidents data. It can be determined that how speed limit and visibility in fog influence the traffic under different volume traffic. The main objectives of this study are to know about bad weather conditions, minimize the risk of collision in bad weather conditions like fog, rain and smoke for safety improving and optimizing traffic. It includes overcoming the drawbacks of additional professional equipment inherent in the previous approaches.

It will minimize the risks related to pedestrians on road. Information collected through vehicles can be used to enable various services like monitoring environment, management traffic system, safety and smart navigation.

RELATED WORK

The research on vehicle crowed sensing has been carried out from the last several years. Many researchers are contributing in this era for Safety improving in vehicular network. Different approaches like image based fog detection, Adaptive Gaussian threshold technique; Wavelet-based contrast estimation, Computer vision techniques and different machine learning techniques are used. However, these techniques have limitations such as many approaches are based on only daytime scenes. Some have drawbacks in terms of computational overhead, quality of image and work worse in bad lightning conditions or at night. In this section, literature related with techniques and experiments is presented.

There are some researches to sense the behaviour of vehicles. In some cases, fixed vehicle-mounted devices are used to observe the vehicle behaviour. Mobile eye application uses radars and cameras to provide the technical assistance for the auto companies [3]. Even though the expenditure of vehicle protection technology is decreasing, these technologies have not been installed in economy vehicles. There is still need of time to set up the safety technologies in vehicle. There are some mechanisms focusing on smart phone applications to support drivers. Applications involving web cameras are considered having relation between inter vehicle distance and communication speed in urban areas [4].

In [5, 6], techniques of collecting data from vehicles using double cameras on smart phones are introduced. One camera is used for noticing driver state and other camera is used for knowing road conditions. The system gathers the information on road surface and transfers it while moving by telephone. Sen Safe application framework is based on smart phone and it can easily install due to the common use of the smart phone. The main point in this framework is sensing the behaviour of vehicle. Non-vision sensors are used for the purpose of improving robustness and accuracy in vehicle sensing to minimize the effect of image quality and irregular driving behaviours.

Drivea [7], iOn Road [8], and Augmented Driving [9] are android applications having capabilities to detect lane exit and notify drivers when there is danger distance to the front vehicle. Camera based applications have the functionality in supporting the driver, they have drawbacks in terms of image quality, computational overhead and work worse at night with bad weather conditions.

For exact estimation of vehicle lines including mixture of video images and telemeter used for range finding was proposed in [10]. In this paper, static camera based system is used for night fog detection. This system relays on capturing image containing light source or specific high contrasted target. But this method can only useful in static way and cannot use in dynamic conditions like driving.

To measure the visibility on the road, Babari, 2012 and Hautiere *et al*., 2006 [11, 12] proposed techniques to use cameras for estimation of the visibility distance from moving vehicles. An advantage of a camera image for measurement of atmosphere extinction is that the image may give direct representation of what the driver actually can see. However, camera techniques require tough method of image processing for dependable visibility estimation, and this is main focus of the above cited studies. Hautière *et al*. (2006) expressed a photographic procedure for calculating the visibility in real time from a vehicle on the road [13]. They used a camera whose images are examines to identify the extreme object with a disparity above the 5 % threshold. The camera technique has also been used for stationary use. E. Debers and C. Busch [14] proposed a model to find out visibility in fog from image of inactive traffic management system. The objective of this research is to know the visibility distance in bad weather conditions from images taken by a video camera. They executed a wavelet based contrast measurements on images. The contrast is usually defined as $c = \frac{|Io-I_b|}{Io-I_b}$

Where I_o, is the object's intensity and I_b is the background's intensity.

Visibility range is obtained from the camera image. This approach relays on localized image features. Contrast also plays an important role in perception of movement, direction and speed. Because this approach is based on visual perception, visual system cannot correctly estimate the speed of object with low contrast and fog may effect in estimation of speed, distance and shape of an object. Furthermore, this approach is dependent on daylight illumination.

An approach about visibility range measurement in fog based on computer vision was proposed by Bronte [15]. A real time fog detection system using an on board camera for a driving application is presented in this paper. This technique contains two image regions, first one is sky and other is road. This technique introduces the vanishing point calculation. If disappearing point is in the upper sky area then fog exists. A point where two image regions touches, is current visibility range. Visibility range is calculated in meters. This approach is based on only daytime scenes. The problem with this technique is that the system discovers fog when it is not nearby. Sun shining effect is a big problem. This approach fails in foggy weather; series of long line vehicles come out in opposite lane.

The paper [16] "Techniques of Vehicle Detection in Fog" introduces the techniques to detect the vehicle in bad weather conditions like fog and smoke. Vehicle detection is important in foggy environment due to poor visibility traffic accidents and collisions happen. In this paper, Adaptive Gaussian threshold technique is used. Threshold value is weighted as addition of the neighbourhood pixels which formulate images clean and clear as compared to real image. In this method image received from camera is totally warped and unclear and will not apparent up to desire level so that front vehicle is clearly detectable.

METHODOLOGY AND EXPERIMENTATION

Optical fog sensor (OFS) is a low power consumption and less price sensor for visibility. The major application of OFS is for traffic use. Backscatter technique is used in OFS to determine the water particles in the atmosphere to measure the visibility. A thin red laser light ray appears from the front of OFS. A detector is fitted back of the lens that is sensitive for coming light into narrow lobe. The detector partly covers the transmitter ray. If the fog particles are detected in overlap area, then light will be spread back. It transmits the output of raw signals on sensor.

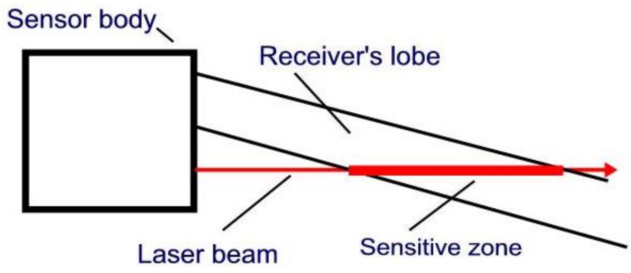

Figure-1. Working of OFS.

Sensitive zone is placed about 30cm forward of the sensor. Its volume is less than 1Ccm.

Object Detection and Distance Measuring Using Sensors

Ultrasonic Sensor

Ultrasonic sensors are those sensors which use ultrasonic waves to detect the object, auto measure distance between itself and the object. This sensor is used in many applications for measuring distance or object sensing where required. It has eyes like two projects in the front which make Ultrasonic transmitter and receiver. This sensor works with the simple formula that:
Distance = speed × Time

Ultrasonic Waves

Ultrasonic waves are those waves whose frequencies are behind normal hearing limit. It will be more than 20 KHz

Generation of Ultrasonic Waves

There is a vibrator in the Ultrasonic sensor which is oscillating at very high frequency that give rise to isolation waves.

Working of Ultrasonic Sensor

Ultrasonic sensor with Arduino is used to find the distance between front moving vehicle and vehicle equipped with Fog detection module. Its working is not disturbed by black material or sunlight. US sensors has two modules one for sender and other for receiver. It comes comprehensive with ultrasonic transmitter module and receiver module.

Figure-2. US sensor.

US sensor has four pins as shown in Figure-2. First pin is VCC pin which is used to power on the sensor. This pin given with usually 5V. Current consumed by this sensor is less than 15Am. So it can be powered easily with on board power supply Arduino Uno Board. Second pin is Triger pin. It is an input to sensor. We have to give short 10ms pulse to this pin to start ranging. After this the module images us wave impulse of 8 cycles at frequency of 40,000Hz. At the same time module make echo pin which is third pin high. Once waves are reflected by object and are observed by receiver, this echo pin goes slow. In other words, the duration of time during which echo pin stays high is equal to the total time taken by Ultrasonic waves to travel from transmitter to object and again from object to receiver. The echo pin stays high during wave propagation. Fourth pin is ground pin which is used to connect to Arduino ground. The transmitter emits ultrasonic waves at frequency 40 KHz and these waves travel through the air. When they are blocked by an object, these waves will get reflected and they are bounced back to sensor. The reflected waves are observed by the receiver module of US sensor. So the total time taken by ultrasonic waves to travel from transmitter of US sensor to object and again from object to receiver is given by the output of sensor. Distance between object and sensor is calculated by formula:

$\text{speed} = D/t$
$D = s \times t$
$\therefore S = 340$ m/s
T= time taken is given by sensor

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The broadcasting and reception time of the signal allows to determine the distance from sensor to object. To calculate distance using above formula, we should know the time and speed. The universal speed of US wave at room conditions is 340m/s. It will calculate the time taken for Ultrasonic wave to come back and turns back on echo pin for that same particular amount of time. So, to calculate the actual distance between sensor and the object we have to divide the product of speed and time by 2 because the same path will be travel by ultrasonic waves twice. Output of this echo pin is time duration in micro seconds. So we have to convert speed which is in seconds to microseconds.

Here speed is 340 m/s

$$S = \frac{340\text{m}}{\text{s}}$$

$$s = 340 \times 10^2 \text{cm/s}$$

$$s = 0.0340 \times 10^6 \text{cm/s}$$

$$s = 0.0340 \text{ cm/}\mu\text{s}$$

$$\text{So } D = s \times t/2$$

Both s and t are in micro second.

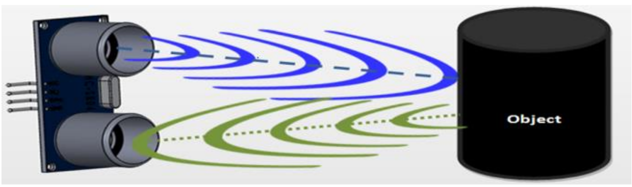

Figure-3. Distance calculation using ultrasonic sensor.

This distance will be used as input. If distance is less than the maximum set value, LED will glow and alert will appear on LCD. Working of US is shown by the flow chart below.

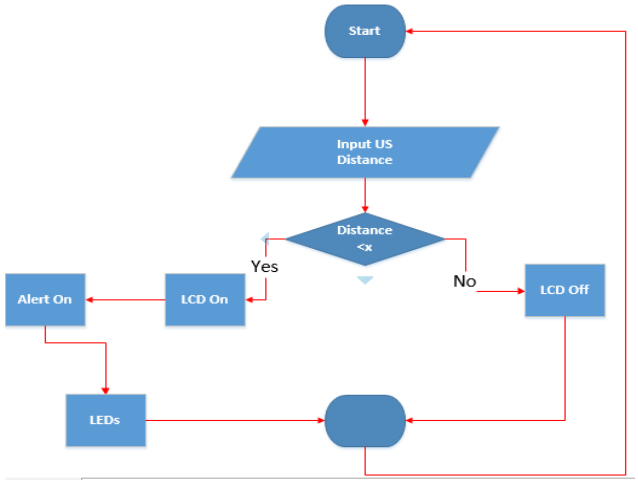

Figure-4. Flow chart for US sensor.

Sequence of activities performed in the whole process is shown in Figure-5. When module is powered on, the ultrasonic sensor will transmit the ultrasonic waves. If there is any object in the way of these waves, then waves bounced back to US sensor receiving end. After this action is performed according to the situation of distance between US sensor and object and user will get the response on LCD.

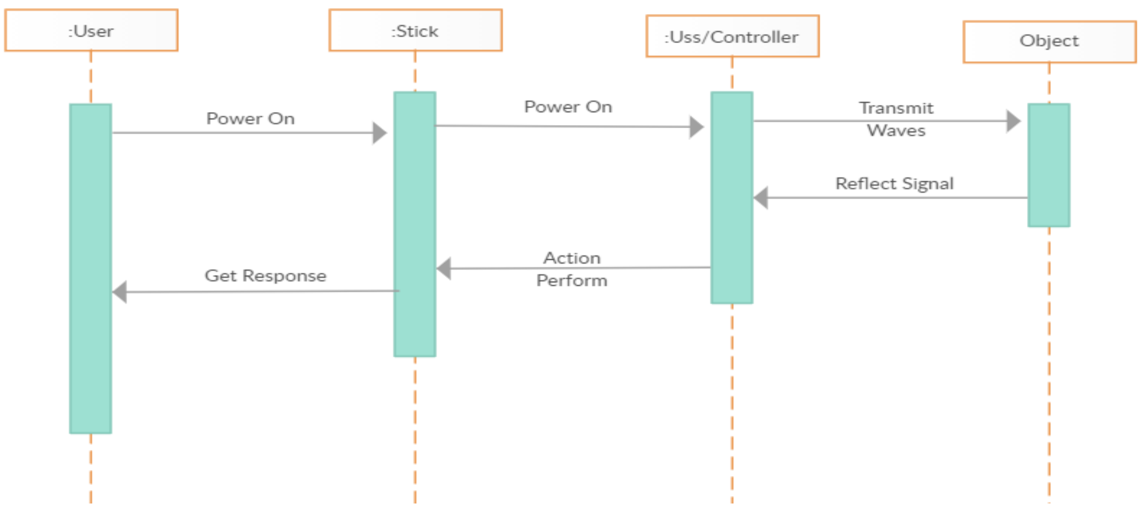

Figure-5. Sequence diagram for US sensor.

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Ultrasonic sensor and Arduino Uno Board are used as hardware in simulation. It is commonly used with both microprocessor and microcontroller. Features of US sensor are given in Table-2.

Table-2. Features of US sensors.

Model Name	HCSR04
Wavelength	75nm
Power Delivered	+5V DC
Operational current	15mA
Frequency	40kHz
Efficient angle	<15 degree
Calculating angle	30 degree
Pulse width of trigger input	10micro second

There is variety of controller and microprocessors in Arduino Board design. This board consists of USB connections, reset button, power jack, crystal oscillators and input/ output pins. Arduino Uno can power via external power supply or USB connection. The pin having supply less than 5V results instability in Arduino Uno. If more than 12V supply is used, the voltage regulator may damage the board on heating. The power pins in Arduino Uno are Vin, 5V, 3V and GND.

Software

Arduino IDE is open source software used for simulation. In this software code is written in C language.

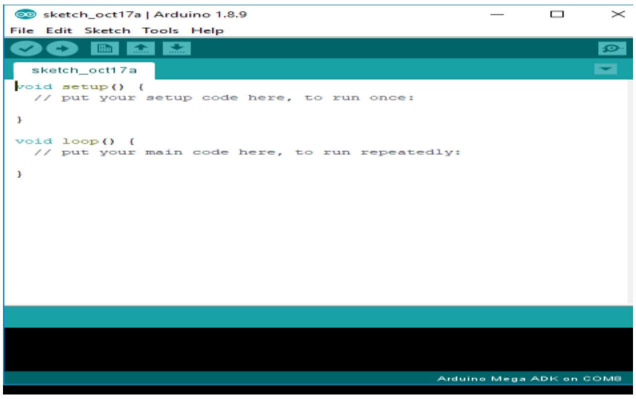

Figure-6. Sketch window for Arduino IDE.

The Figure-6 shows the sketch window used to write code for software. Header files are included in this sketch window. Code is compiled. In case of any error, it is corrected and corrected program is uploaded to Arduino Uno Board.

Implementation of Ultrasonic Sensor

The figure shows the block diagram in which the working of ultrasonic sensor with Arduino Uno Board is displayed. US sensor transmits the pulses of sound through trig pin to an object. When object is detected in the range of sensor, then pulse receives back through echo pin and transfer to Arduino Board. Algorithm is displayed to measure distance from sensor to obstacle. In the IDE software, Three LEDs are connected with Arduino having colours yellow, green and red. If there is no obstacle in front of sensor in given range, then yellow LED glows, that means there is no danger distance or there is no vehicle in danger distance.

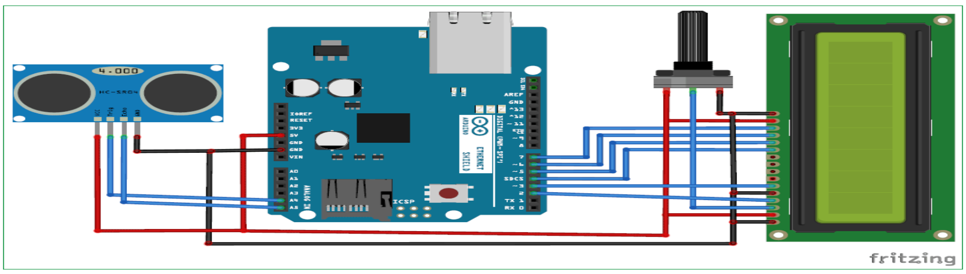

Figure-7. Circuit diagram of US.

Three parameters are set to detect vehicle at three different distance ranges depending upon the visibility distance in fog. If there is moderate fog and distance between front moving vehicle and vehicle equipped with vehicle detection module is greater than 200m, then green LED will glow and message “Normal, no issue” will be displayed on LCD. If there is dense fog with visibility 50 to 100m then yellow LED will glow with message “Caution! Look out” on Display unit. In very dense fog, visibility range is less than 50m and sometimes visibility is low up to 10m called zero visibility. In this situation if the distance between moving vehicles is less than 20m then red light will glow and the alert will be displayed on display unit with message “Stop! About to collide”.

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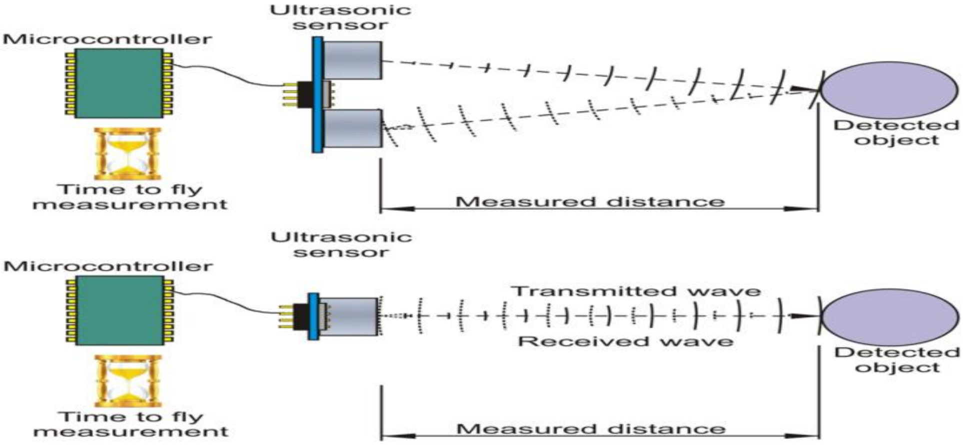

Figure-8. Working principal of US.

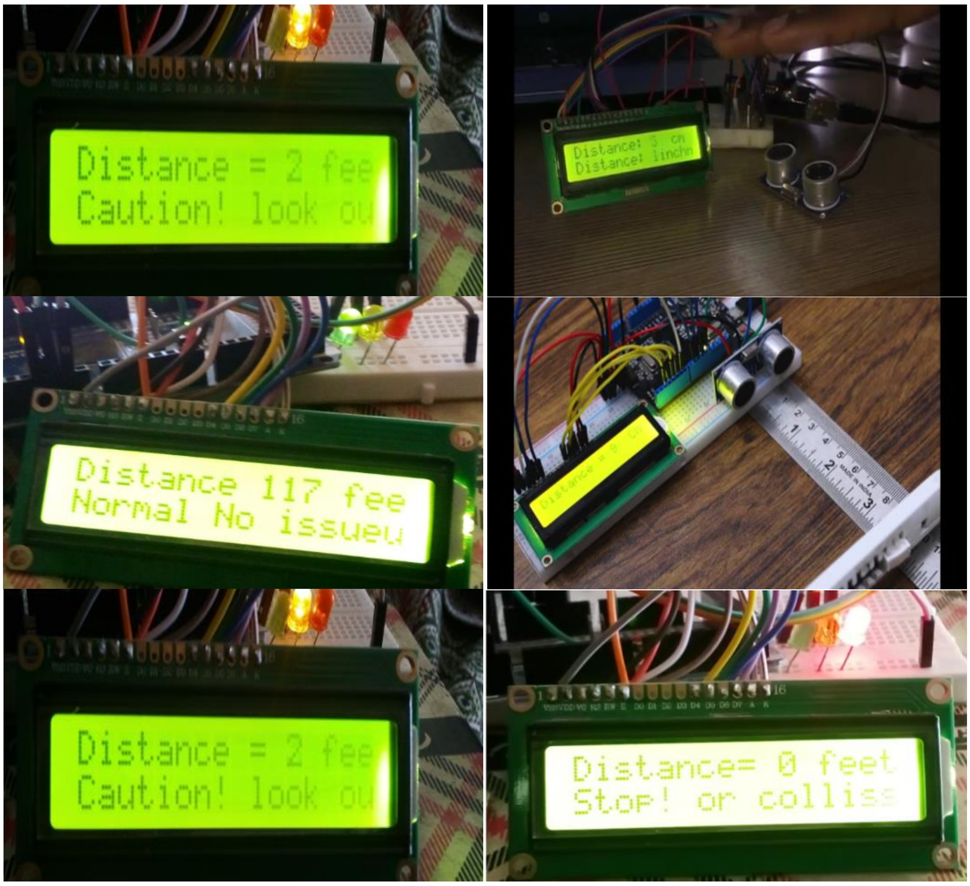

Figure-9. Simulation result.

CONCLUSION AND FUTURE WORK

This research concentrated on the analysis of two main problems, front vehicle detection problem and lane change in bad weather conditions. In case of vehicle crowed sensing, different levels of distance were set according to traffic volume. Distance levels were set according to visibility in fog, dense fog and very dense fog. Fog is an ordinary weather condition that may have great effect on visibility. Visibility has correlation with traffic conflicts and road safety. Different alerts were set with respect to visibility levels. The weather conditions and reduced visibility are natural phenomena and are uncontrollable factors. Traffic volume is also needed which cannot be reduced easily on the roads. Speed limit can be controlled in bad weather conditions to minimize the accidents rate. In this research, three distance level were set to study the safe distance between vehicles in bad weather conditions. In future, 4G and 5G based vehicle crowed sensing can be studied to observe the weather conditions and traffic volume in affected areas.

REFERENCES

[1] http://www.pbs.gov.pk/content/traffic-accidents-annual.

[2] Times of India, 7th January 2019, 13:28 by Tushar Kelshikar.

[3] Applications, http://www.mobileye.com/technology/applications/

[4] Toshiaki Nagai, Kiyoshi MIzui. May 2004. Society of Automotive Engineering of Japan. Institute of Electronics, Information, and Communication Engineers, Technical Report, ITS2004−4.

[5] C.-W. You, N. D. Lane, F. Chen *et al.* June 2013. Car Safe app: alerting drowsy and distracted drivers using dual cameras on smartphones. in Proceedings of the 11th Annual International Conference on Mobile Systems, Applications, and Services (MobiSys 13), pp. 13-26, ACM, Taipei, Taiwan.

[6] Hideki Sunahara, Keisuke Uehara, *et al*. 2002. IPCar: Building the Probe Car System with the Internet. The transactions of the Institute of Electronics, Information and Communication Engineers. B. 85(4): 431-437.

[7] Drivea-driving assistant app, https://play.google.com/store/apps/details?id=com.driveassist.experimental&hl=en.

[8] Turn Your Smartphone In to a Personal Driving Assistant, http://www.ionroad.com/.

[9] Augmented Driving, https://itunes.apple.com/us/app/augmented-driving/id366841514?mt=8.

[10] M. Kilpelainen, H. Summala. 2007. Effects of weather and weather forecasts on driver behaviour. Transportation Research Part F. 10: 288-299.

[11] Babari R. 2012. Estimation des conditions de visibilitéméteorologique par camérasroutières. Université Paris-Est.

[12] Hautière N., Tarel J.-P., Lavenant J. & Aubert D. 2006. Automatic fog detection and estimation of visibility distance through use of an onboard camera. Machine Vision and Applications, 17(1): 8-20. https://doi.org/10.1007/s00138-005-0011-1

[13] Hautière N., Tarel J.-P., Lavenant J. & Aubert D. 2006. Automatic fog detection and estimation of visibility distance through use of an onboard camera. Machine Vision and Applications, 17(1): 8-20. https://doi.org/10.1007/s00138-005-0011-1

[14] Bush C., Debes E. 1998. Wavelet transform for analyzing fog visibility. IEEE Intelligent Systems. 13(6): 66-71.

[15] S. Bronte, L. Bergasa and P. Alcantarilla. 2009. Fog detection system based on computer vision techniques. in Proc. IEEE Conf. Intell. Transp. Syst. Saint-Louis, MO, USA. pp. 1-6.

[16] Singh, Rahul, Someet Singh and Navjot Kaur. 2016. A Review: Techniques of vehicle detection in Fog. Indian Journal of Science and Technology 9.47.