Object Detection System for Vehicles in Fog Environment

Pallavi C[*], U. Aditya Karanth[*], Priya B[*], Ramya S[*], Dr. M. Devanathan[#]

[*] *Final Year, School of ECE, REVA University*

[#] *Assistant Professor, School of ECE, REVA University*

ABSTRACT

Detecting objects of interest and obtaining their clear visual appearances are critical requirements for visual surveillance systems. The weather condition is an important factor while considering an Advanced Driving Assistance System (ADAS). The presence of Fog makes almost impossible for the driving scenarios as it reduces visibility thus becomes a challenging and dangerous task for drivers. So detection of the object becomes a primary task for DAS in Foggy weather. Vehicle or object detection in fog is necessary as poor visibility is the major cause for collision of vehicle and fatalities. Ultrasonic Sensor, LiDAR and Microwave RADAR are used together for optimal performance and to aware the user about the object in advance.

Keywords: *ADAS, Fog, LiDAR, Sonar, Microwave radar, Visibility*

I. INTRODUCTION

Driving in bad weather condition seems to be impossible task as it reduces a visibility and Fogbeing one of the most difficult weather conditions that driver many people face. Fog has the potential to reduce visibility significantly, so it is critical that drivers stay focused on the road in order to stay safe. Sadly, Fog-related accidents cause more than 500 fatalities each year. Poor visibility of object or vehicles in Fog condition May leads to accidents, so identifying vehicle in Fog seems to be very important task to save many lives. The visibility range thereby describes the longest distance at which a black object of adequate size can be observed towards the horizon. In France 2011 it was estimated that 47% of total fatalities were caused due to night driving. Moreover, accidents rate in night is increases by a scaling factor of 1.7 as it is compared with day time. The main reasons for this are poor visibility, speed and drowsiness. To avoid this problem intensity of high-beam headlights is kept low in Fog, as Fog causes dispersion of light. So advancement has to be seen in this regard to automate the system and as well as to increase or maximize the visibility in bad weather.

Adverse effect of sensors weakness, particularly cameras made bad effect on the vision applications of the vehicle thus resulting in failure of ADAS. In particularly unfavourable conditions like fog or rain are major considerations. Firstly, theyaffect the safety of the driver by reducing his visibility. Secondly, they reduce the efficiency of camera based system as they change image quality thus making it inefficient. To ensure the self-sufficiency of the vehicles with more security the vehicle should have find and maintain a distance from vehicle in any ranges, during day and night.

This project major focus will be on the making the vehicle driving safer and self-governing.This framework is utilizing LiDAR for object detection and ranging using laser light pulses, Ultrasonic sensor and two Microwave RADAR’s which uses Doppler effect to produce velocity data about objects at a distance and to detect the motion of body movements. All of these sensors are grouped together for better performance. These sensors recognize the animal, vehicle, human and any of the objects and moreover it is indicated as notice to the driver.

II. RELATED WORK

Through research of a bunch of IEEE papers and a few other articles makes it evident that it is very important and it is used in practical applications. Results of an extensive literature research in the field of Autonomous Driving System enhancement with more emphasis on the use of Vehicle Detection System are presented.

2.1MIT researchers have come up with a system that can produce images of objects shrouded by Fog so thick that human vision can't see through it. It can also measure the objects distance. The inability to handle foggy conditions has been one of the major obstacles in the development of autonomous vehicular navigation systems that uses visible light, which are majorlypreferredby radar-based systems for high resolution and ability totrack lane markers and read road signs .So, the system developed by MITwas a big step toward self-driving cars. The estimation is based on a SPAD camera (single photon avalanche diode) that measure the running time of individual detected photons. A pulsed visible laser is used for illumination the suggested approach is based on a probabilistic algorithm that first estimates the Fog properties (background). Then the background is subtracted from the measurement with the fog leaving the signal photons from the targets which are used to recover the target reflectance and depth.

2.2 Guy Satat, Matthew Tancik, Ramesh Raskar[1]says that , many industries likeaugmented driving, self-driving cars helicopters, airplanes, drones and trains, the significant application is of imaging through Fog. He states that the distribution (Gamma) that is reflected from light profile time varies from the light reflected from objects damped by Fog (Gaussian). This answer to this difference between signal photons reflected from the occluded object and background photon reflected from the Fog .The imaging system is constructed in optical reflection mode with nominal foot print and it depends on LiDAR hardware.

2.3 Rahul Singh, Someet Singh and NavjotKaur [2].In his paper states the following "Vehicle detection in Foggy weather is important because collision of vehicle and low visibility is the main reason for the occurrence of accidents. Cameras and LiDAR are basicallyused to improve the performance.Images which were obtained from the camera in Fog were entirely distorted and it will not resolve it to the required level for the vehicle in front of us to be visible, so to make it clear he used Adaptive Gaussian Thresholding Technique. In this method the threshold value is the weighted sum of the neighbourhood pixel values which will make the image clear as compared to the blurred image. Along with the camera he also used a low cost LiDAR which consists of a camera and a laser, andisused to measure accurate distance up to 10 meters.The system which can measure the distance of the target by using the light is known as LiDAR (Light Detection and Ranging).

2.4 The researcher ZsoltKira has utilized numerous sensors to enhance the identification rate of passer-by. Sensors utilized are LiDAR and IR camera. The contribution from various sensors is sent to course of classifiers, first depends on 'quick convolution organizes classifier' and second is a 'HOG classifier'. These classifiers take choice in view of the information gave by the sensor and further control the diverse actuators, for example, caution, signal, streak light and so forth. At long last they have tried their framework on a Toyota Highlander vehicle. Both the Stationary and Dynamic (40 Kmph) conditions were tested.

III. METHODOLOGY

3.1 LiDAR

LiDAR utilizes laser light to quantify separations. The working principle of Light Detection and Ranging system is really quite simple. It generates Laser pulse train, which sent to the surface/target to measure the time and it takes to return to its source. The actual calculation for measuring how far a returning light photon has travelled to and from an object is calculated by (1).

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(1): Distance = (Speed of Light x Time of returning of light pulse) / 2

3.2 Ultrasonic Sensors

Ultrasonic sensors regularly transmit a short burst of ultrasonic sound to the target, which in turn reflects the sound back to the sensor as an input. The system then measures the time taken for the echo to return back to the sensor and computes this distance to the target using the speed of sound within the given medium. It is the amount of time taken for the sound to travel through the medium and amplitude of the received signal. Based on velocity and time, thickness can be calculated. As shown in (2).

(2): Thickness of material = Material sound velocity X Time of Fight

Time taken by pulse is actually for toand from travel of ultrasonic signals, while we need only half of this. Therefore time is taken as time/2. Hence distance is given as (3).

(3): Distance = Speed * Time/2

IV.PROPOSED WORK

4.1 Integrated Sensors for Object detection in FOG environment.

Objective of this

In this project Microwave Radars a long range and short range Doppler radars, LiDAR and a pair of ultrasonic sensors are interfaced with Arduino as shown in the fig1.

LiDAR (Light Detection and Ranging) is an optical remote sensing system which is used measure the distance of a targetwith lightLiDAR involves transmitter and a receiver, transmitter illuminesthe target with a laser beam and receiver detects the component of light and also a receiver sensor which calculatesthe distance based on the time, operation range is 3m-12m. Ultrasonic setup covers below 3m distance. The received distance is displayed on the screen using an Arduino.

4.2 Block diagram

Microwave RADAR – Short Range, The RCWL-0516 is a Human body induction switch Doppler RADAR. It is a small proximity sensor that uses Doppler Effect to sense the body movement up to 7m distance. This is mounted at the front of a vehicle reads any motion of a human or animal in front of car and raise a flag to the user with a led indicator or a buzzer along with the text display on the screen. The RCWL-0516 also supports an optional light-dependent resistor (LDR) to allow the device to operate only in darkness. This can be very useful in light control applications

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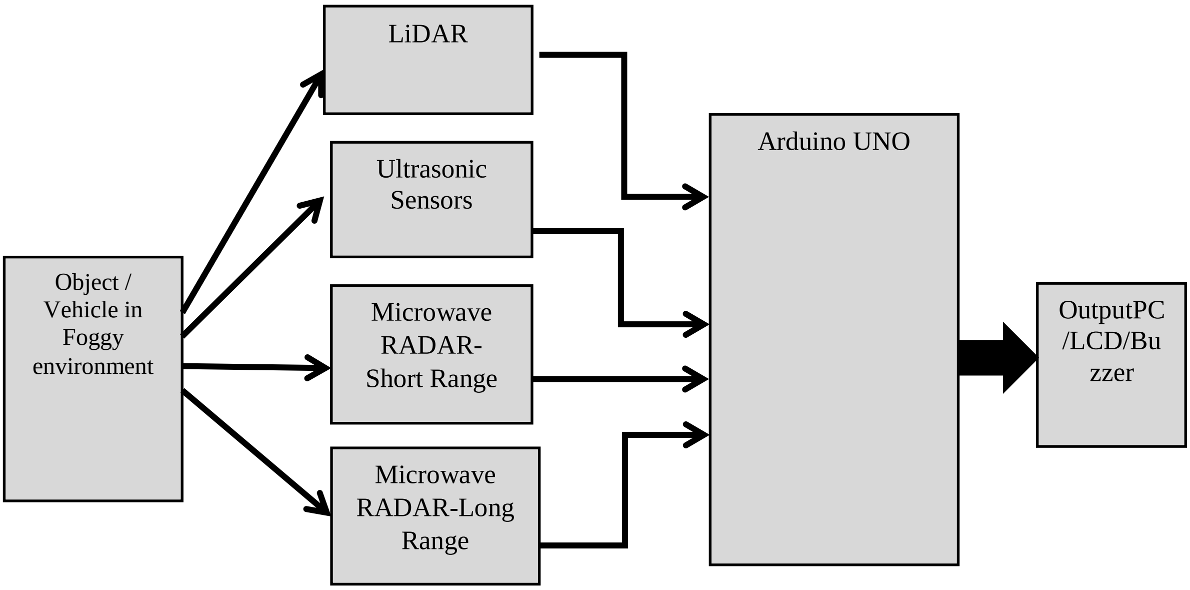

Fig 1: Block diagram of Fog detection mechanism

Microwave RADAR –Long Range, The HB-100 Doppler RADAR is used which is used to detect the velocity of the passer by or incoming vehicle which is relative to the driver.It's range is up to distance of 40m. The HB100 is connected with required circuitry and the acquired sensor data is given to Arduino and is displayed on the screen. As shown in Fig.2

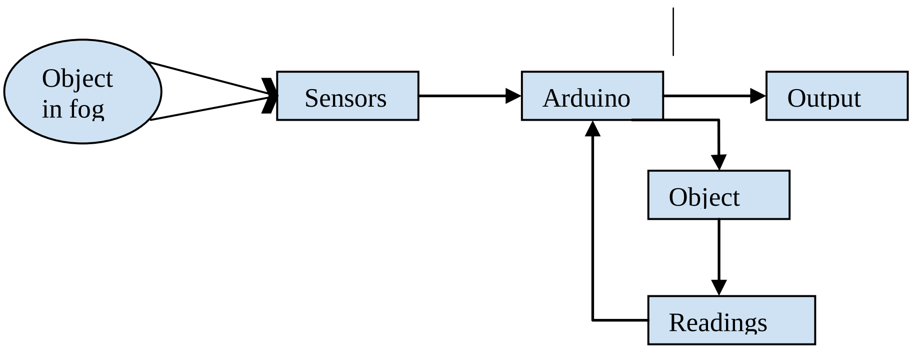

Fig 2: Block diagram of Arduino interfaced with sensors

Ultrasonic Sensor, to determine distance of an objects like dolphins do or bats, HC-SR04 ultrasonic sensor uses sonar. It offers stable readings in an easy-to-use package and excellent non-contact range detection with high accuracyup to 400cm or 4m range its operation doesn't depend on sunlight or black material like sharp range

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finders like IR sensor. This Ultrasonic sensor is mounted on a servo motor and is rotated from 15-165 degrees which takes multiple readings. These readings are given to Arduino controller which in turns process the data and is given to Processing IDE, which is used to represent the ultrasonic sensor data that is direction and distance in a graphical format where a simple application is usedsimilar to a RADAR Screen. Another HC-SR04 is used for extra precession which is fixed and displays the distance of the object on an LCD and alerts driver with a buzzer.

4.3 Hardware setup:

First sensor we have used is aUltrasonic sensor and it is interfaced with Arduino. Thisultrasonic sensor along with Arduino is implemented with the help of Processing Application. We will be using different hardware like Arduino UNO, HC-SR04 Ultrasonic Sensor and a Servo Motor. But the main aspect is the visual representation in the Processing Application.

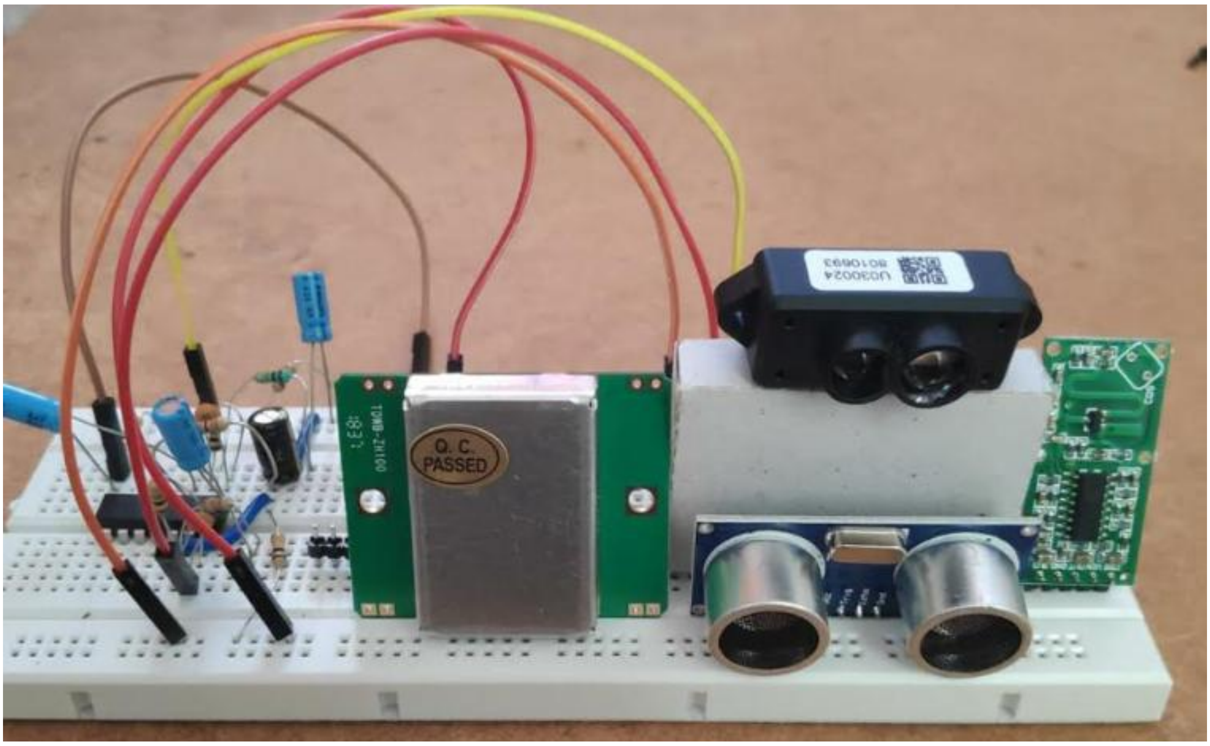

Fig 3: Arduino interfaced with ultrasonic sensor

The control pin of the servo is connected to Pin 12 of the Arduino while ultrasonic sensor's ECHO and TRIG Pins are connected to Pins 11 and 10 of Arduino respectively. A separate 5V power supply (with common GND) is given to the Servo Motor and the Ultrasonic Sensor the connection is as shown in Fig.3. There are two program codes for this project: one for the Arduino UNO and the other for the Processing

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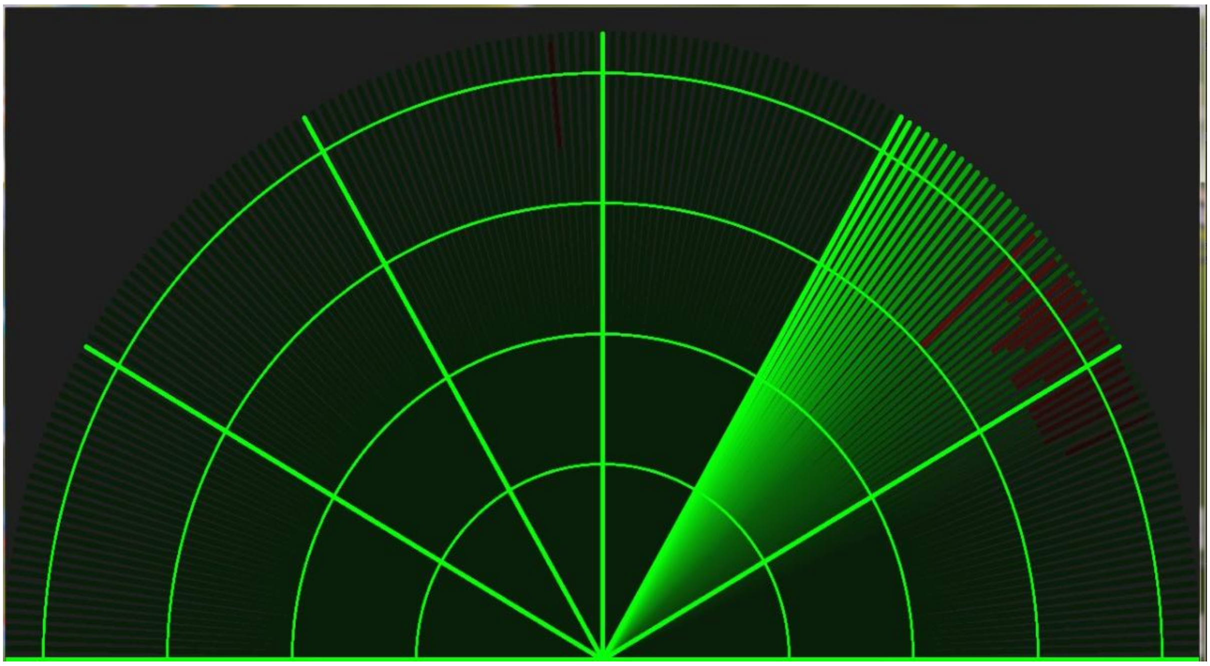

Fig 4: Processing Application output

Initially, upload the code to Arduino after making the connections. We can observe the servo sweeping from 0 to 180 degree and again back to 0. Since the Ultrasonic Sensor is mounted over the Servo, it will also participate in the sweeping action. Then upload a new Processing sketch where we can enter the desired resolution (like 1280×720) and all the calculations will be automatically adjusted to this resolution. Now, run the sketch in the Processing and if everything goes well, a new Processing window opens up like the one shown in Fig 4.

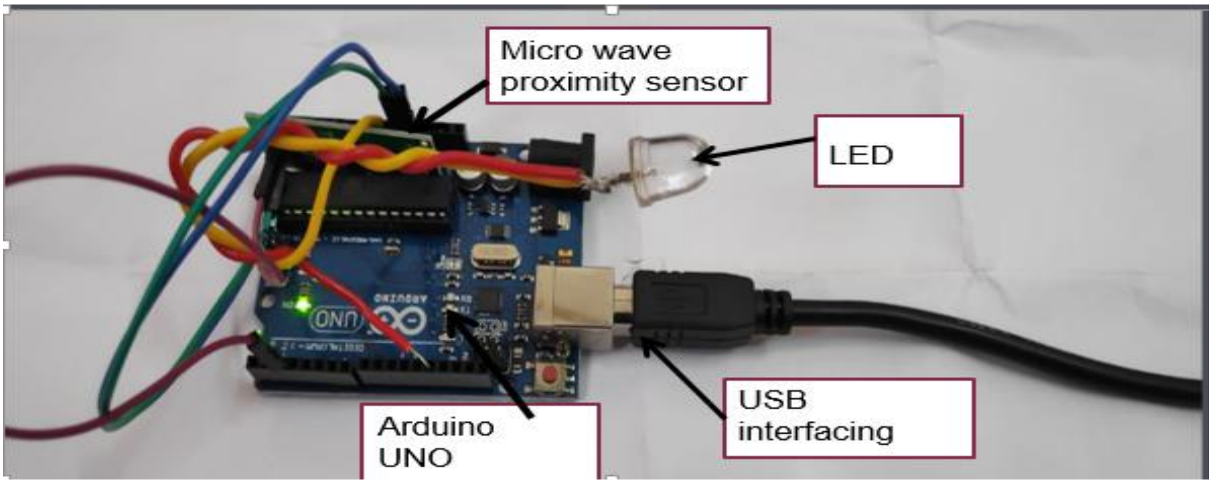

Fig 5: Arduino interfaced with Microwave Radars, LiDAR and Ultrasonic sensor

The RCWL-0516 Doppler radar detects the body movement with the help of Arduino and displays the output on screen along with the Led light as indicator.HB100 radar module can detect the distance within 20m and its transmitted frequency is 10.525GHz detects the velocity of target vehicle. TF-Mini LiDAR sends the light pulses rapidly and able to get more than 100 distance readings per second and HC-SR04 Ultrasonic sensor detects the distance of the object using echo. These readings are displayed on the LCD screen with the help of Arduino.

V.CONCLUSION

In bad weather conditions, especially in Fog it's a great challenge to detect an object. The system can be distracted by many environmental entities such as buildings, tall trees, and pedestrians often prone to deviate the obtained results from actual results. RADARs are often used to detect the objects presence and LiDAR are commonly used as Range finders to determine the distance of an object, whereas when used solely there are some lacking in the quality of results such as LiDAR can't detect objects that are too close but can detect far objects, whereas Ultrasonic sensor will provide accurate reading in short range but fails in long range. So they are often used together to overcome one's disadvantage with other. In comparison with other approaches, the benefit of this approach is to utilize the multiple sensor data to detect the object or vehicle in advance and for safe driving. By using different sensors simultaneously the user can be able to become aware of the object presence and take relative actions and can avoid accidents or collisions in fog. In this model we are achieving this by using the efficient RADARs with the combination of low cost Ultrasonic sensor and LiDAR.

REFERENCES

1. G. Satat, M. Tancik and R. Raskar, **"Towards Photography Through Realistic Fog"**, IEEE InternationalConference on Computational Photography (ICCP), 2018.
2. Rahul Singh, Someet Singh and NavjotKaur**"A Review: Techniques of Vehicle Detection in Fog"**, IndianJournal of Science and Technology, Dec 2016.
3. Stock, K. **"Self-Driving Cars Can Handle Neither Rain nor Sleet nor Snow. Bloomberg Business week"**,Article Published on 17 Sept 2018.
4. Dannheim C, Icking C, Mader M, Sallis P**. "Weather detection in vehicles by means of camera and LiDAR system".** Sixth International Conference on Computational Intelligence, Communication Systems and Networks Nov2014.
5. Hautiere N, Labayrade R, Aubert D. **"Detection of visibility conditions through use of onboard cameras."** IEEE Proceedings of Intelligent Vehicles Symposium; 2005.
6. Huang L, Barth M. **"Tightly-coupled LiDAR and computer vision integration for vehicle detection.**" 2009 IEEE Intelligent Vehicles Symposium; 2009.
7. Zhang F, Clarke D, Knoll A. **"Vehicle detection based on LiDAR and camera fusion."** 17thInternational IEEE Conference on Intelligent Transportation Systems (ITSC); 2014.