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Implementation and Demonstration of Obstacle Detection in Self-Driving Cars with GPS Tracking in Real-Time System

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Abstract: ***In this paper we are mainly focusing on the design of embedded controller for self-driving car in a unique way. Here two major modules play a vital role, one is detecting the obstacle around the car and another one is tracking the exact location of respective car. we can detect the obstacle with the help of RADAR, Li-DAR or Ultrasonic sensors. By using these sensors for detecting the obstacle it is useful to avoid the accidents and allows moving car smoothly without any intervention with the surrounding vehicles. In our paper we are using ultrasonic sensor to detect the obstacle, once it will find the obstacle immediately it slowdowns the speed of the car based on that we have developed the module. Once the speed of the car will reduce, ultrasonic sensor scans surroundings of the obstacle with an effectual angle of 30°of both left and right side of an obstacle; it also finds the obstacle free zone. Once the obstacle free zone have been founded, car move towards free path. If free zone is not found sensors keep on sensing the obstacle till the free zone is found and also status of the car will be notified to the micro-controller. The micro-controller immediately send commands or information to the passenger in the form of audio signals. In the second module we have focused on tracking the car with the help of GPS NEO-6 module. It helps to track the car based on the accurate co-ordinates of longitude and latitude of the respective global position. So this module will helps to navigate from source and to reach the destination without any intervention of surrounding vehicles.***

Keywords: Automated cars, Distance measuring sensor, Li-DAR, RADAR, Ultrasonic sensor, GPS NEO-6, Automated driving systems, Arduino UNO

1. Introduction

Many Experiments have been conducted on Automated Driving Systems (ADS) since 1920's. The first semi-automated driving system is developed by Japan's Tsukuba mechanical engineering laboratory interpreted using two cameras and analog computer. In 2017 Waymo tested its fully automated car without a safety driver in driver place and successfully tested in the particular environment of US. The word Driver less cars or Autonomous cars are just a science fiction in the days of 1990s but the digitization of computer technologies and hardware's of computer systems the vision of autonomous driving can be implemented in real-time. Self-driving car have many features such as obstacle detection, auto steering control, auto braking control [1], Tracking a location [2] of car, detecting traffic signs using cameras [3]. The research article [4] Will give the clear idea about the intelligence control of vehicle using newly developed adaptive-PID controller [5]–[7] Which helps self-driving car to get automatic control over the steering as well as brakes. The concept of controlling vehicles also discussed in research article using Fuzzy logic method [8], [9]. This paper majorly discusses the two features of self-driving car i.e. detecting the obstacle and tracking a vehicle. Some of the best sensors used in self-driving car are LiDAR [10], RADAR [11] and Ultrasonic sensor. The working principles of these sensors are quite similar. These sensors works with emitting signals using emitter, signals reflected by an obstacle, receiving the reflected signals by the receiver. LiDAR [10] technology was first implemented by Google waymo self-driving car to detect the obstacles, pedestrians, animals. RADAR [11] technology works with the reflection of radio waves. These technology mostly used in the aviation to detect the obstacles in the air. These two type of technologies are not required for our problem because LiDAR and RADAR can detect the obstacles even if it is too far from the source. so we are using ultrasonic sensor to find the obstacle within the shortest range of 200 to 500 meters distance from the car to avoid accidents. Thus Ultrasonic sensors are the best solution to detect the obstacles and also blind spots in self-driving cars. By keeping the major factors like distance, reliability, cost and size we have used the ultrasonic sonic sensors in our model. Another major feature in self-driving car is to track the vehicle in real time. GPS [2] module helps in fetching the accurate co-ordinates of longitude and latitude .Thus GPS module is used in self-driving car to track the live location of car in real time.

2. Prototype Model

The robot is designed using Arduino micro controller with CPU Microchip AVR(8 bit) with clock speed 16MHZ. Arduino is a micro controller-based open source electronic.

Proto- typing board which can be programmed using Arduino IDE. The components of Arduino consists of USB connector, Power port, Micro controller, Analog input pins, Digital input pins, USB interface chip, TX RX LEDs. USB port is used to load a program from the Arduino IDE onto the Arduino board. The micro controller used on the UNO board is At- mega328P by Atmel, having Flash memory of 32KB, RAM of 2KB, and EEPROM of 1KB. In this project we have used Arduino Uno because it is easy to implement with Arduino software (IDE) using Arduino programming language. Comparing to other Arduino boards Arduino Uno is inexpensive; Cross-platform which runs on windows, Mac OS, Linux OS and it is a open source with extensible hardware.

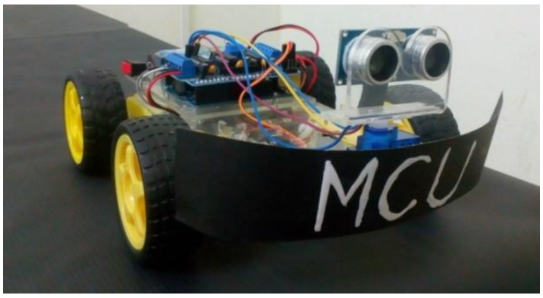

Figure 1: Robot

Figure 2: Arduino UNO

3. Ultrasonic Sensor

Ultrasonic sensors are basically used to detect the object. It works on reflection of sound waves. The sound signals travels at the rate of 340 meters per second through transmitter. Waves get reflected when there is any obstacle nearby the sensor and it gets collected in receiver, where the received signals get amplified then signal is sent to micro-controller and the necessary action is taken by the micro-controller.

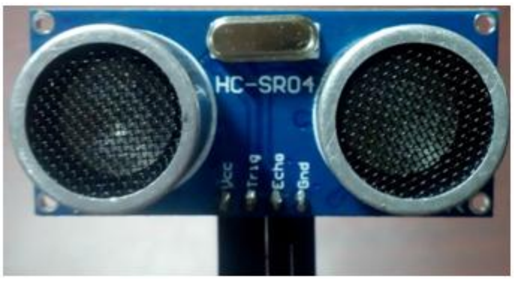

Figure 3: Ultrasonic sensor

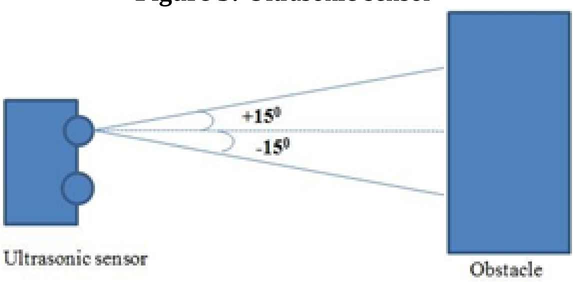

Figure 4: Effectual angle of ultrasonic sensor

Ultrasonic sensors will detect the objects not only at "directly ahead" (at zero degrees) but also at offset of angle. 15°is the maximum effectual angle given for HC-SR04 Ultrasonic sensor. If we consider "directly ahead" as zero degree then ultrasonic sensor will detect objects over a range about 30°i.e. (+/- 15°from zero). Ranging distance of sensor is from 2cm to 400cm. Distance of an object can be determined using distance formula.

4. Proposed Method and Implementation

The self-driving car is implemented with the two major features called detecting obstacle and tracking a car. Detecting the obstacle is implemented with the help of ultrasonic sensor, these sensors works with the help of reflecting the sound

$$Distance = Time \ X \ Velocity \quad (1)$$

The time taken to detect object using ultrasonic sensor where the object is placed 10cm away from the robot (sensor), distance = 10cm.

Velocity of sound =340m/s =0.034 cm/µ s

waves. In this paper we have ~~used~~ HC-SR04 ultrasonic sensor to detect the obstacles. Tracking a global position of car can be implemented with the help of GPS module. We have used

$$Time = \frac{Distance}{Speed} \quad (2)$$

Time = 10 /0.034 =294µs.

The GPS NEO-6 module to fetch the latitude and longitude of a car.

Time taken to detect the obstacle which is 10 cm away from the robotic car is 294 micro seconds. Sound wave from sensor will to travel forward and bounces back from obstacle hence the distance can be calculated as follows,

$$Distance = (Time \ X \ Speed)/2 \ meter \quad (3)$$

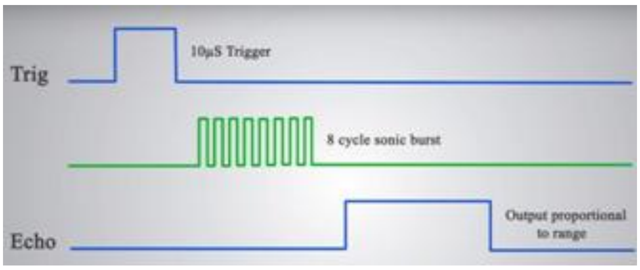

Figure 5: Timing graph of Ultrasonic sensor

By setting TRIG pin to HIGH, the HCSR04 ultrasonic sensor can be triggered to produce an ultrasonic burst. Once the burst is produced by the sensor automatically ECHO pin will go HIGH. This pin will have HIGH until burst hits the sensor again. The distance can be calculated by tracking the high range value of ECHO pin. The complete flow chart of self driving is shown in figure 5.

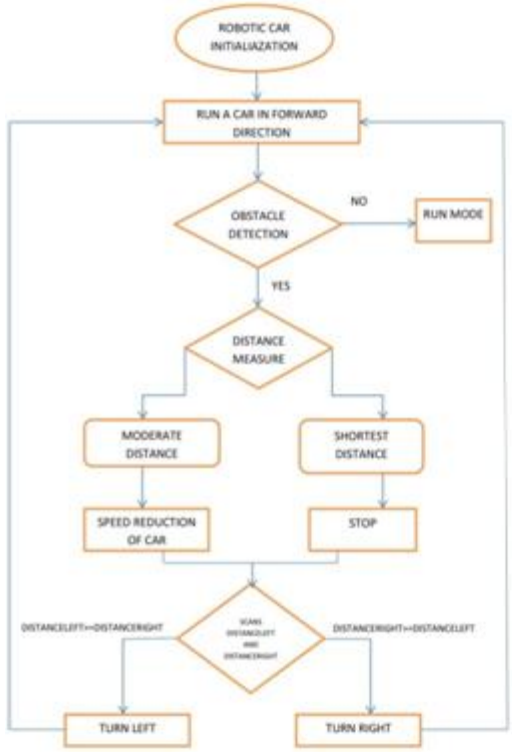

Figure 6: Flowchart

<u>**Algorithm 1** Self driving robotic car to avoid obstacle</u>
Require: maxrange = 200, minrange = 0, Speed = 0.034
1: TRIG←HIGH
2: Time = HIGH value of ECHO
3: **if** ECHO = LOW **then**
4: Distance = (Time * speed)/2.
5: **if** Distance ≤ maxrange and Distance ≥ minrange **then**
6: moveStop()
7: Calculate distanceRight = lookRight()
8: Calculate distanceLeft = lookLeft()
9: **if** distance ≥ Right distanceLeft **then**
10: Turn right
11: moveForward ()
12: Go to 1
13: **else**
14: Turn left
15: moveForward ()
16: **end if**
17: **end if**
18: **end if=0**

a) GPS NEO-6 Module

The NEO – 6 Module is a family of stand-alone GPS receivers featuring the high performance. This module helps in receiving the current location by sending signals to satellites using antenna and the result is tracked and recorded by testing the vehicle outdoor. The co-ordinates send to the Arduino were recorded and traced. The GPS Module helps in getting accurate values of longitude and latitude of car. This module comes with an external antenna and built-in EEPROM with the interface RS232 TTL using power supply from 3V to 5V. The default baud rate of the GPS module is 9600 bps and works with standard NMEA sentences. The repeated GPS data is received by the GPS module with the baud rate of 9600 bps. The serial monitor at baud rate of 9600 bps will give the complete details which are fetched by the satellites. Bunch of information fetched in the GPS standard language called NMEA. NMEA stands for National Marine Electronics Association and it is the standard data format of GPS language. Using the GPS data with accurate value of longitude and latitude it is easy track the exact current location of vehicle using Google maps API.

Figure 7: GPS NEO-6 Module used in robotic car

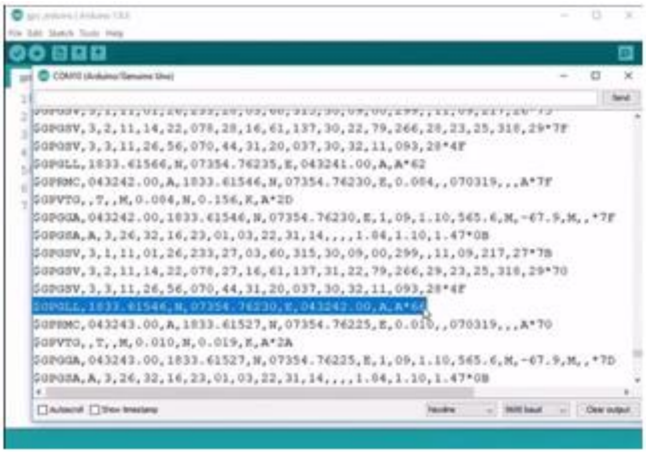

Figure 8: NMEA GPS language fetched from satellites

5. Results

a) Demonstration of robotic car using ultrasonic sensor

Project has been implemented and tested successfully at Maharani Cluster University CS research lab Bengaluru.The robotic car put to the test in obstacle free zone and the car moves smoothly without any distraction, the sound waves transmitted continuously by the ultrasonic sensor and scans the surroundings of the robotic car. If the sound waves get reflected by an obstacle and sends signal to Arduino micro controller, Arduino decides which path is obstacle free and moves towards the obstacle free zone. Figure 9 demonstrates the robotic car moving freely without any suspension. Figure 10 demonstrates robotic vehicle found obstacle in front of it and searching for obstacle free zone using ultrasonic sensor. Figure 11 and 12 demonstrates that the car diverts its direction towards obstacle free zone to overtake the obstacle. Figure 13 and 14 demonstrates that the car drives automatically to normal state to follow the traffic rules The model not only helps to detect obstacle but it is also possible to tracking the current location of car and necessary audio commands will be given to users.

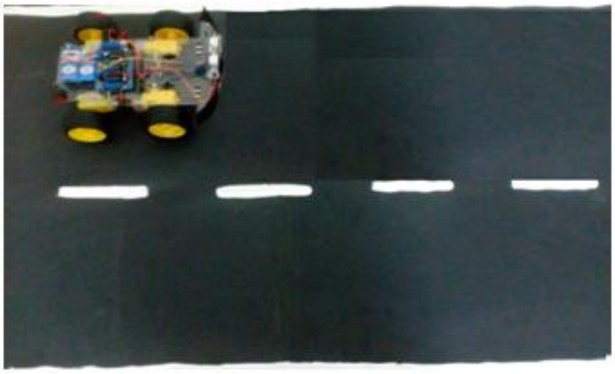

Figure 9: The robotic car moving freely without any suspension in obstacle free zone.

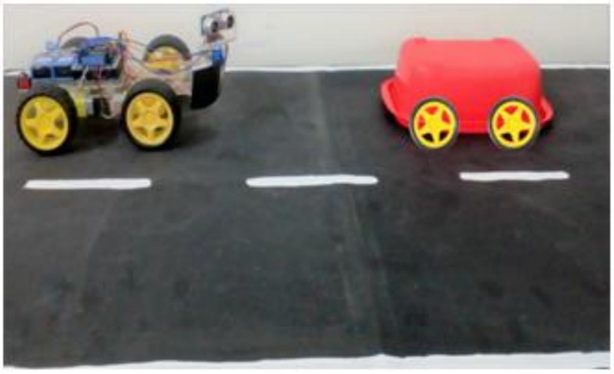

Figure 10: Robotic car continue to sense obstacle in front of it

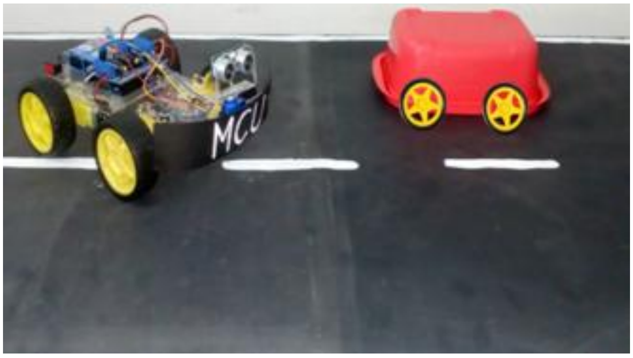

Figure 11: Robotic vehicle diverts its direction due to obstacle in front of it

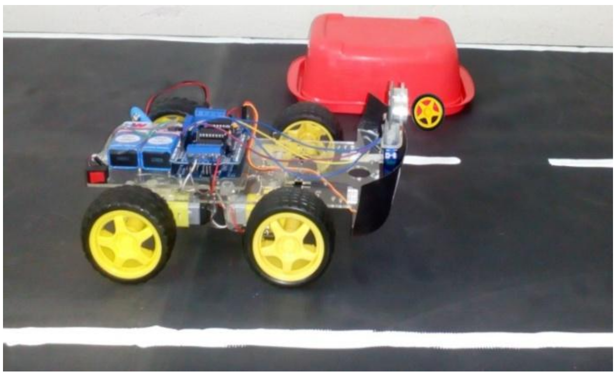

Figure 12: Robotic vehicle changes its direction

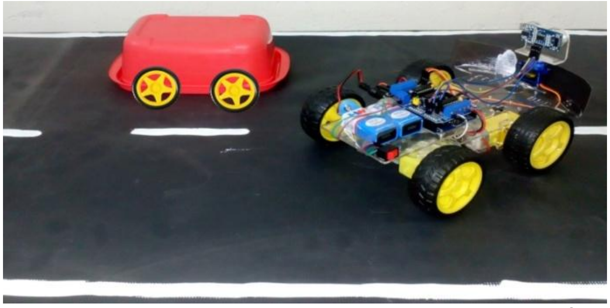

Figure 13: Robotic vehicle Moves towards obstacle free zone by following traffic rules.

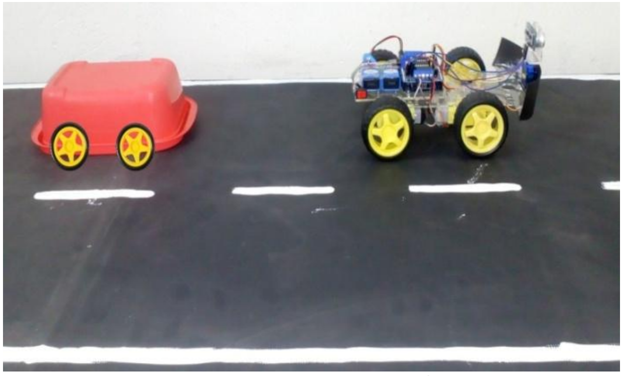

Figure 14: Robotic vehicle continues forward direction towards obstacle free zone

b) Graphical representation of distance vs time.

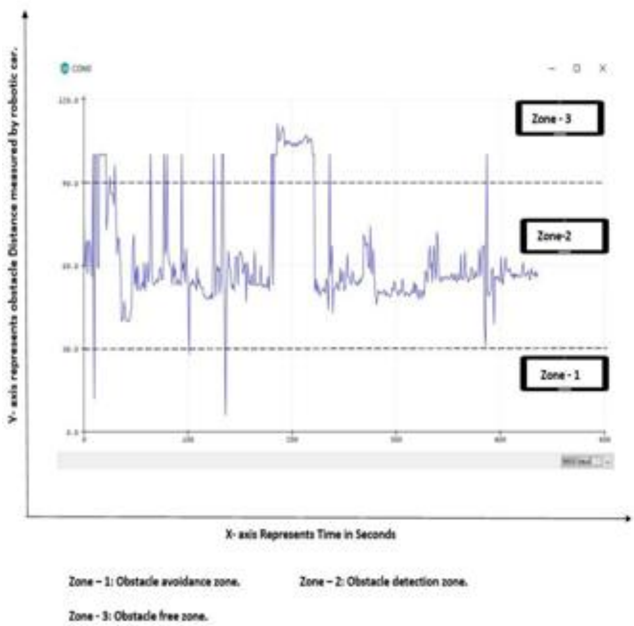

Figure 15: Graph represents distance measured by ultrasonic sensor along with the time

The Fig.15 Graph shows the distance measured by the robotic car using ultrasonic sensor. ”Y” axis represents distance in centimeters and”X” axis represents time in seconds. The graph is plotted with live data of distance measured by the ultrasonic sensor in Arduino IDE .The above graph is divided into three zones.

- **Zone-1** obstacle avoidance zone.
- **Zone-2** obstacle detection zone.
- **Zone-3** obstacle free zone.

Values with above 90 cm in"Y" axis represents obstacle free zone; here the robotic car maintains constant speed within limit. Values in between 30cm and 90 cm in"Y" axis represents Obstacle detection zone, in this zone the car reduces its speed but still maintain to move forward. If the distance gradually decreases with the time then it indicates the obstacle is in motionless. Values less than 30 cm in"Y" axis represents obstacle avoidance zone. Here the car itself takes its own decision, based on signals generated and moves towards either right free zone or left free zone .The robotic car automatically follows traffic rules in such a way code has been designed using Arduino IDE.

c) Tracking car using GPS NEO-6 Module

The exact location is tracked using GPS module by using the coordinates fetched. This coordinates helps to set the source and destination of vehicle and the vehicle path is traced using Arduino simulator. The below image clearly shows the exact location of the car using Google maps API.

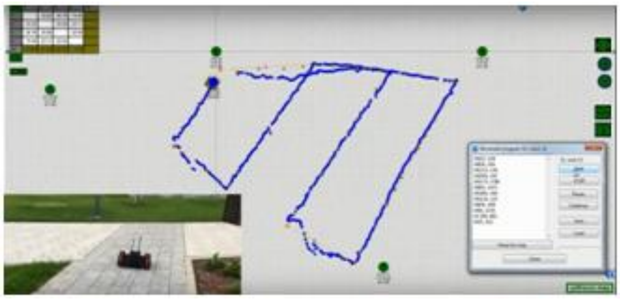

Figure 16: Location tracking and path of vehicle is traced

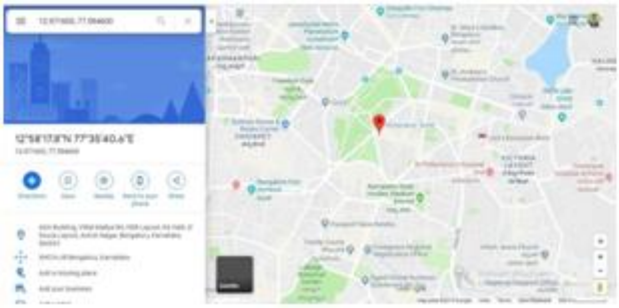

Figure 17: Vehicle location traced by the GPS using longitude and latitude

6. Conclusion

This paper proposed a design of embedded controller for self-driving car in a unique way. We are able to track the self driving car using GPS NEO-6 module and also we can find obstacles come across the path by using ultrasonic sensor. The design is suitable in all weather conditions with high performance rate. We have designed this module in such a way that it follows traffic rules without any interventions. The obstacles are detected within the short range of 200 meters to 500 meters. The future implementation of our paper can adds more applications of self driving car that is cars can be operated using public voice commands, Traffic signal can be detect using image recognition and parking assistance can be provided.

7. Acknowledgements

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References

[1] HiroshiOhno,et al.,"Neural network control for automatic braking con- trol system", Volume 7, Issue 8, 1994, Pages 1303-1312.

[2] Jiann-Shiou Yang Dept. of Electr. and Comput. Eng., Minnesota Univ., Duluth, MN, USA ."Travel time prediction using the GPS test vehicle and Kalman filtering techniques", Published in Proceedings of the 2005, American Control Conference, 2005.

[3] Andrzej Ruta, et al., "In-vehicle camera Traffic sign detection and recognition",published in Machine Vision and Applications ,March 2011.

[4] Pan Zhao,et al., "Design of a Control System for an Autonomous Vehicle Based on Adaptive-PID", Vol:9 issue: 2, Published January 1, 2012.

[5] Le-Anh,et al.,"A review of design and control of automated guided vehicle systems." Erasmus Research Institute of Management (ERIM), report series no. 2004-03-LIS.

[6] Cheein, et al., "SLAM-based Cross-a-Door Solution Approach for a Robotic Wheelchair.", International Journal of Advanced Robotic Sys- tems, (2010) Vol 7, No. 2, pp. 155–164.

[7] Lenain, R., Thuilot, B., Cariou, C., Martinet, P. (2005) Model Predictive Control for vehicle guidance in presence of sliding: Application to farm vehicles' path tracking. IEEE Conf. on robotics and automation. pp 885–890.

[8] Hessburg, T.,"Fuzzy logic control for lateral vehicle guidance.", IEEE Control System Magazine,(1994)Vol 14, pp. 55–63.

[9] Choomuang, R.,et al.,"Hybrid Kalman Filter/Fuzzy Logic based Posi- tion Control of Autonomous Mobile Robot.", International Journal of Advanced Robotic Systems, (2005)Vol 2, No 3, pp. 197–208

[10] Jeff Hecht (jeff@jeffhecht.com),"Lidar for Self-Driving Cars",JANUARY 2018 OPTICS AND PHOTONICS NEWS.

[11] Dickmann et al., "Radar for self-driving cars", 2018/02/06 Diamler.