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Automatic Car Driving System Using Fuzzy Logic

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ABSTRACT: In Boolean logic the truth-value can be 0 or 1. As against this in fuzzy logic, the truth-values of variables may be between 0 to 1 with 0 & 1 being extreme cases. Fuzzy logic finds its application in washing machine, air conditioner, kitchen applications, car control systems, image processing, decision-making, car control systems, Aerospace vehicle control system, etc. One such application, which we are taking under consideration in this paper, is automatic car driving system. This paper describes an automatic car driving system in which the vehicle keeps a distance from the vehicle in front of it and applies break using fuzzy logic. Another parameter is if the car detects object/vehicle in a certain range, it changes it lane and overtakes the object/vehicle and returns to its original lane. The major problem faced by automatic car is the level of assurance of the vehicle in front of it. Therefore, to budge vehicle computers further observing and into jobs related to environment discernment or driving, we must assimilate facets of human cleverness and performances so that vehicles can manage driving models in a way similar to humans.

KEY WORDS*:* Fuzzy, Tesla, Arduino, servo, sensor, Control system, autonomous

I.INTRODUCTION

Fuzzy logic can be explained by taking human feelings as an example. Professor L. A. Zadeh of the University of California at Berkeley founded this logic in 1965 .It uses linguistic variables. We can use fuzzy rule-based systems in various automatic functions .We can use fuzzy logic control in number of ways, from normal to special operating conditions. Traditional logic computing has been used in vehicles for controlling the inside temperature, closing and opening of doors and windows, checking the fuel level, battery level. This paper talks about the use of fuzzy logic for driving a vehicle. In complex situations such as heavy traffic, this task becomes difficult. Therefore, to drive a vehicle automatically we must first need to understand the human way of driving a car. Our first aim was to develop a car whose speed varies depending on the vehicles in front of it. The second aim was to overtake the vehicle moving at slow speed. So far, we have developed a prototype that has two parameters. First parameter is varying speed with automatic braking and the other parameter is overtaking.The Automated Car Driving System has the following objectives to be achieved. They are:

- To design and build up a prototype of Automatic Car Driving System.
- To learn how to control the operation of the prototype using Fuzzy Logic Controller (FLC).
- To avoid any collision between the vehicles by using the Automatic Braking System (ABS).
- To automatically handle speed of the car on different lanes and roads along with smart overtaking.
- To build a smooth automatic parking system for the vehicle to avoid any damage with other vehicles.

II. SIGNIFICANCE OF THE SYSTEM

The paper mainly focuses on how a semi-autonomous vehicle driving system can be implemented using fuzzy logic which will help in the future developments of electric vehicles. The motivation of the project is discussed in section III, study of literature survey is presented in section IV, Methodology is explained in section V, section VIgives results and conclusion of the study, and section VII discusses the future study.

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III. MOTIVATION

This is the motivation behind the Enhanced Autopilot Program made by Tesla, which was first used in 2014, for Tesla Model S, followed by the Model X upon its release. At that time, Autopilot features included semi-autonomous drive and parking capabilities. Enhanced Autopilot Programis an advanced driver-assistance system feature offered by Tesla that has lane correcting, adaptive cruise control, self-parking, ability to automatically change lanes without requiring driver steering, and enables the car to be called to and from a garage or parking spot.

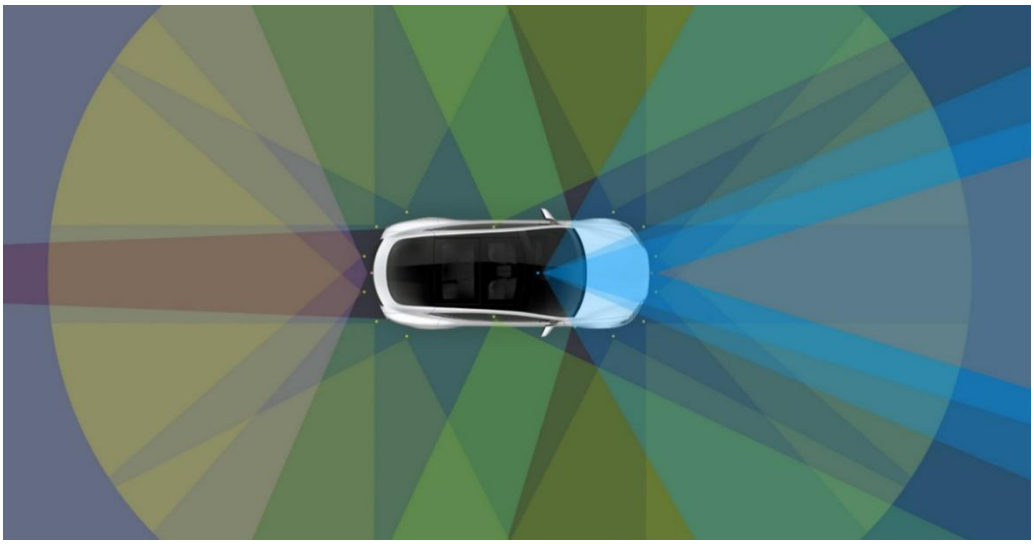

Fig 1. Tesla Enhanced Autopilot Program Overview

III. LITERATURE SURVEY

Carlos González et al. described the lane change system that helps the vehicle to complete overtaking operations. In their work they proposed two level architecture, the low level consisted of fuzzy steering controller and high level architecture consisted of parameters that computed possibility of overtaking. They also controlled the speed automatically keeping the vehicle at appropriate speed or at safe distance from the vehicle in front of it.
M.A. Jarrah et al. proposed a system which warns the driver when any object comes closer to the vehicle. The system also has black box which monitors the last ten minutes of driving to recreate an accident if it happens. The proposed system has automatic braking function which lowers the speed of vehicle by applying brake pressure.
Rolf Muller et al. proposed a fuzzy logic based intelligent cruise control which keeps speed and distance from the leading vehicles. Specific driving and weather situation with individual drivers need were taken into consideration in this project.
M.Sugeno et al. In this proposed paper drivers action were modelled to prepare a fuzzy logic based model car. Control rules for making a car were derived in this work. After successful simulation the author prepared a model car and attempted its fuzzy control with the help of a micro-computer.

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IV. METHODOLOGY

A) System Design

The hardware diagram of Automatic Car Driving System Using Fuzzy Logic is shown below:

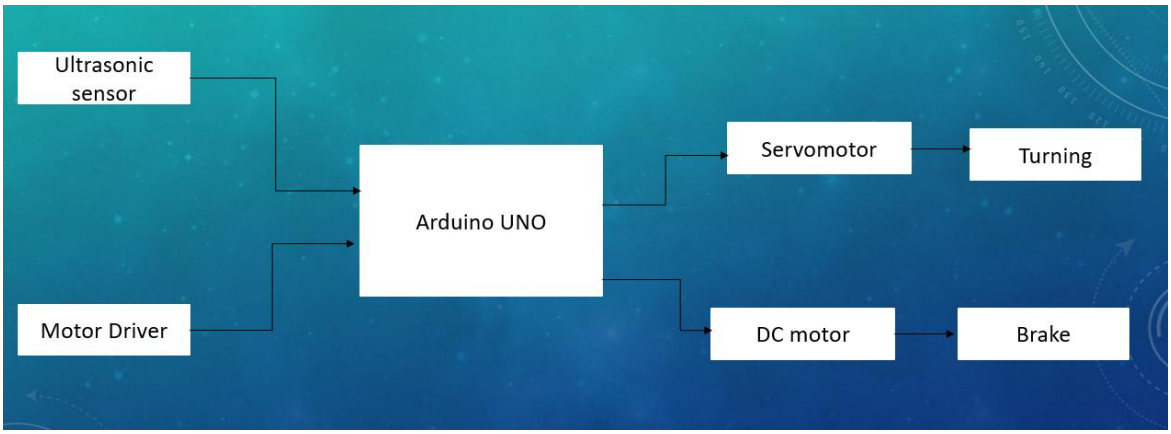

Fig 2. Block diagram of Automatic Car Drivimg System

In the beginning, the user is expected to enter the speed limit and the destination. Arduino UNO is used as the main microconroller for this project. After the user has entered the speed and destination, the ultrasonic sensors at the front,back,side-right,side-left check for obstacles. If the car wants to go forward it will check for obstacles in the front and either of the on side depending on which side of the road it is stationary and if no obstacles found then the vehicle moves forward. As the car moves, it again checks for obstacles in front and side of it as it moves on, if the car is approaching the obstacle it will gradually decrease the speed and finally stop if the ostacle is too nearby.The servo motor is used as the wheels of the car as it can move both sides and change direction as required by the AI. The Tachometer is used to measure the speed of the car as it should not exceed the speed limit. Finally after reaching the required destination, the car stoppes and if we want to park it we can just give the command.

B) Automatic Braking System (ABS)

In Braking system, we are using fuzzy logic to determine the distance of the vehicle in front of our vehicle and apply the appropriate amount of brake required to stop the car. The algorithm used for the braking parameter is as follows

ALGORITHM:

1) The vehicle will determine the distance in front of it.
2) i= four*distance.
3) If i>=255 then i=255.
4) If distance<=20 then speed =0
else speed = i.
5) The vehicle will only apply the required percentage of break to stop it.

The vehicle will move in a lane as usual, if it detects any other vehicle or obstacle around it at a certain distance it will not put a break completely, it will slowly put a break considering the distance of the vehicle around it and finally stop. Thus, instead of applying break completely at once it will gradually apply it, which will avoid unnecessary damage to any vehicle or the person in front of the vehicle or the driver who is driving it.

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The above mentioned automatic braking system using fuzzy logic can be shown as follows:

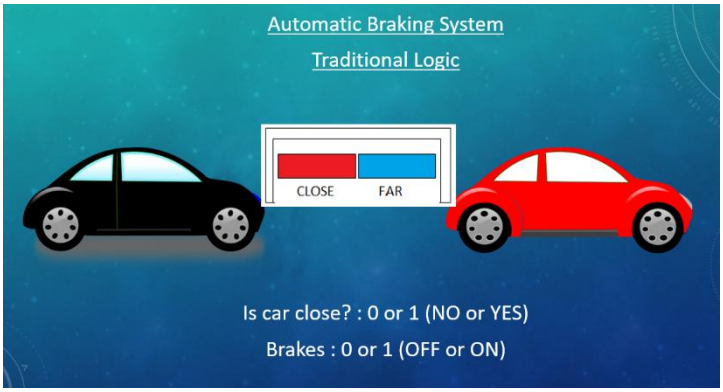

Fig 3. Automatic Braking System Using Traditional Logic

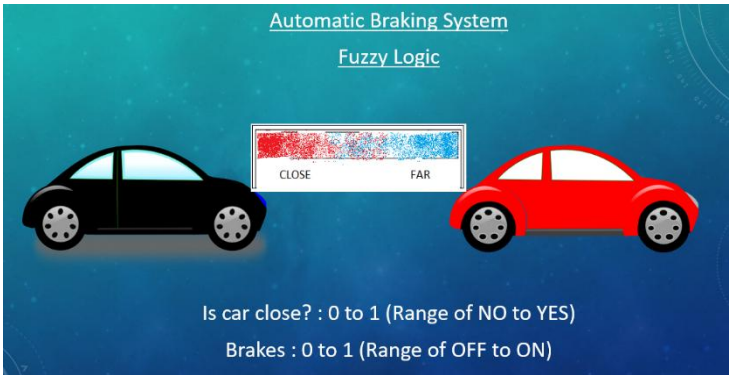

Fig 4. Automatic Braking System using Fuzzy Logic

C) Overtaking System

By using overtaking parameter we can pass the vehicle which is in front of us either moving or stationery. Although some conditions must be fulfilled, the vehicle must first change its lane then overtake the vehicle and return to its original lane. The independent vehicle's speed and routing need to be managed and these tasks can be freely implemented.

ALGORITHM:

1) The vehicle will first detect the leading vehicle.
2) Check the left and right distance.
3) If right distance is more turn right else turn left.
4) After turning move straight until the leading vehicle has been overtaken.
5) Return to the original lane.

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The overtaking system is shown in the following figure below:

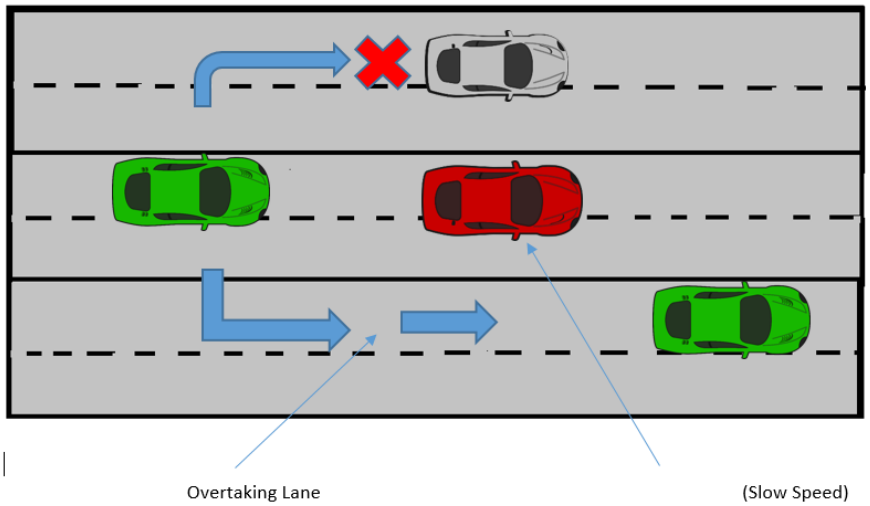

Fig 5. Overtaking System

Initially the vehicle will move in a straight lane until it detects a vehicle, which is moving slow or is stationery. Then it will check the right and left distance. If the right distance is more than the left distance then the vehicle will turn right and after turning right it will move in straight lane, but if left distance is more than right distance then the vehicle will turn left and the move in straight lane. It will move straight till it overtakes the vehicle and then again will return back to its original lane. Two cases are possible while returning to the original lane. If the car has initially turned right to overtake the vehicle then it will turn left after overtaking the vehicle and come back to its original lane. As against this if, the vehicle had turned left initially to overtake the leading vehicle it will turn right to come back to its original lane.

D) ADVANTAGES & DISADVANTAGES

Advantages:

1) Less Accidents
2) Decreased Traffic Jamming
3) Increased Highway Size
4) Improved Human Efficiency
5) Hunting for parking eliminated
6) Enhanced flexibility for the children, the old and the visually or physically challenged
7) Higher speed limits
8) Elimination of traffic enforcement personnel

Disadvantages:

1) Maintenance
2) Actual Cost
3) Feel of driving

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V. RESULT AND CONCLUSION

Our attitude to the vehicle route control problem can be viewed as an autonomous vehicle approach. Automatic vehicles are making their own choices on which action to take by using data from their own sensors and limited communication systems. In this work we implemented two parameters viz., overtaking and automatic braking system. In addition, we have successfully controlled the speed of the vehicle and given particular speeds for the vehicle to drive on various routes.

Route ⇩	Min (in PWM)	Max (in PWM)
Village	40	150
City	60	200
Highway	80	255

Table 1. Various speed values in various situations

VI.FUTURE WORK

Vehicle communication is a type of network in which the vehicle and other objects are the nodes providing each other with information such as safety warnings and traffic information. Therefore, vehicle communication is one of the parameter we can use in automatic driving systems in the future. Use of sensors, cameras is limited in use if large number of vehicles need to be communicated so Wi-Fi and GPS can be used to enhance to autonomous system more.

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