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Driver Assistance System with Automated Traffic Signal Recognition and Safe Overtaking Guidance Using Ultrasonic Sensor and Fuzzy Logic Controller

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ABSTRACT: In recent years due to increasing mobile phone usage, drivers are continuously distracted and it may lead to accidents. To avoid accidents vehicle manufactures are focussing on onboard safety systems. These systems will integrate with road conditions with sensors and radio communication technologies and provide timely alert to drivers, so that driver safety is guaranteed. The paper proposed a part of road safety usingultrasonic sensor , radio communication and fuzzy logic control. The implementation , the proof of concept of this system are tested against various scenarios to verify its correctness.

KEYWORDS: driver assistance system, FLC, Traffic Signal Recognition

I.INTRODUCTION

The upcoming second generation Autopilot cars, [1] will be eventually cheaper than public transport. In India one of the major causes of collisions is DISTRACTED driving [2]. GPS cartography and GPS maps are used in the case of driver assistance systems[5],[6]. Adaptive cruise control systems (ACC) has been implemented by automobile manufacturers in lieu of a conventional cruise control in which Intelligence has been introduced into vehicles through embedded controllers and sensors technologies which help maintain a safe distance between cars [7].Auto-makers are slowly converting their technologies from ACCs to ADAS which is known as Advanced Driver Assist Systems (ADAS) which comprise of one or more warning, prevention, or convenience systems such as ACC, Lane Departure Warning System (LDWS) and/or Collision Avoidance System (CAS) [10].Vehicle automation systems such as ADAS help the risk of accidents, improves vehicle safety, optimizes fuel consumption, enhances the overall comfort of auto-mobiles [7]. Research regarding ADAS have been under progress for the past decade [9]and is still growing because of the increasing demand for safer vehicles. By continuously monitoring the road for potentially dangerous situations, ADAS either alerts or assists drivers to avoid collisions. The primary benefit of ADAS is that it is not inhibited by factors such as fatigue, stress, or distraction. Implementation of an ADAS mitigates much of the risk associated with driving by verifying most of the drivers checks and assessments through an embedded system [10].

In order to circumvent the current availability and validity limitations of GPS, speed sign detection (SSD) system is gaining popularity. The proposed paper has fuzzy logic based ACC in combination with a SSD system to create a novel advanced ADAS. The proposed system's primary function is to reduce distracted driving and speeding which are leading causes of collisions.

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II.OBJECTIVE

For traffic sign alert, we design a radio communication based system. The Transmitter at road will transmit traffic sign and the receiver placed at vehicles will capture this traffic sign and alert the driver by a voice note, Visual display and in the prototype it turns the vehicle into left , Right and stops the vehicle for a while according to the traffic signals (Left,Right and Speed braker)..
For braking control, distance between vehicles is measured using ultra sonic sensor and the measured distance and speed drift is used as input to a fuzzy logic controller which decides the level of acceleration or deceleration to be applied to maintain the vehicle in safe condition.

III.METHODOLOGY

The System architecture with all modules and interaction is shown below

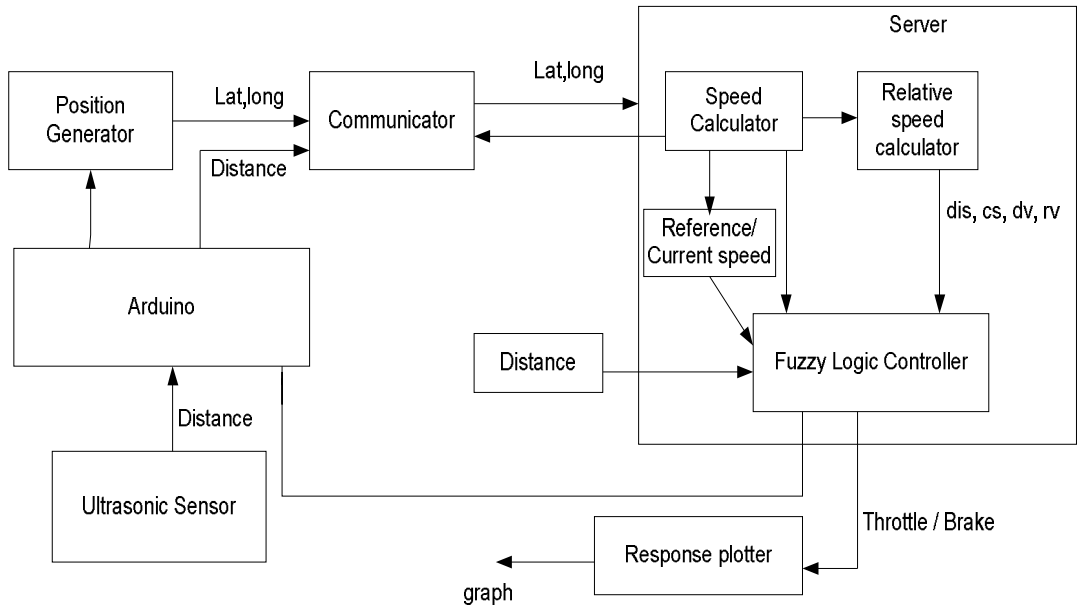

Fig 1: Block diagram of the proposed system

The RF transmitter is connected to an Arduinouno. The RF receiver module is connected to another Arduinouno for demonstrating the traffic signal reception in the form of voice and visual alert.
The Ultrasonic sensor is connected to Arduino. The position of the vehicle carrying the sensor is assumed as latitude 0 and longitude 0 and the target is assumed to be at latitude 1 and longitude 1. The Euclidian distance between the two positions gives the distance between the vehicle carrying sensor and the front running vehicle.
From the distance change in distance measured by the sensor with respect to time the speed of the nearby vehicle, change in speed and relative speed of the nearby vehicle with respect to the vehicle carrying sensor are calculated and given as inputs to a Fuzzy Logic Controller.

The fuzzy logic controller using MATLab gives suggestion in accordance with the rulebase. The defuzzified output gives how much throttle has to be applied by the driver for safe overtaking of the front running vehicle without collision and the MATLab code gives a response plot in the form of a graph.

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IV.IMPLEMENTATION AND FUZZY LOGIC CONTROLLER

IMPLEMENTATION:

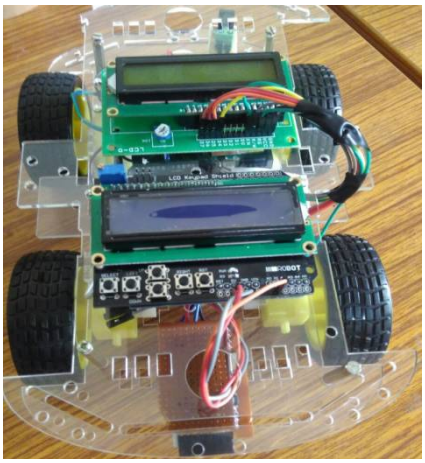

Fig 2 Ultrosonic sensor,RF transmitter and LCD Display mounted on a toy car (vehicle one)
Fig 3 RF receiver and LCD Display mounted on a four wheel vehicle platform (vehicle two)

The main hardware consists of two vehicles. Vehicle one as shown in Fig 2 is composed of ultrasonic sensor, its required circuitry, arduinouno, arduino shield LCD display and RF transmitter mounted on a TOY car. Vehicle two is constructed using four motors, wheels and two chassis. An arduinouno,arduino shield LCD display and RF receiver module are mounted on vehicle two.

FUZZY LOGIC CONTROLLER

A fuzzy logic controller is designed with four inputs. They are (i) distance calculated by the ultrasonic sensor (ii) calculated speed (iii) calculated delta speed which is a change in speed of the near by front running vehicle (iv) relative speed of the near by vehicle with respect to the vehicle carrying the sensor. The output is nothing but the guidance to the driver to recommend how much Throttle has to be for safe overtaking of the vehicle without collision.
The surface of the fuzzy logic controller:

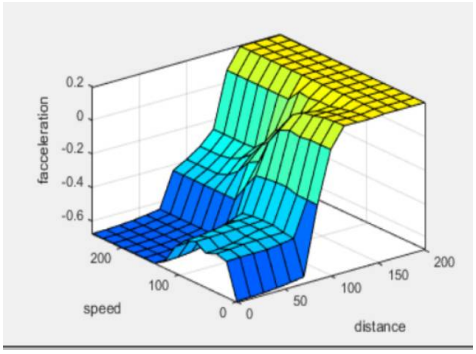

Fig 4 surface of the fuzzy logic controller

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V. WORKING

The working of the hardware is analysed by the following two cases.
Case (i)
The transmitter of the RF module is mounted in one vehicle1 through ARDUINO UNO and the Receiver part of the RF module is connected to vehicle 2 through another ARDUINO UNO.
Whenever a letter 'L' is typed from the transmitter end, the LCD displays "left turn" and at the reception end the vehicle 2 turns to the left direction after when the monitor displays the Left turn traffic symbol and a voice note saying 'Left'.Same procedure repeats when a letter 'R' is typed at the transmitter end , the LCD displays "Right turn" and at the reception end the vehicle 2 turns to the right direction after when the monitor displays the Right turn traffic symbol and a voice note saying 'Right'.Whenever a letter 'B' is typed at the transmitter end, the LCD displays "Speed Brake" and at the reception end the vehicle 2 stops after when the monitor displays the Speed Braker traffic symbol and a voice note saying 'Speed Braker'.
Case(ii)
The distance of the nearby vehicle has been calculated and monitored by ultrasonic sensor which interns the calculation of the speed of the front running vehicle, its change in speed and its relative speed with respect to the vehicle carrying the sensor. The fuzzy logic controller that takes the observed and calculated parameters such as distance, speed, change in speed and relative speed as inputs and gives suggestion to the driver that how much acceleration or deceleration has to be applied for collision less over taking of the vehicle.

VI. RESULTS AND DISCUSSION

The results of case(i) are as follows:
The letters L, R and B are typed one by one at the transmitter end in order to demonstrate the traffic signal alert in the form of audio and visual.
By typing 'L','R' and 'B'at the transmitting end the Monitor at the receiving end displaysand gives voice alert of the traffic signs of "Left turn" ,"Right turn" and "Speed braker" and also the proto type model i.e vehicle two is tured to Left,Rightans Stop for Speed braker option. .

The results of case(ii) are as follows:

For each diatance the speed, relative speed and change in speed are calculated and using Fuzzy Logic controller the value of throttle need to be applied is given through MATLAB as shown in Fig 7.

After 20 distance readings from the ultrasonic sensor the guidance to the driver is given in the form of a graph using MATlab

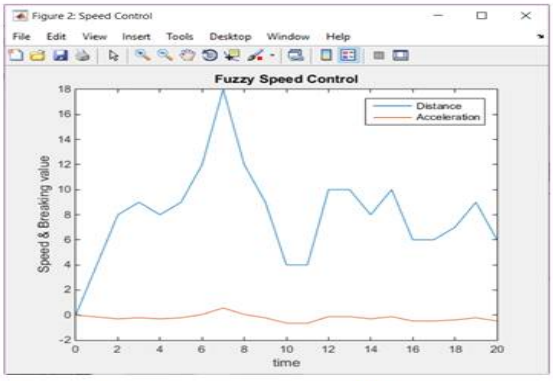

Fig 5 Resulting plot from MATLAB

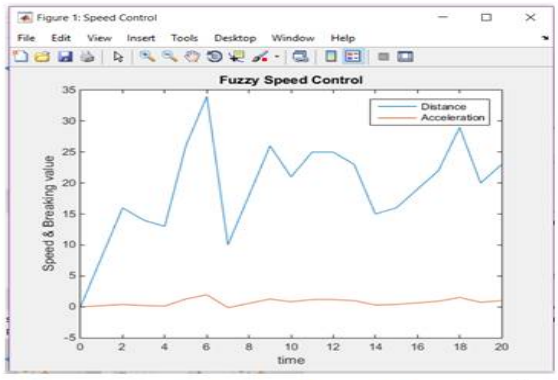

Fig 6 Resulting plot from MATLAB

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In the above graphs it is very clear that whenever the distance (calculated by the ultrasonic sensor) of the near by vehicle is more a positive throttle is applied. Whenever the distance is close by a negative throttle or brake is applied in order to overtake the near by vehicle without collision.

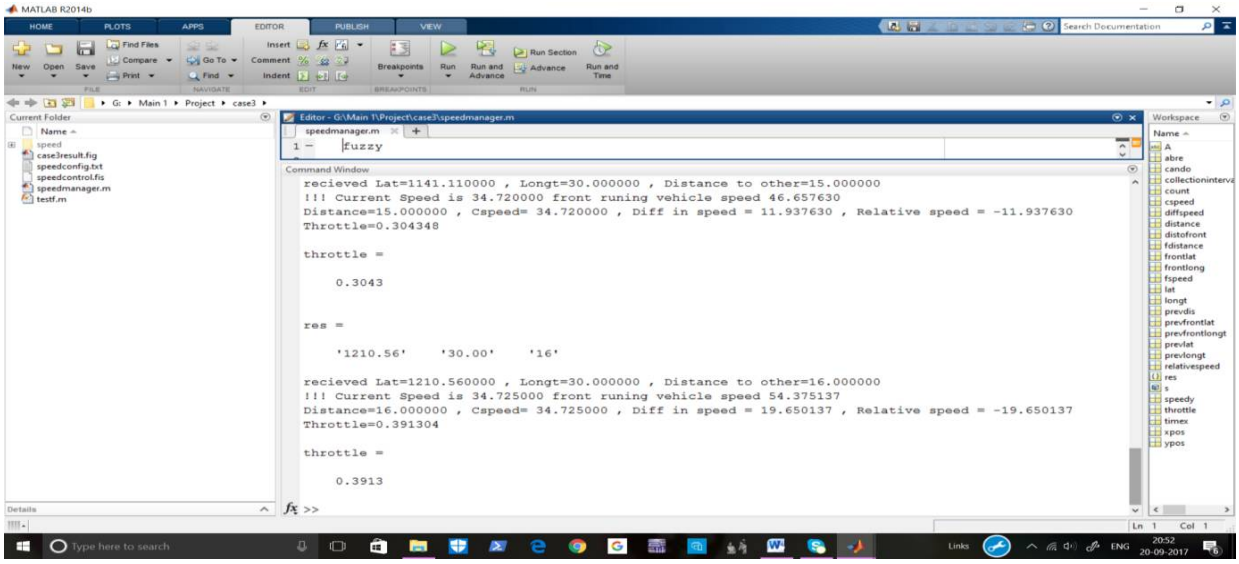

Fig 6 Throttle suggestions by MATLAB for each distance

After 10 distance readings from Ultrasonic sensor the distance, speed of the vehicle carrying sensor, the delta speed and the relative speed are calculated and the resultant graph as shown in Fig7 is plotted by using MATLAB.

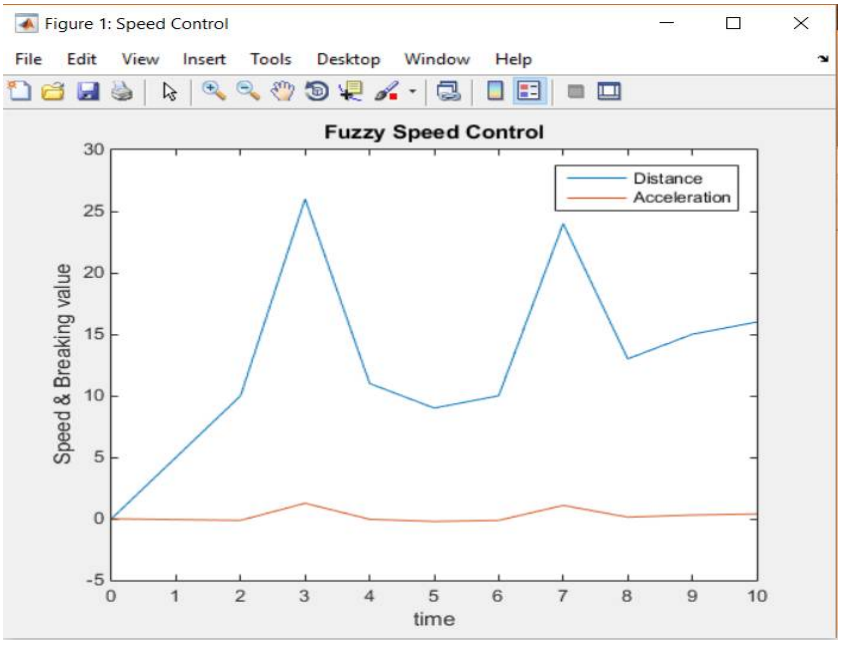

Fig 7 Distance and acceleration plot

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Its very clear from the Fig 7 that whenever the distance is more then the FLC suggest for more acceleration and whenever the distance is less the FLC suggests for lesser acceleration..

VII.CONCLUSION

We have implemented the proposed automatic traffic sign indications through voice and visual alerts and the suggestions and guidance to the driver about how much throttle he has to apply for safe overtaking of the vehicle based on fuzzy logic controller. We have tested each functionality case by case. Traffic signs were able to be sent from transmitter to receiver using ASK modulation. The traffic sign was detected at vehicle and played as voice to alert the driver. Also automatic braking using fuzzy logic is demonstrated and verified for correctness. The future work will be testing the braking model on real vehicle or vehicle emulator to verify the accuracy and its safety effects on drivers.

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