DESIGNING AN ADAPTIVE FRONT LIGHTING SYSTEM WITH VEHICLE SAFETY MEASURES USING FUZZY LOGIC TECHNIQUES AND ATMEGA 2560

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Abstract - Automobiles provide comfort and mobility to owners. While they make life more meaningful, they pose challenges and risks in their safety and security mechanisms. In this research work, the system has (1) Four-step ignition for automobiles, namely: (a) Door lock system, (b)Seat B elt system, (c) Level of Coolant in Radiator, (d) Alcohol detection, (2) Adaptive Front Lighting Systems (AFLS) and (3) anti-collision system using ultrasonic sensor using fuzzy logic. Adaptive Front Lighting Systems (AFLS) using the steering wheel sensor, the front head led can turn left and right. LED Systems perform different lighting scenarios according to the road conditions and incoming vehicles from opposite sides. The Anti-collision system uses the front ultrasonic and back ultrasonic. For example, if an object is near the front of the vehicle, the engine motor will stop; if medium, the motor will be slow. If far, the motor will continue its state. Moreover, the driving behavior is efficient for the traffic flow, comfortable and string stable, dampening traffic shockwaves that travel upstream. It proves the robustness of the proposed solution.

***Key Words*:** Vehicle, AFLS, Anti-collision System, Fuzzy Logic, Atmega 2560.

1. INTRODUCTION

India has a well-knit and coordinated system of transport that plays an important role in developing economic activities by promoting the fair distribution of produced goods and services and the movement of people. India's transport sector share in Gross Domestic Product (GDP) is steadily growing. It is one of the key indicators in the assessment of the socio-economic development of the country. Since traffic accidents are indicators of bottlenecks and other hindrances in smooth traffic flow, NCRB collects detailed data on Road accidents. In India, there were 4,37,396 traffic accidents reported in 2019. Road accident cases in the country have decreased from 4,45,514 in 2018 to 4,37,396 in 2019. The fatalities in road accidents have increased by 1.3% (from 1,52,780 in 2018 to1,54,732 in 2019) of 'Road Accidental Deaths'. In India, Accident cases in States from 2018 to 2019 was reported in Madhya Pradesh (from 49,080 to 53,379) followed by Rajasthan (from 22,401 to 24,281) and Uttar Pradesh (from 40,783 to 42,368).

Car crash deaths account for 1.4% of total deaths per year in the US.94% of fatal regular car accidents are because by human error. There are four deaths per hour due to frequent car accidents. Meanwhile, there are around 285 injuries caused by regular car crashes per hour. Its puts one death for every 100 million miles that a person drives.

Nowadays, Automation can help reduce the number of crashes on our roads. Government data identifies driver behavior or error as a factor in 94 percent of crashes, and self-driving vehicles can help reduce driver error. Higher levels of autonomy can reduce dangerous driver behaviors. It can be distinguished by quality, price, features, and even brand. In the present paper, a fuzzy logic controller was developed. The aim is for the controller to be safe and comfortable, and efficient regarding traffic flow. The core of the controller is a fuzzy inference system. The sensors can detect different vehicle parameters, and the fuzzy rules merge the sensor's values to detect objects at critical points. For all the immediate reactions of the Sensors, the APR voice module response is not immediate. Furthermore, this work has constructed the circuit module and structure for the Four-step ignition and Anti-Collision with Adaptive Front Lighting Systems (AFLS). Using those fuzzy sets, the controller is aware of the safety condition of the vehicle, so appropriate action can be taken to investigate stability, comfort, traffic flow, and react in case of a dangerous situation.

2. RELATED WORK

The proposed system employs the "Adaptive Front Light System of a Vehicle for Road Safety". It focuses on developing a prototype RGB to grey conversion, thresholding, morphological image recognition operations, and processing [1]. In a live camera scene, an RGB to grey conversion is performed. The ADCs convert the data from the steering wheel sensors into digital inputs, then feed it into the 8051 microcontrollers. Using a serial peripheral interface (SPI) and an asynchronous universal receiver/transmitter (UART) [2]. However, the system kinematics modeling and AFS control strategy in a hierarchical controller is based on fuzzy control. The test demonstrated that the model and controller are accurate [3]. [4] The intelligent front-lighting system employs image processing techniques such as neural networks and fuzzy logic and is supported by a prototype database. Finally, it generates the best adaptive light distribution while not illuminating the opposite road. [5] This paper presents AFS control alternatives that use fuzzy logic (types 1 and 2) to determine their operating parameters while considering road conditions. [6] The dynamic control effect of the fuzzy control algorithm of the intelligent headlamp control system based on active safety provides a reliable control foundation for determining the headlamp deflection angle. [7] The alcohol sensor is attached to the steering wheel and controls the vehicle based on the presence of alcohol. Then it sends input to a GSM modem to send an SMS stating that the driver was either not wearing a seatbelt or was intoxicated. [8] A comparison of cascade controllers for boiler water level control using Mamdani is presented in this paper. Type 1 Fuzzy Logic and Interval Type 2 fuzzy logic controller. Based on the implemented MATLAB simulation. [9] Fuzzy logic theory and neural network theory are used to improve safety while driving a Controller design in highly nonlinear processes where explicit mathematical descriptions of the object to be processed become inconsequential. [10] IoT and blockchain technology to improve the security of an innovative lock system. The blockchain network is a peer-to-peer network. It prevents an unauthenticated user from participating in the blockchain network. [11] The purpose is to present a robust seat belt detection approach. Seat belt detection is a critical challenge in traffic video surveillance. A salient gradient map of this type is incorporated into a machine learning approach to perform binary decisions on whether or not the input image yields a seat belt.

According to previous research, there are several methods for implementing the vehicle Safety System. This paper describes the design and implementation of a Fuzzy Inference System that uses a FIS Tree to control vehicle safety measures. Such as door locks, seat belts, coolant levels in radiators, alcohol detection with the ignition system, anti-collision systems, and adaptive front lighting systems.

3. METHODOLOGY

This chapter describes the steps involved in this work, such as collecting databases from various sensors configured with fuzzy logic with the help of Arduino Mega 2560.

3.1. COMPONENTS

ATMEGA 2560 contains 54 digital input/output pins, 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connector, a power jack, and an ICSP header, and a reset button. GEARED DC MOTOR has a gear assembly attached to the motor. The gear assembly helps in increasing the torque and reducing the speed. The speed of the motor is 500 RPM. L298N MOTOR DRIVER MODULE This is a high-capacity DC motor driver module. An L298 motor driver IC and a 78M05 5V regulator are included in this module. It has directional and speeds control over two DC motors. Variable input voltage can be used to control the speed of a DC motor. PWM is a technique that uses a series of ON-OFF pulses to adjust the average value of the input voltage. H-Bridge – Rotation direction control. HIGH-SPEED DIGITAL SERVO MOTOR (MG996R) The Tower Pro MG996R High-Speed Digital Servo Motor rotates 45° in each direction, making it a 135° servo motor. It is a Digital Servo Motor that receives and processes PWM signals faster and better. ULTRASONIC SENSOR (HC-SR04) An ultrasonic sensor, also known as an ultrasonic transducer, is based on a transmitter and receiver and is mainly used to determine the distance from the target object. POTENTIOMETER is defined as a three-terminal variable resistor in which the resistance is manually varied to control the flow of electric current. Its terminal contacts between which a uniform resistance is placed in a semi-circular pattern. The LDR sensor module is a low-cost digital and analog sensor module capable of measuring and detecting light intensity. This sensor also is known as the Photoresistor sensor. This sensor has an onboard LDR (Light Dependent Resistor) that helps it detect light. GAS SENSOR (MQ3) This module is made using Gas Sensor MQ3. It is a low-cost semiconductor sensor that can detect the presence of alcohol gases at concentrations from 0.05 mg/L to 10 mg/L. WATER LEVEL SENSOR The sensor has a series of ten exposed copper traces, five of which are power traces and five are sense traces. These traces are interlaced so that there is one sense trace between every two power traces. PUSH BUTTON (SELF LOCK) The push button switch is usually used to turn on and off the control circuit. Once the external force is removed, the switch returns to the initial position due to the spring's action. The push-button switch can complete basic controls such as start and stop. PUSH BUTTON is used as a start key. It is a small switch. A small metal spring inside makes contact with two wires when it's on, allowing electricity to flow.

Table :1 Requirement parameters

S. No	Components	Input /Output	Operating Voltage	Operating Current
1	Push Button	Input	5v(Dc)	0.1A
2	Water Level Sensor	Input	5v(Dc)	<20mA
3	Alcohol Sensor	Input	5v(Dc)	150mA
4	Ldr	Input	5v(Dc)	<15mA
5	Led (Red)	Output	3v (Dc)	20mA
6	Led (White)	Output	2.8 (Dc)	20mA
7	Potentiometer	Input	5v(Dc)	<10mA
8	Servo Motor	Output	5v(Dc)	1200mA
9	Dc Motor	Output	12v (Dc)	300mA
10	Ultrasonic Sensor	Input	5v(Dc)	15mA
11	L298n Module	Input	12v (Dc)	2A

The system has twelve inputs (Start key, Door lock R & L, Seat Belt R & L, Level of Coolant in Radiator, Alcohol detection, Ldr R & L, Steering sensor, Ultrasonic sensor Front & Back and four outputs (led, APR8-channel module, servo, and

Engine (motor driver)) and data processing unit (Arduino Mega 2560).

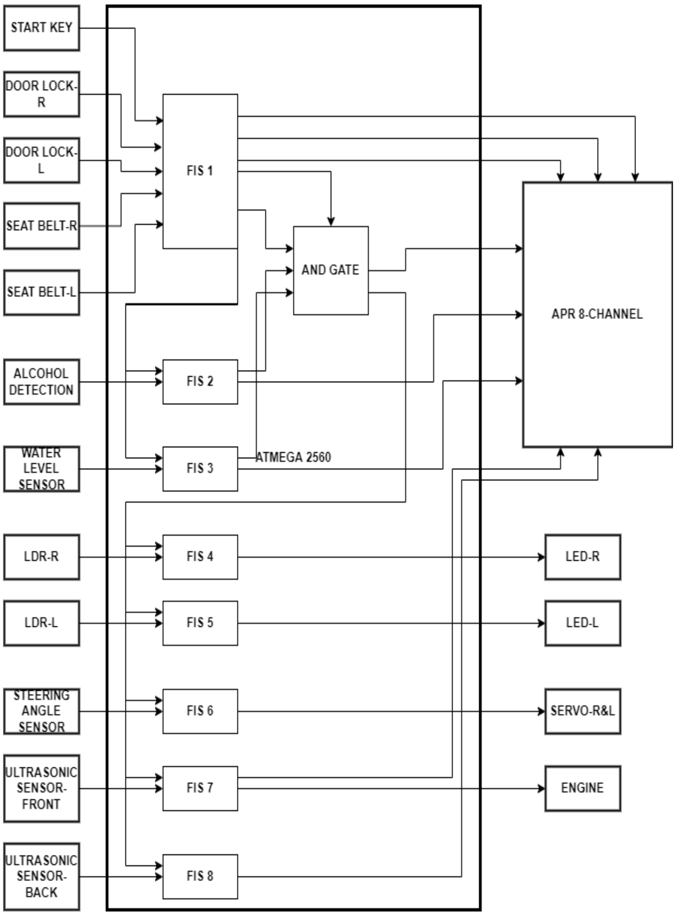

Figure 1: Block diagram of the proposed system

- (a) When the start key is pressed, all sensors are powered. In the FIS system 1 (Start key, Door lock R & L, Seat Belt R & L), check the sensors data to operate the fuzzy rules example, If the start key is on, Door lock R & L are closed, Seat Belt R & L are locked then only enable the Level of Coolant and gas sensor (fis system 2 & fis system 3) Otherwise any one of the inputs does not satisfy its conditions then it activates the corresponding input of the APR8-channel 1, 2, 3.
- (b) In the FIS system two this will check the Coolant level of the radiator if above 50% means the output will be off, otherwise it will activate the corresponding input of the APR8-channel 4.
- (c)In the FIS system three, this will check the Alcohol level. If belove 50% means the output will be off, it activates the corresponding input of the APR8-channel 5.
- (d) Start key, the FIS system 1, 2, and 3 are connected with AND gate. In this gate, if either of the inputs is off (0), then the output is also off. The output will also be on if all of the inputs are on.
- The output of the gate is taken as parallel. One activates the corresponding input of the APR8-channel 6. Another enables the Ldr R & L, Steering angle sensor, and Ultrasonic sensor Front & Back.
- Front Lighting Systems (FLS) using the steering wheel sensor, the front head led can turn left or right. LED Systems perform different lighting scenarios according to the road conditions and incoming vehicles from opposite sides,
- (e) According to the Ldr R in the FIS system 4 it will produce the corresponding input to the LED R. (f)According to the Ldr L in the FIS system 5 it will produce the corresponding input to the LED L.
- (g) According to the Steering angle sensor in the FIS system 6 it will produce the corresponding input to the Servo R & L.
- The anti-collision system is built using the front ultrasonic and back ultrasonic. For example, if an object is near the front of the vehicle, the engine motor will stop. If far, the motor will continue its state. If medium, the motor will be slow.
- (h) According to the Ultrasonic sensor Front in the FIS system 7, it will produce the corresponding input to the Engine (motor driver).
- (i) According to the Ultrasonic sensor Back in the FIS system 8, it will produce the corresponding input to the APR8-channel 8.

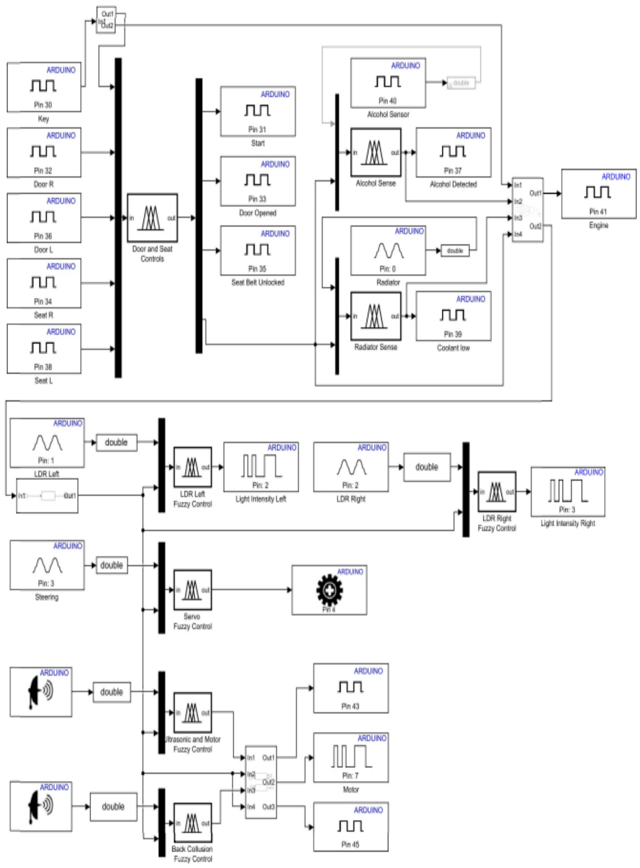

Figure 2: Proposed Fuzzy Inference Systems in Simulink

3. RESULTS AND DISCUSSION

This chapter describes the results and discussions of the prototype; this includes the fuzzy inference systems, output from the various fis, and the final process.

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Figure 3: Fuzzy Logic Designer for Door and Seatbelt (Fis1)

The Fuzzy Logic Designer app lets you design and test fuzzy inference systems to model complex system behaviors. Design Sugeno fuzzy inference systems to add or remove input and output variables, Specify input and output membership functions.

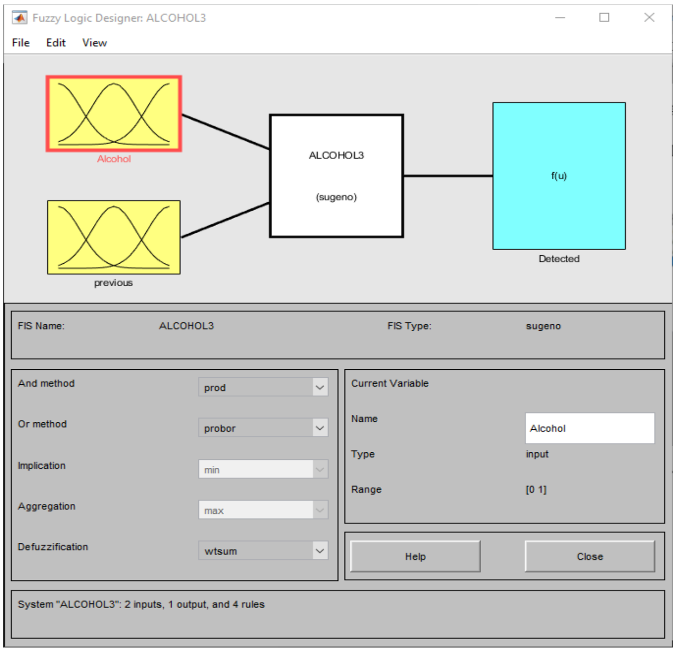

Figure 4: Fuzzy Logic Designer for Alcohol Level (Fis2)

Add The Input Alcohol, Output of Fis 1 And Output Alcohol Detected, and Specifying Input and Output Membership Functions.

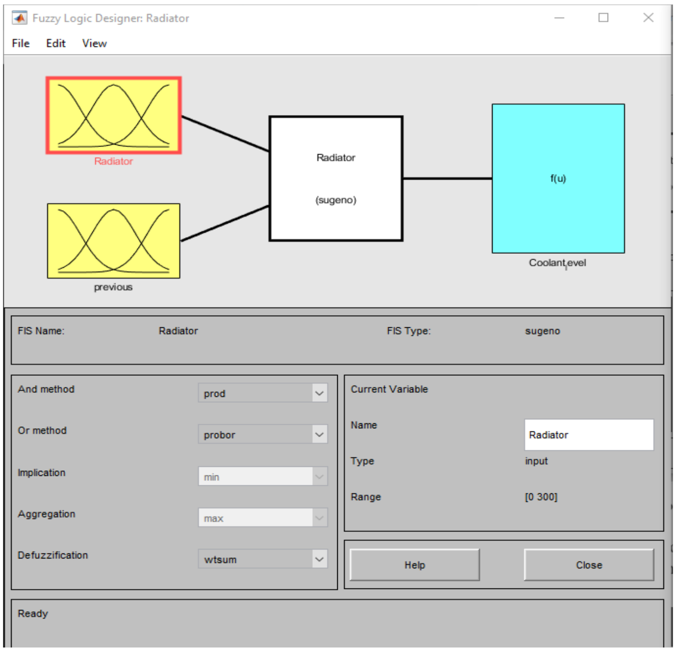

Figure 5: Fuzzy Logic Designer for Coolant Level (Fis3)

Add the input coolant level, the output of fis 1, and output coolant, and specify input and output membership functions in the form of linear.

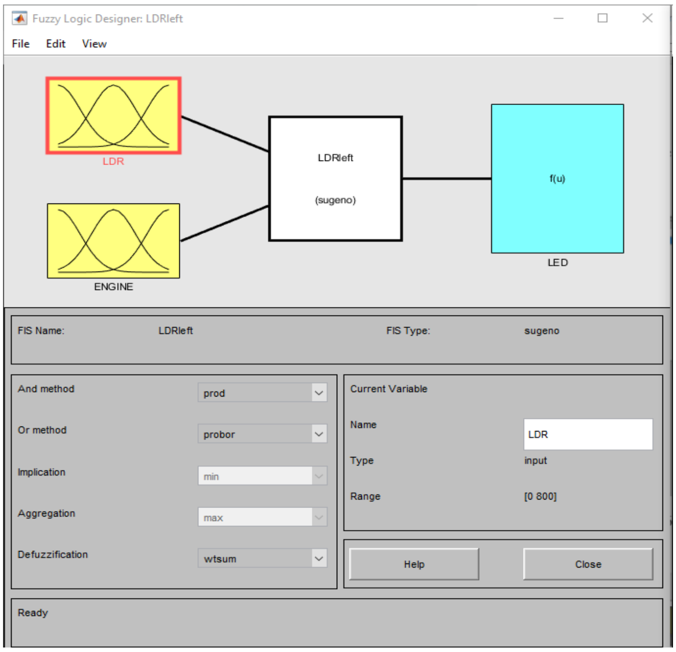

Figure 6: Fuzzy Logic Designer for Head Lamp (Fis4 & Fis5)

Add the input LDR, Engine state, and output LED, and specify input and output membership functions in the linear form.

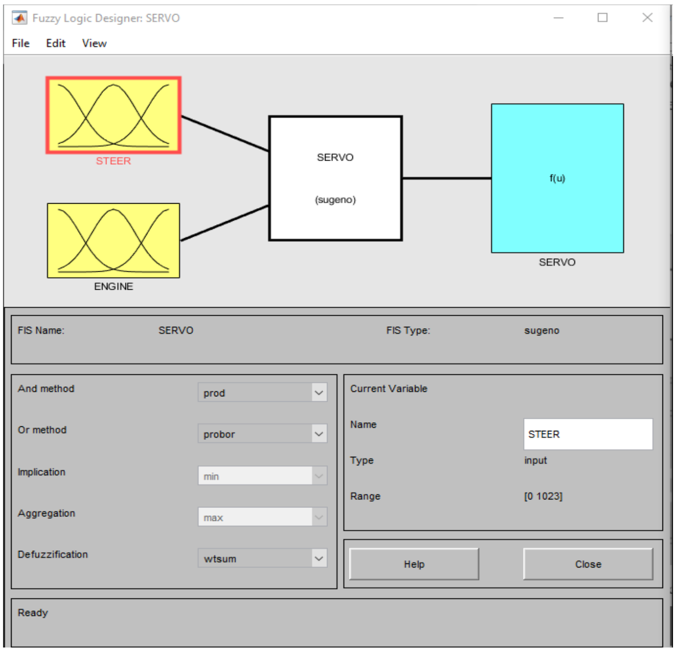

Figure 7: Fuzzy Logic Designer for Head Lamp Position (Fis6)

Add the input Steering angle sensor, Engine state, and output headlight position, and also specify input and output membership functions in the form of linear.

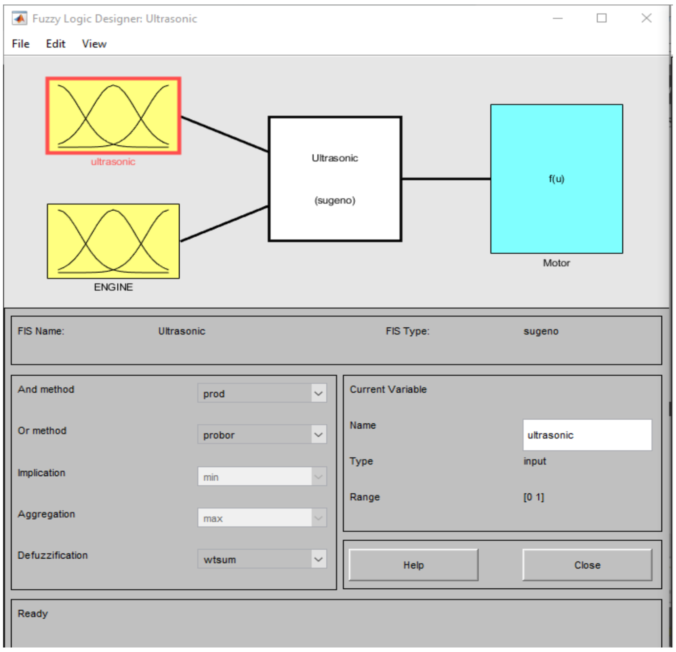

Figure 8: Fuzzy Logic Designer for Engine Rpm Fis7 & Fis8

Add the input front ultrasonic, Engine state, and output engine motor and specify input and output membership functions in the form of constant.

WORKING MODEL

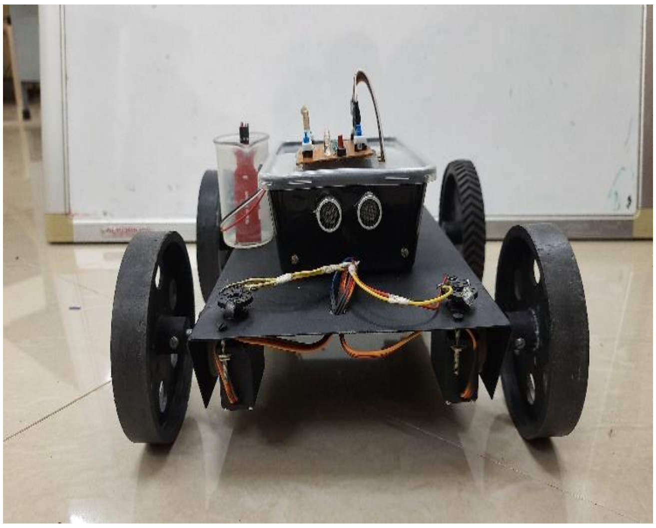

Figure 9: Front view of model with LDR, LED, Servo and Ultrasonic

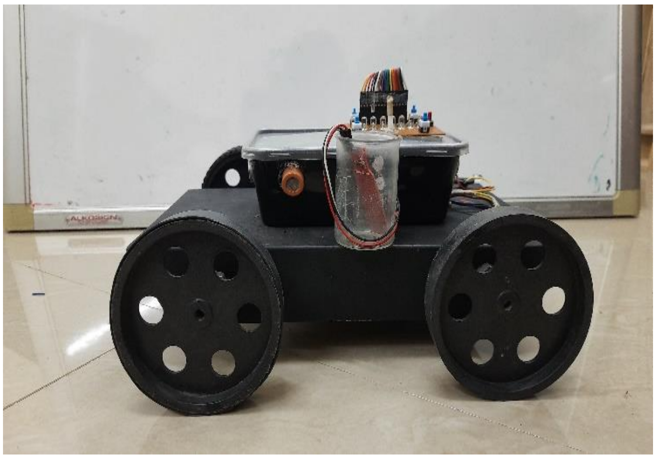

Figure 10: Side view of model with Gas sensor and Radiator level

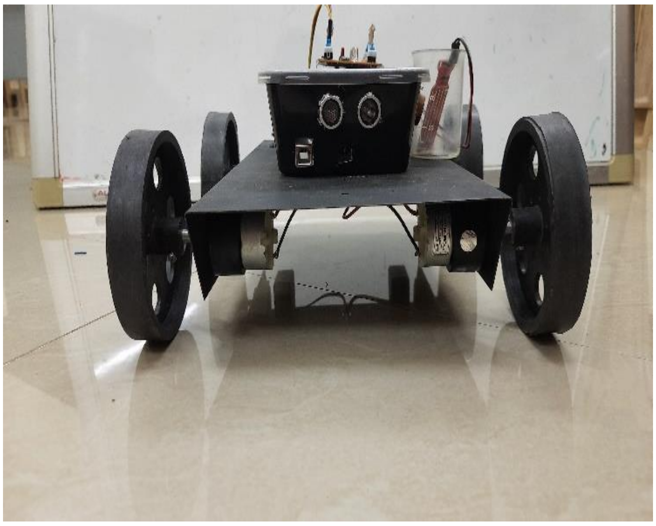

Figure 10: Back view of model with Ultrasonic and Programming port

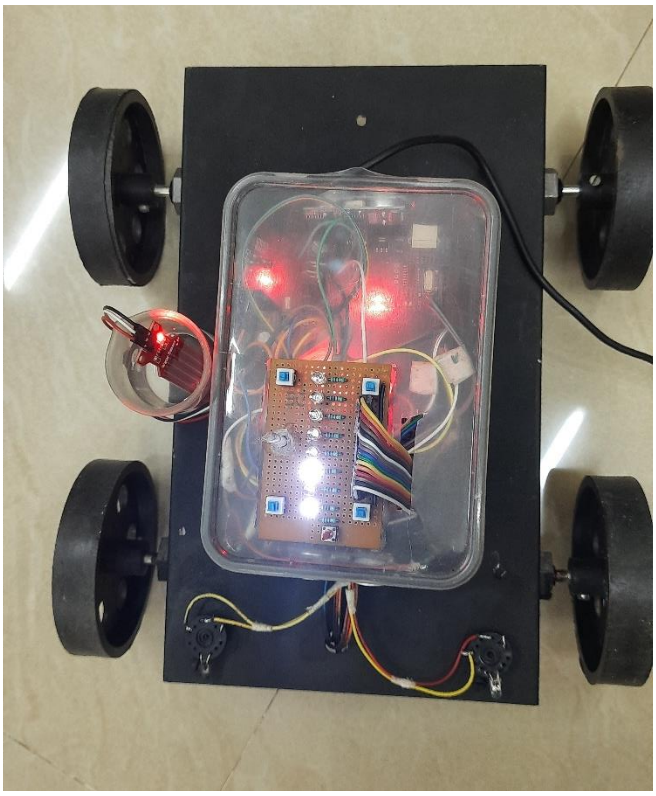

Figure 11: Working Model of Proposed system's Top view with APR indications

DISCUSSION

This Research work, control Adaptive Front Lighting Systems, door locks, seatbelts, radiator coolant level, alcohol detection with ignition, and anti-collision system were monitored using Fis Tree, the efficiency of fuzzy output decreases as the number of inputs in this system grows. Upgrade the controller to solve this problem.

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