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Electronic Systems Design for Driver Alertness

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***Abstract:** Automotive systems are getting more responsive and giving feedback to the driver and passengers with the help of electronic systems ensuring safety. As seen the growth towards electric mobility engineers are more indulged in electronic systems and presenting innovative ideas for future developments. The presented simulation model of an electronic system combines the engine coolant temperature sensor, oxygen sensor, and seat belt warning system. The system is proposed using TINKERCAD software and the software is designed through Arduino. The driver will be able to see the temperature of the coolant and also can find out whether the air and the fuel mixture is rich or lean as well as be alerted for wearing a seatbelt.*
***Keywords:** Engine Coolant Temperature Sensor, Oxygen Sensor, Seat Belt Warning System, Electronics System for Vehicle, Arduino, Software Design using Arduino, Passive Safety System.*

I. INTRODUCTION

Automobiles are getting very responsive and give quick feedback to the commands of passengers. This growth is possible because of the electronic systems present inside the car body. Electronic systems can diagnose any faults and alarm the passengers before any tragedy happens. These systems consist of input, process, and output. They transform one signal to another to give the desired output. These systems can be interconnected to create an electronic system. This assessment describes some types of sensors used in automobiles which after interfacing with the microcontroller creates a reliable electronic system, also the working of different sensors combined to interface with the same microcontroller is presented. The following circuit diagram of an automotive electronic system interfaces an engine coolant temperature sensor, an oxygen sensor, and a seat belt warning system with a microcontroller and gives the information to the driver. The aim of creating this system is to inform the driver about coolant temperature and show whether the air and fuel mixture is rich or lean to ensure a smooth performance of the vehicle. The driver should get notified about wearing the seatbelt before driving.

II. DESIGN

The temperature sensor, air to fuel ratio sensor and pushbutton sends input to the microcontroller and microcontroller provides output to the buzzer, LED and LCD. In the circuit design, the temperature sensor senses the engine coolant temperature and it is then displayed on the LCD. The gas sensor represents the air to fuel ratio sensor and the data is displayed on the LCD as rich mixture or lean mixture or stoichiometric mixture.

The pushbutton works like a seatbelt buckle, when pressed, the buzzer and LED stops.

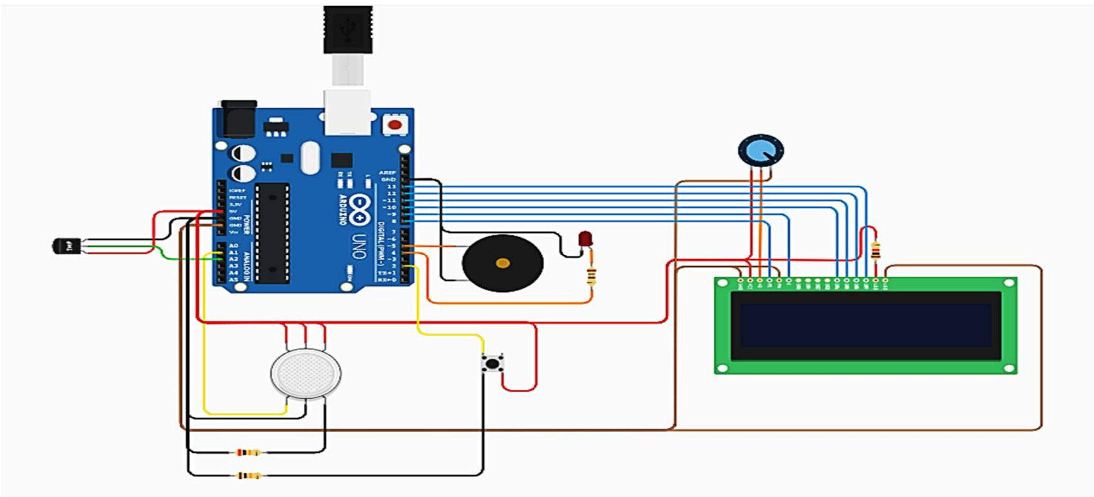

Figure 1: Hardware design

III. SOFTWARE DESIGN

Text | 1 (Arduino Uno R3)

```
#include <LiquidCrystal.h>
LiquidCrystal lcd(8, 9, 10, 11, 12, 13);


float value;
int tmp = A2;

int buttonPin = 2;//pushbutton pin
int buzPin = 5;//buzzer pin
int LED = 4;//led pin
int A = 0;

void setup() {
  Serial.begin(9600);
    lcd.begin(16, 2);

  pinMode(A1, INPUT);//gas sensor input

  pinMode(tmp,INPUT);//temperature sensor input

  pinMode(buzPin, OUTPUT);//buzzer pin output
  pinMode(LED, OUTPUT);//led pin output
  pinMode(buttonPin, INPUT);//pushbutton input


}

void loop() {
  //display and alert if driver is not wearing the seatbelt
  A = digitalRead(buttonPin);//read the value of pushbutton
  if ( A == HIGH )//pushbuton is pressed
  {
  digitalWrite(buzPin, LOW);//buzzer off
  digitalWrite(LED, LOW);//led off

  }
  else {
    digitalWrite(buzPin, HIGH);//buzzer on
    digitalWrite(LED, HIGH);//led on
   lcd.setCursor(0,0);//set position of the lcd cursor
  lcd.print("Wear Seatbelt");//display "wear seatbelt"
    }
  //clear the lcd
  delay(1000);
  lcd.clear();

  //display whether air and fuel mixture is rich, stoichiometric, lean
   int a;
  a = analogRead(A1);//read input signal from gas sensor
  lcd.setCursor(0,0);
  lcd.print("Mixture is :");


  if(a > 700 && a < 800){

    lcd.setCursor(0,1);
    lcd.print("Stoichiometric");


  }

  else if (a > 800 && a < 950)
  {
    lcd.setCursor(0,1);
    lcd.print("RICH");
   }

   else if(a > 0 && a < 700) {

    lcd.setCursor(0,1);
    lcd.print("LEAN");
   }
   //clear the lcd
   delay(2000);
   lcd.clear();

   //display temperature of coolant
    value = analogRead(tmp)*0.004882814;
    value = (value - 0.5) * 100.0;
    lcd.setCursor(0,1);
    lcd.print("Tmp:");
    lcd.print(value);//print teperature value
    delay(2000);
    lcd.clear();

  }
```

Serial Monitor

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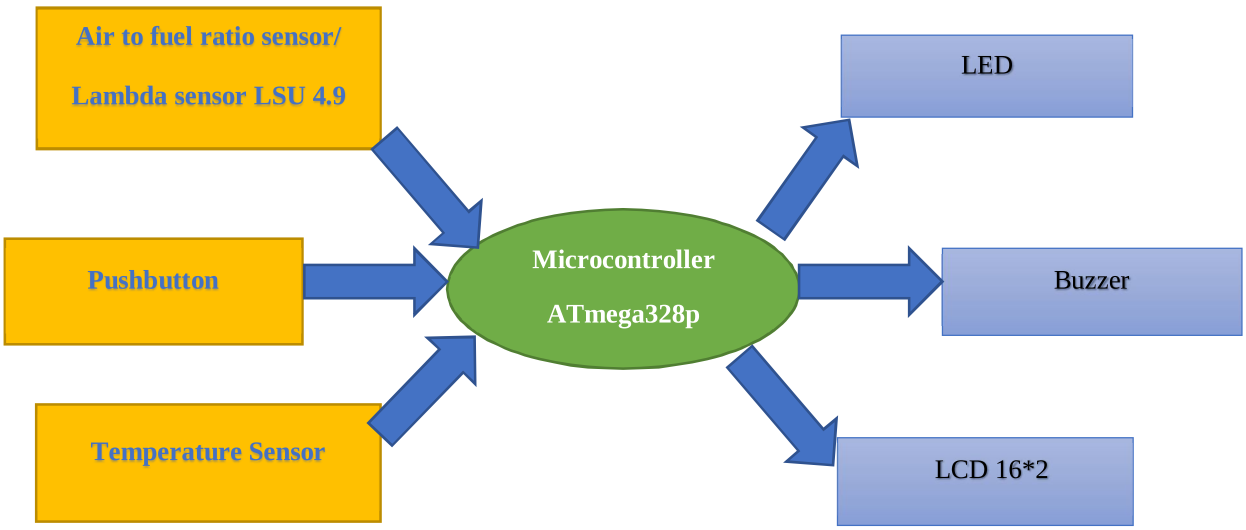
IV. FUNCTIONAL BLOCK DIAGRAM



V. LIST OF SENSORS AND ACTUATORS REQUIRED

1) Arduino Uno which is based on ATmega328p microcontroller
2) Temperature sensor (TMP36)
3) Gas sensor representing air to fuel ratio sensor
4) LED
5) Buzzer
6) LCD 16*2
7) Pushbutton representing locking of seatbelt

A. Controller Description

A microcontroller is a small computer with CPUs as cores along with memory[1]. In this project, the ATmega328p microcontroller is used to interface with sensors.

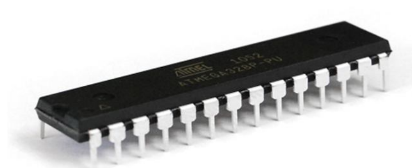


Figure 2: Microcontroller (ATmega328)

ATmega328 is an AVR microcontroller manufactured by Microchip. It follows RISC Architecture and processes up to 8 bits of data. It has a flash type program memory which can store data up to 32KB.

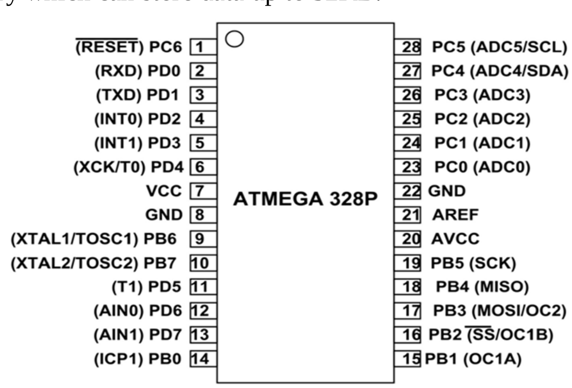


Figure 3: Pin configuration of ATmega328p microcontroller

ATMega328p Specifications

Microcontroller	Atmel ATmega328
Operating Voltage (logic level)	5v
Input Voltage (recommended)	7v-12v
Input Voltage (limits)	6v-20v
Digital I/O Pins	14 (of which 6 provide PWM output)
Analog Input Pins	8
DC Current per I/O Pin	40mA
Flash Memory	32 KB of which 2 KB used by bootloader
SRAM	2KB
EEPROM	1KB
Clock Speed	16MHz
Dimensions	0.73" x 1.70"
Length	45 mm
Width	18 mm
Weight	5g

Figure 4: Specifications of Microcontroller

VI. ANALYSIS OF SENSORS

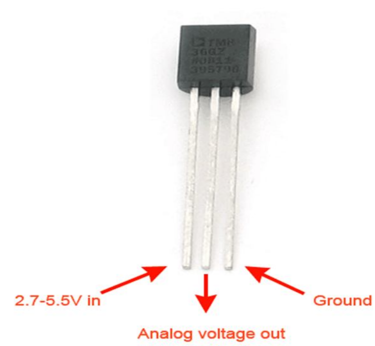


Figure 5: Temperature Sensor

1) *The Temperature Sensor (TMP36):* Used here indicates the temperature of the engine coolant. It can operate on low voltage from 2.7v to 5v. with an output range of 1v to 2v, it can measure temperature from -40°C to 150°C.[2]

Figure 6: Lambda Sensor

2) *Lambda sensor (LSU 4.9)*: Is used to determine the air to fuel ratio. It has a 6 pin configuration. The power needed to operate it is 7.5v and can run with maximum exhaust temperature of 930°C.[3]

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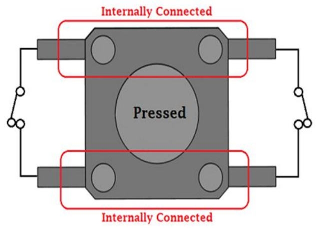

Figure 7: Pushbutton

3) *Pushbutton:* The power rating for pushbutton is MAX 50mA 24V DC, with insulation resistance of 100Mohm at 100v and contact resistance MAX 100mOhm. It can operate under temperature range -20 to +70 ℃.[4]

VII. INTERFACING CIRCUIT DIAGRAM

A. For the temperature sensor: The power pin, output pin (signal pin) and ground pin is connected to the 5v pin, A2 pin and ground pin of the Arduino.
B. For the gas sensor: The A1, H1 and A2 pins are connected to the 5v pin of the Arduino and H2 pin is connected to ground pin of the Arduino. B2 pin is connected to the ground via a 20kohm resistor. B1(signal pin) pin is connected to the A1 pin of Arduino.
C. For the pushbutton: The terminal 1a is connected to the ground pin of the Arduino via a 10kohm resistor. Terminal 2a is connected to the 5v pin of Arduino. Terminal 1b(signal pin) is connected to the digital pin2 of Arduino.
D. The LED is connected with the Arduino digital pin4 via a 120ohm resistor and the buzzer is connected to the digital pin5 of Arduino.
E. Data pins DB4, DB5, DB6 and DB7 of the LCD are connected to the digital pins 10, 11, 12, and 13 of the Arduino.
F. The input values from the sensors is displayed on the LCD in a sequence at a time interval of 1 second

VIII. FUNCTIONING OF SYSTEM

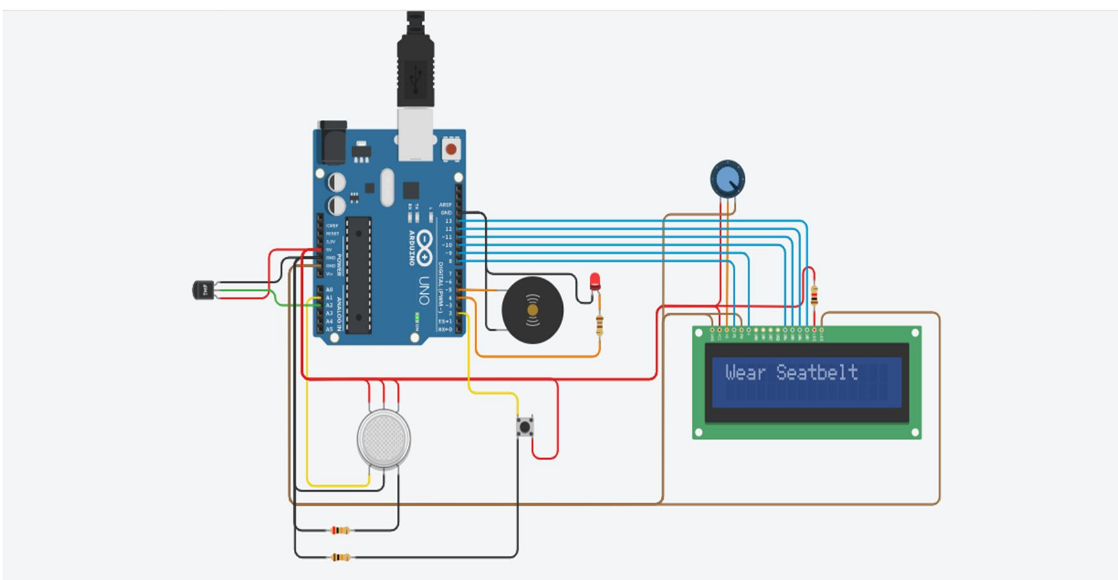

Figure 8

When the system is switched on the first warning of wearing a seatbelt is showcased. Unless the driver wears a seatbelt the buzzer and the LED stay on as shown in figure 8. The wearing of seatbelt action is replicated by pushing the button of pushbutton.

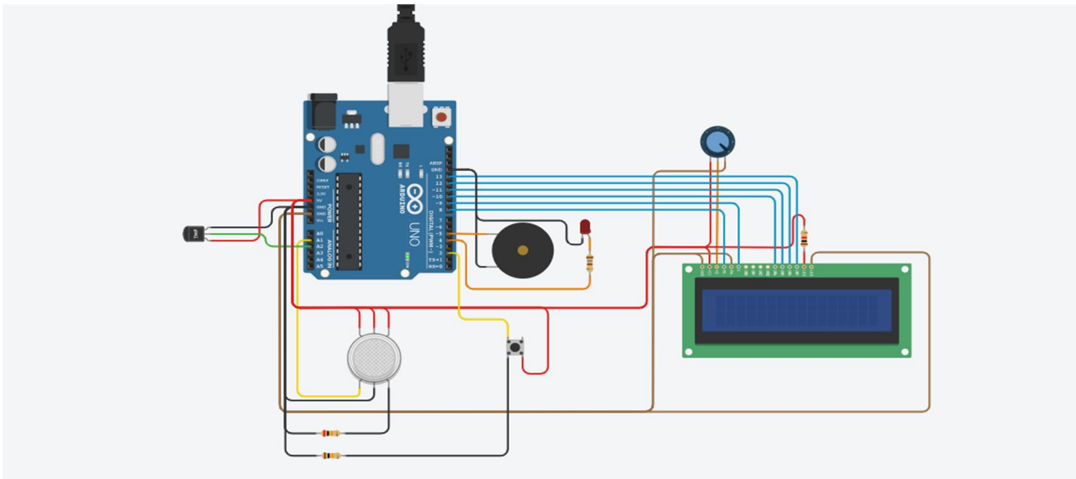

Figure 9

When the pushbutton is pressed the buzzer and LED turns off and LCD is cleared to display other values. (Figure 9)

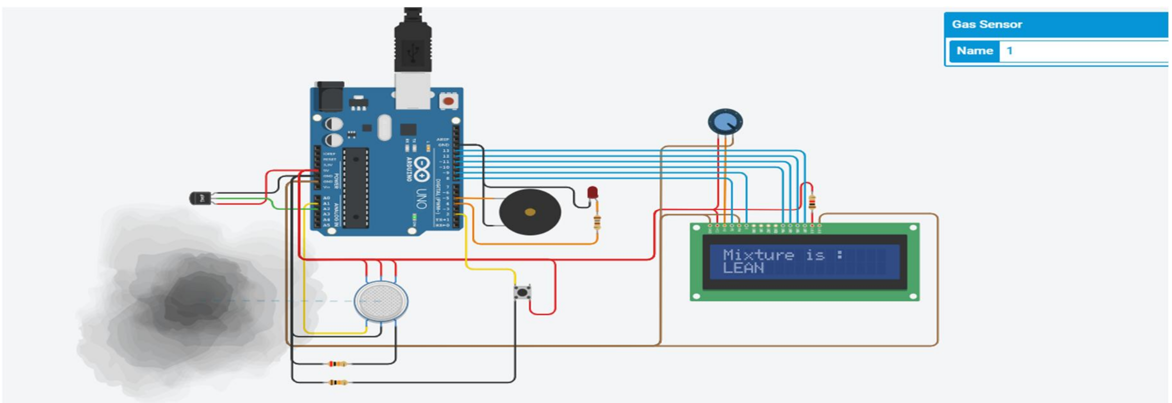

Figure 10

Next, the input values of gas sensor are displayed. When the carbon contents present inside the gas are less, then the driver can get information about air and fuel mixture as lean as can be seen in figure 10.

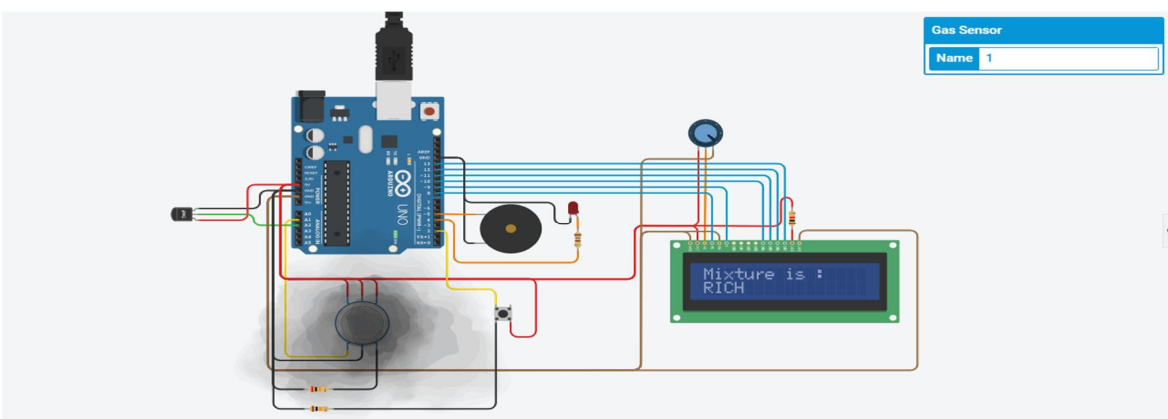

Figure 11

when the carbon contents are more then air to fuel mixture can be determined as rich and it is displayed on the LCD as displayed in figure 11.

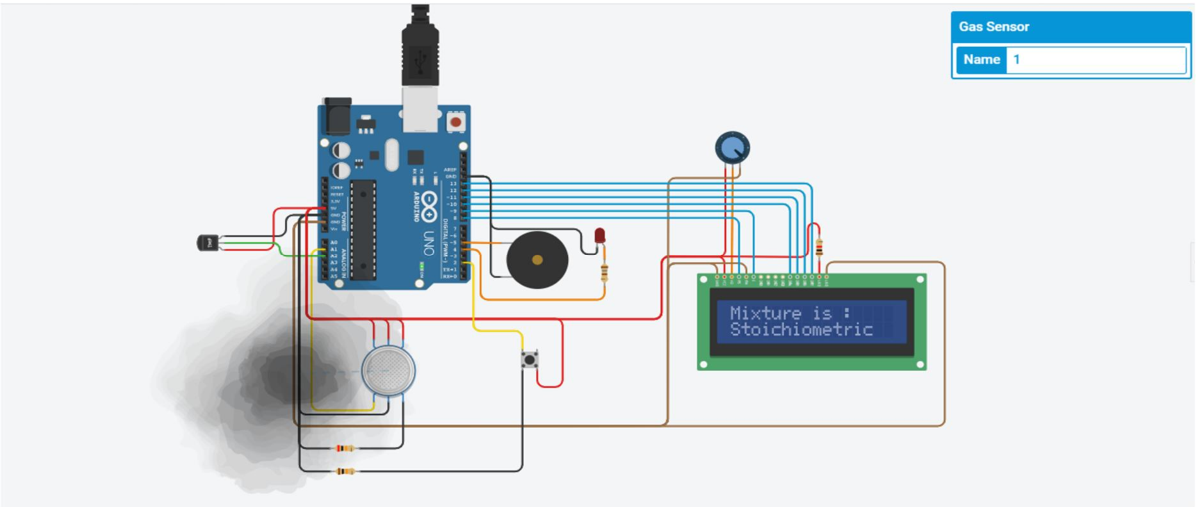

Figure 12

When the carbon contents present in the gas are more than lean mixture and less than rich mixture then the mixture is stoichiometric message will appear on the LCD. (See figure 12)

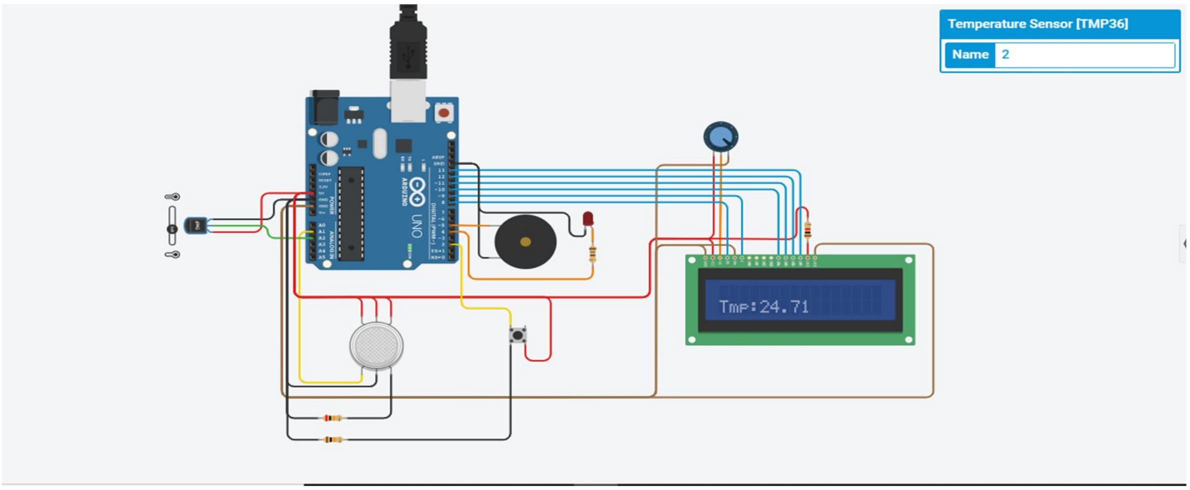

Figure 13

The temperature sensor shows the next value of temperature of engine coolant. With the help of the variable button of the temperature sensor we can replicate if the engine coolant temperature is increasing or decreasing as shown in figure 13. The value is the displayed accordingly.

IX. RESULT & CONCLUSION

The system works efficiently with minute lag which can be due to data processing. A combined system like the one presented, will be an advantage for a vehicle and for the passengers as well. The driver can have an eye on the vehicle's performance just by getting display information and also as a matter of safety the system can alert the driver to wear the seat belt. Further changes can be done in the system for more safety and alerts.

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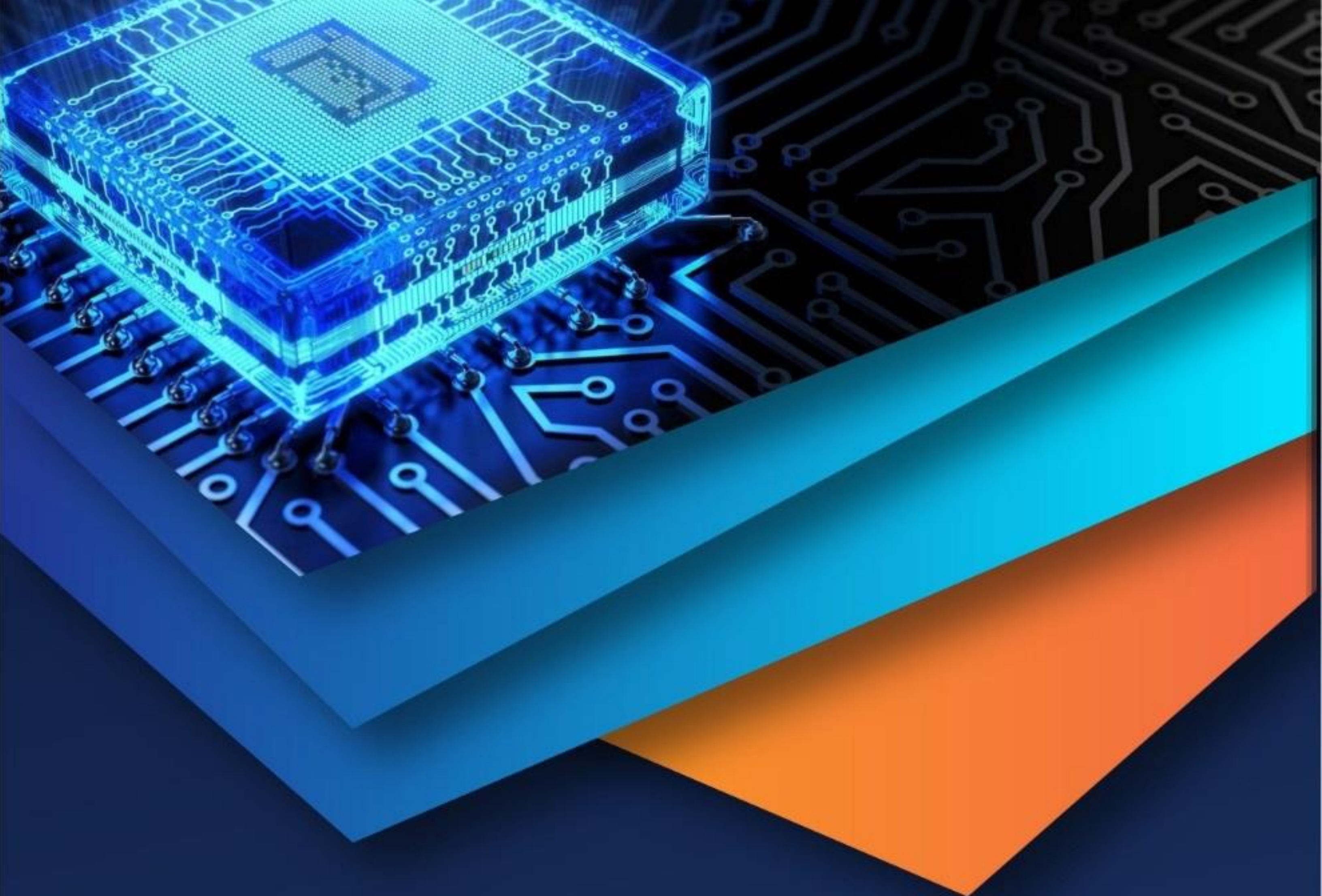

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