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Microcontroller Based Automatically Car Engine Status Monitoring and Control System

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Abstract: An integrated, smart and low cost automatically car engine status monitoring and control system is constructed with the use of standard technology and commercial items which automatically monitor and control the car engine while driving. The main purpose of the system is to design and construct a safety system for the car engine while driving as cost efficient as possible. A temperature sensor LM35 is used for the measurement of car engine temperature. The LDR is used for detecting light due to spark or fire occurred in the car engine. A warning message about the presence or absence of CO gas in the car engine is displayed in LCD. A 12V DC fan is used to reduce the engine heat when the engine temperature has excess heat than normal engine temperature value. LED display is found if the car battery is full or low voltage condition. By the time spark or light is in the engine, the alarm system automatically activates with a limited time. For the system, the simulation result is done by using Proteus professional schematic software. PIC Basic Pro language is chosen for the development of PIC microcontroller. The device can be used for different purposes like greenhouse monitoring, gas leakage detecting, industrial monitoring, weather forecasting and vehicle cabin safety monitoring etc.

Keywords: Microcontroller, ADC, LM35, Battery Voltage, LDR, MQ-6.

I. INTRODUCTION

The challenges of successful vehicle monitoring and controlling systems involve the efficient and specific designs. The applications of car engine status monitoring and control system can be widely found in the fields of transporting environments. The main application of the system is to monitor and control the car engine to which the sensors are connected, giving the information about the car engine. There are two basic parts in the project. First is the parameter monitoring system and second are the parameters controlling system [9]. For the parameters monitoring system, temperature sensor, 12 V battery, light sensor and gas sensor are used to give the values and information of car engine in LCD. A fan for excess engine temperature, two active LEDs for car battery system, and a buzzer for fire alarm system are also used for the parameters controlling system. In this system, car engine is the heart of monitoring and controlling system because it is not only the prime source of transportation but also the prime source of pollution and health problems. Car engine status monitoring and control system is also a process in which it is aimed to obtain the best safety for any vehicle more accurately and effectively.

II. SYSTEM BLOCK DIAGRAM

In the system, temperature sensor senses the value of engine temperature and sends its values to microcontroller for converting analog input values to digital output values. If the car engine temperature exceeds the desired value, then the fan connected to car engine operates to reduce the engine heat. Unless the engine temperature exceeds the limited value, the control system (driving fan) cannot be found. Battery voltage is measured through an ADC channel of

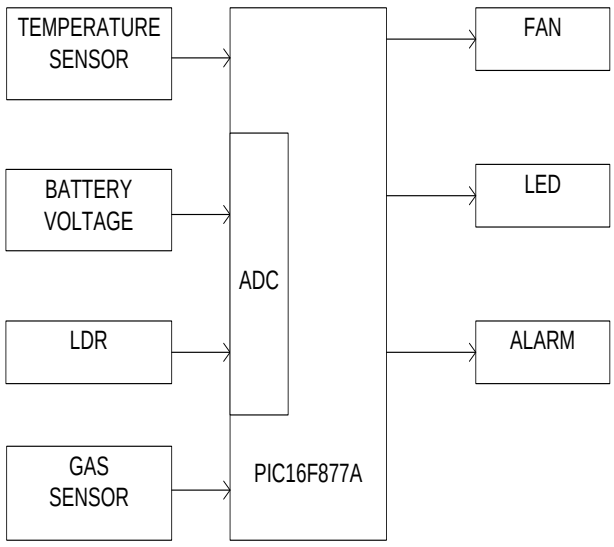

Fig.1. Block Diagram of the Proposed System.

PIC16F877A and the value is displayed on LCD. As shown in fig 1 before feeding to ADC channel, battery output voltage is scaled down to below reference voltage by using a voltage divider network. Because PIC can be damaged by the incoming voltage of car engine. After passing through PIC16F877A, the actual measured voltage from car's battery is displayed in LCD. LDR senses the light due to spark or fire from the car engine. If there is light in the engine, LCD displays a warning message to driver and a safety alarm system includes by using a buzzer. And, if there is CO gas (poison to human) in the car engine exhaust, a warning message can be found in LCD about the presence of CO gas. Finally, LCD displays the values of car engine temperature and battery voltage and also gives the warning messages such as SPARK or NO SPARK and CO GAS or NO CO GAS about the present and absent conditions of car engine lighting and CO gas in the engine while driving.

III. HARDWARE DESCRIPTION

A. Power Supply Section

The 5 Volt dc power supply is constructed for PIC microcontroller(see fig 2), temperature sensor, light dependent resistor, CO gas sensor as well as Liquid Crystal Display. And, 12 V power supply is used to drive a fan and to operate alarm system. The operating voltage range of PIC16F877A is 2.0V to 5.5V. So, a +5VDC 1A voltage regulator, LM7805 is used. It is a linear voltage regulator that can produce a relatively output voltage of +5VDC. Moreover, LM7808, fixed voltage regulator, is also used to regulate the positive 5V output. In this system, PIC microcontroller is used as a main controller unit. LM7805 and LM7808 voltage regulators have some advantages such as low price, easy to use, stable, over temperature auto shutdown and over current drain protection.

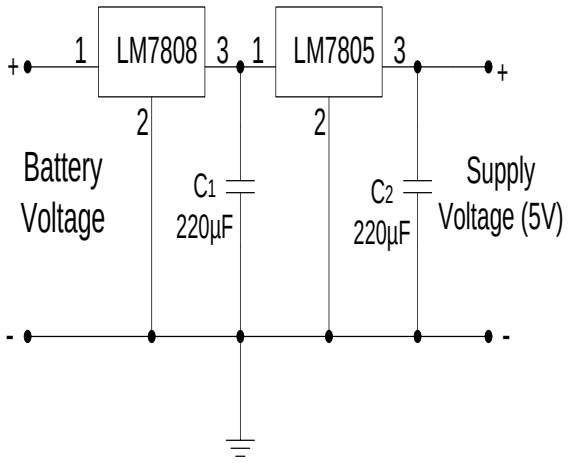

Fig.2. Circuit diagram of power supply section.

B. PIC Microcontroller

PIC stands for "Peripheral Interface Controller''. A microcontroller is an integrated chip which is a part of embedded system. The microcontroller consists of a CPU, RAM, ROM, timers, and I/O ports like a high standard computer. Compared to a human being, the brain is the main CPU and the PIC is equal to the autonomic nervous system [2]. The PIC microcontroller was originally designed as a small, fast, low cost embedded microcontroller with higher I/O capabilities. The PIC microcontroller has a lot of built-in modules like ADC. PIC16F877A is one of the most advanced microcontrollers and it is widely used in modern and experimental applications (se fig3). Among microcontrollers, the simplest and easily used microcontrollers produced by Microchip Technology Company are the most popular microcontrollers used in commercial and industrial applications.

Fig.3. PIC16F877A.

C. Analog-to-Digital Conversion Section

Analog-to- digital (A/D) converter module has fives inputs for the 28-pin devices and eight inputs for the 40/44-pin devices. The conversion of an analog input signal results in a corresponding 10-bit digital number. The temperature and battery voltage monitoring and control system is done with the help of temperature sensor, and 12 V batteries. The entire decision making is done with the help of a microcontroller. Since the incoming temperature and battery voltage values are analog values, they are need to convert digital values. So, A/D conversion is necessary for the system.

D. TIP122 Transistor

The output power of the PIC cannot directly drive the motor so the driver circuit is needed to use. The output of most digital circuits and microprocessor is only five volts at most a few milli-amps. Most electrical and electronic devices require voltages and currents that will damage digital circuits. Therefore, the transistor is intended to operate as the driver. In the project, the two NPN transistors are selected to drive a fan and a buzzer. The TIP122 transistor is also needed for using in power linear and switching applications [3]. Figure 4 shows the design and structure of TIP1222 transistor.

E. LM358

As shown in fig 5, LM358 series consist of two independent, high gains; internally frequency compensated operational amplifiers which were designed to operate from a single power supply over a wide range of voltages. They can

operate at supply voltages as low as 3.0V or as high as 32V [4].

Features:

- Short Circuit Protected Outputs
- True Differential Input Stage
- Single Supply Operation: 3.0 V to 32 V
- Low Input Bias Currents
- Common Mode Range Extends to Negative Supply
- Single and Split Supply Operation

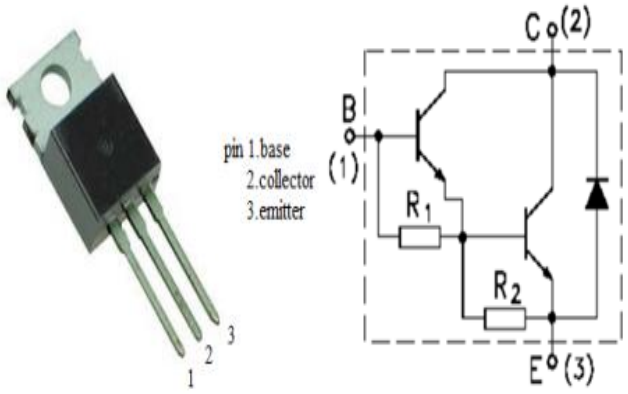

Fig.4. Design and Structure of TIP122 Transistor.

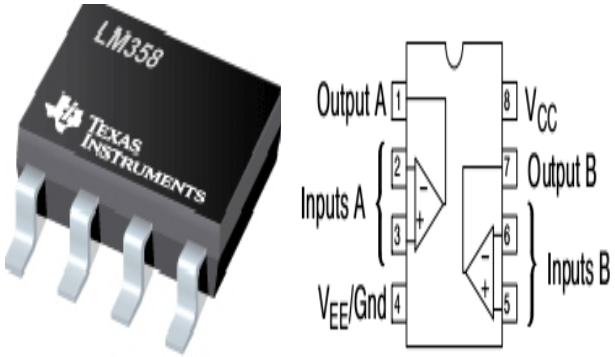

Fig.5. Design and pin diagram of LM358.

F. Liquid Crystal Display

LCD technology has advanced very rapidly and it has technical achievements in higher resolutions, cheaper manufacturing process [5]. Liquid Crystal Displays are a good choice for the electronic dashboards since they operate at low voltages, consume very little power and are also economical. A 14-pin access is provided having eight data lines, three control lines and three power lines. LCD panels could be set up in the dashboard of any cars. In the proposed system, a simple 8-bit 16×2 LCD is used for interfacing with the PIC16F877A. The 16×2 LCD refers to 16 characters per line by 2 lines. There are two important registers in LCD. Code register and Data register. LCD display shows the values and conditions of parameters like temperature and battery voltage, light due to spark or fire and CO gas in the engine. LCD display is very useful for the person who wants to know the information of car engine status while driving. In this system, PORTD pins of PIC16F877A are connected to LCD for providing data signals. The following fig 6 shows the product design of ISIS and LCD.

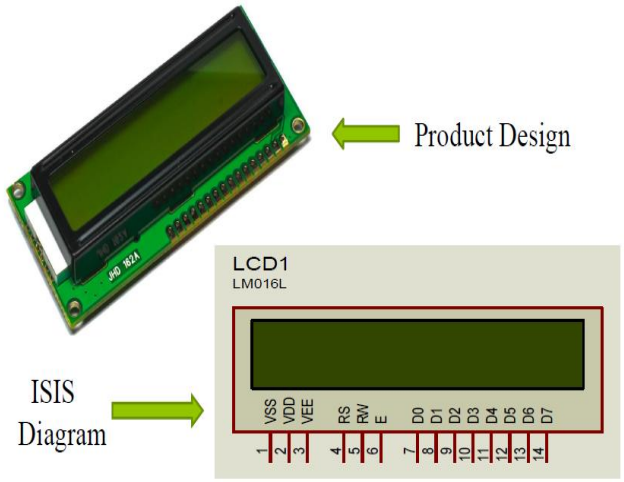

Fig.6. Product Design and ISIS Diagram of LCD.

G. Temperature Sensor

The temperature sensor, LM35 is an integrated circuit sensor that can be used to measure temperature with an electrical output proportional to the temperature (in ˚C). It can also measure temperature more accurately than using a thermostat. A temperature sensor is a device that gathers data concerning the temperature from a source. It is an integrated circuit sensor and has a scale factor (sensitivity) of 10mV/ ˚C. It is related to operate over a -55 ˚C to +150 ˚C temperature range [6]. Another important characteristic of the LM35 is that it draws only 60 micro amperes from its supply and also has capability of a low self-heating. In this project, a temperature sensor LM35 will be used for the purpose of measuring car engine temperature in ˚C (see fig7). Temperature sensor senses the value of engine temperature and sends its values to microcontroller to convert analog input values to digital output values.

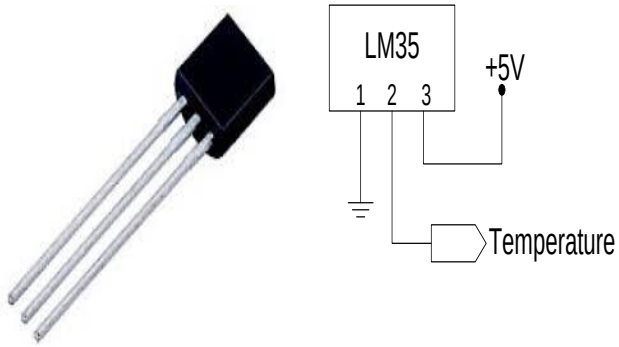

Fig.7. Design and Circuit Diagram of Temperature Sensor.

H. Battery Voltage

In the system, car battery voltage is measured through an ADC channel of PIC16F877A and it will be displayed on

LCD. Before feeding to ADC channel, battery output voltage is scaled down to below reference voltage by using a voltage divider network. Because PIC can be damaged by the incoming voltage of car battery. The operating voltage range of PIC16F877A is 2.0 to 5.4 V. After passing through PIC16F877A, the actual measured voltage from vehicle's battery is display in LCD. The green LED turns on when the car battery is full voltage condition (greater than 11V) and the red LED turns on if the car battery is low voltage (less than or equal 11V).

I. Light Sensor

The LDR is made of a high- resistance semiconductor and it is used to detect light. It is also a variable resistor whose value decreases with incoming incident light intensity [7]. The light sensitive part of LDR is track of Cadmium Sulphide. The resistance of LDR is very high, sometimes as high as 1000K ohm. LDR resistance can be 10K to 15K ohm in the absence of light. LDR sensor is also called a dark sensor. In this system as shown in fig 8, LDR sensor is connected to LM358. One input of LM358 is LDR and another is a reference voltage. When light falls in the car engine, the resistance of LDR decreases. So, the negative terminal voltage also decreases and it is compared to a reference voltage. At that time, a buzzer turns on automatically with a limited time. This concept can also be used to detect light if there is light due to spark or fire in various systems that need to be fire safety systems.

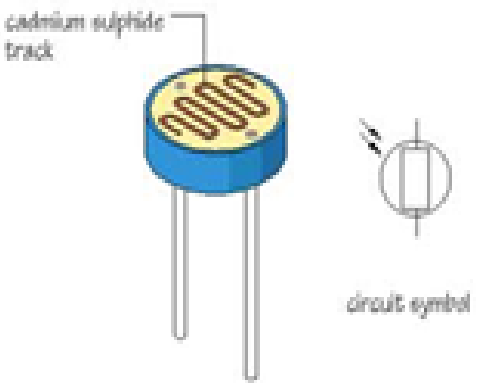

Fig.8. Light Dependent Resistor.

J. Gas Sensor

A gas sensor MQ-6 could be used for detecting the difference combustible gas, especially Methane because it is low cost and suitable for several different applications. It is also a device that detects the presence of CO gas in the car exhaust to prevent the CO poisoning [12]. MQ-6 gas sensor has high sensitivity to Carbon Monoxide gas. It has 6 pin, 4 of them are used to fetch signals, and other 2 are used to provide heating current. The sensitive material of MQ-6 gas sensor is SnO2 (Tin dioxide), a sensitive layer, has a lower conductivity [8]. The proposed system includes an embedded system which detects the present of CO in the exhaust (see fig 9). In the system, the gas sensor output voltage is connected to the input of LM358 [1]. If gas sensor output is greater than reference voltage, there has actually CO gas in the exhaust.

Fig.9. MQ-6 Gas Sensor.

IV. SYSTEM PIN DIAGRAM

The following figure shows the circuit diagram of the car engine status monitoring system.

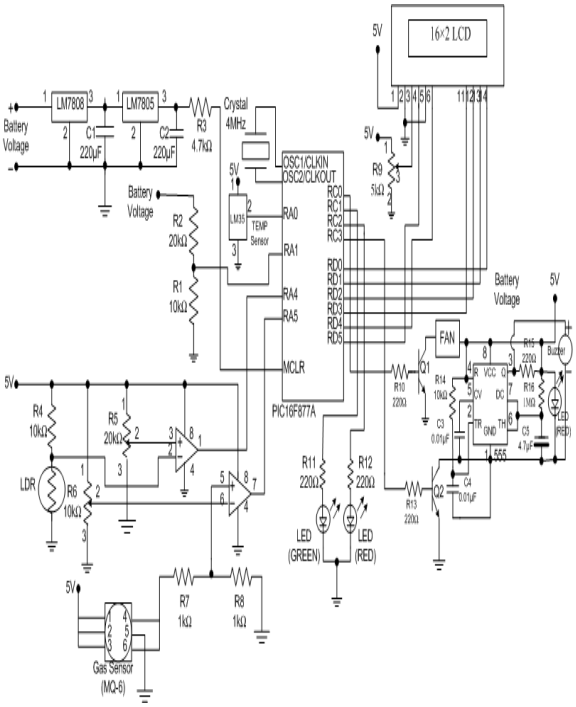

Fig.10. Circuit Diagram of the Car Engine Status Monitoring System.

V. SOFTWARE DEVELOPMENT

The language of PIC Basic Pro is used for software implementation. PIC Basic Pro Compiler is the easiest way to program, the fast and powerful Microchip Technology PIC microcontrollers. PIC Basic pro converts basic language to machine language in the forms of 0's and 1's. This file is called as a Hex file that can be directly programmed into a PIC microcontroller. PIC Basic Pro Compiler can give the direct access to all of the PIC microcontroller registers such as I/O ports, A/D converters, hardware serial ports, etc [10]. The Proteus professional schematic software is also applied to obtain the simulation results.

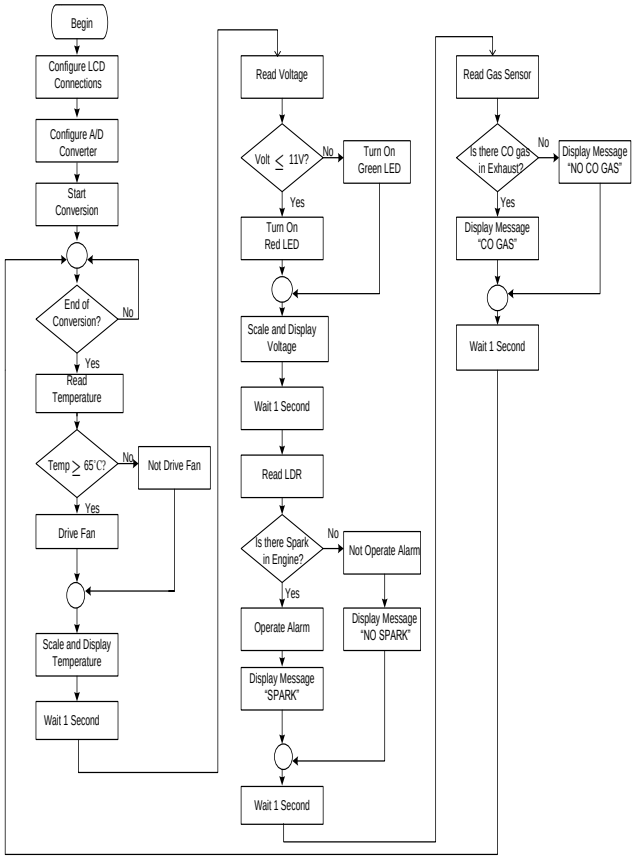

Fig.11. Flow Chart of PIC Programming for Car Engine Status Monitoring and Control System.

VI. HARDWARE IMPLEMENTATION

The value of car engine temperature is continuously sensed by the sensor LM35. When the engine temperature is greater than or equal to the limited degree Celsius (65˚C), the fan connected to the car engine operates automatically. The operation of car engine fan cannot be found if the engine temperature is less than the reference engine temperature value. When the car battery voltage is greater than 11V, green LED turns on for showing full battery condition. The red LED turns on to represent low battery status as soon as the car battery voltage is less than or equal to 11V. If there is light due to spark or fire in the car engine, the alarm system that has a limited time operates for warning the driver. Only the warning message is found in LCD when there is no fire in the car engine in which the light due to spark or fire may be caused at the long time high speed. In the software simulation, a yellow LED is used instead of a buzzer included in the alarm system. The LCD display gives a message “CO Gas” when the toxic CO gas is found near the car engine. The message “NO CO GAS” is displayed in LCD if there is no carbon monoxide gas in the car engine. The hardware construction of the car engine status monitoring and control system is shown in figure 12.

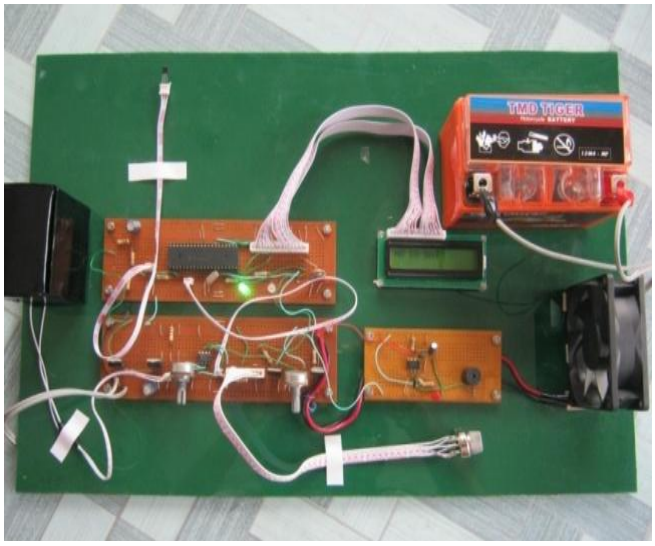

Fig.12. Prototype of the Proposed System.

VII. TEST AND RESULT

A. Displaying Car Engine Temperature Value

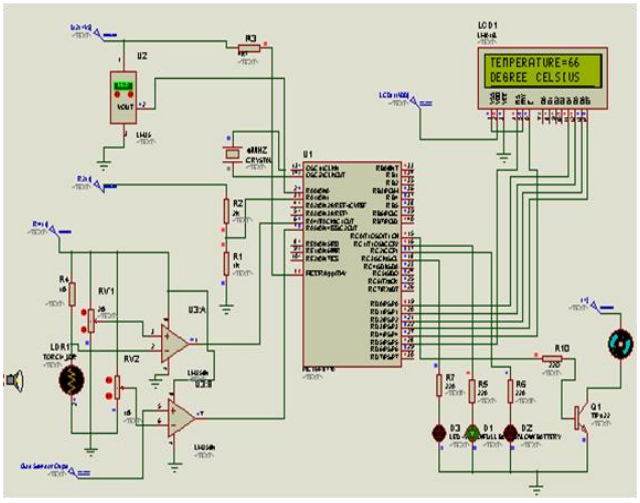

Fig.13. Circuit Simulation in ISIS Software (Temperature Display with Fan Control).

B. Displaying Car Battery Voltage Value

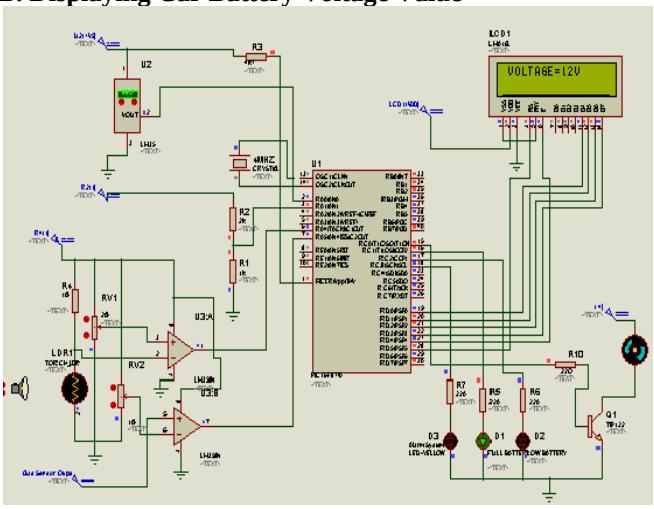

Fig.14. Circuit Simulation in ISIS Software (Voltage Display on Full Battery Condition).

C. Light due to Spark or Fire Condition Displaying

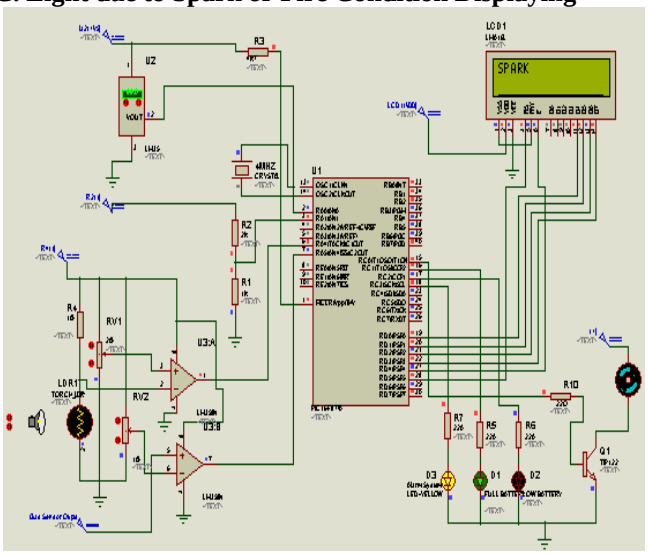

Fig. 15. Circuit Simulation in ISIS Software (Spark Condition Displaying).

D. Carbon Monoxide Gas Condition Displaying

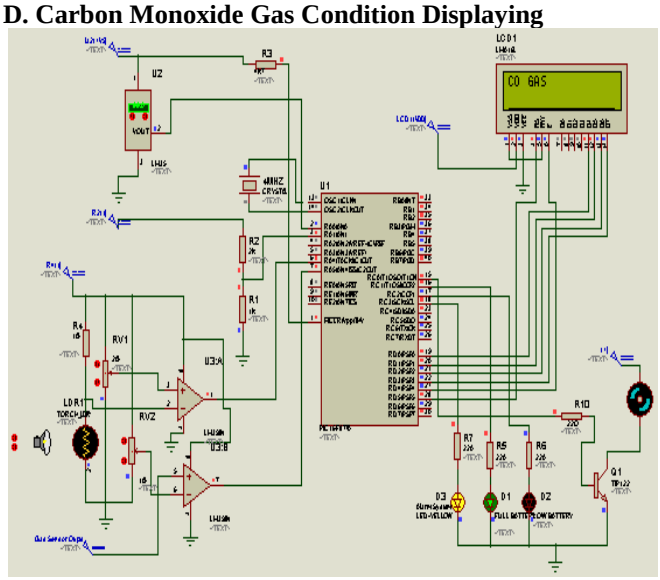

Fig.16. Circuit Simulation in ISIS Software (Present Condition of CO Gas).

The diagrams from 13 to 16 depict the test results of the system.

VIII. CONCONCLUSION

The monitoring and control system of car engine temperature and battery voltage, light and carbon monoxide gas is done with the help of temperature sensor, 12V battery, light sensor and gas sensor. Moreover, a 12V DC fan, two active LEDs and a buzzer are used for the purpose of setting up a control system to overcome unexpected dangerous engine status while driving the entire decision making for car engine status monitoring and control system is done with the help of a microcontroller [11]. LCD connected to the car dashboard displays not only the values of engine temperature and battery voltage but also the warning messages about the present or absent condition of lighting and CO gas in the car engine. If the engine temperature is greater than or equal to reference value, the fan connected to engine operates immediately to reduce the engine heat. When the engine temperature value is under the limited value, the fan connected to the car engine does not operate. If the battery voltage is greater than the limited value, GREEN LED turns on for showing full battery condition. When the car battery voltage is less than or equal to the limited value, RED LED turns on to show low battery status. As soon as light due to spark or fire causes in the car engine, the warning message is found in LCD and then buzzer for alarm system automatically activates with a limited time. If there is CO gas in the car engine, LCD also performs to give a warning message to the driver about the presence of CO gas. According to the car engine status monitoring and control system, unnecessary car engine problems can be avoided without too much cost.

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