



FIRE MONITORING AND AUTOMATIC SUPPRESSION SYSTEM FOR VEHICLES

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Abstract- Safety is an important aspect of any vehicle, the fire hazard is one of a common threat to occupants in vehicle. Fire hazards occur due to overheating of the engine, heating of battery, heating of brakes. This research work provides continuous monitoring of components and controlled suppression. This research work will help to improve the safety related to fire hazards in the vehicle and take appropriate action to avoid it. It gives an early alarm to the driver about abnormal condition related to fire and helps to reduce the possibility of fire. In this system contactless temperature sensor, flame detector, CO sensor, GSM module, and GPS module used and this all interfaces with a controller. This system focus on the temperature of the engine compartment and battery area. An ATmega2560 is used to get sensor information and control output devices. The test is taken with a prototype to get requirement of the system.

Keyword: Monitoring, suppression, fire hazard, GPS module

I. INTRODUCTION

In the world vehicle fire is a very common phenomenon. Many lives are falling into danger. Each year, from 2003 to 2007, an estimated 2,87,000 highway vehicle fires happened in the United States due to this yearly average of 480 deaths, 1,525 injuries and highly property loss [1]. Due to continue advancement in vehicles, it needs to develop a fire monitoring system to avoid fire accidents in vehicles. Majority of vehicle fire occurs in a passenger vehicle. 62.2% of vehicle fire started generally in the engine area, running gears or wheel area. The sources of fire, heat power equipment (63%) electric problem (16%) spark and flame from operating equipment (8%) [2]. The factor responsible for igniting the fire in a vehicle are mechanical failure, fuel leak, short circuit all this are the leading factors that contribute to the ignition of the fires. The challenges in successful vehicle fire monitoring and suppression system involve efficient and specific design. There are three parts of this project first is to monitor temperature and fire risk in the engine compartment and battery area. Second is to suppress fire if catches and third is to send the location to the nearest emergency service station if the fire goes out of control. For detection of fire risk flame detector, temperature sensor, CO gas sensor are used and for sending location GPS and GSM modules are used. Fire monitoring and suppression system is tested with a prototype to obtain the best prevention of fire.

II. SYSTEM BLOCK DIGRAM

In this system, the contactless temperature sensor maps the temperature inside the engine compartment and sends it to the microcontroller. Different colour led is provided as output of the microcontroller to indicate different temperature conditions. A flame sensor is provided for detection of fire, flame gives digital output value to microcontroller. CO sensor is provided to detection of carbon monoxide inside the compartment. If there is flame inside the engine area LED gives warning to driver and controller operate relays for suppression of fire. GPS module continuously provides a location to the microcontroller and for the communication purpose GSM module provided.

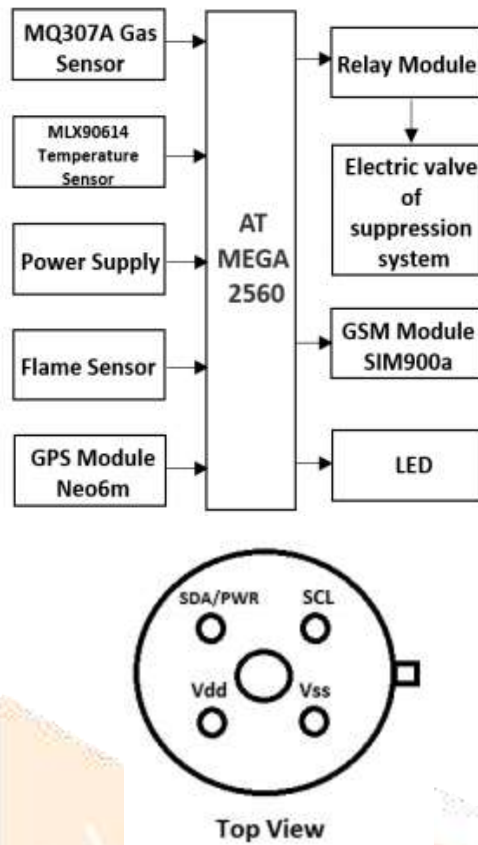


Fig.1 Block Diagram of System

III. COMPONENT DESCRIPTION

1. AT mega 2560

Arduino board is consist of various types of microprocessor and controllers. Arduino board consists of digital as well as analog input and output ports, timers, SRAM, EEPROM and the most important is CPU. Arduino uses C and C++ programming languages. Arduino is originally designed as a low-cost and easy way for beginners as well as for professionals to create projects. This board has serial communication and it is also featured with USB(Universal Serial Bus). All boards are pre-programmed with boot loader which helps in uploading programs to flash memory of Arduino. Varies Arduino boards are available in the market with different features and specifications. Arduino is open source hardware and software. Arduino MEGA 2560 has 16 analog pins and 54 digital pins due to this it provide flexibility to interface different sensors with large number. It have clock speed of 16 MHz, 8 kb SRAM, 128 kb flash memory [3].

2. MLX 90614

Temperature Sensor MLX90614 is a non-contact type temperature sensor used to measure the temperature of the engine area. It has high accuracy and resolution for measurement of temperature.

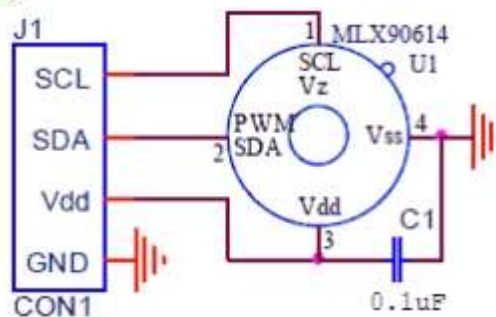


Fig.3 MLX90614 Connection with SMBus

It has a 12c interface for reading temperature and sensor reconfiguration, it is also compatible with SMBus. It has a wide temperature range from -40°C to 125°C for ambient temperature and -70°C to 380°C for object temperature [4].

3. Flame Sensor

The flame sensor is used to detect flame inside vehicle, it can detect light source of wavelength from 760 to 1100 nano meter. Flame sensor based on YG1006 sensor, which is a highly sensitive and high-speed NPN silicon phototransistor, It has black epoxy, due to which sensor get sensitive to IR. It has high photosensitivity which can vary, it can detect flame at an angle of 60 degrees.

4. CO sensor MQ7

MQ7 is a semiconductor gas sensor which detects the CO in the air in the form of concentration from 10 ppm to 10000 ppm. It provides output as analog signal to an input of microcontroller. It is used in the battery area and engine area. In vehicles Lithium Ion (Li-Ion), Molten Salt (Na-NiCl₂), Nickel Metal Hydride (Ni-MH) and Lithium Sulphur (Li-S) batteries are used [5]. Among this Lithium Ion batteries are widely used, the main disadvantage of lithium-ion battery is that it produces high operating temperatures [6]. The major gas produced due to burning on the lithium-ion battery is carbon monoxide. For detection CO, this gas MQ7 gas sensor is provided [7].

5. Neo 6m GPS Module

For location tracking Neo-6m GPS module is used, which has ceramic antenna (25×25×4mm). It has two indicator Power and Signal. It also has data backup battery which saves data during main power cut-off. It has EEPROM to save data. It works on 2.5-3.6v power supply consumes 45 mA. Operating range is -40 to 85 Celsius. It traces 22 satellites with 50 channels. Neo-6m has sensitivity of -161dB. GPS module continually provide location to microcontroller.

6. GSM-Module

SIM 900a has dual bands both GSM and GPRS in SMT module. GSM module is used for sending messages to nearby emergency service station. It uses 900/1800 MHz dual band, it works on 5v supply operating range is from -40 to 85°C. This module has very low power consumption of 1.5 mA. It has PCB size of 71.4x66.0x1.6mm

7. Relay Module

Relay is an electrically operated switch, it consists of input terminal to get signal from the controller and set of operating contact terminal. For system 4 channel, 5v relay module operating modes normally open and normally closed. The relay module has two used to maintain an electric valve close [5].

IV. System pin diagram

- 1. MLX90614 Temperature Sensor
- 2. SIM900A GSM Module
- 3. Neo6m GPS Module
- 4. MQ7 Smoke sensor
- 5. Flame Sensor
- 6. Relay Module
- 7. Arduino Mega 2560

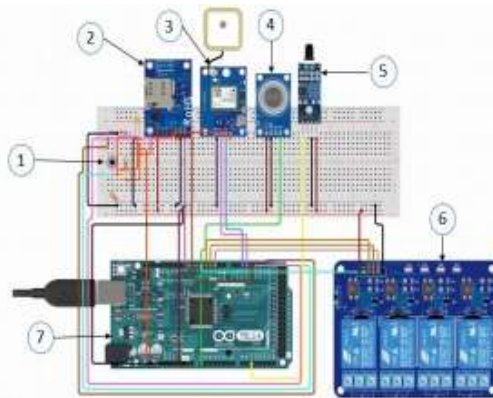


Fig. 4 System pin diagram

V. PROGRAM DEVELOPMENT

Arduino IDE is used to build code, Arduino IDE support c and c+ +, it is the easiest way to build and upload programs in the Arduino board. Arduino IDE provide varies software library for the project. It converts written code into a hexadecimal form which gets uploaded on board.

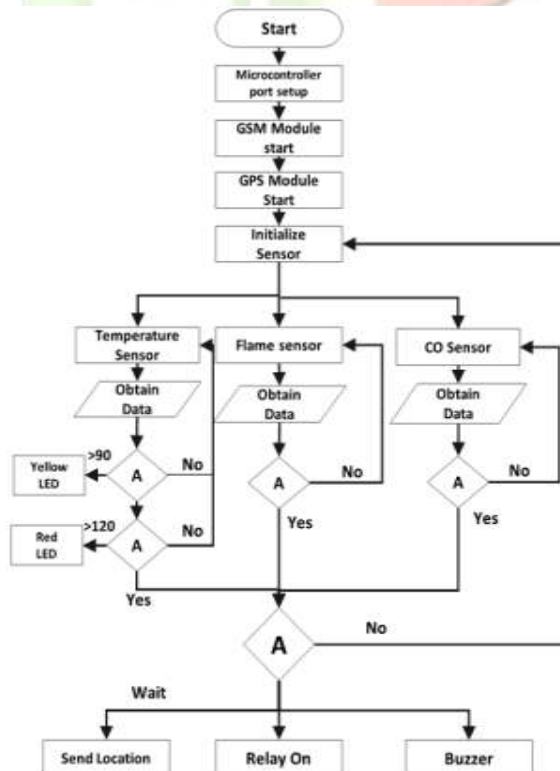


Fig. 5 Flow chart for Fire Monitoring and Automatic Suppression System

VI. HARDWARE CONFIGURATION

The value of car battery temperature and engine temperature is continuously monitored by sensor MLX90614. When the value of temperature becomes greater than or equal to fixed degree Celsius (90 °C), LED in driver cabin turns on indicating that engine temperature is raised above the reference value of temperature. When temperature value goes beyond 120 °C, Red LED turns on which indicates that the engine started overheating. If there is the presence of CO Gas in compartment LCD Displays “CO Gas”. If there is light caused due to spark/Fire in battery area or engine area with temperature above 120 °C, LED in driver cabin blinks continuously indicating fire situation in vehicle, also when these three conditions of flame, temperature and co gas are detected Arduino will send control signal to relay module. The relay module then operates the valve of the extinguisher system, which will suppress the fire. At the same time, the GPS module continuously give vehicle position to Arduino if the fire in the vehicle is gone out of control and suppression system is not able to suppress it then GSM Module sends message to nearby emergency service stations about a fire hazard in vehicles with the current location of the vehicle. The message goes in the form of a Google map link with vehicle number. The hardware assembly of fire monitoring and automatic suppression system is shown in figure.

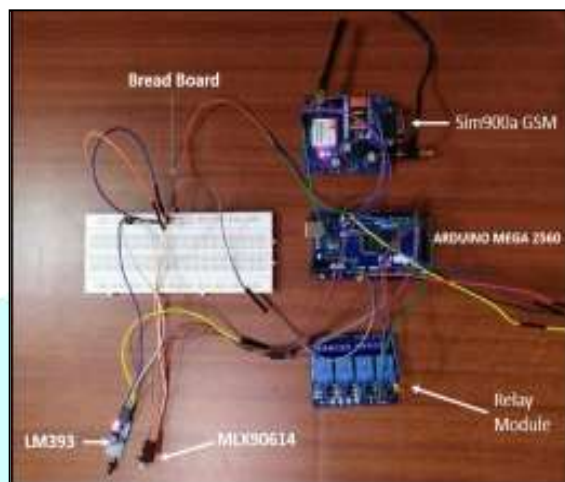


Fig.6 prototype of proposed system

VII. TESTING

Testing is taken with a prototype to check working of system. Burn paper as a fire in vehicle and place it in front of sensor. Temperature sensor detects the temperature of flame and flame sensor detect light released from flame. When both sensors senses and the values are above reference then Arduino controls relay and turn it on.



Fig.6 Fire monitoring system testing with fire

Second testing is taken to check whether the system gives any false alarm for light. The purpose of this testing is to find the difference between light and fire.

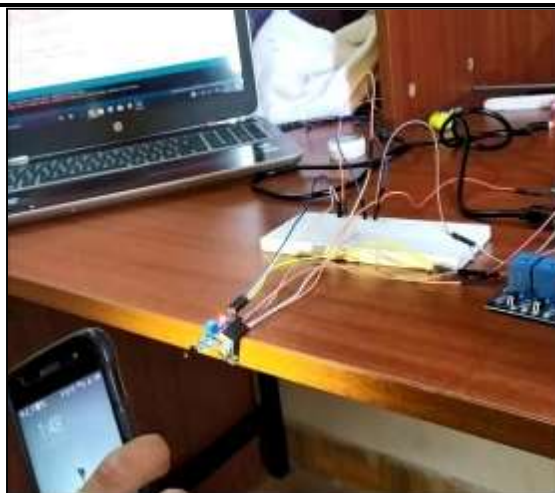


Fig.7 Fire monitoring system testing with torch light

VIII. RESULT AND DISCUSSION

As sensor detect fire and gives signal immediately the relay module get turn on. System is not affected with light, it detects only fire. When the fire remains for more than 20sec Arduino sends message by GSM module with Google Map Link. This message also include vehicle number.

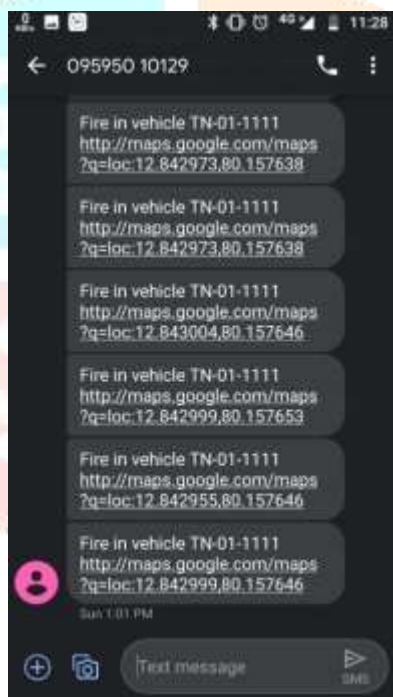


Fig 8 SMS from GSM Module

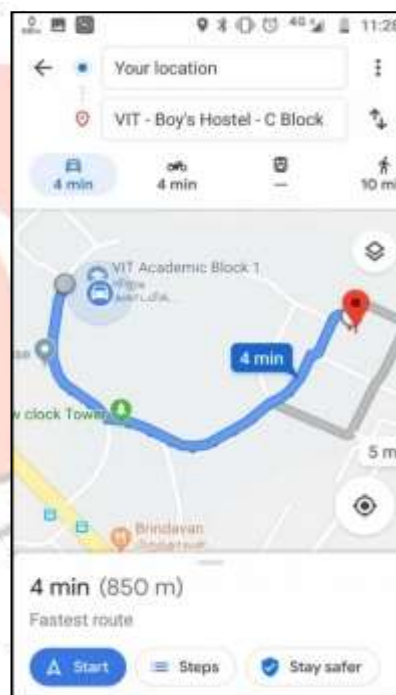


Fig. 10 Direction to reach Vehicle

IX. CONCLUSION

Conventional and electric vehicles uses thousands battery cells for its power requirement. There are chances of overheating, fire, and explosion with batteries. Also due to fuel leakage and electric shortcircuit there are chances of fire and explosion. Therefore, proposed system ensures that this situation do not become hazards and it increases road safety. Algorithm is prepared, implemented, and tested with Arduino board. Prototype detects fire with less response time and without false alarms as per current testing and starts extinguishing system as well as sends message to nearest emergency service station with vehicle current location. Proposed system is multi-sensor fire monitoring and automatic suppression is a low-cost and fast responsive. It will ensures no threats to occupants. Although, implementation and more testing on actual vehicle is needed.

X. REFERENCE

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