IoT-Based Vehicle Fire Suppression System with Emergency Alerts, Speed Monitoring, and Location Tracing.

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Abstract- Nowadays vehicle fire is a common issue in the world. But there was no complete and low-costsystem to prevent it. This paper proposes and implements a system to develop an embedded system that detects the fire, and alarms and suppresses it automatically. Also here is an Android app to show the vehicle's location and its speed. When a vehicle catches fire, the sensors can detect which part of the car is on fire and can extinguish the fire accordingly by spraying carbon dioxide. At the same time, a notification can be sent to the vehicle owner with the proper location, speed, and condition.

Keywords: **IoT-Based Vehicle Fire Suppression System, Emergency Alerts, Speed Monitoring, and Location Tracing.**

I. INTRODUCTION

Nowadays vehicles fire accident is a common issue in the world. An estimated 212,500vehicle fires caused 560 civilian deaths1,500 civilian injuries, and $1.9 billion in direct property damage in the US in 2018 [1]. In the United States alone automobile manufacturers have spent more than $14 million dollars studying the problem of automobile fire outbreaks to gain a better understanding of and effectively deal with the burning of automobiles.

The leading causes of vehicle fires were mechanical failure and electric failure. A system is needed to detect the fire and suppress it automatically. There are already many fire suppression systems available in the market but these systems are so expensive. This paper aims to develop an embedded system, that detects a fire, and alarms and suppresses it automatically. It also uses GPS and IOT systems to notify its owner. Here worked on some specific vehicles namely: buses, cars, and trucks.

II. LITERATURE SURVEY

Researchers have proposed a system to detect vehicle fires, and automatically suppress it. But none have included IOT systems. Robert Sowah and their teammates have proposed a system to design and implement afire detection and control system for automobiles using fuzzy logic. However, the IOT system and advanced suppression systems are absent.[2]

Asma Mahgoub and their teammates have proposed a system to IOT-based fire alarm system. They used ESP-8266 as a control circuit board, flame sensor, and some MQ series Gas sensors. This a very useful fire detection system but a suppression system is absent and a fire location detection system is absent.[3]

These systems do not accurately detect fire, notify it, and suppress it. So a system is needed to detect fire, notify it, and suppress it with low-cost maintenance. These systems are expensive and more complex to implement. That's why an accurate low-cost device is needed to prevent the fire risk.

III. SYSTEM ARCHITECTURE

The proposed model to detect fire, control, monitor, and communicate is shown in Fig-1. The model can be separated into four blocks namely: Sensing blocks, Controlling blocks, communication blocks, and Monitoring blocks. Sensing blocks detect the fire at the proper location. Controlling blocks control the gas valve to prevent fire and notify it by using alarms. It is integrated into three servo control valves and an alarm circuit. Communication blocks communicate with the owner of the vehicle to inform the location of proper fire conditions. Monitoring blocks integrated into 20*4 LCD and web/android app to show the location of the fire and the location of the vehicle. This project is used for buses, cars, and trucks. Arduino Uno is used as a main control board which is based on the Atmega328p microcontroller.ESP-8266 is chosen to attach the IOT feature for this system which communicates the vehicle's owner view Android app and website. MQ-2 gas sensor is used to detect carbon monoxide and other necessary gases from fire smoke to detect fire and LM35 is used to measure temperature which ranges is -55° to 150 °. Here the combined sensor is designed to use UA741 IC, MQ-2 gas sensor, and 7432 OR gate IC. NEO-6M GPS module is chosen to identify the location and speed of the vehicle. SIM-900D GSM module is also used to send and receive an SMS to notify the situation of vehicles. Servo control three-valve is also used to control pipelines to control the flow and direction of Carbon dioxide that comes out from the fire extinguisher. The control switch controls the system board. The ESP-8266 takes the fire condition value from Arduino Uno and takes the location from GPS then sends the data to the Blynk server and sends SMS by using GSM. Here the Blynk web and Android app to view the location and fire conditions of vehicles.

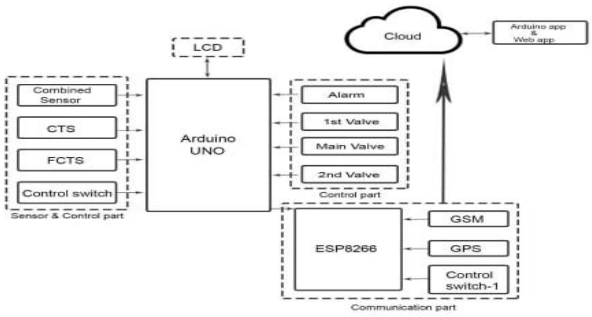

Figure 1: Proposed Model.

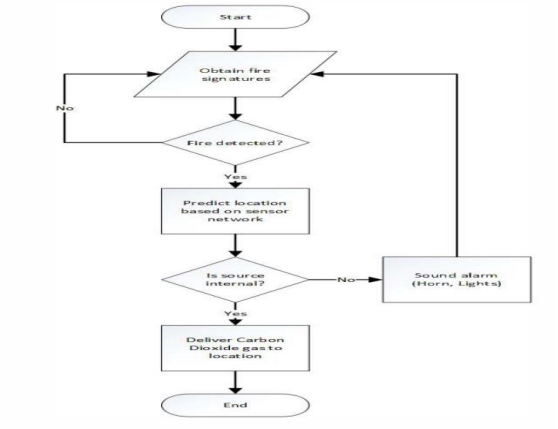

Figure 5

IV. System and Circuit Design Methodology

The architecture designed in Fig-1 is shown in Fig-2,3,4 with full circuit design. Fig-2 shows the combined sensor circuit. Here used an MQ-2 gas sensor and lm35 both outputs are connected with the OR gate (7432 IC). Here it is called a combined sensor. Four combined sensors are connected to the R-2R ladder network. The logic gate provides digital Output. Digital Outputs are converted to analog outputs via an R-2R ladder network that is called DAC (Digital to analog converter). Here also use three Lm35 sensors namely CTS, ECTS1 & ECTS2. CTS, ECTS1, and ECTS2 sensor is used to measure the temperature namely: coolant temperature, and engine cabinet temperature. This sensor provides analog value to Arduino.

Fig-3 shows the main controlling circuit. Here used an Arduino Uno, two push buttons, servo control three valves, a 5v relay, and a buzzer. From fig-2 shows the sensor part. The three sensors provide analog value. Arduino takes the value and calculates the temperature. The equation for calculating the lm35 sensor value is-

tem=(x*$\frac{5}{1023}$*100) °C

tem_e=$\frac{tem_1+tem_2}{2}$ °C

tem=temperature
X=reading
CTS=Coolant temperature Sensor
ECTS= Engine cabinet

Control which is connected to digital pins 8 and 9. When the Arduino gets a value and the temperature limit is crossed the LCD shows the alert and the buzzer is on. But if a human detects this a fault alert then a human can stop the alert by pressing TSS. If a human detects a fire but the sensor can't identify then he can start an alert by pressing MCP (Manual Call point) switch. Here two RX and TX are used to add a communication system.

Fig-4 shows the communication system. Here use ESP-8266 which is the main board that communicates with the vehicle owner and other parts are connected to this board. When the Arduino board provides a signal to the esp-8266 board then the esp8266 board gets the location by using GPS and sends it to the vehicle's owner by using GSM. It also shows the output by using the IOT platform. Blynk IOT is used to monitor the condition of the vehicle through the internet.

Here briefly discuss the installation system design. CTS is installed in the coolant hole and ECTS is installed in the engine cebine. Another system is installed in the vehicle chassis.A controlswitch and LCD monitor are installed behind the driver seat.

Robert Sowah and their teammates have proposed a system using fuzzy logic. But this system design is more accurate better than fuzzy logic.[4]

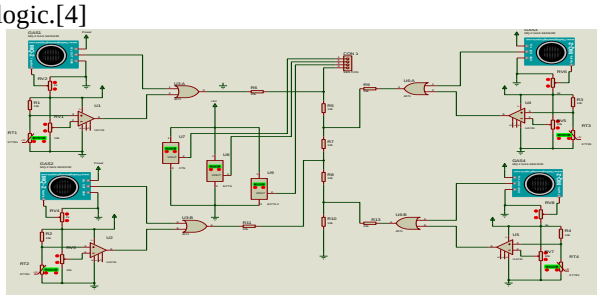

Figure 2

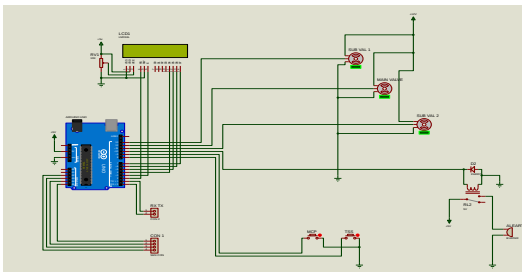

Figure 3

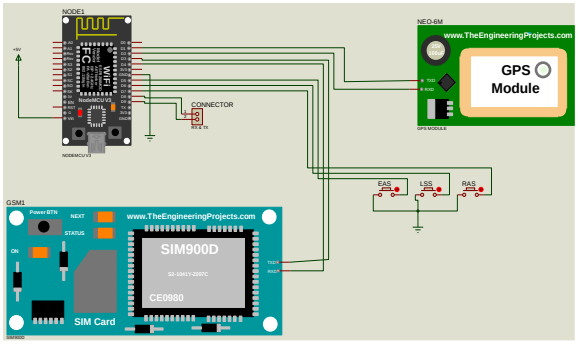

Figure 4

V. Control System and Hardware Implementation

Find fire location based on sensor data. Fig-5 shows the control system. When the sensor is active for fire the main circuit board takes the value from the sensor and finds the location based on the sensor data.[4] Table 1 shows the address from various sensor data.

Combined Sensor	Practical	Simulation	Address from data (Chassis point)
1st and 2nd sensor	162	102	1st and 2nd
3rd and 4th	587	498	3rd and 4th
1st and 3rd	249	332	1st and 3rd
2nd and 4th	481	500	2nd and 4th
1,2,3,4	765	769	1,2,3,4
1st	718	728	1st
2nd	162	105	2nd
3rd	588	499	3rd
4th	765	698	4th

Table-1

Fig-6 shows the full project and hardware implementation. This project is working successfully.

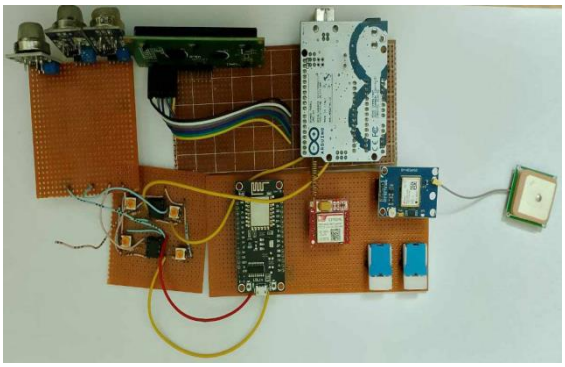

Figure 6

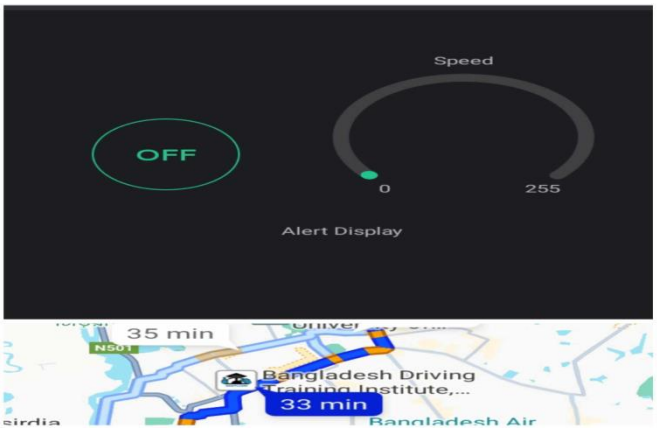

Figure 7

VI. RESULTS AND DISCUSSION

Fig-7 Shows the suggested system result. It shows the graphical representation of apps.

This proposed system has worked successfully. Some error is notified. This type of error has been observed due to increasing or decreasing temperature. But this error is negligible.

VII. FUTURE DEVELOPMENT

In the world every year many people lose their lives and property due to vehicle fires. It has needed a better solution to prevent it. Hence this project was created. But it needs more development. Some future developments are:

1. Integrated AI

2. Human interaction
3. Automatic vehicle parking system when it falls in danger.
4. Accident protection system.

VIII. CONCLUSION

In conclusion, the paper introduces a groundbreaking solution to a prevalent global issue – vehicle fires. By proposing and implementing an innovative embedded system, the paper addresses the need for a comprehensive and cost-effective method to detect, alarm, and suppress fires in vehicles. This system not only identifies the location and type of fire within the vehicle but also automatically deploys carbon dioxide to extinguish it, providing a swift and efficient response to potential disasters. Furthermore, the integration of an Android app complements this system, offering real-time information on the vehicle's location and speed. In the event of a fire, the system not only safeguards lives and property but also ensures that vehicle owners are promptly informed about the situation, enhancing their ability to respond effectively. This multifaceted approach to vehicle fire prevention and management represents a significant advancement in automotive safety and emergency response. It holds the promise of reducing the impact of vehicle fires on lives and property, making our roadways safer and more secure.

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