# Advanced Fire Detection System in Trains

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***Abstract— An Embedded system is an electronic/electro-mechanical system designed to perform a specific task and is a combination of both hardware and firmware. Every embedded system is unique, and the hardware, as well as the firmware, is highly specialized to the application domain. Embedded systems are becoming an inevitable part of any product or equipment in all fields including household appliances, telecommunications, medical equipment, industrial control, etc. Generally, it is seen that a train coach catches the fire due to some reasons and it is not easy to detect the fire initially. This harms the passengers' lives and damages the trains. The braking system used in Indian trains can be stopped either by the driver or by the passenger pulling the chain. To solve this problem, we use fire and smoke sensors to detect the fire and send a signal to the microcontroller. The microcontroller activates the motor and automatically the brakes are applied to the train. In this model, we implement the automatic door opening system and give the information on which compartment, the fire will occur.***

***Keywooords: ESP32-Microcontroller, Servo motors, Fire Sensor, DC motor, Buzzer***

## I. INTRODUCTION

By every new day alternative technologies are being developed which in turn are helping to increase the speed of trains. Indian Railways aims to increase the speed of its passenger trains to 140—180 km/h on conventional tracks. Thus, it can be seen from the trending aspects of railways that they are primarily focusing on increasing the speed rather than the SAFETY of the passengers. The primary focus should be the safety of passengers. Generally, it is seen that when a train compartment catches fire due to any reason its not easy to detect the fire initially and react to it. Due to this train does not stop instantly, which results in casualties and heavy damage to the train. Security in travel is the primary concern for everyone. When these accidents are occurring in remote areas or during the night times the loss or damage being caused is at higher rates. The damage is heavier due to improper reach of service at right time due to improper communication. This time delay is causing heavier damage. Most of the fire accidents are due to a lack of passenger knowledge. Fire accidents can be stopped by educating the people about the safety measures, but in case of a fire accident occurs, then we have to take measures to control the fire. Generally, when a compartment catches fire, it is hard to identify the occurrence of the fire and take the initiatives to control it. Hence, we need an automated system to reduce the casualties. Here we, propose an automated system that not only detects any fire or explosion but also carries out necessary operations for the safety of passengers like sprinkling the water in the compartments. In this system, we use a fire sensor to detect any fire accidents and a smoke sensor to detect any explosions. An ESP module is used to transfer the alert message to the driver and simultaneously a motor is used to open the doors.

## II. EXISTING SYSTEM

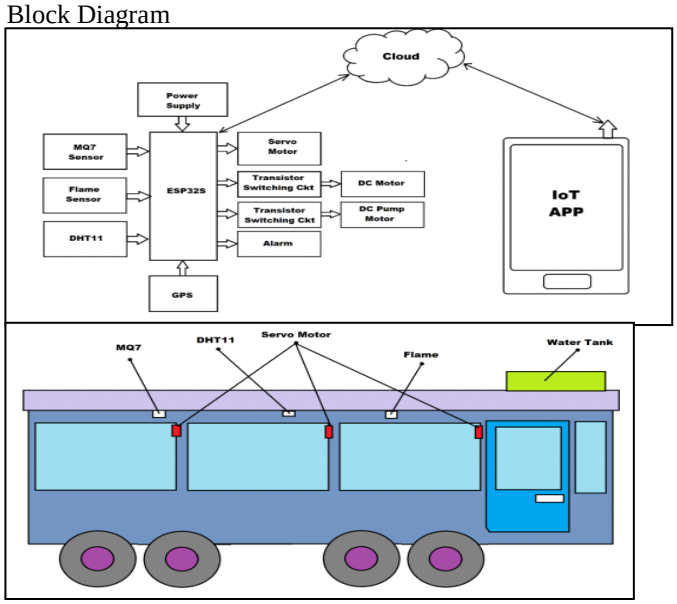
Railways are one of the best modes of transport and the development of railways in our country took place rapidly. Still there are numerous unsolved problems like fire accidents, train collisions, etc., the railway department has taken measures to stop the problems. The inner parts of the train are mostly made of less prone to catching the materials. Most of the materials are fire resistant. Even after all these, a fire can arise due to short circuit of wires or if any passenger carrying inflammable material. Keeping all these problems in mind, the railway department has installed fire extinguishers in all the compartments. Hence, the use of fire extinguisher doesn't flash to them immediately. At present, the railway department is using aspiration -based smoke and flame sensors. In this system, there is a chamber where the air present inside the compartment is pulled into a chamber. In this chamber the light is subjected to a test, if there are any suspended particles it will scatter the light rays, which is emitted by the laser. Once the scattering is above the threshold level, the alarm alerts the passengers. During a fire accident, the suspended particles will be more in the air compared to normal. Hence, they are using the aspiration based smoke detector. These mechanisms are one of the fastest to detect any change in the scattering part of the air.The automatic fire-initiated braking and alert system consists of ATMEGA microcontroller and motor driver[1-4].

## III. PROPOSED SYSTEM

The trains are used for transporting people and goods. Mostly, the people prefer the train journey for longer distance as it is cheaper. The notices showing do not smoke, do not carrying inflammable material are the precautionary warnings about the fire in each compartment. However, because of poor maintenance of illegal activities of social elements, the fire accident in train occurs frequently. We have to take certain steps to control and prevent the fire. In case of fire, we first have to alert the passengers. Even the driver needs to be alerted[1-8]. The transmission of message should be done using a wireless system so that any wires do not burn. In our proposed system, we make use of ESP32 Microcontroller for the basic computation process. At the compartment section, we use a flame sensor, smoke sensor to detect the smoke, a buzzer for alerting the passengers, a servo motor to automatically slide open the door. A water sprinkler is used to sprinkle the water all over the compartment and reduce the fire and control the temperature to normal. To transfer the signal to the drivers, we make use of a ESP module. In case of a fire accident, the flame sensor detects the fire and if there is any change in its threshold value, and then it sends the signal through microcontroller. At the compartment

section, firstly, the buzzer goes on alerting the passengers. Next the water sprinkler is used to sprinkling the water so that the fire is extinguished and the temperature becomes normal. Simultaneously, the door of the train will be automatically slid opened, making it convenient for the passengers to move out. By using the Blynk application, the problem and location is transmitted to the respected station authorities. The proposed system block diagram Fig.4.1 consists of ESP32 microcontroller, flame sensor, GPS, MQ-7 sensor, servo motors, dc motors, DHT-11 sensor and power supply. Proposed system. Shown in Fig.4.2 in which the sensors are connected so that they can detect the fire, smoke etc.

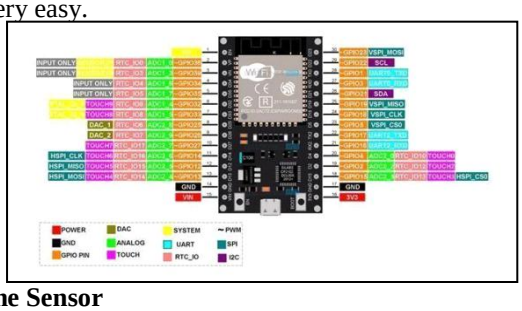
Block Diagram




VI. HARDWARE DESCRIPTION

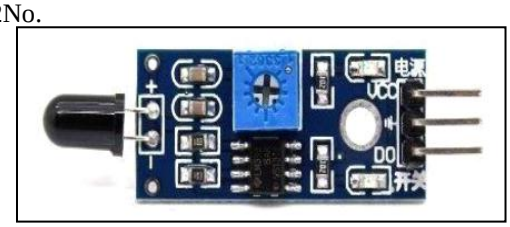
**ESP 32S Microcontroller**

ESP32 is a low-cost System on Chip (SoC) Microcontroller from Espress if Systems, the developers of the famous ESP8266 SoC. It is a successor to ESP8266 SoC and comes in both single-core and dual-core variations of the Tensilicas 32-bit XtensaLX6 Microprocessor with integrated Wi-Fi and Bluetooth. The good thing about ESP32, like ESP8266 it is integrated with RF components shown in Fig.5.1 are Power Amplifier, Low-Noise Receive Amplifier, Antenna Switch, Filters and RF Balun. This makes designing hardware around ESP32 very easy as you require very few external components. Another important thing to know about ESP32 is that it is manufactured using TSMCs ultra-low-power 40 nm technology. So, designing battery operated applications like wearable, audio equipment, baby monitors, smart watches, etc., using ESP32 should be very easy.



**Flame Sensor**

This flame sensor or fire sensor module works on the concept that when a flame or fire is burning it emits IR signals. This IR signal is then received by the IR receiver on the fire sensor module Fig.5.5 to detect the flame or fire. The sensor has an operating voltage from 3V to 5.5V and has both digital and analog output. The sensitivity of the digital output can be controlled by the on-board potentiometer. Detection angle of sensor is 60 degree and range is theoretically 100cm but practically you can get up to 20-30cm. This flame sensor consists of a photodiode, resistor SMD package of value 10K-2N0, capacitor SMD package of value 100nF — 2No, resistor SMD package of value 1K-2N0, potentiometer of value 10K- 1No, SMD led-2No.

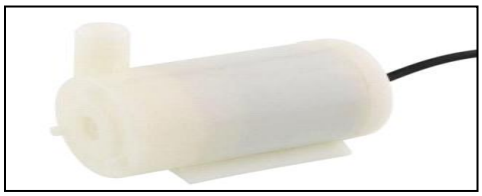



**Servo Motor**

A servo motor is a type of motor that can rotate with great precision. Normally this type of motor consists of a control circuit that provides feedback on the current position of the motor shaft; this feedback allows the servo motors to rotate with great precision. If you want to rotate an object at some specific angles or distance, then you use a servo motor. It is just made up of a simple motor which runs through a servo mechanism. If motor is powered by a DC power supply, then it is called DC servo motor, and if it is AC-powered motor then it is called AC servo motor. Apart from these major classifications, there are many other types of servomotors based on the type of gear arrangement and operating characteristics. A servo motor of Fig.5.11 usually comes with a gear arrangement that allows us to get a very high torque servo motor in small and lightweight packages. Due to these features, they are being used in many applications like toy car, RC helicopters and planes, Robotics, etc.


**DC Pump Motor**

This is a low cost, small size Submersible Pump Motor Fig.5.10 which can be operated from a 3 ~ 6V power supply. It can take up to 120 liters per hour with very low current consumption of 220mA. Just connect tube pipe to the motor outlet, submerge it in water and power, it. Make sure that the water level is always higher than the motor. Dry run may damage the motor due to heating and it will also produce noise.

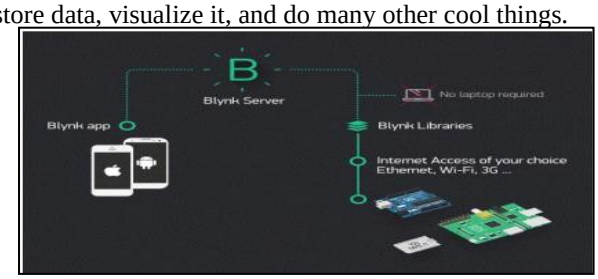


**Buzzer**

An audio signaling device like a beeper or buzzer may be electromechanical or piezoelectric or mechanical type. The main function of the buzzer shown in Fig.5.9 is to convert the signal from audio to sound. Generally, it is powered through DC voltage and used in timers, alarm devices, printers, alarms, computers, etc. Based on the various designs, it can generate different sounds like alarm, music, bell & siren.


**Blynk App**

Blynk was designed for the Internet of Things. It can control hardware remotely; it can display sensor data, can store data, visualize it, and do many other cool things.

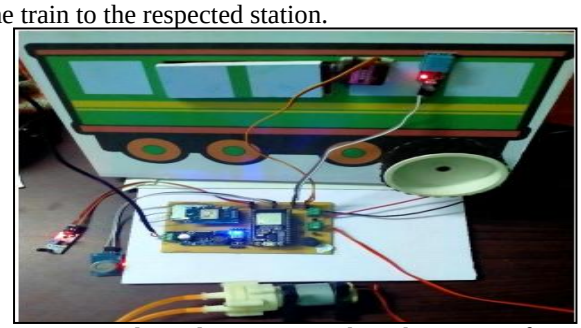



## V. RESULTS& DISCUSSION

The proto type of proposed system in which it is used to detect fire and smoke to alert the passengers.

If any fire will occur, the fire sensor detects the fire and if any smoke occurs, the smoke sensor detects the smoke. So, the system alerts the passengers by the buzzer. A DC Pump motor is used to sprinkle the water in the compartment and the servo motor is used to automatically slide the opening of windows when fire and smoke are detected.

Blynk app is used to monitor the situation. If any fire will occur, it sends an alert message along with the location of the train to the respected station.



During normal conditions, i.e., when there is no fire and smoke, no danger in the train. The data of temperature and humidity is observed and the location of the train is tracked by using the blynk app.

When there is a fire, then the fire sensor detects the fire and sends the notification through the blynk app. Here it is alerting as fire at train in the particular coach number so that they can observe the problem. If there is smoke then smoke sensor detects the smoke and sends an alerting message.


## VI. CONCLUSION

Our project concentrates on the use of a controlled system that saves life and public property (train) during fires in trains. The main focus of the project is to apply the brakes to stop the train as soon as the fire and smoke are detected and send signals to the respected station. It also activates the alarm so that the passengers can evacuate the place before the fire spreads. The passengers can evacuate from the train by using this system upon automatic opening of the windows. The speed of fire spread also gets reduced as the train is stationary.

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