FORESTALLING FIRE ACCIDENT IN TRAIN

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Abstract - *Fire accident is the most dangerous accident in trains. The fire accident is mostly an incipient fault. If this is not treated in early days, it leads to a huge disaster. The combined operation of an extinguishing system and communication system by using IOT is used in this project. Several units are installed in each compartment. Each unit consists of a Humidity sensor, a smoke sensor and a Node MCU ESP 8266 microcontroller. Humidity sensor detects the change in moisture content due the fire while Smoke sensor detects the smoke generated by the fire. When either of the sensor gives output as high, a signal will be transmitted to the microcontroller .The possible way to extinguish fire is using fire extinguisher (fire extinguishing ball) and water sprinkler system. Fire extinguisher ball will be placed in a safety box which is locked with the help of solenoid lock. This solenoid lock gets signal from the microcontroller during emergency condition. So as a result lock gets opened and fire extinguishing ball will fall down from the safety box. When this fire extinguishing ball gets in contact with the fire it extinguishes the fire. If the fire is not quenched, microcontroller activates the water sprinkler system and water is sprayed in the compartment to quench it. The water is drawn from the overhead Aluminium tank which is present in the compartment. Once the fire is detected microcontroller also sends message to the loco-pilot of the train and nearby fire engine using the microcontroller shows the compartment under fire in all other compartments so the people may escape the fire easily. So that the firefighters can reach the emergency spot quick and can take necessary action to extinguish fire.*

***Key Words*: Fire Accident prevention in train using IOT, IOT based fire extinguishing system, Fire Accident in Train, Fire , Train, Railway Accidents Prevention, Indian Railways, IOT in Railways, Fire detection system, Fire control system, IFTTT App,Train Alarm system.**

I. INTRODUCTION

The fire incidences in trains are among the most serious disasters to human lives and the property of Indian Railways. Thus the prevention of train fire has become a serious concern for Railways. A train fire is different from a fire in other places in the manner in which it breaks out, grows and spreads, and in the method of fighting it. Fire in a coach on running train is very dangerous because it spreads very quickly to other coaches due to fanning effect..

Disaster can be defined as a horrific event which causes the loss, decline, deterioration of production and loss of human life. Disasters cause huge financial loss and human suffering and death. Disasters can occur as a consequence of the impact of a natural or a human-caused hazard. Natural hazards comprises of earthquakes, volcanic activity, landslides, tsunamis and tropical cyclones. Artificial disasters include illegal discharge of oil, or accidental such as toxic spills and nuclear meltdown. From the reference survey, economic aftermaths have an increasing trend as average annual damages resulting from natural. When train accident occurs in the trains, there had been only few options to extinguish fire and save the lives.

Method 1: Use Fire Extinguisher

Using fire extinguisher present in the compartment to put off the fire. Fire extinguishers are kept in each compartments

Method 2: Alert Fire Fighters

Alerting fire fighters to quench the fire. It is also noted that the arrival of fire fighters takes time, depending on the traffic, availability of personnel and equipment etc. There is also possibility of huge property loss and loss of lives.

II. DESCRIPTION

To forestall the fire accident in train and to communicate about the status of the train to the respective foreperson and the passengers to avoid loss of life.

To do this we use two sensors Gas ,Temperature and Humidity sensors when fire occurs it detects it and sends signal to microcontroller the micro controller initiates the buzzer and sprinkler system and sends notification to fire department via Node MCU ESP8266 Wifi module interfaced with *IFTTT(IF This Then That)Application* through *Internet Of Things(IOT).*

The objectives of the proposed solution could be divided into three general categories.

•To Detect any Fire accident in Train.

•To Minimise the loss of lives in Fire accident in train.

- To Implement the Automatic Fire Rescuing Service and Information system in a Train using a Sensors and Node MCU ESP8266 Wifi Module.

Causes of fire accidents in train are as follows,

- Carrying inflammable goods in trains

- Malpractices like Smoking

- Electrical short circuits

- Mishandling of pantry equipment

- Throwing waste material outside the dustbin

- Mischievous activities

III. PROPOSED SYSTEM

In this system, the microcontroller Arduino UNO controls the overall operation with a Node MCU ESP8266 WiFi module. The microcontroller gets all the input signals from the input components like Gas sensor and Temperature and Humidity sensor then it check for the appropriate conditions to be met if it is a fire accident. When such conditions are met, it sends the commands to the output components and so the Train stops following the output commends from the components.

The block diagram of the Fire accident Prevention system is shown in Figure, The diagram shows the input and output components connected to Microcontroller (MCU).
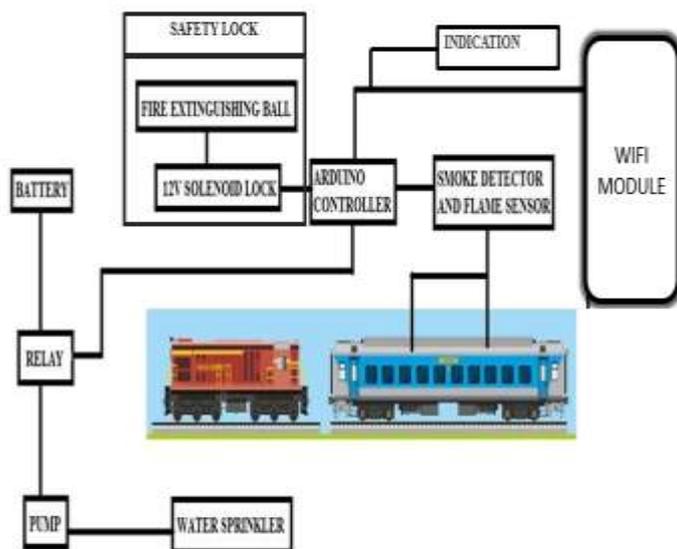

Figure-1: The block diagram of the Proposed system

The input components comprise of Gas sensor, Smoke sensor, and the Temperature and Humidity sensor. The Output components comprise of Buzzer, Emergency Lamps, LCD Display to intimate Warnings to the Loco Pilot and also to each of the compartments with the details of the

compartment on fire , Pumps, water sprinklers and Node MCU ESP8266 WiFi module ,and Safety box (an extinguishing system which contains AFO(Auto Fire Off)Fire Extinguisher ball.

Fire accident prevention in train involves combined operation of two systems:

- Fire Extinguishing system

- Emergency Alert system.

III. a. *Fire Extinguishing system :*

The idea is to install 'units' in the compartments of the train. Each units contain sensors like gas sensor , smoke sensor, Temperature and Humidity sensor. The units will be placed in a uniform interval which in turn depends on the sensitivity of the sensors. The sensitivity could be manually adjusted in the sensor itself.

When there is a fire accident, initially either Temperature and Humidity sensor or the smoke sensor goes high i.e. it gives 5V as output. There is also case when there are false accident indications, like smoking within compartments. In order to avoid such cases, inbuilt delay in the programming can be implemented, there will be 2 units at both the entrances of the compartments. So, when there is detection in any of the sensors, 5V signal is sent to the Arduino UNO microcontroller. Water sprinkler starts to sprinkle the water through the pump connected to the tank of respective compartment on fire and The safety box consists of AFO extinguisher ball, 5V relay will open the closed box , so that the passengers can throw it to extinguish the fire as its working operation is very simple and easy too as it should be thrown on to the fire and automatically it bursts and extinguish the fire .

The relay gets activated by the command pulse from the microcontroller, thus supplying enough current to open the box. AFO ball will burst with which the contact of fire and the temperature should be minimum 70 degree Celsius. AFO contains Mono Ammonium Phosphate powder. On explosion, the chemical powder spreads throughout the open/ closed area, forming a layer between the fuel and the oxygen.

As we know, any combustion requires both a fuel and oxygen. Without oxygen, there will be no combustion. So a barrier of closely packed solid material is formed to break the contact between the fuel and the oxygen. This will cause the quenching of the fire. It is also noted that in some cases, the fire may persist (due to any other sources apart from the extinguished part). So as a precaution measure, a secondary system is activated. It is noted that the water tanks for domestic or toilet use will be present above the location of unit. The microcontroller will send command to the 5V relay which in turn activates the pump to operate.

As a result, the water pump sucks the water from the aluminium tank and sprays the water throughout the compartment via the nozzles of the sprinkler. This will delay the fire to spread. It gives time for the passengers to exit the respective compartment.

The secondary system is included in this project only to delay the fire so that the fire personnel can arrive just in time to extinguish the additional sources of fire. These are the processes which takes place in extinguishing system.

III.b. *Emergency Alert system:*

Now at the same time, The microcontroller sends command signal to LCD displays in each compartments and also to the Loco Pilot as "Fire is Detected" and stops the train , Buzzer starts to alarm , Emergency lamps will turn on throughout the train compartments.

In addition to that, we have using the Node MCU ESP 8266 WiFi module and it also works simultaneously and sends Notifications to three or many forepersons of nearby Railway stations, Railway Police , and Loco Pilot through the IFTTT Application which is to be connected through the WiFi and same IFTTT Login ID should be used for smartphones to get the Notifications which should be sent by the IFTTT app in case of fire. So obviously the exact location of the train during the fire can be found be the GPS(Global Positioning System) tracker of that Train and then by the notification sent by using IOT based IFTTT app, one can know about the fire accident happening in train.

This notifications will be sent continously until the input sensors keeps on sensing the fire and smoke which is above the preset value or critical value.

This overall process is done through the Arduino Programming Code done in Arduino IDE and the Node MCU ESP 8266 can also be programmed by the Arduino IDE. In the programming code of Node MCU the URL ID of the respective login should be copied to get the notifications. Once the login is created it can be used in several smartphones and computers to get the same notification.

So, this system overcomes the disadvantages of the previous proposed systems by provides a better way of communication and by the usage of better fire quenching methods.

IV. SYSTEM ARCHITECTURE

A. MICRO CONTROLLER- Arduino UNO : The **Arduino Uno** has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 Analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. Instead, it features the Atmega8U2 microcontroller chip programmed as a USB-to-serial converter.

B. NODEMCU ESP-8266:

The Node MCU ESP-8266 is one of the development board created by Node MCU to evaluate the ESP-WROOM-32 module. It is based on the ESP-8266 MCU that boosts Wifi, and Low Power support all in a single chip.

C. SENSING COMPONENT:

The sensors are used to sense the particular parameter and send signal to the central controller. There are various types of sensors present in this paper they are Temperature sensor, Humidity sensor. These sensor having its own characteristics of measuring its value.

1. Temperature sensor

A Temperature sensor is a device, usually an RTD (resistance temperature detector) or a thermocouple, that collects the data about temperature from a particular source and converts the data into understandable form for a device or an observer. Temperature sensors are used in many applications like HV and AC system. In this we use it to measure the temperature of the hall and kitchen.

2. Humidity sensor

A Humidity Sensor is one of the most important devices that has been widely in consumer, industrial, biomedical, and environmental etc. applications for measuring and monitoring Humidity. Humidity is defined as the amount of water present in the surrounding air. This water content in the air is a key factor in the wellness of mankind. In this we use it to measure the Humidity of the hall and kitchen.

3. Smoke Sensor

The MQ-2 Gas sensor can detect or measure gases like *LPG, Alcohol, Propane, Hydrogen, CO* and even *methane*. It comes in handy when trying to detect one particular gas. When it comes to measuring the gas in ppm the analog pin has to be used, the analog pin also TTL driven and works on 5V and hence can be used with most common microcontrollers.

Output voltage of the sensor changes accordingly to the smoke/gas level that exists in the atmosphere. The sensor outputs a voltage that is proportional to the concentration of smoke/gas.

In other words, the relationship between voltage and gas concentration is the following:

- Greater the gas concentration, greater the output voltage

- Lower the gas concentration, lower the output voltage

D. LCD:

A liquid-crystal display (LCD) is a flat panel display or other electronically modulated optical device that uses the light modulating properties of liquid crystals

E. Electromagnetic relay:

A relay is an electrically operated switch. It consists of a set of input terminals for a single or multiple control signals, and a set of operating contact terminals. The switch may have any number of contacts in multiple contact forms, such as make contacts, break contacts, or combinations. Here the making and braking of contacts are based on the input signals.

F. Safety box:

To keep the fire extinguisher ball safely.

G. Submersible pump:

A submersible pump is also known as ESP (Electrical Submersible pump). It is a device which has a hermetically sealed motor close – coupled to the pump body. The whole assembly is submerged in the fluid to be pumped. The main advantage of this type of pump is that it prevents pump cavitation, a problem associated with a high elevation difference between pump and the fluid surface. Submersible pumps push fluid to the surface as opposed to jet pumps having to pull fluids.

H. AFO ball Fire extinguishing ball:

Many times fires begin when there is no one around and before long it can cause massive damage to property or worse – become life-threatening. Even when the fire is noticed by someone, it might take precious minutes before an effective means to stop the fire is obtained and utilised. Many standard fire extinguishers are bulky, heavy and not easy to operate especially under pressure. It is also necessary to get close to the fire in order to put it out effectively using standard fire extinguishers. Additionally, sometimes the fire extinguishers in hand are unsuitable to the type of fire e.g. petrol, gas, electrical etc. Even if a variety of extinguishers do exist on the premises, they need to pass periodical inspections to ensure they are effective and safe to use. If such inspections were not carried out within the required time frames, there would be a good chance that they will fail when needed most.

Combustion may occur when there is a combination of three elements: fuel, oxygen and heat. The Elide Fire Ball or AFO (Auto Fire Off) Ball is a scientifically-proven and effective self-activating fire extinguishing solution for virtually any situation where there is the possibility of an accidental fire. It can be in the home, the office, car, factory, boat, and restaurant.

H.a. WORKING PRINCIPLE of AFO Fire extinguishing   ball

The Elide fire ball provides a rapid, convenient and simple means to fight a fire. Simply throw or roll the ball into the fire from a safe distance. The operation is so simple that even a child can stop the fire before it spreads, endangering life and/or property. The Elide Fire Ball will activate itself within seconds from coming into contact with flames and release a mono ammonium phosphate chemical powder which separates the three elements and extinguishes the fire. Dry Mono ammonium phosphate type powder is environmentally friendly and safe for humans, animals, plants and various electrical devices. The ball has passed many safety standards worldwide.

During activation, the fire extinguishing ball produces a loud explosion noise which is rated at 120 decibels. Regarding hearing loss specifically, the noise produced by the Elide Fire Ball is at an acceptable universal level as measured by a variety of global standards institutions. From our point of view, we think that the noise produced is an efficient alert to the existence of a fire.

H.b. AFO Fire extinguishing ball Specifications:

Table-1: *Specifications of AFO Fire extinguishing ball:*

Medium	Dry powder
Coverage Area	8-10 m^2
Weight	1.3 kg
Diameter	147 mm
Activation Time	3 seconds
Activation Trigger	Flame
Warning Audio	120 B
Fire Types	Classes A, B, C and E

H.c.Comparison table between AFO Fire extinguishing ball and Normal Fire Extinguisher:

Table-2: *Comparison of Parameters between AFO Fire extinguishing ball and Normal Fire Extinguisher:*

Parameters	AFO Ball	Normal fire extinguisher
Weight	1.3kg (Light weight)	Heavy weight
Packaging	Spherical	Cylindrical
Fitment	Can be fitted in any plane	Wall mounted
Usage	Manual/Auto	Used manually only
Operation	Only after flame touch at 85℃	Only 10% people trained to use it manually
Direction	Chemical spread 360º uniformly	Can be sprayed at one point only at a

		time
Fire above the fitment	Can be easily extinguished as it activates in 360º	Possible only manually
Alarm	Inbuilt, makes a loud noise of 120- 127dB when activated	No such feature, external alarm system to be attached
Content	Eco friendly dry powder	Dry powder
Response time	3 – 5 seconds	No such facility
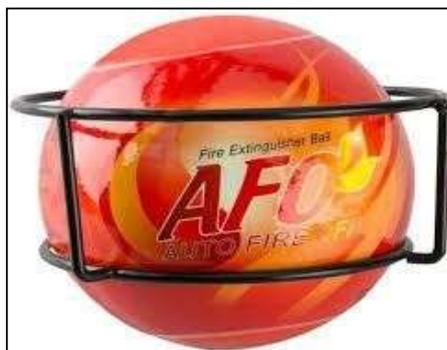
Figure-2: AFO Fire Extinguisher Ball

I. Chassis:

The Chassis which we use for the project is to represent the train and its compartments consists of two major parts,

- Engine part

- Compartment part

They are connected to DC gear motors and L298N H-bridge.

I.a. DC gear motor:

A DC motor is any motor within a class of electrical machines whereby direct current electrical power is converted into mechanical power. Most often, this type of motor relies on forces that magnetic fields produce. Regardless of the type, DC motors have some kind of internal mechanism, which is electronic or electromechanical. In both cases, the direction of current flow in part of the motor is changed periodically. The speed of a DC motor is controlled using a variable supply voltage or by changing the strength of the current within its field windings.

I.b. L298N H-bridge:

H-Bridge is a driver IC which is used to control the motor supply. It can be used to reverse the direction of motor rotation as well as employ PWM methods. H-Bridge are commonly used for DC geared motors, servo motors, Stepper motors, etc. The L298N motor controller follows the H-bridge configuration, which is handy when controlling the direction of rotation of a DC motor.

V. Flowchart of the working prototype model of the proposed system

Table -1: Sample Table format
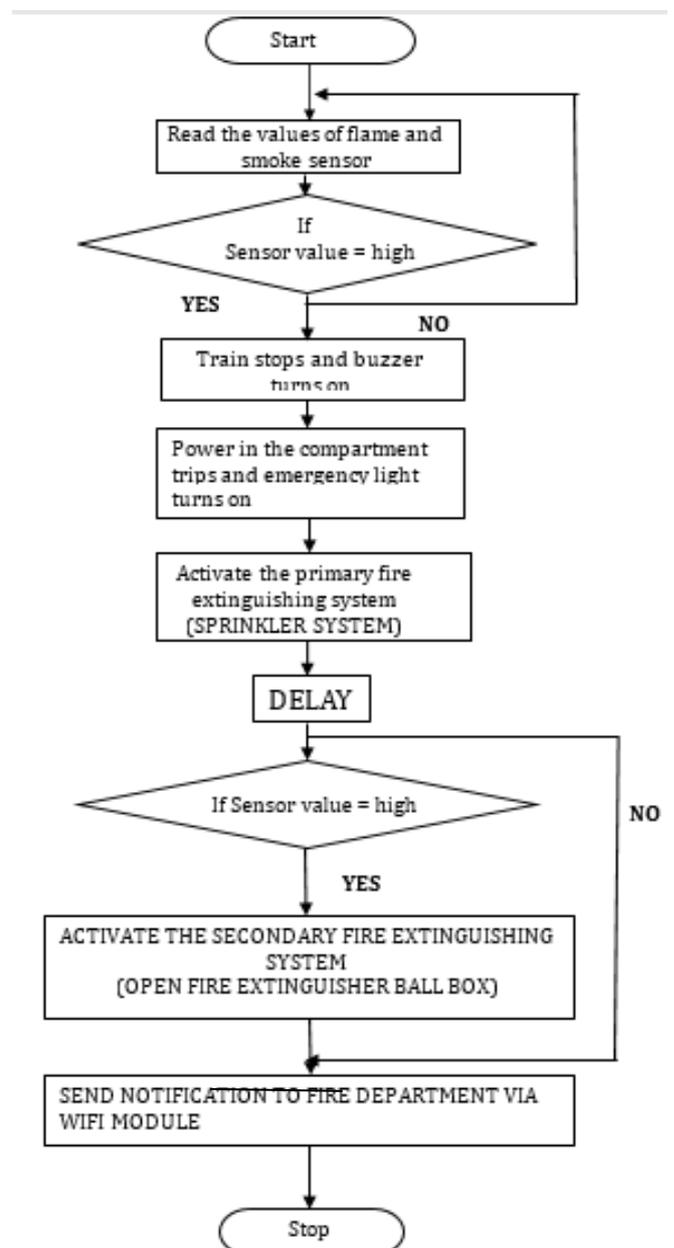
VI. Images of the proposed system outputs:

**FIGURE-3: Train during Normal Traction (no fire).**
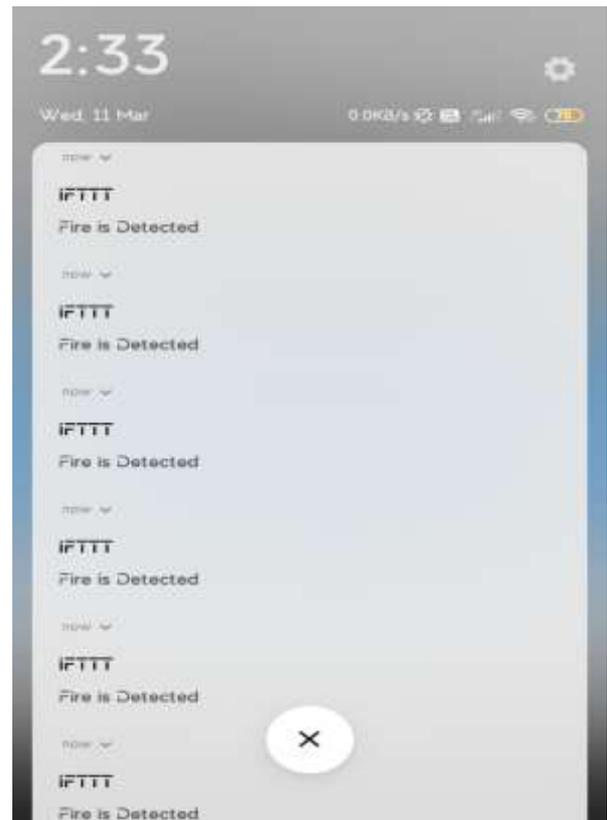
**Figure-5: Fire alarming Notifications from IFTTT application via NodeMCU ESP8266 by IOT.**
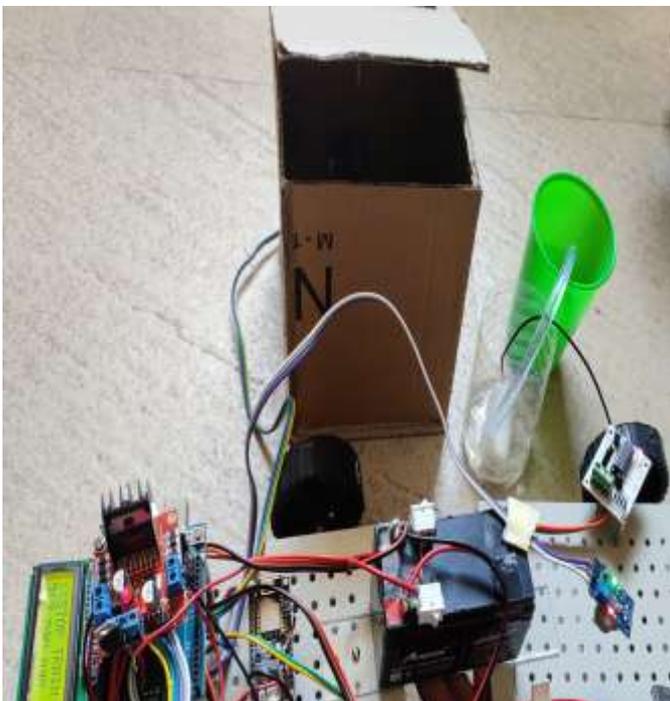
**Figure -4: Train during Fire Accident**
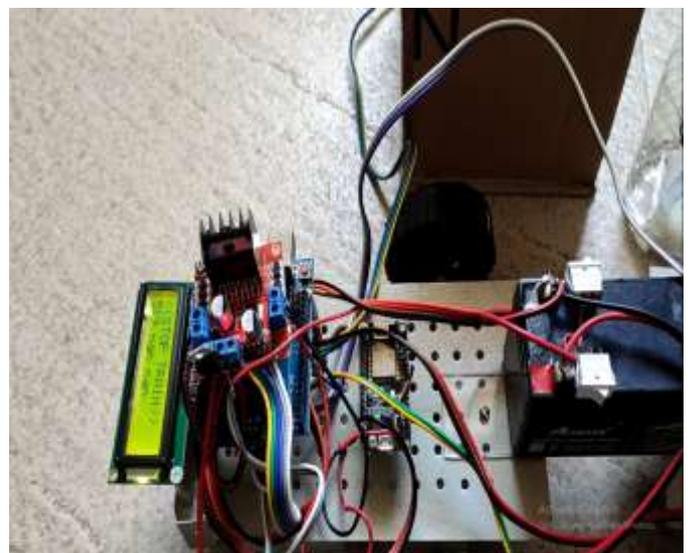
Figure-6: LCD output

VII. Conclusion:

Thus using this system fire can be detected at the very first stage and can be extinguished either using sprinkler system or with the fire extinguisher ball and send notification to the fire department using WiFi module and also signal the passengers and the loco driver.

IX. Acknowledgement:

X. References:

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XI. BIOGRAPHIES

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