JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

A Novel Approach For The Safety of Metro Train By Incorporating Smart Fire System

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Abstract: Fire accidents on the train occur resulting in serious injuries or even severe disability which is closely related to health and safety. Since there are chances of catching fire in the train because of short-circuits and the unintended risk of accidents has been occurring. In view of this, it was intended to develop the smart fire system by using Arduino and IoT to enhance safety in the train and control the fire in the train compartment. This work proposes the "Smart Fire System Using IoT" in train by integrating IoT devices, including smoke and temperature detectors, Arduino, and other complementary equipment. The idea of the work is when a fire occurs, the Arduino is proposed to sense the surroundings for the occurrence of fire with the help of a fire and gas sensor. The development of smart fire system is built based on an Arduino board. The fire is detected at an early stage by utilizing the temperature sensor and smoke sensor and there is a simple to advanced converter, which changes over the simple signs got at the sensor end to computerized and afterward transmits them to a smaller scale controller and to the Arduino Simultaneously, Arduino sends the information to the Wi-Fi module will then the accompanying information to the IoT site. A water sprayer-producing device connected to an Arduino board is switched on to control fire. A door will automatically open during fire conditions which are controlled by Arduino. This prototype system can help to improve their safety standards with immediate response by preventing major accidents. This will eventually allow both the lives and the properties from the disaster. The prototype has been created in order to carry out the verification trials that are required. The results demonstrate that the control approach of the suggested model was successfully used on a test bed with reliable outcomes for controlling fire hazard conditions. Both passengers and the train itself would gain advantages from the proposed smart fire system's improved safety.

***Index Terms*– Driverless train, smart fire system, IoT ESP 8266module**

I. INTRODUCTION

A computer system called an embedded system is made to carry out one or a small number of specific tasks, frequently under real-time computing limitations. It serves as a part of a larger equipment, usually consisting of other mechanical and physical parts. A general-purpose computer, like a personal (PC), on the contrary, is intended to be adaptable and to suit a variety of end-users needs. Embedded systems handle many common devices nowadays. One or more digital signal processors (DSPs) or microcontrollers serve as the main processing cores for embedded systems. Technology has advanced significantly in all parts of our lives, including transportation, which has experienced a significant revolution. Despite this, train accidents are becoming more common. The most common causes are caused by humans, whereas some are caused by incidents or accidents. In India today, if a train catches fire in any cabin, the alarms would sound, but no fire controllers will be activated. Trains have standard fire extinguishers that are activated manually. It will take more time. To address this issue, we are creating a smart fire system comprised of a nozzle spray mechanism and a sensor. This is controlled via Arduino programming. When a train catches fire, the door automatically opens, and the nozzle automatically sprays water to suppress the flames.

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II. LITERATURE REVIEWS

Parkash Ratan, Chandra Jogi

This project aims to display off the metro train's capabilities transportation, which is normal in a large number of advanced countries. A controller has been set up on this train so that it to operate automatically from one station to the next. To move the train one station to the following, they used an ARM 7 CPU. They also employed an infrared sensor, which is used to open the door.

D. Pradeep simha1, N.Ajay kumar2,K.Pavan3,O.Anuf

The PIC microcontroller was used as the CPU in this project. An infrared sensor senses when the train arrives at the terminus, so it stops instantly. Part of this automation task is explored in this study, and a microcontroller-based prototype is constructed. The prototype includes actions like as travelling along a predetermined course with predefined stations, sensing station arrival, and thus properly halting. Messages are announced to passengers via a display that is synchronized with the train's passage through its path. Alarms signals are generated as well as necessary. Controlling the opening and shutting of the doors, as well as the time of such activities, is taken into account.

S V S Prasd, K Nishanth Rao, V Arun, D Laxma Reddy

This paper describes the technologies employed in control system-equipped driverless trains. TO avoid errors resulting from human error while driving, many cases have been created that provide station information such as the direction, arrival and departure timings of a train. All stations' distance between each other is predefined in a way that is meaningful to the passengers, and the screen shows a message that includes the quantity of travelers on board the train. This metro train is operated by a controller who drives the train one station to the following. The procedure will be repeated for the remaining stations after the train reaches its destination

Bharathi K V1, Divya2, Raseeda S3, Tejaswini N S4, Dr.Shankaralingappa C B

This study is intended to display the technology utilized for the movement of metro trains in the vast majority of developed countries. As a CPU, they used ARM 7. An infrared sensor senses when the train arrives at the terminus, so it stops instantly. The door then closes, and the train departs at the moment specified by the programmed in the controller. An LCD connected to the ARM 7 displays the passenger counts and stations. A motor driver IC interfaced to the ARM 7 controls the train's movement. The train has a buzzer that warns passengers before closing the door and also before beginning. This study is intended to demonstrate the technology utilized in metro train movements in most developed countries. As a CPU, they used ARM 7. An infrared sensor senses when the train arrives at the terminus, so it stops instantly. The door then closes, and the train departs at the moment specified by the programmed in the controller. An LCD connected to the ARM 7 displays the passenger counts and stations. A motor driver IC interfaced to the ARM 7 controls the train's movement. The train has a buzzer that warns passengers before closing the door and also before beginning ARM 7. The train incorporates a buzzer to alert the passengers before closing the door and also warn them before starting.

Naga Swetha R1, Yashwanth Badri2, Mahesh3, Rabbani Basha

They employed a controller that allows the train to operate automatically from one station to the next. The suggested technology is a self-driving trainthat does not require a driver. As soon as the train comes into the station, it automatically stops, as detected by an RFID Module. The door then automatically opens, allowing passengers to board the train. It additionally contains a passenger counting area wherein the number of individuals stepping on and off the train is recorded. They've also deployed a buzzer to warn people before closing the door and before looking.

Premchand bharti, ratnesh pandey, ashwini mathurkar

This study servers as an example of the train in movement technique that is used in the majority of industrialized nations. In this driverless metro train, the controlled halting of the train between stations is made possible by our Arduino- Based controller. The improvement of a framework for a driverless train initiated using an Arduino-based controller is shown in this study. Various sensors are included in the hardware circuit design, which is constructed on circuit boards, for automation purposes. The components are put together in a train-like framework. Trains without drivers are equipped with a control system that is programmed to direct them along a specific path

Rupal jain

They employed an 8051-family microcontroller, which serves as the project's CPU. An IR sensor detects when the train enters the station and causes it to stop instantly. The train door then automatically opens, allowing the passengers to board. The door then shuts after the predetermined amount of time. Additionally, it has a section for counting passengers that keeps track of those getting on and off the train. Regardless of the time given for the door to remain open, the door closes when it hits the maximum occupancy level.

III. Material

- **Arduino Uno:**

Arduino is used as the main controller in this project. Open-source electronics platform Arduino incorporates simple hardware and software for managing and modifying the date. Sensors and motors, among other internal parts, were delivered. The Arduino Board can transform inputs like a tweet, a finger press, or a light on a sensor into outputs like running a motor, turning on an LED, or posting anything online. You can operate your board by giving its microcontroller a set of instructions.

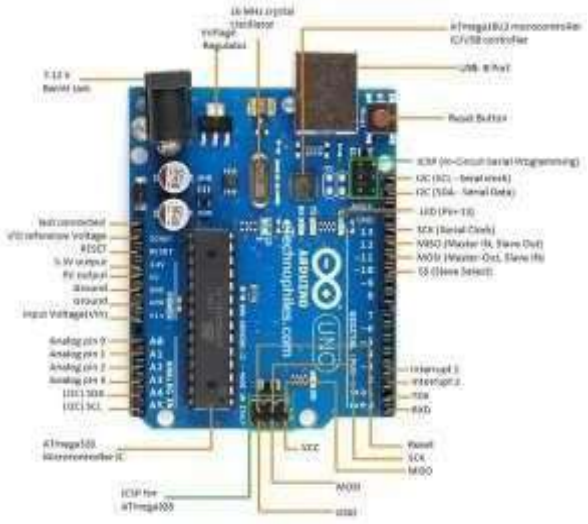

Fig.1: Arduino Board

- **ESP32 / ESP8266: -**

ESP32 / ESP8266 is used for IOT to create, Deploy & monitoring of Battery

The Arduino IoT Cloud supports a large selection of third-party boards based on the ESP32 and ESP8266 Wi-Fi microcontrollers. Simply select the third-party option in the device setup to get started. Connecting ESP32 & ESP8266 to Arduino Cloud IoT.

Fig.2.ESP32 / ESP8266

- **NTC Thermistor Temperature Sensor: -**

It is extremely temperature sensitive. It is commonly used to detect the temperature of the surroundings. An NTC thermistor is a temperature sensor that measure temperature using the resistance qualities of ceramic/metal compposites. Our full spectrum a number of advantages of NTC sensors include their small dimensions, outstanding long-term stability, high accuracy, and precision when it comes to thermal sensing.

Fig.3 NTC Thermistor Temperature Sensor

- **Mq-135 gas or smoke sensor: -**

Fig.4: Mq-135 Gas Sensor

The MQ-135 Gas sensor is capable of identifying smoke, ammonia (NH3), Sulphur (S), benzene (C6H6), and other hazardous gases. Both a digital and analogue output pin are present on this sensor, much like on other gas sensors from the MQ series. The digital pin swings high if the level of these gases in the air rises beyond a threshold that has been set. To set this threshold value, utilise the built-in potentiometer. It is possible to determine the concentration of different gases in the atmosphere using the analogue signal produced by the analogue output pin.

- **IR Sensor:**

Fig.5: IR Sensor

An infrared sensor is a piece of technology that uses light to detect items close by. An IR sensor can identify movement and heat from an item. Typically, thermal radiation of some kind is emitted by all infrared emitting items. Despite being undetectable to the human eye, these radiations can be detected by an infrared sensor. Simple infrared photodiodes are used as the emitter and detector, respectively, whereas simple infrared LEDs are used as the emitter. The photodiode is sensitive to infrared light with the same wavelength as the IR LED. The intensity of infrared light that strikes a photodiode has an impact on its resistances and output voltage

IV. Working of System

Initially when auto metro train starts, it moves automatically with the help of motors which is nothing but DC motors via L293D driver. The IR sensor senses is the platform arrived or not. When the platform arrived then and then only door will get open. Also, IR sensor senses the person and door will open automatically so that the person will leave the train. Safety management provided with the help of the smoke sensor and temperature sensor. When there is any gas in compartment reaches to certain limit or value then door will open automatically. When the compartment catches the fire due to any reason then it will get detected by temperature sensor. As soon as it will get detect, the water from the nozzle is sprayed into the compartment. At same time train's speed will also get reduce and train will stop. The door will open with the help of rack and pinion mechanism. All the operation are done or controlled by the Arduino mega board using ESP 8266 with inbuilt wifi module. The timing for opening of the door and closing of doors are preprogrammed.

Fig.6 Actual Working Model

V. Calculations

✓Design of Support

Area of rectangular

We had taken a teak wood frame which is available in the market of thickness 4 mm and length, width according to requirement.

Thickness = 5 mm

W = 300mm

L = 400mm

The total surface area of the rectangular prism is given by:

A = 2(lb + bh + lh)

= 2((400 x 300) + (300 x 5) + (400 x 5))

= 247000 mm^2

Mass = 0.385 Kg = 0.385 x 9.81 = 3.776 N

From CATIA v5 software

@ Area = 247000 mm^2 = 0.247m^2

Moment of Inertia I_{CM}

= 1/12 x M (w^2 + l^2)

= 1/12 x 3.776(400^2 + 300^2)

= 78666.6 Nmm^2

✓Assume load on the frame including all components = 5Kg = 49.05 = 50 N

FOS = 1.5 = 50X 1.5 = 75N

Perpendicular distance = 400 / 2 = 200 mm

M= 75 X 200 = 15000 Nmm^2

M= 15000 Nmm^2

I = 78666.6 Nmm2

Y = Distance of the layer at which the bending stress is consider = 5/2 = 2.5 mm

Sigma b = M X Y / (I)

= 15000 X 2.5 / (78666.6)

= 0.4766 Mpa

Wood Plywood 13.8 Ultimate Yield strength Hence Design is safe.

- Motor selection on total pay load of component

✓Total weight on the frame

= 50N + 2 Kg extra load = 70 N + 19.62 N = 90 N

= 100N

✓No wheels 4

Load is distributed into 4 wheels

Actual load = total load / no. of wheels

= 100/4 = 25 N

✓Diameter of inside hole of a wheel 10mm

Torque = ½ Force X Diameter

= ½ X 25 X 10mm

= 125 N.mm = 0.125 Nm.

VI. CONCLUSION

The proposed effort focuses on reducing accidents brought on by fires spreading inside train or metro compartments. This system is completely autonomous with IOT Monitoring of the compartment's temperature and humidity. It also has a fire and smoke sensor that activates the sprayer if a fire breaks out in the enclosure. Another automation uses an IR sensor to open the compartment door when it detects a station wall. Finally, the thesis has been completed in its entirety. The problem definition, literature review, design, computation, and other necessary components have been satisfied, and the programming and testing framework have also been effectively constructed.

VII. ACKNOWLEDGMENT

First of all, we would like to express our gratitude to Prof. V.B. Hiwase, who served as our mentor and showed us how to efficiently complete the dissertation. We appreciate Dr. Pravin Nitnaware, HOD-Mechanical Engineering, for motivating us to act honorably and adopt a research-based methodology. We appreciate other faculties' advice and willingness to share their knowledge with our school. Last but not least, we want to thank our friends for helping us organize and stack our work better.

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