iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 12 **Issue:** VI **Month of publication:** June 2024

DOI: https://doi.org/10.22214/ijraset.2024.63232

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 12 Issue VI June 2024- Available at www.ijraset.com

Train Crash Avoidance System

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Abstract: ***This paper introduces a Train Crash Avoidance System (TCAS) designed to prevent catastrophic incidents by providing timely alerts. The system seamlessly integrates with existing railway infrastructure and emergency response systems, ensuring a coordinated reaction from all authorities involved. The system consists of an emitter, a receiver, and a signalling system. When the train derails, the signal emitted will be disturbed by the rail and hence the receiver will not get the signal. Consequently, the signalling system will alert the station masters of the nearby railway stations who will, in turn, inform the authorities so that they can take prompt action and the passengers can be evacuated as soon as possible.***
Keywords: Emitter, Reciever, SIM 800 L, Arduino UNO R3, LDR, SIM 800L, Train Derailment, Laser emitter, Train Crash Avoidance System(TCAS)

I. INTRODUCTION

As transportation grows increasingly faster and better, there has been an increasing interest in the safety mechanisms of the various modes of transport. Ensuring a safe journey for everyone involved has become the need of the hour, especially as the number of commuters is at an all-time high. In the railways, derailments and unmanned railway crossings are among India's major causes of train accidents. The number of unmanned railway crossings has reduced significantly in the past few years. However, the frequency of train derailments is not reducing; hence, there is a need for a system that will avoid collisions in the case of a train going off the rails so that the loss of lives and property can be minimized.

The current system in use by the Indian Railways is the Kavach system. Before it, there was no automated system to prevent train accidents. The system relies on the proximity between the train and the train in front of it. As the approaching train detects another train in front of it, it alarms the loco pilot and instructs him to apply the brakes. This system uses proximity sensors to detect the obstacles in front of it. The major drawback associated with this system is that it only works efficiently if the distance between the two trains is more than a certain minimum distance. This means that the derailed train and the approaching train are relatively close enough, that the system fails and an accident might be caused. Moreover, there is no provision to inform the important railway authorities so that further action can be taken swiftly. No real-time information is relayed to the senior authorities so that important decisions can be made regarding the possible delay of other trains on the same line.

We have made a system to prevent oncoming trains from crashing into an already derailed train. This has been done with the help of a Light Dependent Resistor and a laser emitter and receiver, which will be placed on opposite sides of the undercarriage. When the train is derailed, the laser signal will be interrupted. Since the receiver consists of a Light Dependent Resistor, it will not receive a signal from the laser emitter and the system will send a signal to alert the station master. The station master can hence alert all the trains on the line to halt and consequently prevent further catastrophes. Also, the emergency services can be informed which will ensure that the people affected get the required medical help. This will ensure a much faster response time to the derailment and the complications that may arise due to it. The system has a high accuracy rate so as to prevent false positives that might cause an unnecessary stop in operations, and false negatives, as a lot of lives would be at risk.

II. LITERATURE REVIEW

1) R. Lakshmi Devi, G. Saravanan, K. Sangeetha, S. Pavithra and S. Thiyagarajan, "Smart Train Accident Detection And Prevention System Using Iot Technology,"- using ultrasonic sensor for impact identification and automatic use of train brakes.
2) Vartika, C. R. Krishna, R. Kumar and Yogita, "Sentiment Analysis of Train Derailment in India: A Case Study from Twitter Data,- Using sentiment analysis to detect the majority opinions relating to train derailments using various machine learning algorithms.
3) A. Matsumoto et al., "A New Monitoring Method of Train Derailment Coefficient,-Uses new methods to determine the perpendicular and horizontal forces on the train tracks.

4) Z. Zhihui, Z. Jun, Q. Wenxiao and Z. Qingyuan, "Simulation and Analysis of Derailment of Freight Train on Bridges,"-Uses physics formula to find the causes of train derailments on rail bridges.The conclusion is that derailments on these bridges is caused due to lack of rigidity during construction.

5) M. SureshKumar, G. P. P. Malar, N. Harinisha and P. Shanmugapriya, "Railway Accident Prevention Using Ultrasonic Sensors,"-Uses ultrasonic sensors to detect possible collisions and relay this information to the nearby station.

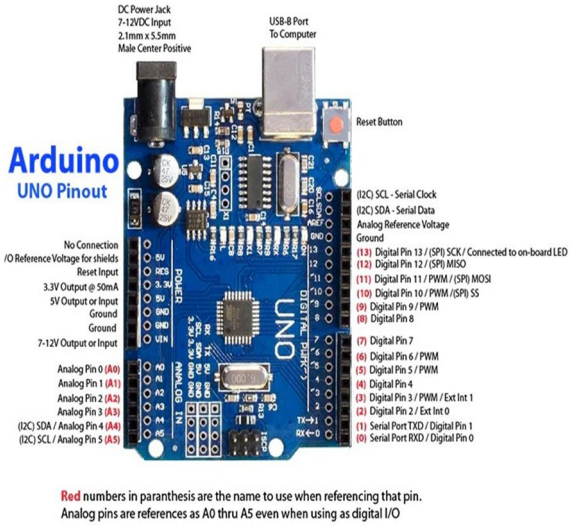
6) B. A. Khivsara, P. Gawande, M. Dhanwate, K. Sonawane and T. Chaudhari, "IOT Based Railway Disaster Management System,"- uses Internet of Things to detect train accidents using accelerometer and smoke detector.

III. METHODOLOGY/EXPERIMENTAL

A. Materials/Components

Following are the Required components-

1) *Arduino UNO R3:* Arduino UNO R3 is a versatile microcontroller board. Powered by the ATmega328P chip, it features digital/analog pins, USB connectivity, and compatibility with a wide range of sensors and actuators. It has 14 digital I/O pins of which 6 are analog pins, USB connection through an input pin, a power input pin and a reset button. Ideal for prototyping and DIY projects, it's the heart of countless innovative electronic designs.



[Fig.1]

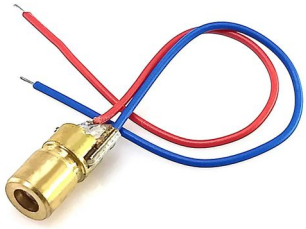
2) *LDR:* The Light Dependent Resistor (LDR) is a photosensitive device that changes resistance with changing light intensity. Utilized in our project, it enables light-sensitive functionalities, such as triggering responses or adjustments based on environmental illumination. LDR is a special kind of resistor that works on the principle of photoconductivity,i.e-the current passing through the resistor is dependent on the incident light. The intensity of the incident light is inversely proportional to the resistance.

[Fig.2]

3) *SIM800L:* SIM800L is a miniature cellular module which allows for GSM transmission, that provides wireless communication capabilities by sending and receiving SMS and making and receiving voice calls. Compact and versatile, it facilitates SMS and GPRS data transmission. It can only connect to the 2G network. Ideal for projects requiring mobile connectivity, it empowers applications like remote monitoring and IoT devices in our college project.

[Fig.3]

4) *Breadboard:* A Breadboard is a versatile solderless prototyping board used in electronics. Featuring a grid of interconnected holes, it allows quick and temporary assembly of circuits. Ideal for experimentation, it simplifies component connections, fostering efficient design and testing in our college project.
5) *D-type Battery:* D-type batteries, larger cylindrical cells, and power devices like flashlights. Alkaline ones offer 1.5V, rechargeable NiMH provides 1.2V. Check compatibility for optimal performance in your electronic devices.
6) *Laser Emitter:* A laser emitter is a device that produces a focused beam of coherent light through the stimulated emission of photons. Commonly used in applications like communication, cutting, and medical procedures, lasers vary in types and wavelengths. Ensure safety measures and adhere to specifications for effective use in your project.



[Fig.4]

7) *Buzzer:* A buzzer is a sound-signalling device found in alarms and electronic circuits. It emits continuous or intermittent sounds, with types like electromagnetic and piezoelectric. Consider voltage and resonance frequencies for optimal use in your research project.

[Fig.5]

B. Software

The code for the project has been written in the Arduino IDE using C language. A provision has been made so that calls are made only once in a minute. Moreover, once a call has been made, the SIM800L module will not try to make a call again unless the LDR detects the absence of light incident on it.

```
void loop() {
  val = analogRead(senpin);
  Serial.println(val);

  if (val < 100 && !callMade && callAttempts < maxCallAttempts) {
    Serial.println("Train derailed");
    digitalWrite(13, HIGH);

    // Make a call instantly
    if (!fona.callPhone("7083690846")) { // Replace with the desired phone number
      Serial.println(F("Failed to make a call"));
    } else {
      Serial.println(F("Call initiated!"));
      callMade = true; // Set the flag to indicate that a call has been made
    }

    delay(callDelay); // Add delay between call attempts
    digitalWrite(13, LOW);
    callMade = false; // Reset the flag for the next attempt
    callAttempts++; // Increment the call attempts counter
  } else if (val >= 100 || callAttempts >= maxCallAttempts) {
    // Reset the flag and counter when light is detected again or after max attempts
    digitalWrite(13, LOW);
    callMade = false;
    callAttempts = 0;
```

C. Synthesis/Algorithm/Design/Method

1) This project aims to make a system that informs the station master when there is a train derailment. The components used are a laser emitter, receiver, buzzer, LED, Arduino UNO R3, SIM800l, and breadboard.

2) Our group visited the Ghorpadi train yard, where we took measurements of the undercarriage and found out that in the case of a train derailment, the spring planks of the train will be below the level of the train track.

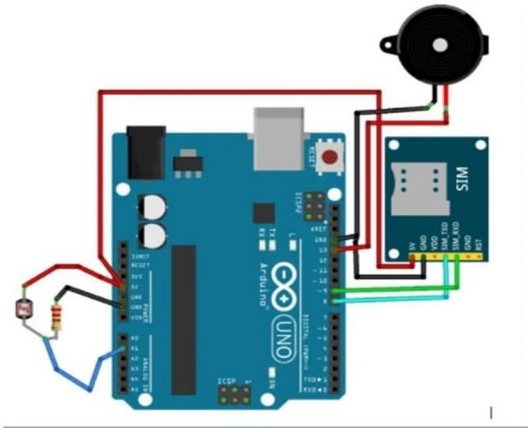
3) Hence, in the unfortunate scenario of a train derailment, the signal sent by the laser emitter will get obstructed by the train tracks and hence the receiver end will not receive the signal.

4) When the signal is interrupted past a certain set time limit, the station master will be alerted via the SIM800L module, which will call and message the station master.

5) The station master will then alert the emergency services, who will assist in the evacuation and help the injured people.

6) Thus, our goal is to bring attention to the people affected by the train derailment and prevent further damage to by preventing oncoming trains from crashing into the already derailed train, will be achieved.

IV. CIRCUIT DIAGRAM



V. RESULTS

1) Initially, we connected a Light Dependent resistor to the analog pin of the Arduino Uno. This was done to output the light incident on the LDR as a value that could be used further. This incident light comes from the laser diode on the other side of the train. In the absence of light, the LDR outputs a certain output value.

2) Next, we connected the SIM800L to the Arduino Uno. When the module is connected and a working SIM is inserted, it takes around 7 to 8 minutes to connect to the cell towers. The successful connection is denoted by the Built-in light on the SIM800L module, which will blink every three seconds when a secure connection is established.

3) We have integrated both, the SIM800L module as well as the LDR in a single assembly, using a breadboard and jumper wires.
4) When the beam of light from the laser emitter onto the LDR is obstructed, the value output by the LDR falls below a certain threshold, following which, the SIM800L sends a call to the given mobile number through the Arduino with the help of the given code, thus sending an alert that the train has been derailed.
5) It takes 25 to 30 seconds for the station master's number, which will be input into the code, to receive the call.
6) A delay of 30 seconds has been added, so that the process can be terminated in the case of false detection of train derailment.

VI. CONCLUSION

In conclusion, we have used a Light Dependent Resistor (Fig.2) as a sensor to detect the derailed train through the absence of light emitted by the laser (Fig.4), SIM800L module (Fig.3) to send a signal via call to communicate that the train has been derailed to the station master, who will be the first point of contact so that medical help can be given to the people affected by the accident and other trains on the same line can be alerted so as to avoid further crashes. Through this project, we aim to prevent the loss of life and property by preventing further mishaps. In the future, MPU6050 can be integrated to add another layer of detection to the current system. In addition to this. LIDAR can be used to preemptively detect the fault in the train tracks, thus acting as a first layer of detection, so that subsequent damage can be prevented. Our system is a cost-effective and high-accuracy system made to address the shortcomings of the current system in use by the railway systems of various countries.

VII. ACKNOWLEDGMENT

We would like to express our sincere gratitude to Prof. Supriya Telsang for the valuable guidance and input she gave us, for solving our doubts, and for encouraging us. We would also like to thank our esteemed Head of Department, Prof. Dr. Chandrashekhar Mahajan for providing us with the opportunity to make this project in a group to develop various teamwork skills. This project's student team consists of Pranav Apsingekar, Pranav Pendse, Sachin Prasad, Pratha Sawant, Pratyunsh Katkar, and Pranav Dhanayate.The credit for the implementation of the project goes to these team members.

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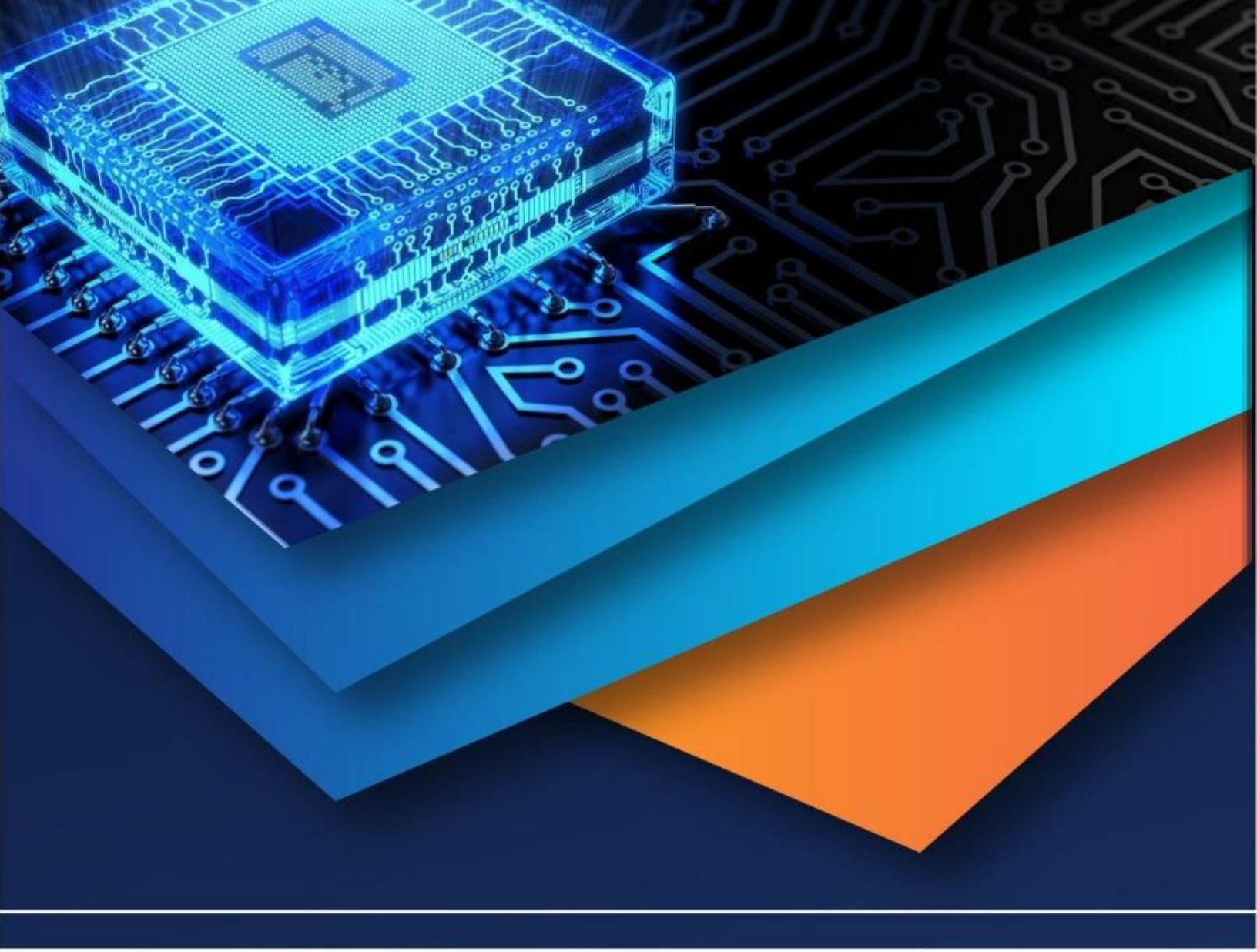

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