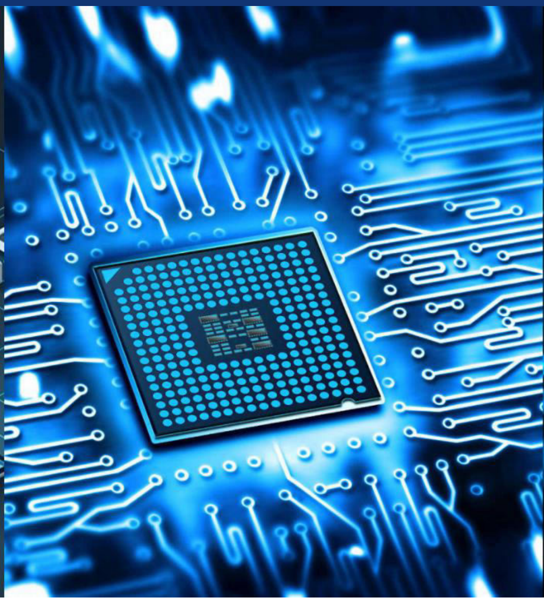
IJIRCCE

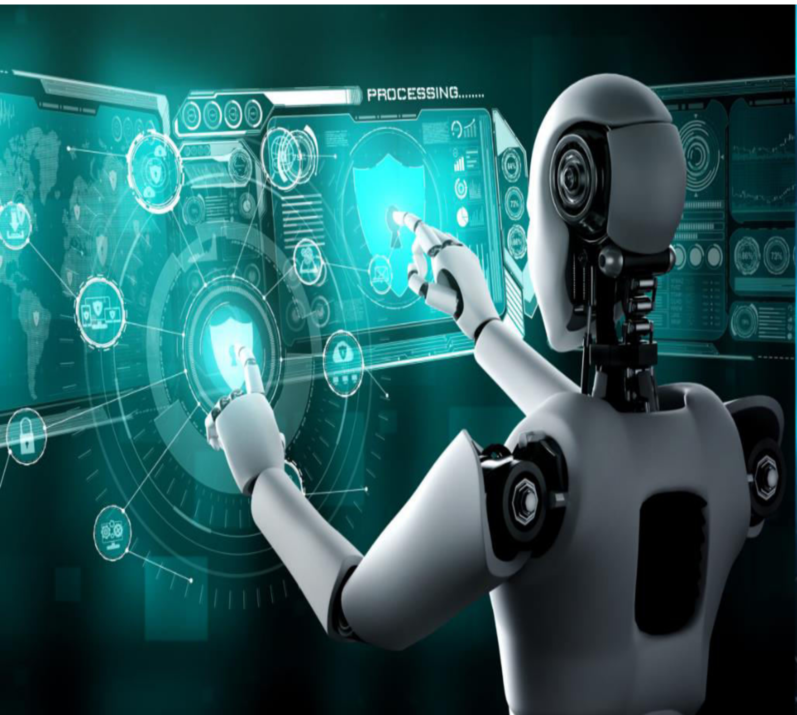
ISSN(O): 2320-9801

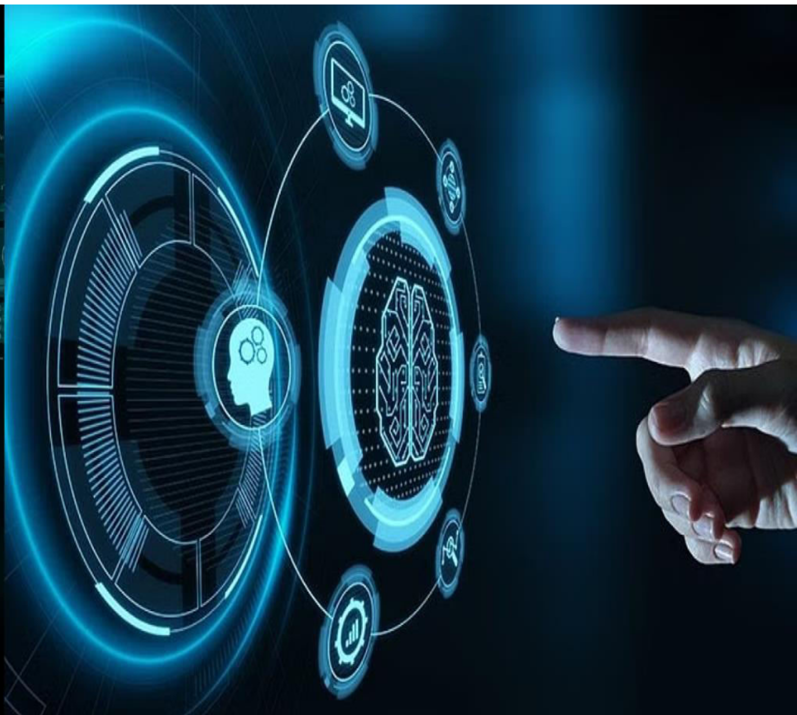
ISSN(P): 2320-9798



International Journal of Innovative Research in Computer and Communication Engineering

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)





Impact Factor: 8.771

Volume 13, Issue 3, March 2025

www.ijircce.com | ijircce@gmail.com | +91-9940572462 | +91 63819 07438

www.ijircce.com | e-ISSN: 2320-9801, p-ISSN: 2320-9798| Impact Factor: 8.771| ESTD Year: 2013|

International Journal of Innovative Research in Computer and Communication Engineering (IJIRCCE)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

IoT Based Railway Safety Management System

Chaithra VS, K Kanika, Suneela R, Rashmi.M

Head of Department, Department of Information Science and Engineering, Sambhram Institute of Technology, Bangalore, India

Bachelor of Engineering, Department of Information Science and Engineering, Sambharam Institute of Technology, Bangalore, India

ABSTRACT: The Railway Track Tracer System for Creature Detection aims to enhance railway safety by preventing accidents caused by the presence of animals or other creatures on the tracks. With the increasing frequency of wildlife-related incidents on railroads, this system provides an automated solution to detect and alert railway authorities about creatures approaching or on the tracks in real-time. The system employs a combination of sensor technologies, such as infrared sensors, ultrasonic sensors, and cameras, integrated with machine learning algorithms to accurately identify and classify animals. Upon detection, the system triggers an alert, which is sent to nearby stations or train operators, allowing timely intervention to prevent accidents. The use of IoT (Internet of Things) networks ensures seamless communication and response coordination across vast railway networks. This innovation not only ensures the safety of passengers and crew but also minimizes the risk of harm to wildlife, contributing to both public safety and ecological preservation.

KEYWORDS: Acoustic analysis, artificial neural network, Internet of Things, Real-time Alert System, railway faults detection.

I. INTRODUCTION

Railway safety is a critical concern globally, with one of the significant threats being wildlife encroachment on railway tracks. Accidents caused by animals on the tracks not only endanger human lives but also result in damage to railway infrastructure and harm to wildlife. With an increasing number of wildlife-related incidents, there is an urgent need for an effective detection system that can prevent such accidents and enhance the safety of both passengers and animals. The traditional methods of wildlife detection, such as manual patrols or basic sensors, are often inefficient and insufficient to provide real-time alerts, especially in remote or less-monitored areas.The Railway Track Tracer System for Creature Detection aims to address this challenge by integrating state-of-the-art technologies, including Acoustic Analysis, Artificial Neural Networks (ANN), and the Internet of Things (IoT). Acoustic sensors capture sound patterns produced by animals in proximity to railway tracks, while machine learning algorithms, particularly ANNs, process and classify these signals to differentiate between different creatures and other disturbances.

II. PROBLEM STATEMENT

In The development of an automated system capable of efficiently and reliably detecting cracks and defects in railway tracks. This system must effectively address the diverse environmental and operational stresses that railway tracks endure; ensuring the timely identification of potential hazards to prevent accidents, uphold passenger safety, and minimize maintenance expenses.

III. LITERATURE REVIEW

Aliza Raza Rizvi ,Rauf Khan "Crack detection in railway track using image processing", IEEE 2017.[1]
In this paper, a method to detect cracks in railway tracks has been presented using image processing techniques. The method replaces manual inspection of the track section, by automatic inspection. A video camera can be installed in separate sections of the track to take images of the track section and then it can be input to the suggested system to detect any cracks in the track section. This will help to detect cracks immediately and reduce the possibilities of any mis happening. Since the system would be automatic and will require less manual intervention, the utmost efficiency of the system can be ensured.

www.ijircce.com | e-ISSN: 2320-9801, p-ISSN: 2320-9798| Impact Factor: 8.771| ESTD Year: 2013|

International Journal of Innovative Research in Computer and Communication Engineering (IJIRCCE)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

Fei Yan, Tao Tang, Junqiao Ma," An Accident Casual Model for Railway Based on Operational Scenario Cognition Conflict" IEEE 2018. [2]

Traditionally, accident or incident analysis are focusing on the cause-consequence chain methods, like Fault Tree or Event Tree, which are hard to find root cause of accidents. To solve this problem, some system safety analysis methods come out, like Accimap, FRAM and CAST based on STAMP. However, they are good at solving safety management issues, functional failure analysis or causal scenarios analysis, and can be used to capture safety requirements and help system designers to deep understand safety requirements. But the true logic of accident or incident do not analyzed, which is related to human or equipment cannot conceive the right status of train operational status on time. If so, it"s easy to ensure safety by train stop. The objective of this paper is to present the mismatch or inconsistency among human cognition, equipment execution and train operation of railway train control system. Also, railway accident is a kind of expression of operational scenario conflict. Singapore metro accident is analyzed as case study. Boulanger, J., & Mertens, D. (2020): Blockchain-Based Voting Systems: Challenges and Opportunities.

Xiao Hong WANG, Jiao HAN," Knowledge Graph Construction for Railway Electrical Accident Analysis" IEEE 2019. [3]

Rail system"s electrical accidents happen frequently; yet currently existing accident data are presented/stored as unrelated information, which makes it difficult for us to achieve data correlation. In order to discover hidden connections between different types of railway electrical accidents and integrate these seemingly independent data into a structured body of knowledge, a semi-automated construction process is explored to build a knowledge graph for all railway electrical accidents for the past 8 years in China. The experiment results show that CNN classifier can obtain perfect classification performance, and needn't diagnose the faulty equipment of accidents artificially, which can greatly save time and effort. The knowledge graph we constructed in this paper is not only used to analyze and diagnose the faulty equipment of railway electrical accidents, but also can help us discover trends and changes of these accidents. In addition, the knowledge graph also lays a solid data foundation for the progressively intelligent railway electrical systems.

IV. OBJECTIVES

• **Enhance Safety Measures:**
Implement IR sensors for track monitoring to detect obstacles, potential hazards, and cracks, ensuring early identification and mitigation of safety risks. Integrate fire sensors to rapidly identify and respond to fire incidents within train compartments or the railway environment, prioritizing passenger safety.
• **Optimize Train Movement:**
Utilize DC motors for precise control over train acceleration, deceleration, and movement, enhancing overall operational efficiency and passenger comfort.
• **Automate Emergency Responses:**
Employ relays to automate the detachment of train compartments in the case of fire emergencies, preventing the spread of fire and minimizing potential damages.
• **Fire Suppression Mechanism:**
Integrate water pumps to activate automatically in response to fire incidents, contributing to the rapid suppression of fires within the railway premises.
• **Real-time Communication:**
Utilize Node MCU for real time communication, enabling immediate message intimation to relevant stakeholders such as authorities, emergency services, and passengers during critical situations.
• **Seamless Connectivity with Zigbee:**
Implement Zigbee technology to establish seamless communication between different components of the railway system, facilitating remote monitoring and efficient data exchange.

V. ARCHITECTURE

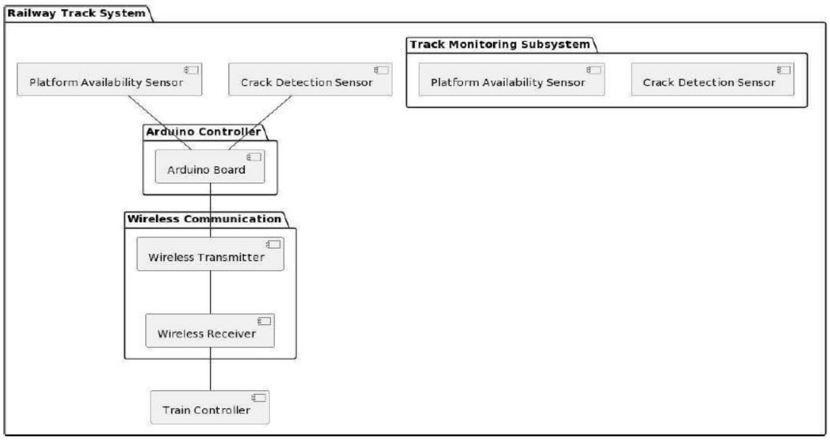
1.The "Track Monitoring Subsystem" consists of sensors for crack detection and platform availability checking.
2. These sensors are connected to an Arduino board, which serves as the controller for data acquisition and processing.
3. The Arduino board communicates wirelessly with the "Wireless Communication" module.
4. The "Wireless Communication" module comprises a transmitter and receiver for sending data between the track monitoring subsystem and the train controller.

www.ijircce.com | e-ISSN: 2320-9801, p-ISSN: 2320-9798| Impact Factor: 8.771| ESTD Year: 2013|

International Journal of Innovative Research in Computer and Communication Engineering (IJIRCCE)

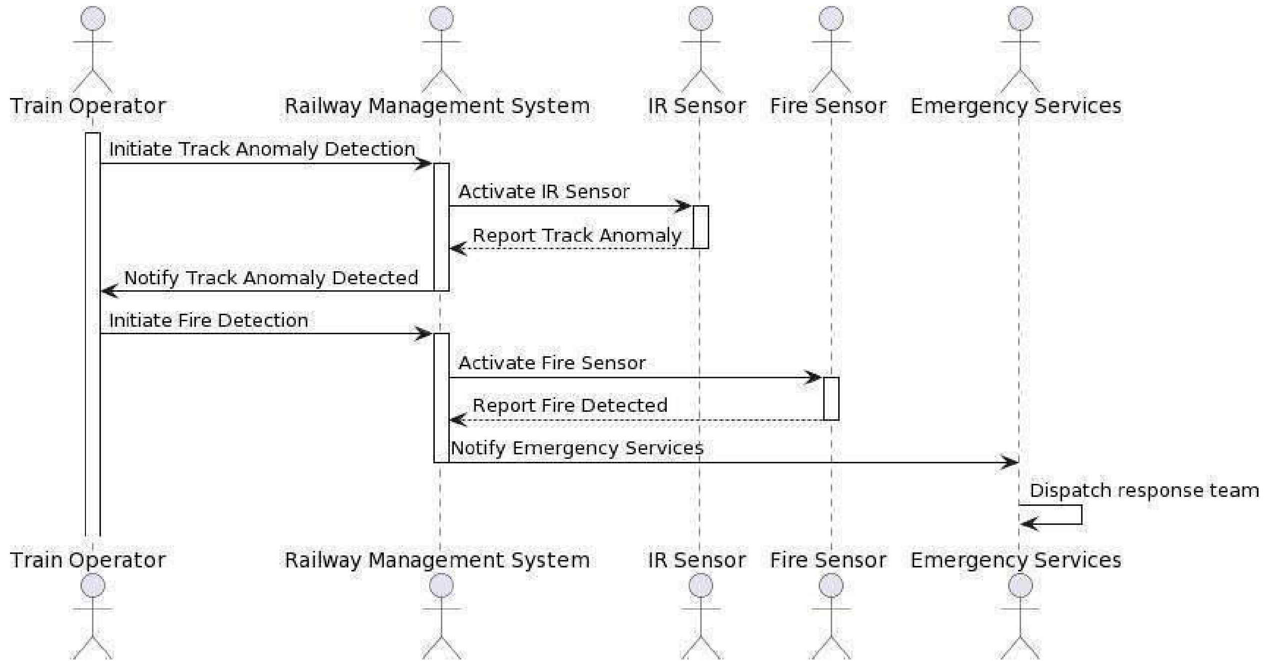
(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

5. The "Train Controller" receives data from the track monitoring subsystem to take appropriate actions based on the detected conditions.
   This architecture allows for real-time monitoring of track conditions and platform availability, enabling the train controller to make informed decisions to ensure safe and efficient railway operations.



Dataflow:
A dataflow diagram is a graphical representation of the "flow" of data through an information system, modeling its process aspects. A DFD is often used as a preliminary step to create an overview of the system without going into great detail, which can later be elaborated. DFDs can also be used for the visualization of data processing. A DFD shows what kind of information will be input to and output from the system, how the data will advance through the system, and where the data will be stored.

Sequence Diagram:



A sequence diagram shows object interactions arranged in time sequence. It depicts the objects and classes involved in the scenario and the sequence of messages exchanged between the objects needed to carry out the functionality of the

www.ijircce.com | e-ISSN: 2320-9801, p-ISSN: 2320-9798| Impact Factor: 8.771| ESTD Year: 2013|

International Journal of Innovative Research in Computer and Communication Engineering (IJIRCCE)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

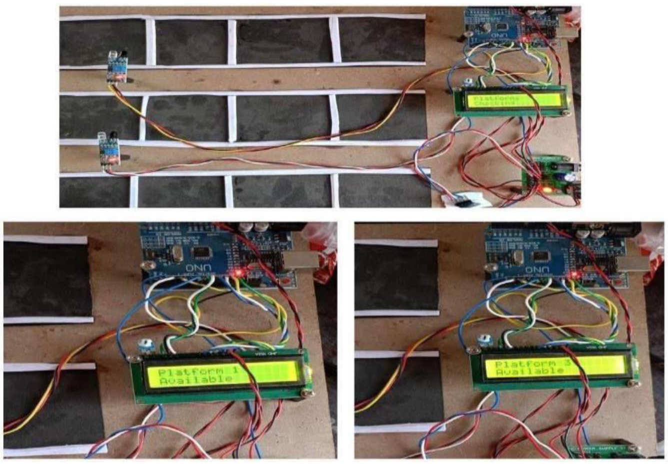
scenario. Sequence diagrams are typically associated with use case realizations in the Logical View of the system under development.
Sequence diagrams are sometimes called event diagrams or event scenarios. A sequence diagram shows, as parallel vertical lines (lifelines), different processes or objects that live simultaneously, and, as horizontal arrows, the messages exchanged between them, in the order in which they occur. This allows the specification of simple runtime scenarios in a graphical manner.

VI. RESULTS

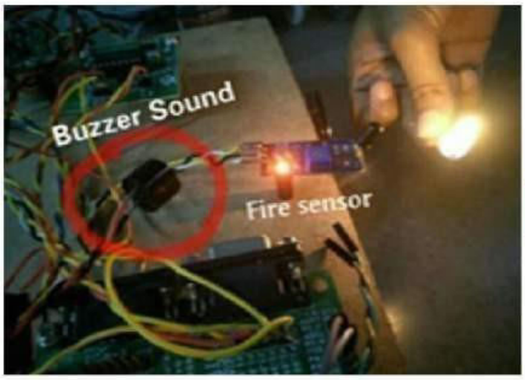
1. Detection of crack in the track

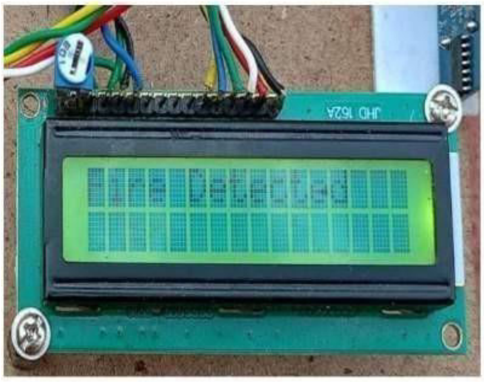
Two IR sensors are placed on either side of the train. These IR sensors are placed in front of the first compartment to detect the crack in rail. The train stops moving as soon as the crack is detected. Depending on which side the crack is found message will be displayed on the LCD accordingly. If the crack is detected on the left side "LEFT SIDE CRACK DETECTED" is displayed. If the crack is detected on the right side "RIGHT SIDE CRACK DETECTED" is displayed.

2. Platform Availability Detection
This module is for detection of platform availability and intimating upcoming train whether to enter station or not. The principle involved in checking platform availability is when the crack is detected the light does not get reflected to IR sensor and the train stops. Here IR sensorsare placed on the platform and a message "PLATFORM 1 AVAIALBLE" " is displayed on the LCD.

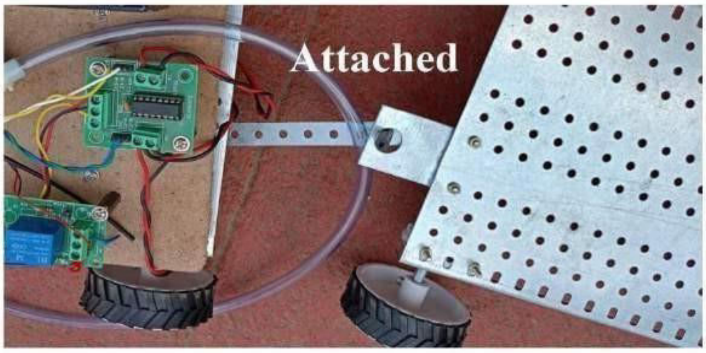


3. Fire detection

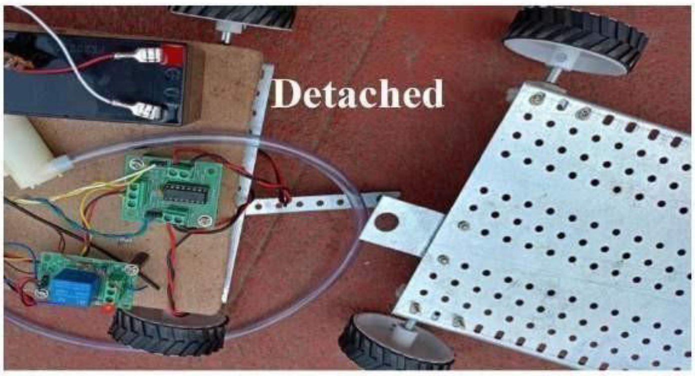




Message displayed when fire is detected



Before fire was detected



After fire was detected

VII. CONCLUSION

System will help to reduce accidents caused due to railway cracks, fire and accidents happening while arriving train to the platform. An automatic method is used to inspect in railway track for crack detection which helps in maintenance and monitoring the condition of railway tracks without any errors. System uses a fire sensor to detect the fire. Quick actions are taken to avoid spreading of fire to other compartments and alert the passengers. Future work in IoT-based railway track fault detection could focus on several areas to enhance the efficiency, accuracy, and reliability of the system. Advanced Sensor Technologies explore and integrate more advanced sensor technologies such as distributed acoustic sensing (DAS), fiber optic sensors, or advanced imaging techniques (e.g., LiDAR) to detect various types of faults with higher precision and accuracy. Predictive Maintenance shift towards predictive maintenance strategies by leveraging historical data, real-time sensor readings.

The predictive analytics to anticipate potential faults before they occur. This can help minimize downtime, optimize maintenance schedules, and reduce operational costs. Integration with Railway Infrastructure integrate the IoT-based fault detection system with existing railway infrastructure, such as signaling systems, maintenance management systems, and asset management systems, to create a comprehensive railway maintenance ecosystem. Remote Monitoring and Control develop remote monitoring and control capabilities to enable railway operators to remotely access and manage the fault detection system from a centralized location. This includes real- time monitoring of track conditions, automated alerts for critical issues, and remote configuration of sensor parameters.

Detection of crack in the track Two IR sensors are placed on either side of the train. These IR sensors are placed in front of the first compartment to detect the crack in rail. The train stops moving as soon as the crack is detected. Depending on which side the crack is found message will be displayed on the LCD accordingly. If the crack is detected on the left side "LEFT SIDE CRACK DETECTED" is displayed. If the crack is detected on the right side "RIGHT SIDE CRACK DETECTED" is displayed. Fire detection This sensor will detect the fire using flame recognition technique. As soon as the fire is detected the compartments will detach from one another by using L-clamp and a DC motor. This quick detachment prevents the spreading of fire. Sprinkler will also be activated when fire is detected. By using sprinkler, we are controlling the fire and reducing the damage caused by it.

In the future, autonomous railway safety vehicles equipped with advanced sensors and AI-driven diagnostics can be deployed for continuous track monitoring. These vehicles can travel ahead of passenger trains, scanning the tracks for cracks, obstacles, and potential hazards. If a fault is detected, the system can send an immediate alert, allowing authorities to take preventive measures before an accident occurs. Such autonomous systems can significantly enhance railway safety and reduce human intervention in track inspections.
By integrating these advanced technologies, the IoT-based railway fault detection system can revolutionize railway safety, minimize accidents, and ensure a smooth and efficient transportation network.

REFERENCES

Research Papers and Articles:

1. R.Thendral and A ranjeeth "Computer vision system for railway track crack detection using deep learning neural network",2021.
2. YaoXing Zhang;Wenju Li;Huiling Chen;Maoxian He, "CRTSII Track Slab Crack Detection Based on Improved YOLOv3 Algorithm" 2020 5th International Conference on Mechanical, Control and Computer Engineering (ICMCCE)
3. Fei Yan, Tao Tang, Junqiao Ma "An Accident Casual Model for Railway Based on Operational Scenario Cognition Conflict", 2018 International Conference on Intelligent Rail Transportation (ICIRT)
4. Hafeez-Ur-Rehman siddiquri "Railway Track Faults Detection using acoustic analysis", 2022
5. Aliza Raza Rizvi,Pervez Rauf Khan,Dr Shafeeq Ahmad"Railway Track Crack Detection", International Journal of Advance Research and Development, Volume3, Issue3, 2018

Books:

6. The Internet of Things: Key Applications and Protocols" – By Olivier Hersent, David Boswarthick , Omar Elloumi Covers IoT protocols and applications that can be used in railway systems.
7. Embedded Systems: Introduction to Arm Cortex-M Microcontrollers" – By Jonathan W. Valvano
   Helps in implementing sensor-based safety measures in railway systems.
8. Wireless Sensor Networks: Principles and Practice" – By Fei Hu
   Explains sensor networks, which are crucial for railway monitoring and safety

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

INNO SPACE
SJIF Scientific Journal Impact Factor

doi crossref

निस्केयर NISCAIR

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN COMPUTER & COMMUNICATION ENGINEERING

9940 572 462 6381 907 438 ijircce@gmail.com

www.ijircce.com

Scan to save the contact details