International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 09 Issue: 04 | April - 2025 SJIF Rating: 8.586 ISSN: 2582-3930

Railway Track Crack Detection with automatic locomotive Brakes applying system using smart technology

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Abstract

Indian railway is one of the largest railway lines in the world, it has 69,181 kilometre (42,987 miles) in route length, with a total running track length of 109,748 kilometre (68,194 miles). This rail transport is the major travel mode of many people and goods in India. Railway track integrity is critical for the safety of rail transport. Conventional manual inspections are labour intensive, error prone, and often delay maintenance actions. In this paper we present a novel approach and a patrolling vehicle to detect the railway track cracks using. The smart technology helps to apply brake when there is a major defect in the rail track. It also sends signals to nearest sub stations to alert the defect. Experimental results on a simulated track environment demonstrate a detection accuracy exceeding 95% with minimal false positives. The proposed method is cost-effective, works under diverse environmental conditions, and promises to enhance rail safety by facilitating timely maintenance interventions.

Keywords:

Railway track, crack detection, smart technology, patrolling vehicle, simulated track, enhanced rail safety, real-time monitoring

1. Introduction

Railway transportation has a crucial play role in the development of country economy and infrastructure. It is one of the most cost-effective modes of transportation for both passengers and goods. So, any cause of accidents and delays has to be avoided. However, in today's scenario the accidents and railway track defects are challenging to identify and increasing maintenance, cost and more labour. Even then also it is not accurate. To address these issues smart technology can be integrated into railway system.

This project mainly focuses on railway track crack detection using smart technologies like sensors and IoT- based technology. It sends signals to nearby railway authorities and apply automatic locomotive brake in emergency. The project aim is to show how do railway become more secure

transportation in India by using smart technology and intelligent railways minimize damage to infrastructure.

2. Literature review

The overall review of is paper is the integrity of smart technology to railway networks. The smart technology can be upgraded in future with many other technologies this makes many advantages to rail transportation. There are many upcoming fastest moving train projects in India and whole world so regular manual checking is impossible for this largest track so this project can help. For this continued research and testing is needed for its requirement in the railway system. And its capability to face many challenges.

3. System Overview

The proposed system consists of a Wi-Fi enabled module which is connected by railway track and patrolling vehicle with the help of application. When the crack is detected, this module is used to connect the railway authorities. The main components include:

- **ESP8266EX Wi-Fi module:** This is an integrated Wi-Fi chip used to host the application. The connector gives access to the pins used for series communications like RX and Tx. It is also enabled with internal SROM and ROM and external SPI flash memory.

Figure (1): - ESP8266EX Wi-Fi module

- **Buzzer:** It is used to give an alert sound when the crack is detected on the railway track.
- **RF Transmitter:** It is used to send radio frequency to carry data to maintenance control centre. This is connected with the micro controller.

Figure (2): - RF Transmitter

- **RF receiver:** receives automated alerts with defect location data to the maintenance control centre that was sent by RF transmitter.
- **LCD (Liquid crystal display):** It is here used to display the crack alert and engine start, stop on the patrolling vehicle.

Figure (3): - LCD

- **2-channel relay board:** This acts as the switch in the circuit and allow low power circuits to control high power circuit, which gives protection and insulation.

Figure (4): - dual channel relay board

- **Power supply:** A rechargeable lithium-ion battery i.e. DC power is used in this system.
- **DC motor:** It is used to run and stop the vehicle when in emergency.

- **Micro controller:** It is used to run the application and controls the whole algorithm of the system.

4. Experimental Setup

4.1 Test Environment

Experiments were conducted on a controlled test track simulating real railway conditions with metal. Artificial cracks of varying widths and depths were introduced into sample rail sections to test detection sensitivity. Different conditions, of track connection types are tested to know the accuracy.

Figure (5): - simulated test track

4.2 Data Acquisition

The data acquisition is noted visually by seeing the patrolling vehicle that was simulated exactly like the train engine. It is checked whether it is applying the brakes properly and signal sent to substation correctly.

4.3 Performance Metrics

The experiment has given an amazing performance of applying brakes with in milliseconds of crack detection. The buzzer gives an alert sound when cracked is detected and engine is stopped.

4.4 Working process

Sensors mounted on the train track continuously monitor the defects. If crack or any defects identified it processes the data by microcontroller. The data processed is then transferred from RF transmitter. The RF receiver is used to receiver the signal. ESP8266EX Wi-Fi module is used to give memory and help to run of algorithm. So, when crack is detected on simulated test track it send signal to both engine and to nearest railway substation. The engine then applies emergency brake if defect is near to it and alerts by buzzers sound and display an alert message on LDC. The brake is applied with in milliseconds and engine is stopped. This allows the loco pilot to check the track whether it is safe to move or not, then he can start the engine if it is safe.

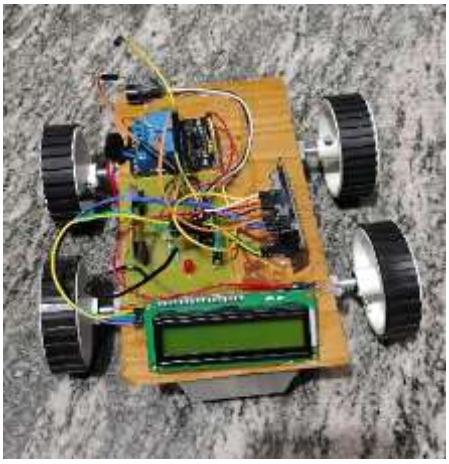

Figure (6): - patrolling vehicle

5. Result

Through this paper we found that real time monitoring of railway track is possible. And it has an error percentage less than 5. This smart technology integration can secure life, minimize cost and accurate.

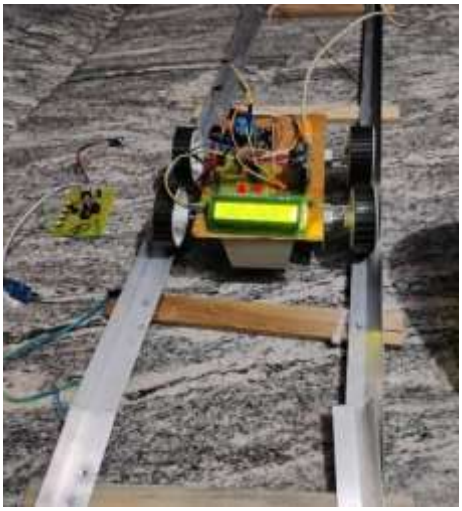

Figure (7): - Testing on simulated track

6. Future scope

In this paper we used smart technology. This can be taken forward by including AI (Artificial Intelligence) and IoT (Internet of things) which makes the detection more accurate and efficient.

7. Conclusion

The proposed system offers a great advancement in railway safety. By using real – time monitoring and automatic locomotive braking mechanism. The automatic braking mechanism helps the train to avoid collisions and derailing. This increases the safety of passengers. This also helps in easy maintenance and cost of manual inspection can be reduced. This project can develop better infrastructure and more improvements like AI and IoT can take them to peak.

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