



RAILWAY TRACK INSPECTION SYSTEM

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Abstract: Railway Track Inspection is a critical task to guarantee the security and proficiency of rail transportation. Traditional manual inspections can be time-consuming, inclined to human blunder, and incapable to give real-time information. This paper presents an automated Railway Track Inspection System with Internet of Things (IoT) which is planned to identify deficiencies such as splits, misalignments, and wear on railroad tracks. This project showss a Railway Inspection system using sensors and it is a energitic implementation that combines the usage of GPS and GSM module. It sends alert messages along with the geographical locaion of area. An ESP32 Microcontroller is used to control and handle the activities of this device and can send the detected problem location online. The system can naturally distinguish and classify defects, providing alerts for immediate maintenance. This approach not only enhances the precision and speed of track inspections but also decreases the risk of accidents, improves maintenance scheduling, and brings down operational costs.

Keywords: Internet of Things (IoT), ESP 32, GSM, GPS Module .

I. INTRODUCTION

In today's world, transportation being one of the biggest drainers of energy, its mantainability and

security are issues of importance. Indian railways are the fourth biggest railroad organize in the world. The rail transport is developing day-by-day in India. Nearly 80% of the transport in India is being carried out by railroad network.

Railways are one of the major modes of tansportation but still our facilities are not that accurate and safer as compared to the international standards. Improper maintenance and the currently irregular and manual track line monitoring mistake from workers is also a problem in the Indian Railways. The major problem is that there is no efficient and cost-effective technology to detect problems in the rail tracks and the lack of proper maintenance is also a factor. Several trains derail occurs each year because of track quandaries. The wellbeing of rail travelers is compromised by disappointments such as splits. Aside from splits, which are the most common cause of prepare crash, railroad operations are too defenseless to rail collisions, crossing rates, fire, and other causes of rail accidents.

This has a negative influence on culture. Road accidents also result in the death of animals, which is the most severe and irreversible loss. This is due to a shortage of train services as well. To avoid all these issues, we came up with the solution where a IoT based Railway Inspection System is implemented which will detect cracks ,obstacle,fire or water and thus helps to reduce the accidents of railways.

Therefore, there is a need to have new technology

which will be robust, efficient and stable for both crack detection in railway track as well as object detection. This project talks about a Railroad Review framework utilizing sensors and is a energetic approach which combines the utilize of GPS following framework and GSM module to send alarm messages and the geological arrange of area. ESP32 is the main microcontroller we are using in this project. Ultrasonic sensor is used to detect the crack and obstacles on the track which is connected to ESP32. Fire and Water sensor is used to detect fire and water on the track respectively. L2938 is used to run the system which act as the motor driver. The system will run on the track and as the crack , obstacle , water or fire is detected the system will stop and send the GPS coordinates to the authorized person as well as the data of location is stored in the database online which used to monitor.

II. LITERATURE SURVEY

Title of paper	Method/ Techniques used	Analysis and Observation
“Railway Inspection System Using IoT” <i>International Research Journal of Engineering and Technology (IRJET)</i> ,2023.	IoT-based railway track inspecting system, Sensor techniques	Proposed sensor-based railway track inspection system in which ultrasonic sensor is used for track level measurement, and IR sensor for object detection.
“Automated Railway Track Crack Detection System” <i>International Journal of Research in Engineering and Science (IJRES)</i> ,2022	The real-time monitoring system is used,crack detection, obstacle detection , fire and water detection	It contributes to improving operational efficiency and detection thus safety is ensured
“Railway Track Fault Detection Using MI & Iot” <i>Journal of Emerging Technologies and Innovative Research (JETIR)</i> , 2024	The proposed method for the railway track condition using IoT , Machine learning etc	The proposed method for the railway track condition using IoT , Machine learning etc
“Detection and Maintenance for Railway Track Defects: A Review” <i>IOP Conference Series: Earth and Environmental Science</i> , 2023	Track detector, Real-time monitoring equipment, Unmanned aerial vehicle inspection technology	Detect railway track condition and gives idea about several problem related to railway tracks
“Train Based Automated Inspection for Railway Fastening System”, <i>Division of Operation and Maintenance and Acoustics Department of Civil, Environmental and Natural Resources Engineering</i> , 2021	Sensor technology , Internet of Things (IoT),, Proper planning	IoT technology. By integrating components like a Raspberry Pi, stepper motor, ultrasonic sensor, LCD display, and cloud server, the system can detect faults.
“Intelligent Image-Based Railway Inspection System Using Deep Learning-Based Object Detection and Weber Contrast-Based Image Comparison” <i>Journal of Computing Research and Innovation (JCRINN)</i> , 2019	Facility Inspection Algorithm, Image Reconstruction, Facility Detection Using Convolutional Neural Network	Proper image based system is used for real time image generation along with deep learning algorithms
“Railway Track Monitoring System” <i>International Journal of Innovative Science and Research Technology</i> ,2028	Testing of Ac Solenoid Electromagnet , Vibration processing , GSM and GPS	Vibration based damage identification method is used and some electrical concepts

III. PROPOSED METHODOLOGY

This project work aims to design an automated railway track inspection system. The proposed system utilizes GPS framework along with GSM module. NodeMCU is the fundamental microcontroller in the framework. Ultrasonic sensor is utilized to identify obstacles. Fire and Water sensor is utilized to detect fire and water on the track individually. Laser Sensors are utilized to identify wear or the splits on the tracks. L2938 is utilized to run the framework which act as the engine driver. L2938 is used to run the system which act as the motor driver. The NodeMCU is activated initially, followed by the ultrasonic sensor and all the other modules.

The ESP32 NodeMCU makes a individual hotspot to which we interface our versatile gadget. SIM will be inserted in the GSM for the messaging purpose. The system is not fitted in the train that is, it is separate system that moves before the railway and does the whole inspection. If any fault is detected the system will stop and send the geographical location of the detected location to the nearby station. Hence the further actions can be initiated and fixed thus helps us for convenient Inspection of the Railway Track. Ultimately it will contribute for the avoidance of railway accident and proper railway administration.

1. Block Diagram :

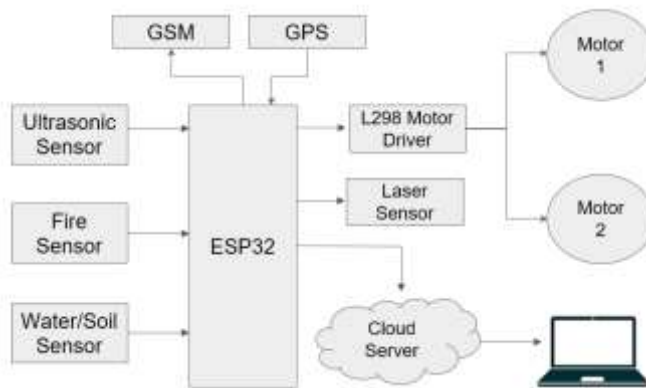


Figure 1. Block Diagram of Proposed System

2. Software Requirements :

The software implementation part includes programming of NodeMCU. All the programming for the ESP32 NodeMCU is written in the Arduino Integrated Development Environment platform in C programming language. The Ultrasonic sensor is interfaced with Arduino board which converts the analog voltage values from sensor to corresponding units. The GSM and GPS module interfaced with NodeMCU to

determine location of the fault and sent location coordinates to specified number provided in the Arduino code.

For the designing of PCB board we used easyeda.com website. It is fast and very convenient to use. Further we are using thingspeak.com for the interfacing of our sensor and maintaining the overall data. This is an open IoT stage in which you can total, visualize, and analyze live information streams in the cloud. You can also send data to ThingSpeak from your devices, create instant visualization of live data, and send alerts. Thus it is using a cloud based data management hence it falls under the IoT model.

3. Hardware Requirements :

3.1 ESP 32 NODE MCU :

The ESP32 is a powerful, low-cost, low-power system on a chip (SoC) developed by Espressif Systems. It is widely used in Internet of Things (IoT) applications, smart devices, and embedded systems due to its integration of Wi-Fi, Bluetooth, and a wide array of other peripherals in a single chip. It has 16 MB memory 32 bit controller, 2.4GHz wifi connectivity and 18 Analog & Digital Pin.



Figure 2. ESP 32 Node MCU

3.2 LASER SENSOR :

Laser sensors are sensors that use laser technology to detect, measure, and sense objects or surfaces. They are highly accurate and are commonly used in various industrial and commercial applications. We are using this sensor specially for detecting cracks in the track of railways. Main purpose of doing this is that this sensor provides accurate and specific readings than ultrasonic sensors.



Figure 3. Laser Sensor

3.3 ULTRASONIC SENSOR :

The Ultrasonic Sensor is marketed as a Ranging Module as it can be accurately used for detecting cracks , obstacle and measuring distances in the range of 2cm to 400cm with an accuracy of 3mm. Working Voltage - DC 5V, Working Current - 15mA. Its has the measuring angle of 15 degree. The pin stays HIGH until the ultrasound hits an object and returns to the Ultrasonic Receiver.. We are using HC-SR04 model of this sensor which will detect obstacles on the tracks.



Figure 4. Ultrasonic Sensor

3.4 GPS MODULE :

GPS module recipients discover applications in smartphones, fleet administration frameworks, and comparative advances to track areas or find object. The acronym GPS stands for Global Positioning System . It is often referred to as Navigation System with Time and Ranging (NAVSTAR) GPS. Its has 5Hz position update rate and EEPROM to save configuration settings.



Figure 5. GPS Module

3.5 GSM MODULE :

A GSM module is a device empowering electronic gadgets to trade data with one another through the GSM organize. GSM, a computerized cellular communication standard, offers a system for remote communication among portable gadgets. The GSM module capacities as a specialized gadget, empowering the consistent exchange of information by means of the GSM arrange. It has Working Current of 800mA and Working Voltage of 3.7V



Figure 6. GSM Module

3.6 MOTOR DRIVER :

The L298 is a popular dual H-bridge motor driver integrated circuit (IC) used for controlling DC motors and stepper motors. It allows you to control the speed and direction of two DC motors simultaneously, or control the phases of a stepper motor. The L298 is widely used in robotics, automation, and other embedded applications where motor control is necessary. Operates up to 35V DC and Maximum power consumption is 20W.



Figure 7. Motor Driver L298

3.7 SOIL SENSOR :

A Soil Sensor is an electronic device used to measure various parameters of soil, primarily moisture content, but sometimes also temperature, pH, nutrients, and other physical properties. In this project we are using soil sensor to detect water . We are using this sensor instead of water sensor as it becomes dry very early thus give exact reading. Main Chip is LM393 and Operating Voltage Range - 3.6~5 VDC.

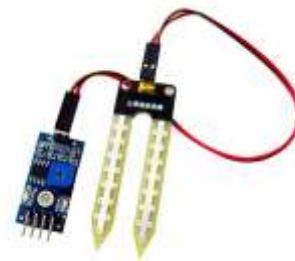


Figure 8. Soil Sensor

3.8 FIRE SENSOR :

This fire sensor is used to detect fire on the railway track . Operating voltage is 3.3V-5V and Detection angle about 60 degrees . It gives Output in digital switch (0 and 1).



Figure 9. Fire Sensor

IV. OUTPUT

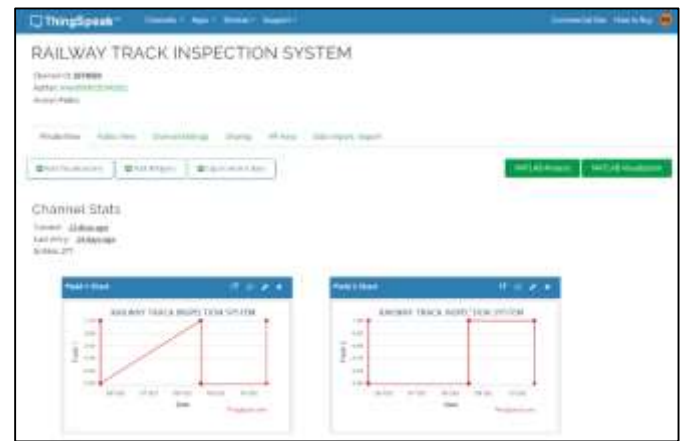
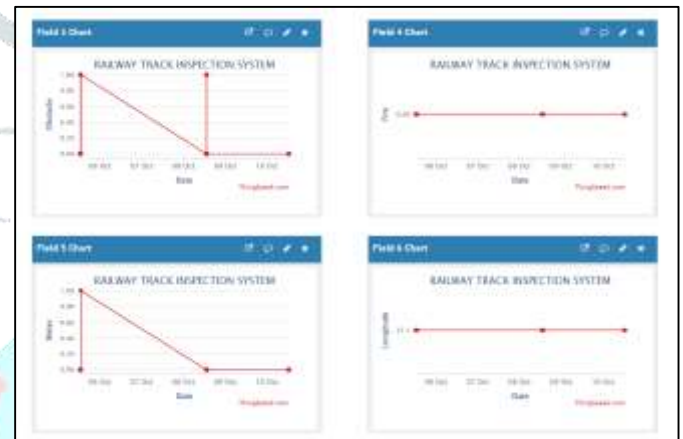
4.1 Demo Module :



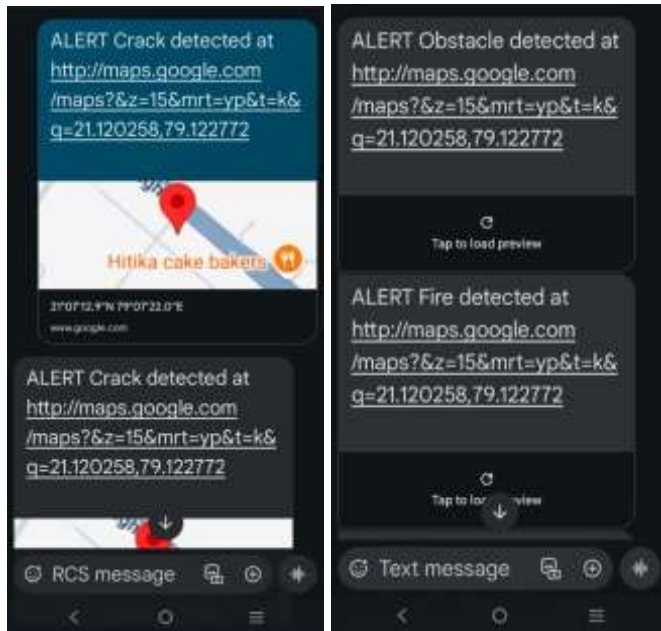
Module

Figure 10. Demo

4.2 Cloud Live Data :



4.4 Message Alert :



V. CONCLUSION :

The Railway Track Inspection System is a vital solution for ensuring the safety, efficiency, and reliability of railway transportation. By leveraging technologies such as IoT, sensors (e.g., ultrasonic, fire, or soil moisture sensors), and wireless communication modules like the ESP32, this system can detect track anomalies, such as cracks, alignment issues, or track deformation, in real time. Automated data collection and remote monitoring significantly reduce the time and labor required for manual inspections while increasing the precision of detection.

Such a system improves overall safety by preventing derailments or accidents due to track faults. Additionally, its proactive maintenance approach extends the life of railway infrastructure, lowers repair costs, and minimizes service disruptions. The integration of this system into railway management ensures more secure, efficient, and reliable train operations, marking a significant advancement in modern railway safety practices.

VI. REFERENCES :

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