Implementation of IoT Based Defect Detection in Railway Tracks

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***Abstract*— To ensure public safety, railway transportation needs regular inspections and immediate maintenance. Long - handled evaluations are not only simplytime consuming, and the accuracy of defects identification is also dependent on the inspector's skill and productivity. Robots may be placed in locations that are hard to access, such railroad lines, and they can be controlled from control rooms to enable quicker inspection. Automation- based IoT solutions are provided by computing and robotics. The robot has an infrared sensor that it uses to detect cracks in the railway track. When it finds a crack, the robot stops and sends its location to the cloud, allowing for the identification of the cracks.**

Keywords*— *IR sensor, ESP32 CAM, Motor Drivers

I. INTRODUCTION

Transport is important for moving people and things from one location to another. Safety and reliability are the major aspects of transportation systems that are frequently questioned, particularly in rail transportation systems. One of the mostimportant forms of transportation in ournation is the railroad. In India, railway transportation plays a key role in reducing the growing needs of a rapidly growing economy. Early inspection techniques are essential for maintaining secure railways that guarantee safe travel. When a train is in shunting mode and travelling less than 45 km/h, many accidents occur. In order to avoid danger, train attendants use the manual approach to observe the status of the railway up ahead. They then communicate their observations to the driver. Furthermore, a natural disastermight toss anything onto the train track that can't be removed in a distant location very soon. We reasoned that if our system couldidentify certain barriers or objects and alertthe control room, they would be able to take the appropriate action to prevent accidents.For avoiding those accidents proposed system use some electronic devices (components) which was mentioned below the enhancement of transportation capacity and quality is crucial for economicdevelopment. An automated system that consists of a robot equipped with an IR sensor and a camera is proposed in this paper. The robot can detect cracks in railway tracks and take pictures of them, while GPS is used to determine their latitude and longitude. The images of the defective railway tracks will be sent through the cloud.

II. LITERATURE SURVEY

Several railway accidents have been brought on by derailments. The railway track's defects are mainly responsible for this. Because of lack of care, these cracks generally go unnoticed. Train accidents area problem that is further complicated by manual track monitoring. It has the ability to find even tiny cracks that are formed in the railroad tracks. The proposed testing train travels along the railway track's alienated path and looks for defects [1]. We require a reliable system for detecting railway track cracks to improve security and inspections. Track cracks are located using the railway line's crack detection system. The suggested device is utilized to find the railway crack before 10 kilometers[2].

In order to resolve the problem of track defects. The complete system framework isdescribed in the paper for the purpose of identifying a rail surface crack through testing, the system's accuracy and dependability are good [3]. When anaccident is detected, the device will informthe operator to reduce rail traffic crack crashes, the crack detection track system was created.

Though this technique can detect deep underlying defects with the help of sensorsused in the proposed system [4, 5]. The authors of [6, 7] have developed a system for detecting rail flaws can locate both the rail and any rail defects. And the authors describe the creation of a system for identifying rail faults to identify rail problems.

We offer in this paper an automated systembased on the NODE MCU and sensors. Therobot system is autonomous and made out of ultrasonic sensors. The suggested system can identify cracks using low-cost, low- power, quick detection methods that don't require human participation, and quick analysis methods [8].

III. METHODOLOGY:

This project's primary objective is to find railway track defects. A microcontroller (Node MCU), motor drivers, an IR sensor, a GPS module, a camera, and a cloud serverbuild up the proposed system. It consists ofhardware based on the ESP-32 module. Theinfrared sensor sends out energy and detectsreflected rays in order to identify track defects. The sensors will detect the cracks and update the cloud server (Telegram) of the detection. A GPS receiver may utilize the Global Positioning System to determine the precise time and three-dimensional position of an object by using signals that are accessible at all times on or above the earth. The motors L293 and L293D aremultiple high-current quarter drives.

There are four D.C.-powered wheels and driver aid motors on the robotic gadget. The device is placed on a railway track that hasIR sensors installed near to the motor wheels on either side of the track. The unit is moved along the track at a speed that allows the IR sensor to find track defects. While navigating the path, if the robot detects a crack, it automatically stops and uses its GPS module to locate the exact Latitude and Longitude of the crack. The system includes a camera module as well, which is used to send a captured image of adetected fault along a specific path to the railway authorities. This means faster inspection and prevents the cloud from becoming overloaded with information. Therefore, the railway operators will identify the area using coordinates, and necessary actions will be done immediatelyto fix those tracks.

IV. COMPONENTS

A. *Node MCU:*

The Node MCU is an Internet of Things (IoT)-focused microcontroller board with firmware that can be handled through Lua. The ESP8266 Wi-Fi SOC powers its firmware, while the ESP-12 module servesas the foundation for its hardware. The programmable clock frequency range of this microprocessor is 80 MHz to 160 MHz,and it supports RTOS. Node MCU features 4MB of Flash memory and 128 KB of RAM for encrypting data and programs.

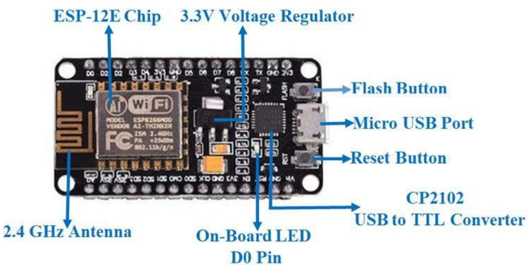

Fig 1: Node MCU

B. *IR Sensor:*

Infrared light, also described to as "infrared radiation," is a type of electromagnetic radiation that is on the other end of the electromagnetic spectrum beyond ultraviolet, just below the red component ofvisible light. Despite being transparent, infrared operates on the same principles as visible light and is capable of reflecting upon and passing through transparent materials like glass. Infrared receivers are located on the front of every piece of streaming media equipment, and infrared remote controllers use this infrared light tocommunicate with it. In essence, wheneverusers press a button on a remote, amicroscopic infrared diode on the front of the remote flashes out pulses of light at a rapid speed to all of your equipment. The device obeys the orders once it determines that the signal is its own.

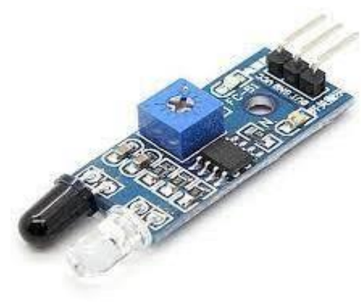

Fig 2: IR Sensor

C. *GPS:*

GPS receiver determines its location by precisely synchronising signals from theGPS satellite constellation, which is positioned far beyond the Equator. Every satellite continuously broadcasts messages that include the time the message was delivered, the satellite sending the message's precise orbit, and other information.

Fig 3: GPS

D. *Motor Drivers:*

These two half-H drivers with large currents are the L293 and L293D. At voltages between 4.5 V to 36 V, the L293 isintended to provide bidirectional driving currents of up to 1 A. At voltages between 4.5 V to 36 V, the L293D is intended to produce bidirectional driving currents of upto 600 mA. Both components are made to drive inductive loads, such as bipolar and dc stepping motors, solenoids, relays, and other devices. The connected drivers are activated and their outputs are active and inphase with their inputs when an enable input is high. When the enable input is low, these drivers are off, and their outputs are inthe high-impedance state. With the proper data inputs, each pair of drivers produces a full-H reversible drive that is perfect for solenoid or motor applications.

Fig 4: Motor Drivers

E. ESP32 CAM:

Since the ESP32-CAM is developed on theESP32-S module, it has similar features. Based on ESP32, the ESP32-CAM is a compact, low-power camera module. The 4MB RAM on this device is utilized to buffer camera image data.

Fig 5: ESP32 CAM

F. Buzzer:

Audio signalling equipment like buzzers and beepers are used. As an audio indicator, it produces sound in the 1–7 kHz range. The hearing threshold is highest in this band of frequencies. A buzzer's piercing sound could also be heard even in a setting with a lot of background noise. Commonly utilised as sound alarms are buzzers and communication devices.

Fig 6: Buzzer

V. BLOCK DIAGRAM

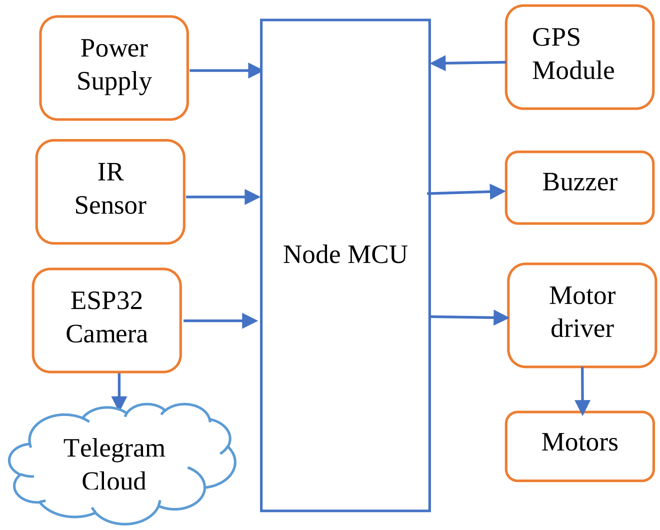

Fig 7: Block Diagram

VI. GRAPH

The relation between IR sensor ranges and crack detection probabilities is plotted on a graph. IR sensors have wavelengths up to 780 nm. If a crack is immediately detected, the buzzer rises HIGH and ON.

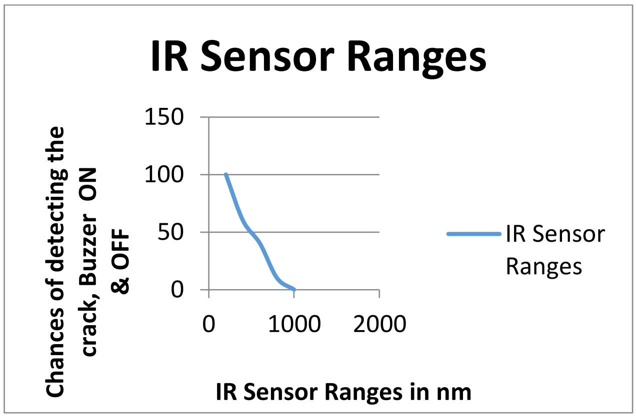

Fig 8: Graph of IR Sensor Ranges

VII. RESULT

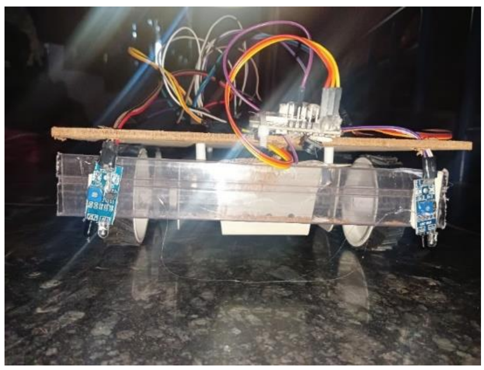

Fig 9: Hardware Structure

Finally, the detected crack location will be identified by using by its latitude and longitude values, also we get the link to access the route through map.

https://www.google.com/maps/search/?api=1&query=16.508553,80.653030

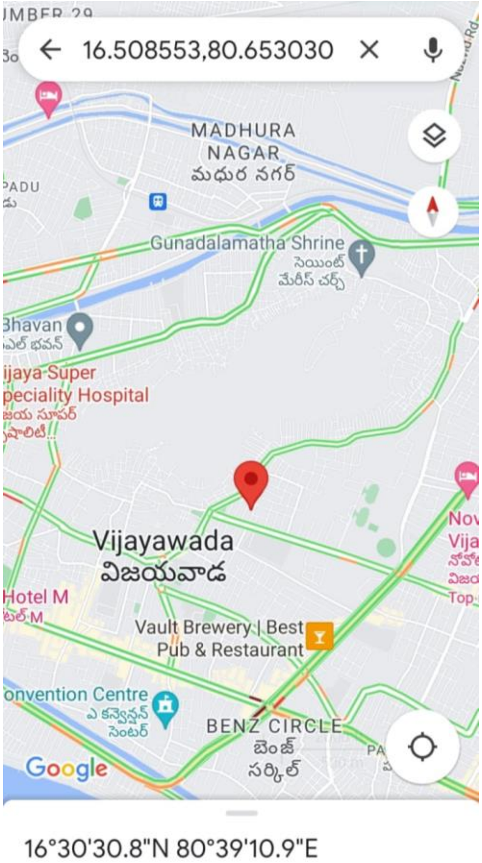

Fig 10: Detected Location

VIII. CONCLUSION

The IoT based defect detection in railway track system detects the cracks in the railway track. The detected crack, position of the crack are collected by the system. The position of the crack is needed to identify where the crack is located. This is done by using the GPS module. Along with a buzzer is inserted to turn ON whenever the crack is detected. The main aim of this project is to reduce the power consumption, to improve the railway maintenance and to provide the safe journey to the passengers. By this defect detecting system the above all requirement are possible.

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