Crack in Railway Track Detection and Alerting

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Abstract - *The Indian Railways is one of the leading public transport systems all over the world with route length over 68,103 KM. However, regardingfacilities, services and safety of people is not yet reached the global standards. Other factors include gaps in between tracks, irregular checks in detecting faults and improper maintenance. The past incidentswhich took place show that the accidents taking place are due to improper maintenance of tracks. But manual checks are still the method used onrailways which are time consuming. The proposed system was designed to overcome the above problems by developing a preprogrammed railway track detection system which is an effective method implemented using Raspberry Pi Pico as a Processor. The IR sensors were used in detecting gaps between railway track and an alert message is sent through Telegram Application along with locality of the fault so the railway department can take necessary steps to avoid accidents and many lives of people.*
***Keywords**: Raspberry Pi Pico, IR Sensor, ESP8266, L296D IC, GPS Module.*

I INTRODUCTION

In today's world transportationplays a major role in carryinghuman being, animals, and commodities from one place to another. The different modes of transportation include air, water, and land.It is necessary for day-day business activities which allows in exporting large amount of goods to different locations. Right from evolution of man transport has been an impulsive in expansion of trade. But the fundamental facilities and running cost of shipping have a major impact on business. Railways occupies the first position in transportation all over the world. Railways are a means of transportation which uses steel tracks to transport from one place to another. The invention of railways revolutionized transportation and made it possible to move large quantities of goods and people across vast distances easily and effectively. India is going to be a largest railway network all over the world, but it has not reached the global standard yet. Although it has many advantages such as the ability to carry large amounts of weight with less energy comparedto other modes of transportation. However, railways require a significant amount of infrastructure and maintenance which is expensive [1]. The problems faced are the improper maintenance of tracks which have been ended in the formation of cracks in between tracks and other relatedissues caused by anti-social elements. The study shows that the accidents occurring in railways are due to improper maintenance and disjoints on rail track. Railways still use manual checks for detecting faults on the tracks, which is time consuming. To overcome all those problems an automatic crack or gaps detection system is designed using the various components with its advanced features. The Suggestedsystem which helps the railway officials to not only in detecting cracks on the tracks but also finding the position of the fault

through the alert information sent in Telegram. So, the necessary steps are taken to avoid accidents and save many lives of people.

II LITERATURE SURVEY

The Literature review provides motivation in developing a new system of crack detection on railway tracks. In the existing system, techniques such as visual inspection, video transmission and various methods are used in detecting faults on railway tracks to avoid accidents occurring to those faults. Manual checks or visual inspection is the widely usedtechnique which indicate the process of visually inspecting the tracks by trained person to identify and locate cracks or other forms of damage. During the inspection the person should walk along the tracks, visually examining them for any signs of cracks, breaks or other faults that could pose safety risk. Although manual inspection is the widely used method it is time consuming, limited coverage, human error etc.

Using various automotive techniques to avoid collisions between trains which is implemented using RF and lasers in automating signals. A Bluetooth technology device is fixed at front and backside of compartments once the signal between the compartments is lost. Automatic brakes are applied to avoid derailments. To detect cracks on tracks UV transmitter and receiver are used in locating and sending an alert message is to the nearest station to take necessary actions and avoid accidents [2] Using Arduino Uno in processing the data, an automatic robot is designed in which an IR sensor is used in detecting cracks on tracks in which it is fixed at both the ends of wheel. The GPS and GSM module are also connected with the processor which is used in identification of location and transmitting an alert message to the nearby station and other sensors such as ultrasonic sensor, PIR sensor are used in detecting movement of human and animals on track. An eddy current method in crack detection is an excitation coil induces an alternating magnetic field in the rail, which interacts with metal and generates eddy current in which presence of crack alters the flow of these currentas soon crack is detected a notification is sent to pilot with the help of device [3].

Table 1 Comparative Table Representing Different Methods

SL. No	Title	Authors	Components Used	Drawbacks
1.	Railway Track Crack Detection Robot [1]	• Mohammed Rafi • H Kerur • M N Dinesh • Muhamad Nawazpeer • Manjunath Elavi • Manoj H • Muhammad Ayan M K	• Node MCU • Ultrasonic Sensor • DC motor • GPS module	• Processing speed is less.
2.	Railway Track Crack Detection [2]	• Arun Kumar R • Vanishree K • Shweta K • Nandini C • Shweta G	• Arduino • Ultrasonic Sensor • GPS module • GSM module • DC motor	• Processing speed is less than 20MHz. • Cost is high.

3.	Railway Track Crack Detection Using Arduino [3]	• Gokul Ramamoorthy • Tushar Karthikeyan • Ganesh Yenugudati	• Arduino • Ultrasonic Sensor • IR Sensor • GSM module • GPS module • DC motor • LCD display	• Cost is High • Processing speed is less.
4.	Railway Track Crack Detection using GPS and GSM [4]	• Dr. Nanda Kishore • Aishwarya K S V • Pallavi • Ruchejadhav J	• Arduino • IR Sensor • GSM module • GPS module • LCD display	• Memory is less. • Processing speed is less.
5.	Railway Route Crack Detection System [5]	• Laxmi Goswami	• Microcontroller • IR Sensor • LCD Display • DC motor	• Microcontroller cannotbe reprogrammed. • Speed is less.
6.	Railway Track Crack Detection and Obstacle Detection using Arduino [6]	• Benitta N • Belfiya J V • Jancy J • Prof. Shrisaranya	• Arduino • IR Sensor • Ultrasonic Sensor • GPS module • GSM module • DC motor	• Processing speed is less. • Cost is high.
7.	Railway Track Crack Detection System [7]	• D Naresh Kumar • M Udhay • G Brahmini • M Sagar Kumar	• Microcontroller • IR sensor • PIR sensor • GPS • GSM module • DC motor	• Microcontroller cannot be reprogrammed. • Memory is less. • Cost is high.
8.	Implementation of Railway Crack Detection and Protection [8]	• Prof. N Karthik • Prof. R Nagarajan • Prof. S Suresh • Prof. R Prabhu	• Microcontroller • IR sensor • GSM • LED • Buzzer	• Processing speed of microcontroller is less.

III METHODOLOGY

A. Existing System

In Existing System of automatic crack detection to avoid accidents occurring and save many lives. Figure 3.1 describes the block diagram of the existing system in which ultrasonic sensorswere used to locatecracks on railway track. The signal received from the sensor is processed by Arduino as soon asthe system detects the crack an alert message is sent through GSM module to the authorized person. But these techniques take lot of processing power and longtime in detecting which is a drawback.

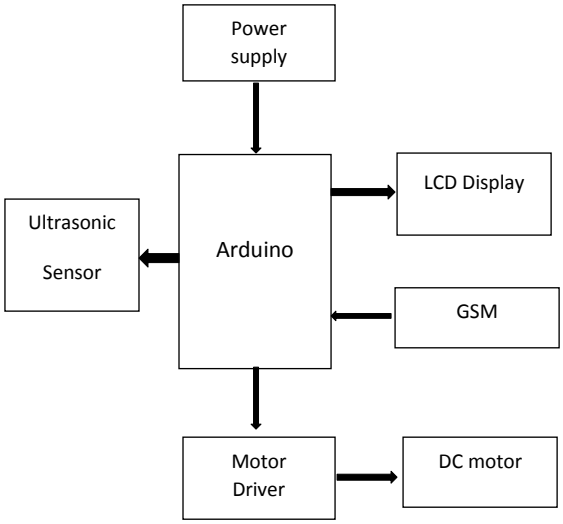

Figure 3.1: Block Diagram of Existing System

B. Proposed system

The suggested system overthrow limitation of existing system which are used in detection of cracks on railway track. In the designed system Raspberry Pi Pico is an open-source microcontroller boardthat is used and ESP8266 board is connectedto Pico. It can be used as a Wi-Fi module. Two IR sensors are fitted before wheels and GPS module is employed in locating latitude and longitude. Figure 3.2 represents the block diagram ofthe proposed system. Here, Motor driver can be used to drive the geared motor in forward or backward direction.

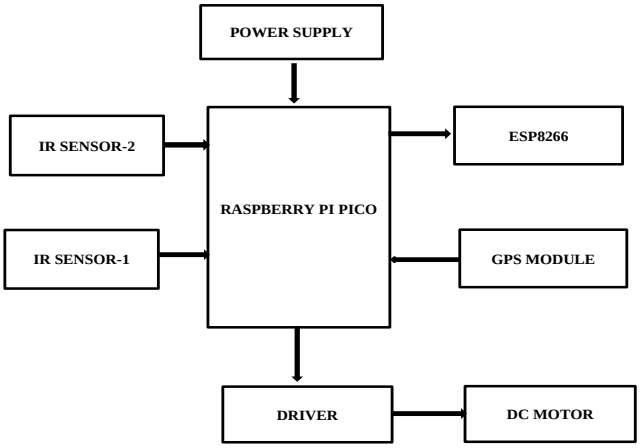

Figure 3.2: Block Diagram of Suggested System

Steps involving in finding cracks and alerting

1. Initially ESP8266 gets connected to Wi-Fi and the GPS starts blinking to locate the accurate location with latitude and longitude.
2. The signals sent with the help of GPS unitare processed by Raspberry Pi Pico and triggers motor driver.
3. The DC motor starts moving on railway track and continuously monitors the track with the help of IR sensor.

4. Whenever the cracks are detected using IR sensor the system stops moving.
5. An alert message is sent to railway authorities with the exact location of crack through Telegram.
6. As soon asan alert message is delivered the system starts moving again to monitor the tracks and finding cracks.

C. Requirement Analysis

1. Raspberry Pi Pico: The Pico is built around the RP2040 microcontroller chip, which is designed by Raspberry Pi as detailed in Figure 3.3. The RP2040 chip features a dual core ARM cortex M0+ processor running at 133MHz, 264KB of RAM, and variety of I/O options. It provides a collection of GPIO pins and It can be used to connect with othercomponents such as sensors, actuators, displays, and more.

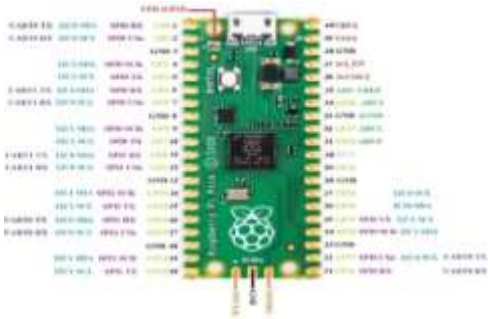

Figure 3.3: Raspberry Pi Pico pin configuration

2. ESP8266: The NodeMCUdevelopment board comes with an in-built WIFIunit designed for embedded projectsIt consists different GPIO pins and other pins in which each pins have its own function. Figure 3.4 represents ESP8266, andit operates at 80MHz. It is a low cost 32-bit microprocessor.

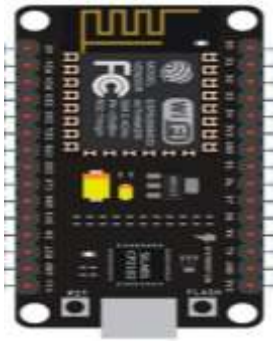

Figure 3.4: ESP8266

3. IR sensor: An Infrared ray sensor are device used to detect and measure infrared radiation in its surroundings environment. It includes IR emitter and IR receiver as pointed in Figure 3.5 in which it transmits radiation light and receives and measures the intensity. The sensitivity can be changed to measure required distance.

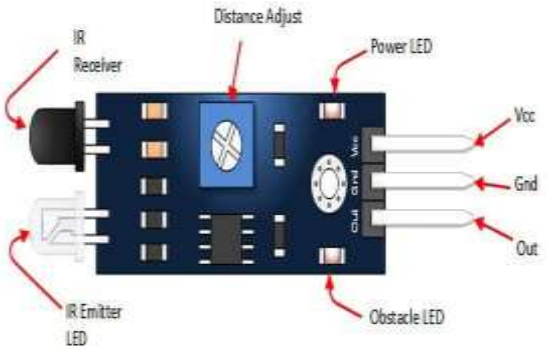

Figure 3.5: IR sensor

4. GPS Module: NEO-6M V2 is a GPS (Global Positioning system) module used in tracking the location and sending data which is latitude and longitude of its position. It features an integrated ceramic patch antenna and rechargeable backup battery as in Figure 3.6.

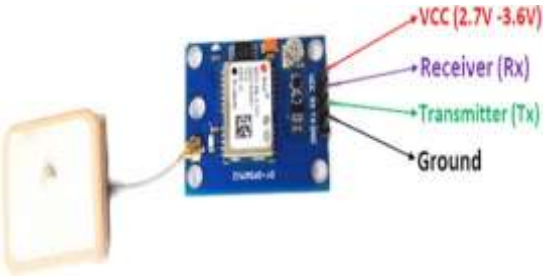

Figure 3.6: GPS module

5. DC Motor: Figure 3.7 represents DC (Direct current) motor is an electronic device which converts electrical energy to mechanical energy. It is generally used in toys, applications, including industrial machinery, robotics, and household appliances.

Figure 3.7: DC Motor

6. Motor Driver: The Driver as shown in Figure 3.8 uses L293 which is a popular integrated circuit which serves as a motor driver, designed to control the speed and direction of DC motor and stepper motor. The L293 IC can drive two motors simultaneously and is capable of handling high voltage loads.

Figure 3.8: Motor Driver

7. Power Supply: DC-DC powering unit is a multi-voltage output conversion also known as Buck converteras in Figure 3.9. The module is powered by 6V to 12V input and provides three fixed DC outputs 3.3V, 5V and third output is direct connection to DC input. Perfect for providing support power for electronic design, and DIY projects.

Figure 3.9: Power Supply

8. Software: Arduino IDE is a software platform used for writing, compiling, and uploading code to Arduino microcontrollers. Th features of open-source integrated software which is used in coding various Arduino boards.

IV RESULTS AND CONCLUSION

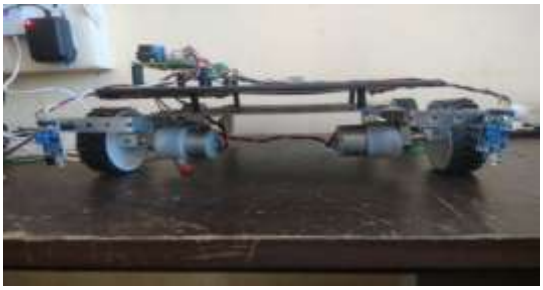

Figure 4.1: Model on Detecting Crack in Railway Track

The crack in railway track detection model is designed to automatically identify the cracks on railway track.

Figure 4.2: Telegram Notification

Figure 4.1 represents the designed model crack in railway track detection and Figure 4.2 represents an alert notification sent through Telegram as soon as crack on Railway track.

V CONCLUSION

The latest research work the existing systems require more time, attention, effort as well as uneconomical in crack detection. In conclusion, the development of automatic railway track crack detection system using Raspberry Pi Pico, ESP8266, IR sensor and GPS module is a promising application of Internet of Things (IoT) technology and acost-effective and reliable solution for track monitoring systems. By detecting cracks in the railway track, the system helps in preventing accidents and ensure safe transportation. The system operates by measuring changes in IR reflectance caused by small gaps in the railway tracks. The data collected is processed using Raspberry Pi Pico as a unit and triggers ESP8266 which sends an alert message to railway officials through application pointing latitude and longitude of the fault. The results shown by the system are effective in enhancing the safety and efficiency of railway transportation.

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