IOT Based Flaw Detection System In Railway Tracks

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Abstract- *Railway transportation is a critical infrastructure in India and many other countries, serving millions of passengers daily. Ensuring track safety is paramount to preventing accidents caused by cracks, obstacles, or derailments.*

This paper presents an IoT-based Flaw detection system in Railway Tracks using an Arduino-controlled robotic vehicle equipped with IR sensors (for crack detection) and an ultrasonic sensor (for obstacle detection). The system integrates a GPS module to log real-time location data and a GSM module to send instant SMS alerts to railway authorities, including a Google Maps link for precise fault localization. This vehicle detects defects, and stops operation upon identifying defect.

The proposed model enhances railway safety by providing automated fault detection, and alert generation, reducing reliance on manual inspections. Its low-cost, scalable design makes it suitable for widespread deployment in railway maintenance vehicles. The results demonstrate crack and obstacle detection with accurate GPS-based location reporting, proving its effectiveness in improving track maintenance efficiency and accident prevention.

Keywords- Railway safety, IoT, Arduino, crack detection, obstacle detection, GPS tracking, GSM alerts.

I. INTRODUCTION

Railways are mostly used for People Transportation and Transferring Goods but it does have disadvantage of crack in railway track and derailing i.e. train going off the track. This causes large scale accident; lot of people will lose their lives. And the other reason might be animals walking into line of rail or any waste left on the tracks results in derailing of train.

Cracks in tracks vary in size and depth, often evading manual inspection.Current detection methods rely on labor-intensive visual checks, which are inefficient and prone to oversight.

Fig. 1 Part of the track which was completely broken

To address these challenges, this study proposes an automated IoT-based flaw detection system using infrared sensors for crack detection and ultrasonic sensors for obstacle identification. GPS to locate the coordinates and GSM Module to Share the location of the Fault that has been detected to the near by Authority. Arduino Uno acts as main unit which controls all this components in the circuit. By automating defect detection, this system aims to enhance track safety, minimize human error, and prevent large-scale accidents, thereby safeguarding lives.

Fig. 2 Part of the track which was has a Crack

Fig. 3 Accident due to crack in track.

EXISTING MODEL

Current railway track inspection systems primarily rely on manual visual checks, camera-based monitoring, and magnetic field techniques. In India, physical inspection remains the most common approach despite being time-consuming and prone to human error. While video transmission allows for track monitoring, it often fails to detect minor cracks .The eddy current method, which uses electrical currents to identify flaws, suffers from inaccuracies and high computational demands. These conventional methods are slow,and inefficientmaking them unsuitable for preventing sudden track failures.

II. PROPOSED MODEL

Our IoT-based system introduces an automated solution for real-time crack and obstacle detection using IR sensors, ultrasonic sensors, and a Ardiuno Uno Microcontroller. The ultrasonic sensors measure track deviations and detect obstacles, while IR sensors identify cracks. Upon detection, the system instantly transmits an alert—along with GPS coordinates—via GSM to railway authorities, enabling swift maintenance action. Unlike previous models attached to trains, our design is independent from any maintance vehicle ensuring independent operation. The system's simplicity and outdoor durability make it cost-effective and low-maintenance, while sensor accuracy ensures fault detection. Key features include:

- Sensor Network: Detects cracks, vibrations, and obstacles.
- Real-Time Alerts: SMS notifications with fault location and severity.
- Preventive Maintenance: This model overcomes manual inspections and train-dependent systems, significantly enhancing railway safety and efficiency.

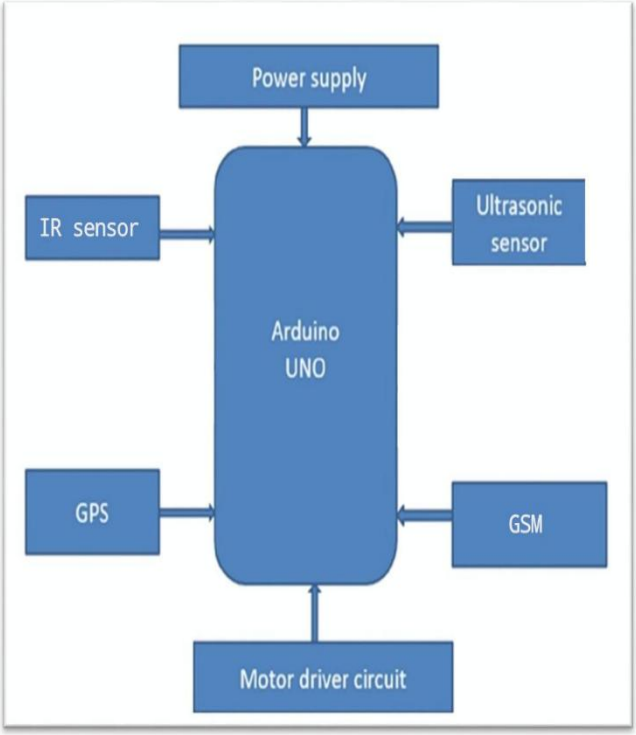

Fig.4 Block Diagram

III. METHODOLOGY

We developed an IoT-based railway track monitoring system to detect cracks and prevent accidents. The system integrates sensors, a microcontroller, and wireless communication modules to identify track defects and immediately alert railway authorities with the precise fault location

A. Workflow:

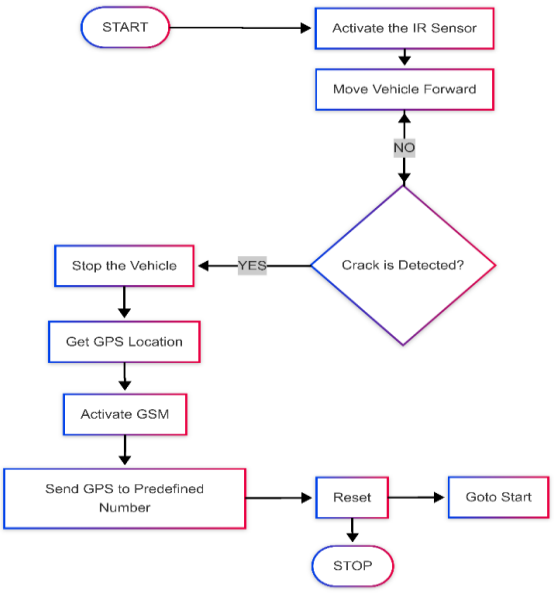

Fig.5 Workflow

B. Hardware Components:

a) Arduino Micro Controller

The Arduino micro controller as shown in Fig., is the main component in the model which controls and coordinates all the other components to work synchronously. All the components will be connected to micro controller with the help of jumping wire.

Fig. 6 Ardiuno uno

b) IR Sensor

IR Sensor as shown in Fig,. will detect the crack. When there is a crack in the track there will change in the frequency of reflected ray from track to the IR receiver

Fig. 7 IR Sensor

c) Ultrasonic sensor (HC-SR04)

It detects obstacles by emitting sound waves and measuring their reflection time, providing 2-400cm range detection with ±3mm accuracy.

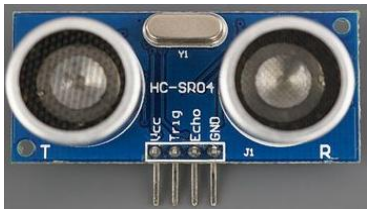

Fig. 8 Ultrasonic Sensor

d) Neo- 6M GPS Module

Whenever a crack is found GPS will capture the location of the crack, which will send to the railway authorities as shown in Fig.

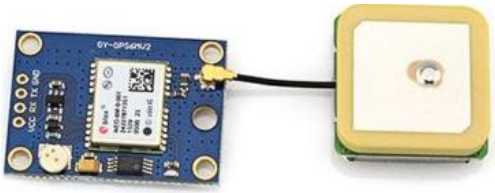

Fig. 9 GPS Module

e) GSMA7670C 4G-LTE-CAT1 Module

GSM module will help in sending message to the registered mobile number (Railway Authorities) along with the location of the crack captured by GPS which is shown in Fig.

Fig. 10 GSM Module

f) L298N Motor Driver IC

It controls dual DC motors with 2A/channel capacity, featuring PWM speed control and built-in protection diodes. It connects to Arduino via IN1-IN4 pins for direction/speed control while handling 5-20V motor voltage.

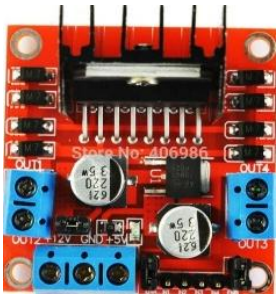

Fig. 11 L298N IC

SCHEMATIC DIAGRAM

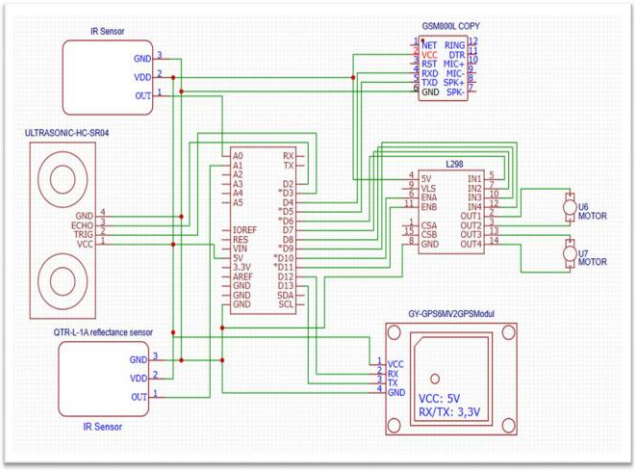

Fig 12: Schematic Diagram of Flaw Detection System

IV. RESULTS AND DISCUSSION

Here the proposed module is made up of hardware which was previously explained in the description of the system design hardware.

- **At Normal Condition:**

IR sensor involves the transmission of infrared rays which are received by the IR receiver sensor. The transistor is used as an amplifier section and remains in an OFF state during normal conditions. Relay remains OFF and the vehicle continues to run uninterrupted.

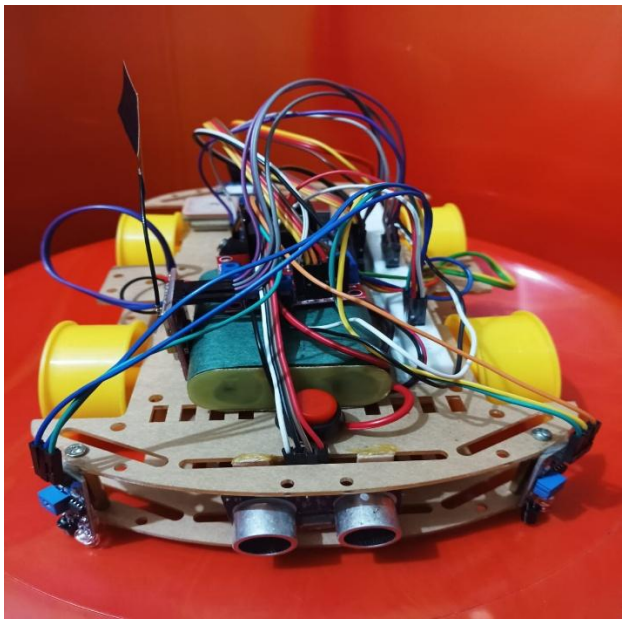

Fig. 13 Flaw Detection System

- **At Object Detection:**

This time Using Ultrasonic Sensor it takes for the sound to return calculate an object. If an object is detected, the GPS location is obtained using the IOT module, and the robot comes to a stop while alerting the authorities.

Fig. 14 Obstacle Detected

- **At Crack Condition**:

The IR sensor has a high resistance when it is detecting a crack on the track. When a crack is detected, the sensor output becomes high. The robot automatically stops when the reflection becomes zero, indicating the presence of a crack. The GPS then calculates the robot's location and determines spot.

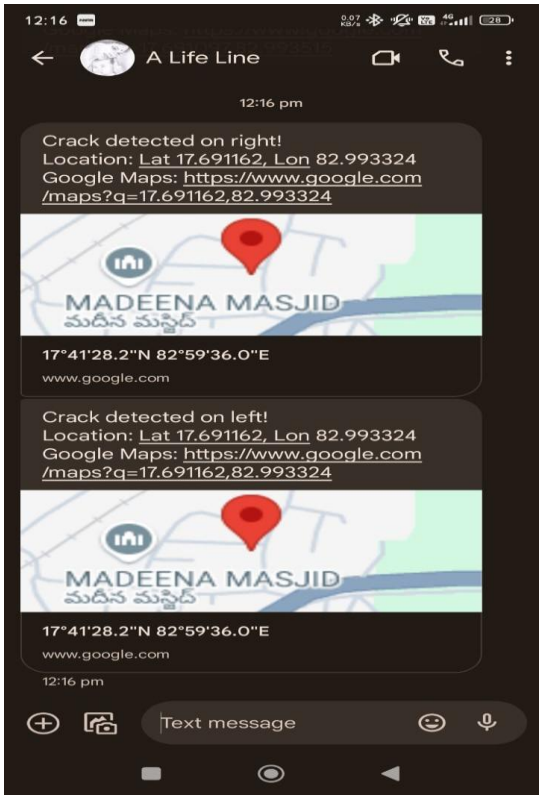

Fig. 15 Crack Detected

V. CONCLUSION

From flaw detection model we are able to find cracks and avoid train accidents; different types of cracks can be identified and repaired. The GPS fetching exact location of the crack is an added benefit. The time taken to send the message to the registered phone number is also very quick. This system enhances safety and efficiency by using sensors, wireless communication, and data analysis to identify issues early. It reduces accident risks, lowers maintenance costs, and improves rail operations. In conclusion, the IoT based flaw detection system in railway tracks is a promising technology for up coming future.

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