



Railway Route Crack Detection System

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ABSTRACT: Railway track maintenance is crucial for ensuring the safety and reliability of railway transportation systems. One significant challenge in track maintenance is the timely detection of cracks, which can compromise the structural integrity of the tracks and pose safety risks to trains and passengers. To address this challenge, researchers and engineers have developed various railway track crack detection systems. This paper presents an overview of such systems, focusing on their principles of operation, detection techniques, and technological advancements. We discuss traditional methods such as visual inspection and manual testing, as well as modern automated systems utilizing technologies such as ultrasonic testing, electromagnetic induction, and infrared thermography. Additionally, we explore the integration of artificial intelligence and machine learning algorithms to enhance crack detection accuracy and efficiency. Furthermore, we highlight the benefits and limitations of existing systems and discuss potential avenues for future research and development in this field. Overall, this paper provides insights into the state-of-the-art railway track crack detection systems, aiming to facilitate informed decision-making and advancements in railway infrastructure maintenance practices.

Index Terms - Arduino, DC Pump, Disinfectant sprayers, Sanitization robot, UV-C light.

I. INTRODUCTION

Railway is one of the most significant transportation modes of our country but it is a matter of great sorrow that, railway tracks of our country are very prone. That's why, a vast number of accidents are occurred every year due to this primitive type of railway tracks and as the consequences of those accidents we lose huge number of lives every year. These types of incidents motivate us to think over the above mentioned issue and take necessary steps to protect those lives. Through our proposed system, we need to establish more modern and secure railway system. Besides this, there is no such type of technology or system in our country which can stop the collision between two trains coming from the opposite direction of each other on the same track. We actually think over this matter and motivated to do so. Moreover, natural disaster can throw any object on the rail track which cannot be removed very quickly in the remote area. We thought if our system can detect those object or barrier and inform to the control room then they can take necessary to avoid accident. Figure1 depicts the crack on track. The Rail transport is growing at a rapid pace in India. It is one of the major mode of transport but still our facilities are not that accurate, safer as compared to international standards. A survey on the internet states that about 60% of all the railway accidents is due to derailments, recent measurements shows that about 90% are due to cracks on the rails. Hence it is not safer for Human Life. This needs to be at the utmost attention. These goes unnoticed and the properly maintenance of tracks is not done.

In previously existing system, the work is to be done manually, but the proposed system has a robot which will run automatically on the tracks. System having LED and LDR sensor assembly, but the main disadvantage is that the LED and LDR must be placed opposite to each other and also the environment needs to be perfect to detect the track. To overcome this disadvantage, here sensors are used, which will detect the crack accurately. The existing system is slow, tedious and time consuming. This system has GSM

and GPS module which will give the realtime location or coordinates in the form of Short Message Service (SMS) to the nearest railway station.

II. OBJECTIVES

- Design and develop a functional prototype of the crack detection system.
- Implement continuous monitoring capabilities to detect cracks in real-time.
- Provide immediate alerts and notifications to maintenance teams when a crack is detected.
- Develop a cost-effective solution that minimizes installation and operational costs.

III. LITERATURE REVIEW

Laxmi Goswami project titled "Railway Route Crack Detection System" This paper proposes a railway route crack detection system. More particularly, this paper presents the detection system that is capable of detecting any cracks or disjoints in the railway tracks by using microcontroller based smart robot. Most of the goods are transferred from one region to another region through railways only due to its low transportation cost, fastness, reliability and less chance of accident. For long distance travel, lots of people prefer railways rather than roadways as trains are very much comfort and fare are also very less. Therefore, for these reasons it is very necessary to provide a safety to the tracks of railways. Hence for this an advance technology-based robot is develop that is capable of locating FAULTS OR CRACKS IN THE TRACK and protect the trains from any accident.

Arun Kumar et al. (2020) project titled " Railway Track Crack Detection" In India railways transportation service is the cheap and the majority convenient mode of passenger transport and also for long distance and suburban traffic. The main cause of the accidents happened in railways are railway track crossing and unrevealed crack in railway tracks. 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 discusses a Railway track crack detection using sensors and is a dynamic approach which combines the use of GPS tracking system to send alert messages and the geographical coordinate of location. Arduino Microcontrollers used to control and coordinate the activities of this device.

Rahul Dekate et al. (2022) project titled "Review: On Crack Detection Technique For Railways Track By Using IR Sensors" The main cause of cracks and other rail problems is often overlooked due to improper maintenance and unusual track line monitoring that accidents on railway tracks vary according to the current situation. Crossing a railway track and cracks not exposed on railway tracks. Therefore, there is a need for new technologies that will be robust, efficient and stable in both the detection of cracks in the railway line and in the acquisition of objects. Today the system has some limitations, if the bridge or track is damaged, that information goes to the people in the train station, informing and informing the corresponding trains will take more time to disseminate that information.

IV. Methodology

4. Block diagram

The main aim of project is to design the railway crack detection using Ultrasonic sensors. The project block diagram is shown in Figure 2, which contains microcontroller (Arduino), ultrasonic sensor, motor driver, motor, GPS module when the crack is detected, relevant geographical location coordinates will sent to the nearest station. This recording and sending of coordinates are done by GPS module. GPS network used by cell phones provides a low cost, long range wireless communication channel for applications that require connectivity rather than higher data rates. Infrared transmitter is one type of the LED which emits infrared rays generally called IR transmitter.

Ultrasonic sensor is used to detect the crack in the rail track with measuring the distance from track to sensor. Ultrasonic technique is the most effective method which detects cracks on a railway track. An android application will be developed to intimate about the rail cracks. As and when a rail crack is detected by the crack detection system. The corresponding loco pilot will be intimated through a pop-up message. This pop- up notification service will be implementing with the help of GPS module.

I. MODELING AND ANALYSIS

A. Process of the rail track system

- Initially the tracks are being continuously monitored with the help of sensor, which is used to detect the crack in the track.
- This monitoring is done with the help of ultrasonic sensor in order to sense the minor changes also which can be quite difficult with other sensors.
- Whenever the crack gets detected with the help of ultrasonic sensor it passes the alert of crack found to the Arduino microcontroller.
- The Arduino microcontroller will perform the process assigned to it accordingly.
- The process mainly includes positioning, sending and alerting through the help of GPS module.

As the message gets delivered to the Railway Authority, the alert is to be taken into account and important measures must be taken by them in order to avoid future incidents and miss happenings which can lead to loss of human life and also to major injuries.

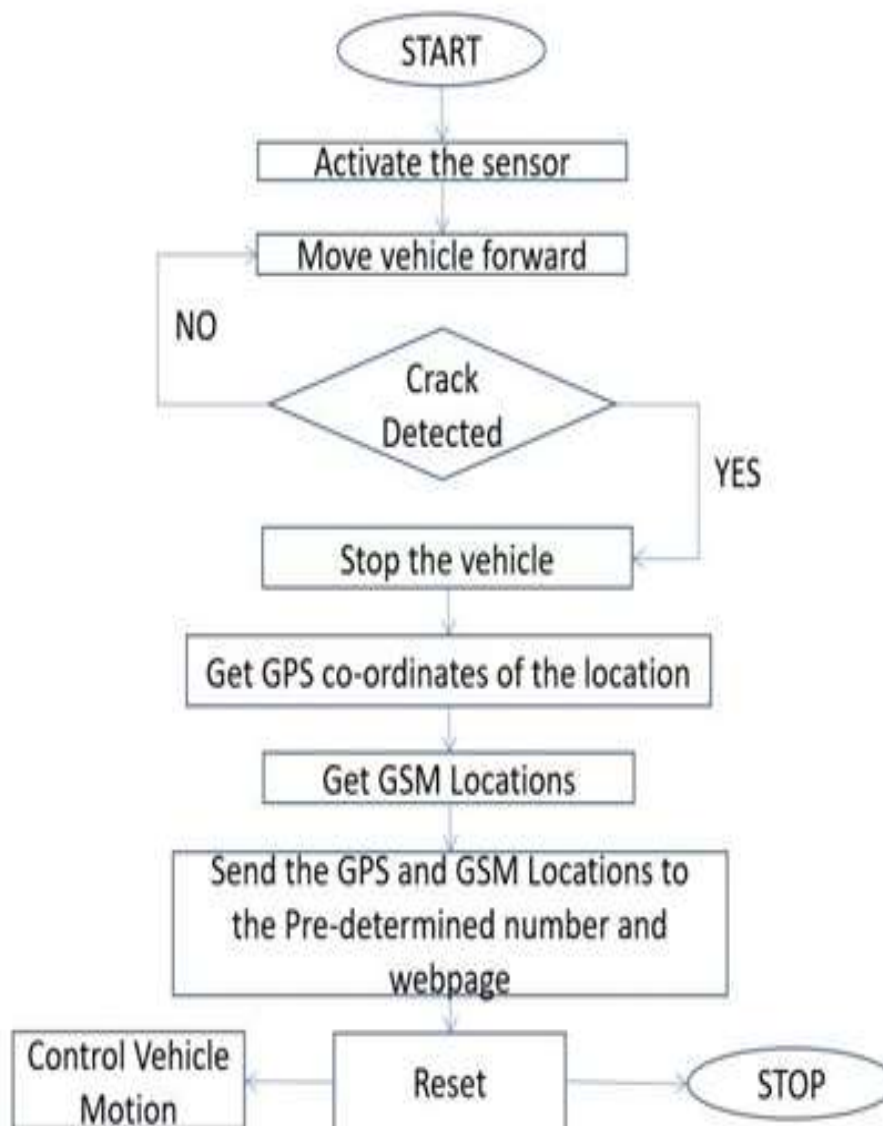


Figure1: Flow Chart

Block diagram of Proposed System:-

The project block diagram is shown in Figure 2, which contains microcontroller (Arduino), ultrasonic sensor, motor driver, motor, GPS module. Initially the system will move on the track using motor, motor is given power through a motor driver and commanded through Arduino controller. Whenever there is crack detection the motor will stop and the system will halt on the track. The crack is detected using ultrasonic sensor. After the crack detection the location data is to be sent to control room. GPS modules are used to get precise location of the car. This location is fed to controller. After successful delivery of message to control room, controller provides a signal to motor driver initiating the motor and hence car starts to move on the track. This process continues till the operator turns the system off.

Implementation:

Construction model of circuit

The main objective is to define any railway track fault using this system, which is implemented in effective and will also function efficiently. This method will be helpful in regular track checking as it is more convenient than the handheld checking system. The current system has a railway laborers' walking on the railway tracks and detecting the fault manually. In Figure 6 here we are using arduino for control action to make system we are connecting Ultrasonic sensors and IR sensors to detect the obstacle and we are connecting dc motors, GPS module is used. This requires a lot of time and labour. So we are using ultrasonic sensors and IR sensors for railway track crack detection. The testing vehicle consists of motors driven by a motor driver. The IR, and Ultrasonic sensor which is connected to the Arduino. Message is generated using GSM and GPS and will be sent to the nearby station.

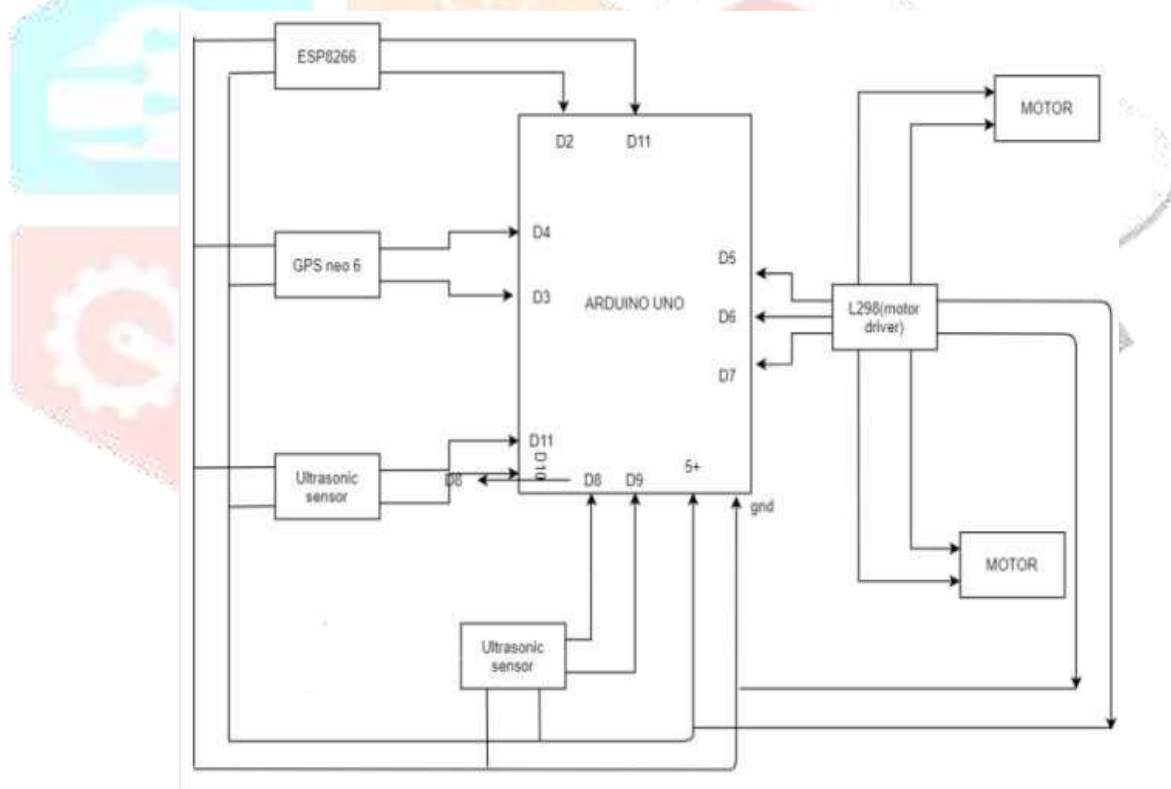


Figure2: Block diagram of Proposed System.

- **Motor Driver: L298N**

The L298N is a dual H-Bridge motor driver this allows speed and direction control of two DC motors at the same time. Motor L298N driver contains an IC as shown in the figure 10. The module can drive DC motors that have voltages among 5 and 35V, with a peak current capable of 2A.

- **Ultrasonic Sensor**

An ultrasonic sensor is an instrument that measures the distance to a question utilizing ultrasonic sound waves. An ultrasonic sensor employs a transducer to send and get ultrasonic waves that reflect off back data approximately an object's vicinity.

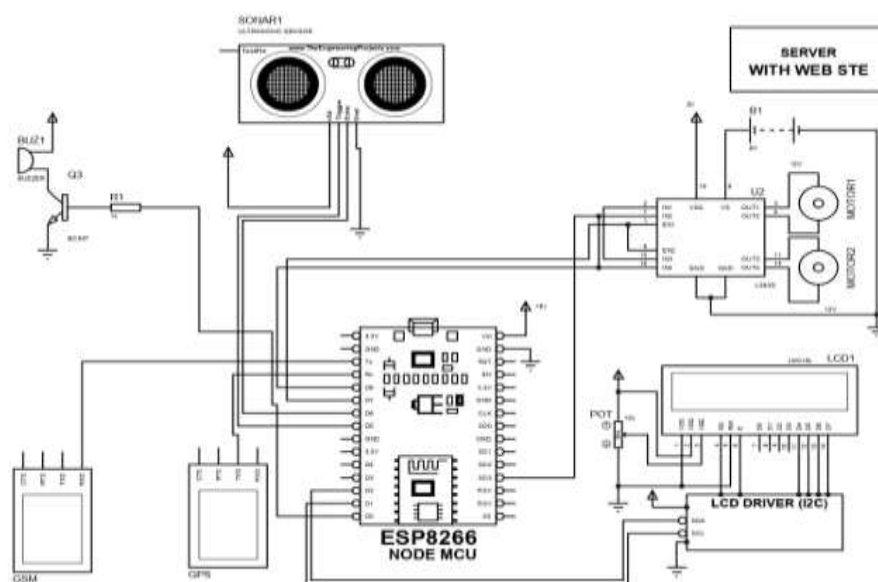


Figure3: Circuit diagram of Proposed System.

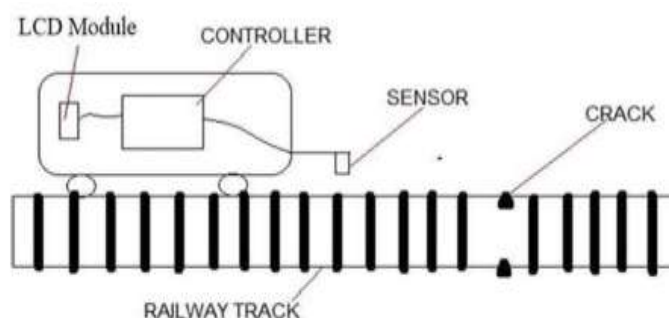
• Generating a system

In the system crack in the tracks is detected by means of sensor and Arduino microcontroller, measuring distance for two railroads. In this project we have used ultrasonic sensors to detect the crack. The below figure 11 shows system for detecting the crack using ultrasonic sensors. It uses to measure the distance between the two tracks. If any crack occurred in the track means latitude and longitude coordinates of the place are to be sent to the nearest railway station or control room and ultrasonic sensor measured the

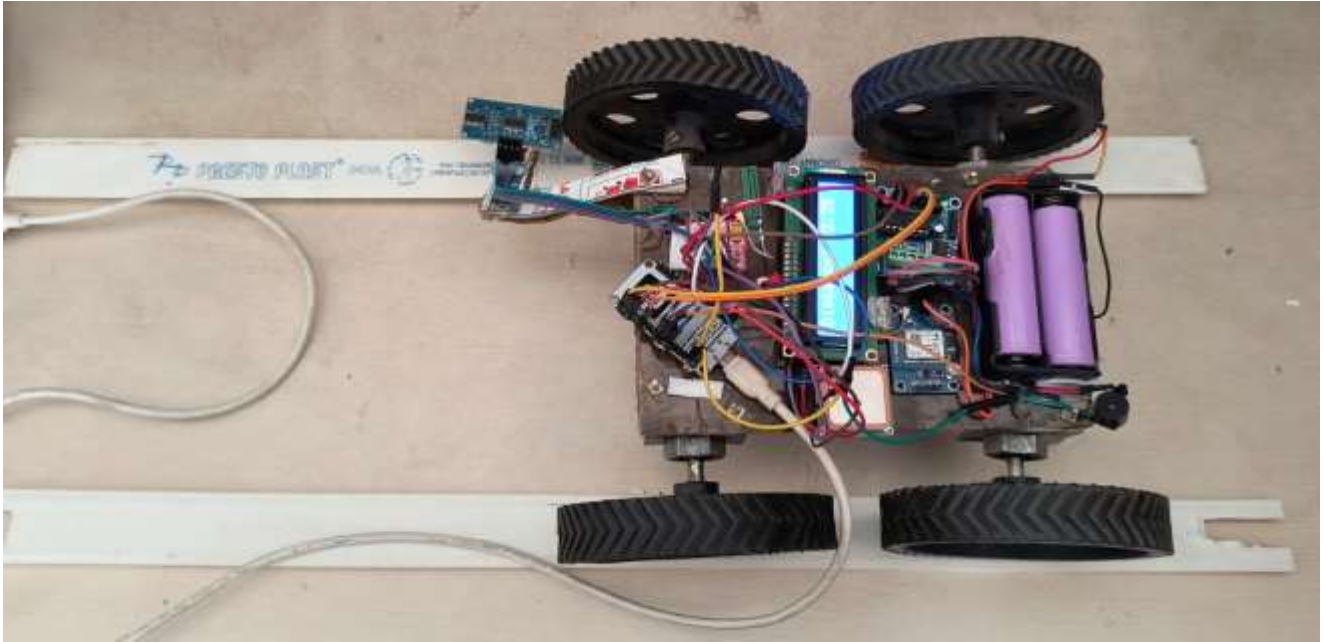
of the processing technique. The crack detection can be made of two ways. They are Destructive Testing and Non- Destructive testing. It is part of a vision system, generating a crack map to support condition monitoring for buildings, distance between the two tracks if there is any variance found the message which contains coordinates of that particular place will be sent to the nearest station or control room with the help of GPS module. This project is to be made in order to change the system of crack detection in railways which can be resulted out as not only cost-effective but also with good accuracy and time saving facility.

• AUTOMATIC CRACK CHECKING-

Rail Crack detection is the process of detecting a crack in the structures using any The suggested method uses successively radiometric, geometric and contextual information. The vehicle draws power from the battery. The optical sensor is used to detect the crack in the railway track. Suppose any racks are in the track the vehicle will automatically stop.



II. EXPERIMENTAL SETUP:



In our project, there are two set of IR sensor units fitted to the two sides of the vehicle. This unit is used to activate/deactivate Node MCU transmitter unit when there is any cracks in the track. The IR transmitter and IR receiver circuit is used to sense the cracks. It is fixed to the front sides of the vehicle with a suitable arrangement. When the vehicle is Powered On, it moves along the model track. The IR sensors monitor the condition of the tracks.

In normal condition the motor, LDR, Serial transmission is in initial stage. When the battery power supply supplies the microcontroller then its starting the motor in forward direction and serial transmission is used to send the messages to the microcontroller. When a crack is detected by the IR sensor the vehicle stops at once, and the GPS receiver triangulates the position of the vehicle to receive the Latitude and Longitude coordinates of the vehicle position, from satellites. The Latitude and Longitude coordinates received by GPS are converted into a text message which is done by microcontroller. The Wifi module sends the text message to the predefined number with the help of SIM card that is inserted into the module.

A. At Normal Condition:

The IR transmitter sensor is transmitting the infrared rays. These infrared rays are received by the IR receiver sensor. The Transistors are used as an amplifier section. At normal condition Transistor is OFF condition. At that time relay is OFF, so that the vehicle running continuously.

B. At Crack Condition:

At crack detection conditions the IR transmitter and IR receiver, the resistance across the Transmitter and receiver is high due to the non-conductivity of the IR waves. When the track is in continuous without any cracks then output of IR LED and Photodiode will be high. As soon as the crack detected by the system the IR sensor reflection will be equal to zero and the robot will be stopped automatically. Another IR sensor is used to monitor the pit on the way of the railway track. When this output is high then it is concluded that there is no pit in the track. But if any pit is detected by the sensor the output of the sensor given to the microcontroller will be zero and again the microcontroller will stop the robot.

IV. CONCLUSION

The purpose of this Automatic Crack detection system is to provide a low cost, at the same time an accurate automated system to detect all kinds of the crack present in the railway track. Our automated robot was able to detect the outer cracks present on the track using an ultrasonic sensor, then it gets the exact location through the GPS module and is sent to a mobile phone as an SMS via a Wifi module. The data received is stored in a cloud database. This automated system can detect cracks developed on the outside as well as inside thereby avoiding derailment of trains which results in a huge number of fatalities every year. The uniqueness of our system is that it detects the outer surface crack as well as the inner surface cracks, making it a very accurate system to detect, monitor and maintain railway tracks. Implementation of this system in our Indian Railways will prove to be revolutionary and increase the safety of train movements.

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