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Design and Development of Railway Track Crack Detection System

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ABSTRACT: With a total length of nearly 1,15,000 kilometers, Indian Railways operates one of the longest rail networks in the world. However, Indian Railways falls short of international norms in terms of dependability and passenger safety. Among other things, the lack of prompt diagnosis of cracks on the tracks and the ensuing maintenance raise major concerns about the safety of rail transportation and also Due to the time commitment and need for trained technicians, manual track detection is laborious and ineffective. Thus, it contains a demand for novel technologies that would be dependable, successful, and consistent for each item recognition and recognising cracks in train tracks. This project examines the use of sensors to identify railway track cracks. It takes a dynamic method that combines the use of a buzzer system to transmit alarm Notification and the coordinates of the site. This device's operations are managed and coordinated using Arduino microcontrollers.

KEYWORDS: Arduino Nano, Infrared Sensor, DC Motor, Drive Controller, Buzzer, LCD, LED.

I. INTRODUCTION

One of our nation's most important sources of transportation is the railway, yet the fact that our nation's railway rails are so vulnerable is a source of great sadness. Due to these outdated railway tracks, numerous accidents occur every year, and as a result, a significant number of people perish as a result of such incidents. These kinds of events urge us to consider the aforementioned problem and take appropriate action to safeguard those lives. We need to develop a more advanced and secure railway system through the use of our proposed method. In addition, there is no technology or mechanism in our nation that can prevent a collision between two trains that are travelling along the same track in different directions. In India, rail transit is expanding quickly. Despite being a popular means of transportation, our facilities are not up to par with international standards in terms of accuracy or safety. According to an internet study, derailments are to blame for 60% of all railway accidents, and recent data indicates that rail cracks are to blame for 90% of those incidents. It is therefore not safer for human life. The importance of this requires immediate attention. These are ignored, and the tracks are not properly maintained. The task is currently done manually, but the planned system uses a robot that will operate automatically along the tracks. The main drawback of the system's LED and LDR sensor assembly is that it requires a flawless environment and that the LED and LDR be situated in opposition to one another in order to detect the track current system is cumbersome, time-consuming, and slow. Existing problems associated previous system are overcome by our proposed system.

II. LITERATURE SURVEY

1. "Railway Track Crack Detecting Robot using IR and GSM" by Pravin ram R, PrasathR, Nanda Gopal R, Hari babu.

The study discusses the use of an IR sensor to find cracks in railway tracks. In one possible version, a sensor oriented to detect the fracture is installed on the railway carriage that is hauling the control equipment. This project focuses on the identification of problems found by monitoring equipment on the tracks to be checked so that maintenance teams can later uncover these defects. It is related to a procedure for monitoring the state of rail on train lines. Two metal sensors that are permanently mounted in the train's wheels are utilized to detect rail cracks. Every sensor will generate a signal.

2. “Detecting Cracks and Obstacles in RailwayTracks” by P V V N D P Sunil, Y N V V L P rasanna, M L P rasanna, P S ravana Gayathri.

Using the distance that lies among the surface of the track and the sensor, a sensor made of ultrasound is used to identify fractures in the rail line while an infrared sensor is employed for identifying the presence of objects in the track. To find the cracks, a microcontroller called the Arduino is being used. The evaluation of the robotic vehicle pauses when a fracture or item is found, and its axial and latitudinal positions are relayed by Text to GSM and GPS before being delivered in formation to close-by trains using RF Transmission. Here, the robotic portion is equipped with an RF transmitter, while the train portion is equipped with a receiver. The suggested method is quite reasonably priced. Likewise the surface of the fracture place and the adjacent area are scrutinized.

3. “Design and Fabrication of Automatic Railway Track Crack Detection System” by SajanThomas, Suhaib M V, Saran Kumar S, VigneshT, T.Vandarkuzhali

The objectives of this paper is to address this issue by creating an automated system to identify cracks in railway tracks that incorporates an infrared crack sensing module based on the technology of GSM. This system will allow maintenance personnel to respond immediately to the crack's location. The automatic railway track fractures detecting system consists of up of several different parts. It consists of a DC motor, GSM module, GPS receiver, Arduino board, GPS antenna, and IR sensor. The Arduino board acts like the system's operational platform. Through coding or programming, the GSM module is linked to the Arduino platform. Similar to that, a specific program is used to interface the GPS receiver with Arduino.

4. ‘By Shailesh D. Kuthe, Sharadchandra A. Amale, and Vinod G. Barbuddhye, "smart Robotics for Railways Tracks Fracture Monitoring Systems Employing LED-Photodiode Assemble."

The system utilizes an infrared LED-Photodiode assembly for real-time crack detection and incorporates a smart robot equipped with a microcontroller and motor circuit. The robot can accurately detect cracks on the railway trail and display the crack information on an LCD screen. Unlike traditional inspection methods that require periodic maintenance, the proposed system offers an automated and efficient approach to enhance monitoring processes. The paper provides a comprehensive explanation of the system's technical aspects, including the components used and the crack detection algorithm.

III. DESIGN CALCULATION SELECTION OF MOTOR

12V DC Motor, Power 60 Watts, Motor Torque $P = 2 \pi N T / 60$

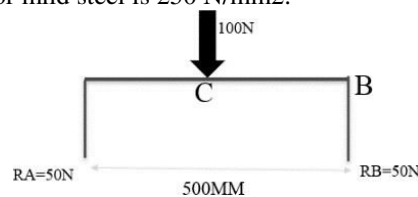
$$T = 60 \times 60 / 2\pi \times 600$$

$$T = 9549 \text{ N-m}$$

As the supplied torque is greater than the required torque our design is safe, and we can select 12V and 5A,60 DC motor.

DESIGN OF FRAME:

Frames layout While the weights placed on the majority of the structure that is linked to the wheel are not constant, sufficient allowance must be made to minimize the negative consequences of load variations. The ASME rule states that the maximum allowed shear load for mild steel is 250 N/mm².



The maximum bending moment is occurred at point C. so BM about C=WL

$$\text{Bending Moment (at C)} = 50 \times 250 + 50 \times 250$$

$$\text{Bending Moment (at C)} = 25000 \text{ N-mm}$$

According to flexure formula by considering the pure bending moment, $M/I = \sigma/Y$



Now as we are using the 1-inch square hollow pipe with 3 mm internal thickness.

$$I = \frac{bd^3}{12} = \frac{(25) \cdot (25)^3}{12} = 32552.0 \text{ mm}^4$$

$$\sigma = \frac{M \cdot Y}{I} = \frac{(25000 \cdot 25)}{32552}$$

$$\sigma = 19.20 \text{ N/mm}^2$$

As the induced stress is less than the Yield Strength (250 N/mm²) of the material our design is safe

DESIGN & ANALYSIS

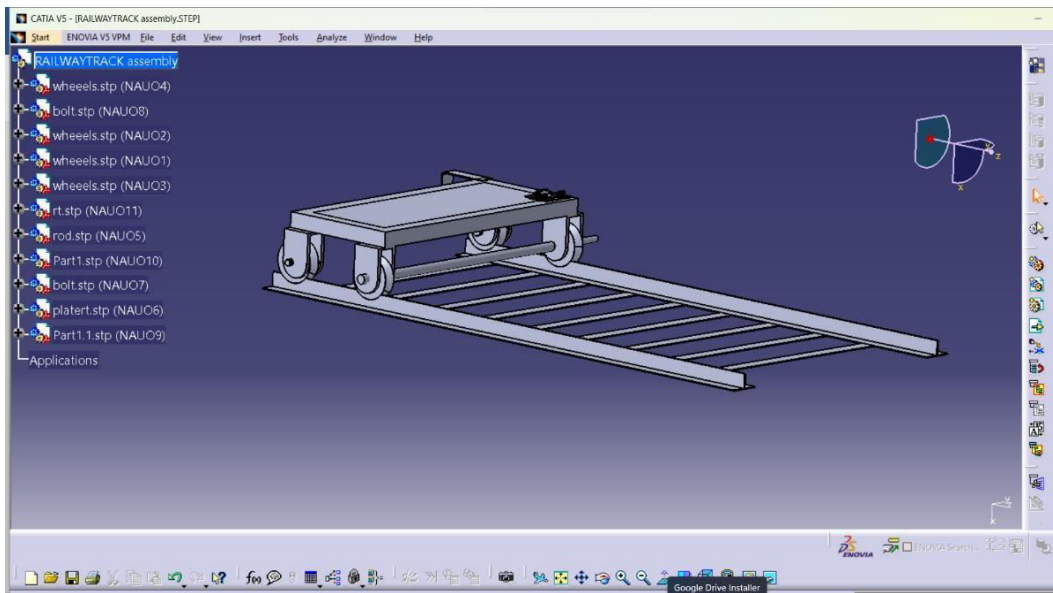


Fig.1 CAD MODEL

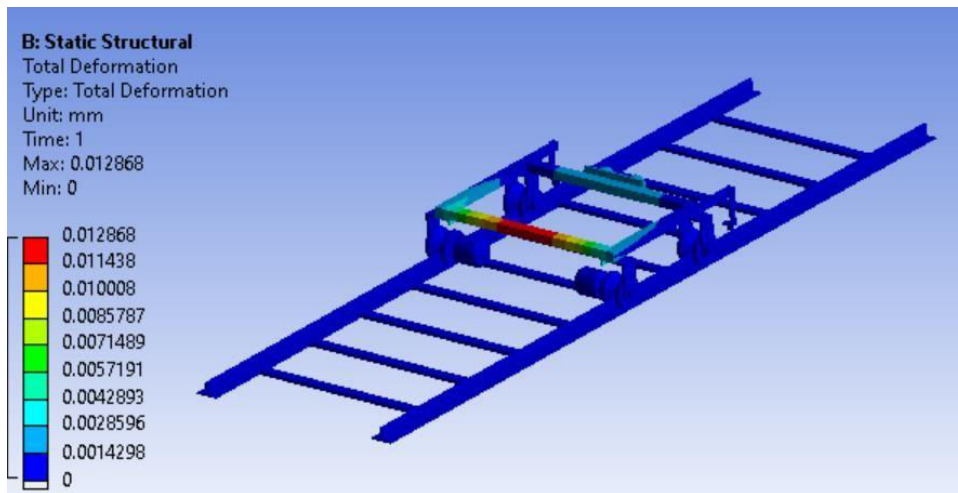


Fig. 2 ANSYS of Assembly

STEPS OF ANALYSIS

Step 1: Modelling:

Modelling of the portion includes intricate geometrical characteristics. The most important and initial step in any analysis is this one. Just take it from me: when you model your domain effectively, you'll cut down on rework and save



a lot of time. Consider the geometry carefully and attempt to comprehend why you are modelling this element. This will give you the knowledge need to get rid of Remove unnecessary geometrical characteristics to reduce processing duration and unneeded detail. Usually keep in mind that little is more.

Step 2: Material definition:

In this phase, material characteristics are specified. These material characteristics vary depending on the kind of analysis required. You can successfully complete this phase by doing a literature search for related issues. surprisingly, you're practically done if the material you want to utilized in your simulation is available in the material library of your FE tool. Simply choose the attributes and extract the content from the collection.

Step 3: Definition of loads

In this phase, we'll figure out the outside pressures that the component's mass is exerting on the human form. We need apply caution while defining the sort of force in order to prevent issues like unique characteristics.

Step 4: Boundary conditions

This process is primarily carried out to simplify the issue from the standpoint of technology. For instance, the user may be aware of some initial circumstances in some situations before beginning analyzing them (such as as the movement of an object in the geometries).

Step 5: Meshing

Finite components are the reduced more basic shapes that make up your architecture. Different kinds of materials and their uses are covered in any typical FEM textbook. To prevent issues for the end user, several software programs now automated this procedure.

Step 6: Solution

When specifying the model's attributes, this step is completed in the backend. Do you understand the idea of discretization? This translates equations involving partial differentials into mathematical formulas, to put it simply. This will make it easier for the program to translate the equations into matrices. worldwide matrix for the entire shape are created from each of the element matrix and then solved by solutions for unidentified variables.

Step 7: Post-processing

Every FEM program will include a feature to show the user whether the solution was finished satisfactorily. The computed parameters (Displacement, von Mises Stress, etc.) are shown in the shape of contour maps or charts once the solver produces the report in question. This would, in my opinion, be the most thrilling aspect for most newbies. To verify your simulation's results, a solid physical knowledge of the phenomenon that you are replicating is crucial. It is always more preferable to compare your findings and method of resolution with existing research or scientific studies.

IV. COMPONENTS AND DESCRIPTION

The following are the primary elements of the automated rail track fracture detecting system Infrared Sensor:

- Arduino Nano
- Battery
- LCD (Liquid Crystal Display)
- Motor Driver (L298N)
- D.C. Motor
- LED
- Buzzer

Circuit Implementation Diagram:

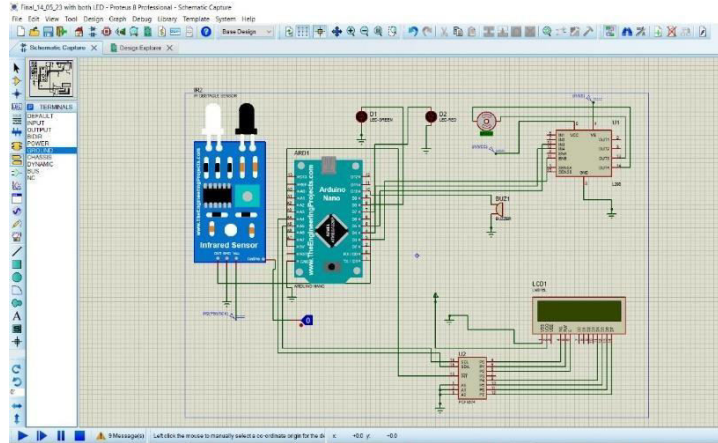


Fig. 3 Circuit Connection for System design

V.WORKING PRINCIPLE

In our Concept, there are two set of Infrared sensor units fitted to the two sides of the vehicle. The Infrared transmitter and Infrared receiver circuit is used to sense the cracks if there is cracked on track its gives alert signal to microcontroller to stop the vehicle and when there is no crack vehicle run on track for further detection.

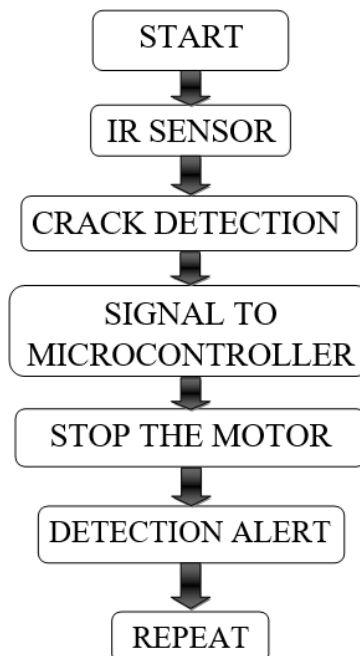


Fig. 4 Flow Diagram

The resulting schematic 4, shown in the following illustration, contains the technique described below.

- For the purpose of to discover rail fractures, detectors are first used to always track the traces.
- The employment of an infrared sensor in this observation allows for the detection of even minute modifications, which can be difficult to do with conventional sensors.
- Each time an issue is detected, an infrared detector recognize it and sends a warning to the Arduino microcontroller.



- d. The Arduino microcontroller will carry out the task set to it in the appropriate manner.
- e. The key steps of the procedure involve placing, sending, and alerting with the use of a buzzer.
- f. The alarm is sent to the Railway Authority as soon as the communication arrives. They must take significant steps to prevent occurrences and near-misses that could result in serious injuries as well as the loss of life in the future.

VI.CONCLUSION

Trains disasters will be significantly decreased by the deployment of an self-driving car for railroad line examination and fracture identification, which will have a significant influence on railway management. This will assist in keeping railway tracks in good condition by allowing for error-free maintenance and monitoring of track status. Detecting railway track cracks and preventing train accidents to a great amount The design of an autonomous vehicle makes it capable of spotting track faults that, if promptly repaired, will lower the number of train accidents.

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