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IoT Based Robotic Car for Railway Track CrackDetection System

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ABSTRACT : People in poor countries experience a high number of accidents. It is unacceptable for any nation to lose a member due to an accidental cause of death. Railways are an important mode of transportation in India. Manual investigation is necessary for finding cracks on railway tracks, which are constantly repaired by railway personnel, even during regular inspections. Sometimes the crack may go unnoticed. This could lead to a train accident or a disaster. To avoid this problem, an effort has been made to automate railway crack detection. The ultrasonic sensor identifies obstacles present in railway tracks and LDRSensor is used to detect the crack occured on railway track. Here, we're using an Arduino microcontroller. After detecting a crack or object, the robotic car stops and sends its longitudinal and latitudinal positions to the control station via SMS, GSM, and GPS. This initiative is crucial for ensuring train and passenger safety. This robot helps maintain robust and dependable tracks, improving train travel.

KEYWORDS: GSM, GPS, LDR, Ultrasonic Sensor, Internet of things, Railway fault detection.

I. INTRODUCTION

Railway transport is a vital component of specialization, enabling the separation of product production and consumption sites Because increased trade results from improved transportation, transportation has historically encouraged growth. Transport capacity and rationale have always been key factors in economic growth. However, transportation infrastructure and operations are the biggest energy consumers and have a significant impact on the environment. Making transportation is safely it is the most important concern. In India, Railway transportation plays a significant role in supplying the essential transportation infrastructure needed to meet the constantly expanding demand of an economy that is expanding at the rapid space India has the fourth largest railway network globally, but there are concerns about its dependability and meeting requirements. When GSM, GPS, and a microcontroller-based system work together, they create an effective way to detectbroken railway tracks and avoid train derailments. Positionedbetween two stations, the gadget uses TSOP sensors to detect cracks in the track with sine waves. If a crack is found, the sensor alerts the Arduino UNO board, which is used to activate the GPS receiver. The GPS is used to determine the location and inform the control authority. Additionally, whenthe sensor signals, the web cam starts recording.

The goal is to create a railway track crack detection system that uses Ultrasonic sensors and a microcontroller that can identify cracks along its course. An ultrasonic sensor finds things and cracks. This provides the microcontroller with this data, stopping the Train right away. IoT-based robotic car for track crack detection system offers an efficient and automated solution for identifying and addressing railway track issues. issues. By integrating sensors, connectivity, and robotics, it enhances the accuracy and speed of crack detection, contributing to overall rail safety. This technologyhas the potential to reduce maintenance cost and improve their reliability of rail infrastructure making it a promising advancement in railway monitoring system.IoT-based robotic car for track crack detection system presents a cutting-edge solution to enhance railway safety. Through the integration of sensors and robotics, it offers an efficient and automated approach for detecting track cracks, contributing to improved maintenance practices and overall reliability of rail infrastructure.

These innovations hold a promise for reducing cost and advancing the effectiveness of railway monitoring system. The project focuses on the development of an innovative solution using Internet of Things (IoT) technology to enhance railway track maintenance. The IoT-based Robotic Car for Track Crack Detection is designed to autonomously traverse railway tracks, equipped with sensors for real-time crack detection. This autonomous system aims to improve the

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efficiency and accuracy of track monitoring, ensuring timely maintenance and enhanced safety in railway operations. Arduino microcontroller in the IoT-based roboticcar for track crack detection system provides a versatile and accessible platform for managing various components of theproject. Arduino can serve as the central brain, orchestrating sensor data acquisition, processing, and decision-making. Its user-friendly environment facilitates rapid prototyping and integration of sensors, such as cameras and crack detection modules.

II. LITERATURE REVIEW

The primary purpose of inspecting railway lines is to do predictive maintenance, discover faults, and ultimately reduce the likelihood of train accidents. Railway lines must be inspected on a regular and frequent basis. Human inspection of hundreds of thousands of miles of track is time- consuming, labor-intensive, and prone to human mistake. Because of human error, manually operated devices areinsufficient to monitor track health on a consistent, dependable, frequent, and universal basis; thus, automatic identification and monitoring of track faults/cracks is required. As a result, a variety of automated solutions have been created to minimize workload and increase efficiency.

Non-destructive evaluation (NDE) techniques for rail track inspection include electromagnetic approaches (eddy current testing [1], magnetic flux leakage (MFL) testing [2],guided wave-based systems (ultrasonic testing [2], [3], guided wave detection [4]), vision-based systems, IoT-based systems, and acoustic-based systems. More information about the tools and techniques used to inspect train tracks may be found in [1] and [4]. The literature is categorized into electromagnetic, guided, and computer vision. The nextsections cover IoT and acoustic-based approaches.

A. ELECTROMAGNETIC APPROACHES

A special kind of sensor system for finding fasteners on trains was talked about in [5]. This sensor works by using electricity to create a kind of magnetic field on the rail and other metal objects nearby. Then, another part of the sensor picks up signals from this magnetic field. Tests both in labsand out in the field showed that this method can spot a single fastener even from about 65 millimeters above the rail. Theyalso figured out a way to use the time it takes for the signal for to the comeback to tell if any claims are missing from the fastening system.

B. GUIDED WAVE SYSTEMS

In [6], they talked about a way to check for defects without damaging the object. Specifically, they used a method called ultrasonic testing with a device called the DIO 562. This device not only scanned the rails but also collected data about their shape. Then, they analyzed this data on a computer using a special program called DIO 2000.

In [7], they introduced a way to diagnose rail problems without touching them, using ultrasound. They used lasers that don't damage the rail to create waves. These waves bounce back and are detected by a method called rotating laser vibrometry, which measures how the rail moves and vibrates. By analyzing the signals from these waves, they were able to spot any faults or issues in the rail.

C. IOT BASED SYSTEMS

In the paper [9], they showed a self-driving robot that used asmall computer called a PIC microcontroller and sensors todetect obstacles. This robots also had a GPS device to findthe location of crack and when it found one, it sent text messages through a mobile network using a GSM module. In [10], they presented a system that constantly monitorsrailway fishplates In real time using the Internet of Things(IoT). This system keeps track of every bolt on each fish plate and if any bolt starts to come loose, it immediately sends alerts to the main railway monitoring center, nearby stations,and even to train drivers who are approaching the areaIn [11], they demonstrated a prototype robot that could spotvarious issues on the surface of rails like cracks, squats,corrugations, and rust.

D. ACOUSTIC BASED SYSTEMS

The authors of [18] suggested a system that uses sound analysis to find defects and determine what kind of repair is needed. In [19], they proposed a system that automatically detects faults on railway tracks. It uses sound analysis to identify three types of fault regular track, track with wheel burn and elevated track.

The work discussed in [20] used data from acoustic emission monitoring and information from a database related to sound. They developed a new method called transfer learning to evaluate the condition of train tracks. Specifically, they created a CNN model called NA-AE, which utilized knowledge from a pre-existing model called Audio Set to understand the unique features of sound captured by spectrograms over a period of two months.

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III. PROPOSED DESIGN

The block diagram for this suggested design is illustrated inthe picture below. Power supply, GPS Module, ultrasonic sensor, LDR Sensor, Motor driver, DC Geared Motor, GSMModule, Buzzer, and LCD Display are all included. The components are described in full below.

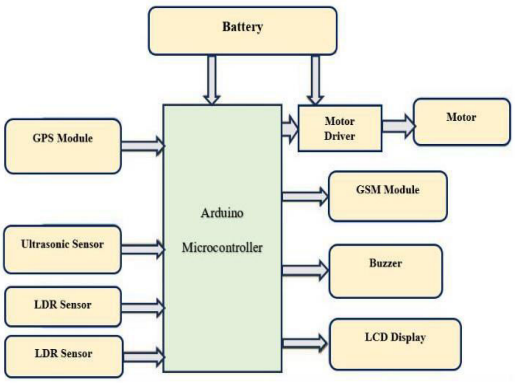


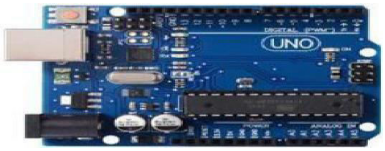
FIGURE 1 Block diagram of the proposed system

The proposed system outperformed existing system constraints for identifying faulty railroad lines. In this proposed system, we employ the Arduino UNO board. Arduino is an integrated open-source development environment that greatly simplifies coding. The suggested system consists of an ultrasonic sensor for detecting obstructions and LDR sensors with LEDs for fracture detection.

The L293D motor controller/driver contributes to the DC motors' power supply. The Arduino controllers are primarily used to regulate sensor outputs and to transmit information via a GSM module, which sends a signal to the control authority if a crack or impediment is detected via SMS. Using the GPS module, the exact latitude and longitudinal direction of the incorrect track are determined. The L293D motor controller/driver contributes to the DC motors' power supply.

IV. REQUIRED COMPONENTS

Arduino UNO:



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Arduino is like a mini computer that you can program to do different things. It's made up of simple parts and software thatanyone can use. It has pins where you can connect wires andsensors, a USB port for connecting to a computer, a power jack, and a reset button.

Node MCU:

Node MCU ESP8266 WiFi module is an upper source development firmware based on the popular Esp 8266 12E WiFi module you may program the ESP8266 WiFi model using or Arduino Ide.

Ultrasonic Sensor:

An ultrasonic sensor is like a little device that can tell how far away something is. It does this by sending out sound waves that we can't hear, called ultrasonic waves. When these waves bounce off an object and come back, the sensor measures how long it took for them to return.

GSM Module:

The GSM SIM 900 is a device that helps electronic gadgets like your phone or computer connect to mobile networks. It has a special port (serial port) that allows it to communicate with other devices. With this module, you can send and receive text messages (SMS) through your device.

GPS Module:

GPS is like a high-tech map that helps you figure out where you are on Earth. It works by using signals from satellites that are flying around in space. Your GPS device picks up these signals and uses them to figure out exactly where you are. It can show you your location using coordinates called latitude and longitude, or it can show it to you on a map.

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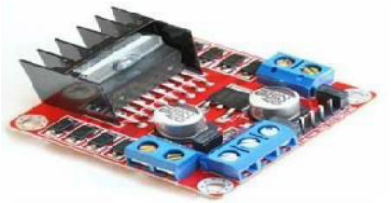
DC Motor:

A geared DC motor is a motor that has gears attached to it. These gears help the motor to move at a certain speed, which we measure in rotations per minute (RPM).The gear assembly also helps to make the motor stronger, so it can push or pull things with more force. Basically, the gears makethe motor stronger but slower.

Motor Driver:

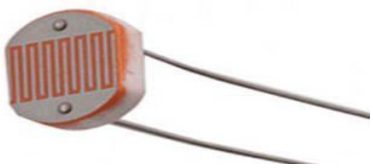


The L293D motor controller helps motors move in both directions, meaning they can go forwards and backwards. It works with voltages between 5 volts and 36 volts.

Battery:

Rechargeable batteries are like little energy tanks that store power. When they run out of energy, you can refill them by sending electricity to them. This means you can use them again and again, instead of throwing them away after one use like regular batteries.

.LDR Sensor:



In the LED-LDR system, the LED keeps shining light as it moves along the railway tracks. If there's a crack in the track, some of the LED's light will shine onto the Light Dependent Resistor (LDR) through the crack. The amount of light reaching the LDR depends on how big the crack is. So, if there's a big crack, less light will reach the LDR, and if it's a small crack, more light will reach it.

V. PROCESS OF THE RAIL TRACK SYSTEM

1.Initially, the robotic car is sent on the railway track to monitor any obstacles or cracks that may have occurred on the track. The robotic car then moves onward.

2.Initially, the tracks are continuously monitored using a sensor to detect cracks or obstacles.

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3.Ultrasonic and LDR sensors are used for monitoring, detecting slight changes that other sensors may miss.
4.Ultrasonic and LDR sensors detect cracks and obstacles and inform the Arduino microcontroller.
5.The Arduino microcontroller will carry out the task provided to it properly.
6.The method mostly involves location, sending, and alerting using the GPS module.
7. When a message is delivered to the Railway Authority via GSM or WiFi, they must take appropriate action to prevent future incidents and injuries.

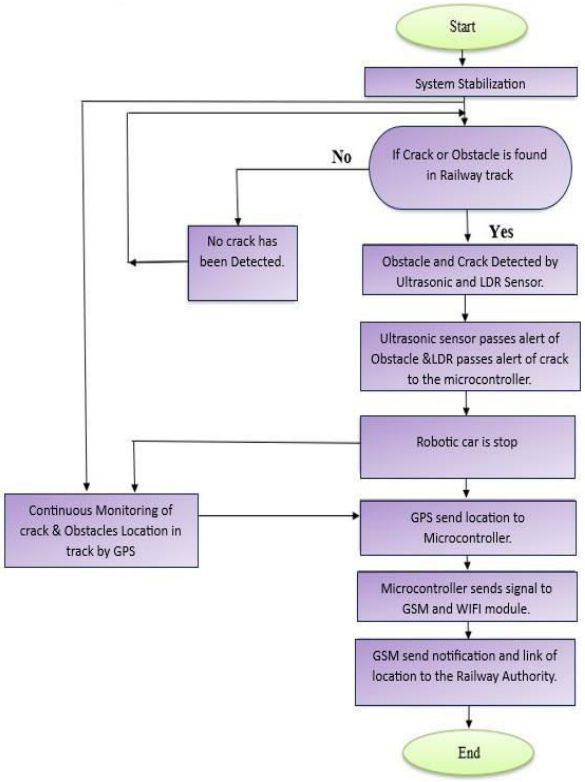

FIGURE 2 Flowchart for Monitoring Vehicles

VI. APPLICATION AND ADVANTAGES

Application:
Automatic detection of crack on railway track.Used in any industries to detect the obstacles. **Advantages:**
There are some advantages of this Project. Which are listedbelow –
The automatic crack detection method works better in thetechnical field.
Quick response is achievedReduce manual inspection.Simple in construction
Easy to maintain and repair
Cost of unit is less when compared to other.

VII. IMPLEMENTATION

Here the proposed model is made up of hardware which was previously explained in the description of the system designhardware.
STEP1 When all the components are active, the robot travelsconstantly on the track until there is no crack on the railway track as shown in figure 4.

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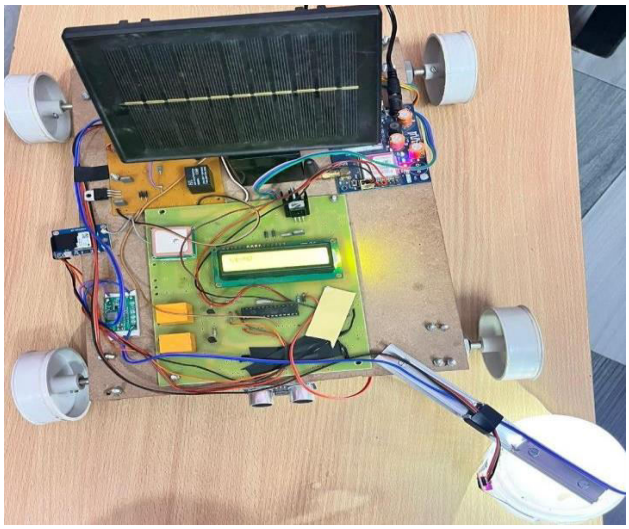

FIGURE 3 Proposed Model

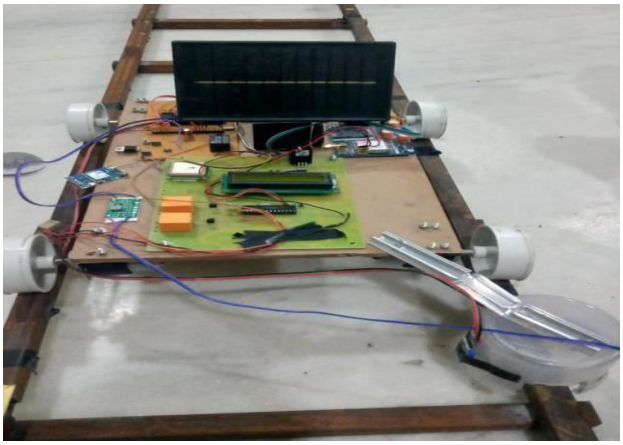

FIGURE 4 Proposed Model With Track

VII. RESULT

The illustration below shows the SMS received on the mobile phone, along with the latitudinal and longitudinal position at the place where a crack or obstacles is detected. **STEP2** When the LDR sensor detect a crack on the track robot comes to a stop GPS locate the crack and display the crack detected message which is communicated to the control system via GSM has shown in figure5.

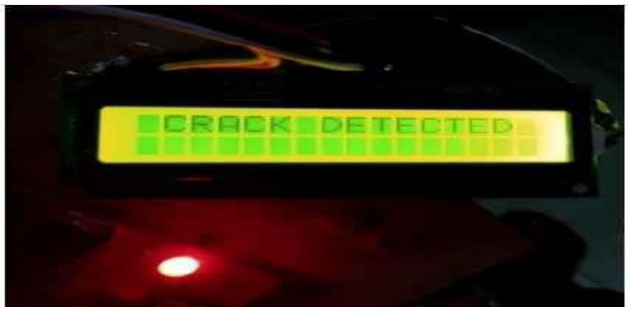

FIGURE 5 LCD Displaying Crack Detected Message

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FIGURE 6 LCD Displaying Crack Detected Message **STEP3** An alert message is provided to the concerned authorities together with the latitude and longitude values ofthe location where crack has been detected as shown in fig6

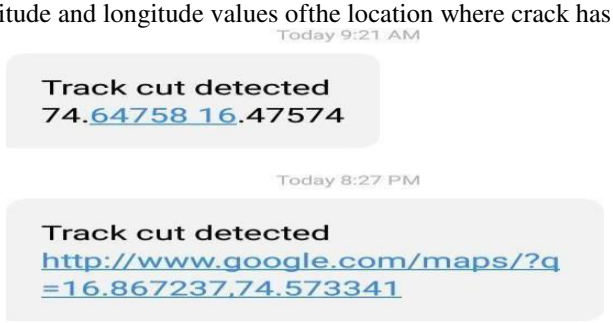

FIGURE 7 SMS Received in Mobile Phone

VIII. CONCLUSION

The railway is the most commonly used mode of transportation by the people and for goods. The project aims to improve rail track management by reducing manpower. Our study makes it possible to detect cracks in railway tracksas well as obstacles on the tracks. In the proposed technique,an ultrasonic sensor is utilized to detect obstacles on the track, while an LDR sensor is used to detect cracks. The robotic part continuously monitors the crack and obstacle. GPS detects the location of cracks and obstacles, which are subsequently sent to authorities using GSM. The information is also sent from the robotic part to nearby train sections using the wifi module. This will improve railway track maintenance and monitoring, reducing train accidents significantly. The railway track crack detection autonomous vehicle finds and repairs cracks or deformities on the track, reducing train accidents.

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