



International Journal of Research Publication and Reviews

Journal Homepage: www.ijrpr.com ISSN 2582-7421

IoT- Based Railway Track Crack Detection System

***Dhananjay Mali¹, Chetan Bari², Shubham Patil³, Pournima Patil⁴, Himanshu Bhamare⁵,
Pranjal Kasar⁶, Divya Patil⁷**

^{1,2,3,4,5,6,7}UG Student, Department of Electrical Engineering, R. C. Patel Institute of Technology, Shirpur, Dhule, Maharashtra, India

ABSTRACT

Railway safety is part of modern transportation. If railway tracks fail they can cause accidents and loss of life. Continuous monitoring of railway track is necessary to detect crack. I am writing about an internet of things railway track crack detection system that can automatically identify sections of railway tracks and send instant alerts. The system use infrared & ultrasonic sensors to monitor cracks & obstacles on the railway line. An arduino UNO collects the sensor signals. Controls how the system works. When a crack appears on the railway track the GPS receiver reports the point and the GSM communication send a message to railway authorities. This proposed model reduces the need for inspections speeds up detection and improves railway safety while keeping costs. Railway transportation has become one of the ways for people and goods to move because it is affordable reliable and can carry a lot. As railway networks grow, maintaining railway track safety becomes a challenge for authorities. Cracks that form on railway tracks because of train movement, weather changes, corrosion and heavy mechanical stress can lead to railway accidents if proper monitoring is not carried out. The proposed project aims to create an automated railway crack detection model that can raise railway safety standards. The system performs railway track monitoring with sensor technologies and real-time communication modules. By adding GPS and GSM technology railway authorities receive fault notifications, with location details. The created prototype offers a way to reduce accident risks and make railway maintenance more efficient.

Keywords -Internet of Things, Train Safety, Crack Analysis, Arduino UNO, GSM-Based communication system, GPS enabled location tracking system, Infrared obstacle detection sensors

Introduction

Railway transport is one of the used transportation systems in India because it is affordable and suitable for long-distance travel. Every day many trains carry moving people and good from one location to another. Due to usage and changing weather conditions small cracks may develop on railway tracks over time. If these cracks are not detected early they can create accidents and economy loss in the system because peoples trust on railway to the railway journey is low ticket and not to changes any accident and big benefits in railway to no Traffic in track then train goes fast and reached the passenger as fast there destination then peoples are give the highest priority of their journey to the railway. In areas railway track inspection is still done manually by workers. This process takes time and sometimes small damages are not easily visible. Because of this there is a need for a system that can check railway tracks automatically and provide information to the railway employee to detect the faults. Important goal to that hardware is to make a system they can find cracks in railway tracks using Technology that allows devices to communicate over the internet. This project is about making a railway track crack detection system using Internet of Things technology. The project is focused on designing a railway track crack detection system that uses Internet of Things technology to get the job done. The railway track is checked for problems like cracks and things that are in the way. This system uses tools called sensors to find these issues on the railway track. The sensors look for cracks and obstacles on the railway track. Arduino UNO controls the operation of the system. When any fault is detected the GPS receiver identifies the point and the GSM receiver send a note to the railway authorities. This system helps to decrease the inspection work. It really improves railway safety. The railway safety is a thing. This system helps to make it better. The location and the GSM module are very important in this system because they send a message to the railway authorities. It also provides faster fault detection and fast response during emergency situations. It is the good about the railway. This project are design, to our team to find fastly the crack, on track. They rapidly to. Save the human lives. This project also benefit to the workers they work on railway track to fault find the track are easily because we are also used here IOT to find the cracks.

Working

A hardware uses a vehicle that moves along the railway track for monitoring purposes. IR sensors constantly check the track used by train surface to find crack or gap. Ultrasonic sensors help identify obstacles and measure distance while the vehicle moves. The Arduino UNO receives signals from all the sensors. Is in charge of managing the operation of the Arduino UNO system. This means the Arduino UNO controls everything. When the system notices to gap or fault, The railway line the GPS receiver detects the position and the mobile communication system works together & send a warning message

to the railway authorities. The railway authorities then receive this message from the location via wireless communication. A robotic hardware are driven by DC motors that are connected to the hardware. This L298N hardware helps The DC motor drives the mechanical assembly. The DC motors work in L298N Circuit used to control the motor make the robotic vehicle go where we want it to go. The complete system works automatically. Helps improve railway track safety.

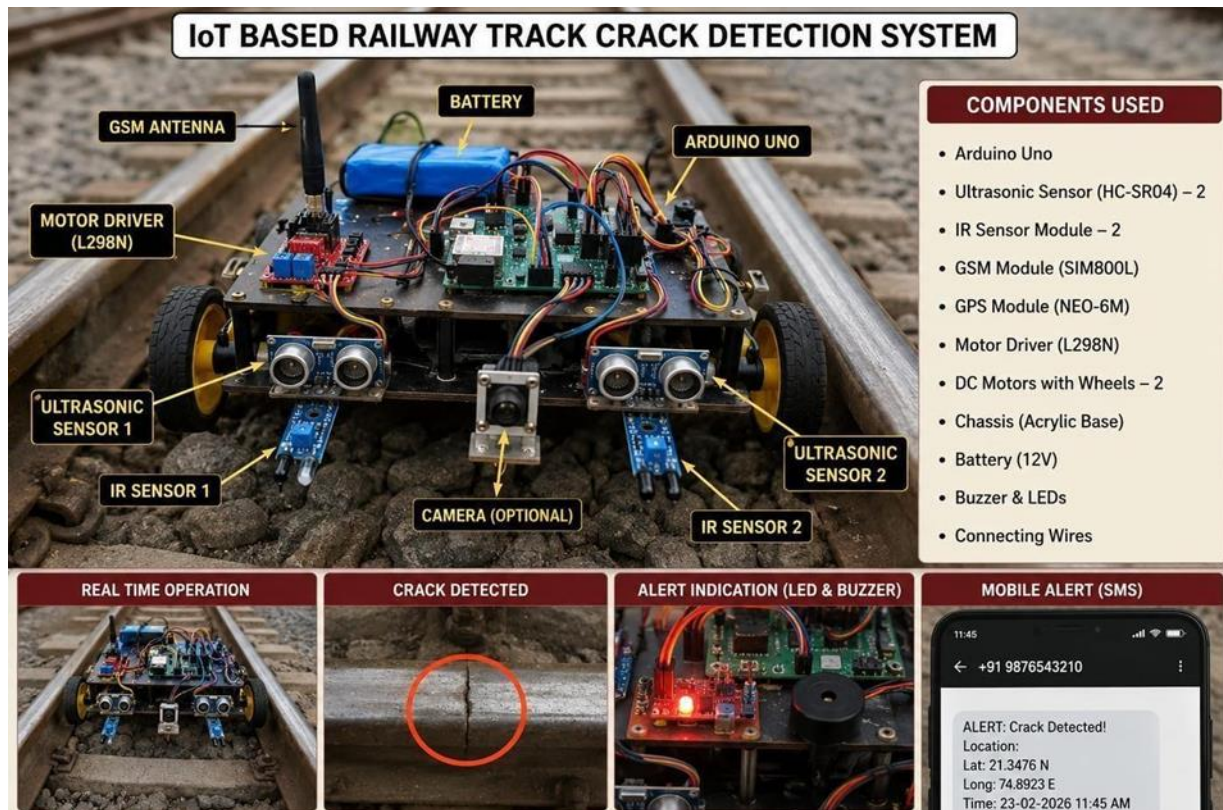


Fig1- Hardware Implementation of the IoT-Based Railway Track Crack Detection System

Component Needed

1. Arduino UNO
2. IR Sensor Module – 2
3. Ultrasonic Sensor (HC-SR04) – 2
4. GSM Communication Unit (SIM800L)
5. GPS Receiver Unit (NEO-6M)
6. Motor Driver Module (L298N)
7. DC Motors with Wheels – 2
8. Battery (12V)
9. Buzzer
10. LED Indicators
11. Connecting Wires
12. Chasis (Robot Base)

Setup

1. Mount all sensors on the robotic chassis.
2. Attach the IR sensors and ultrasonic sensors to the Arduino UNO board.

3. You need connect the GSM-based unit & the GPS receiver unit so that the GSM based unit and the GPS receiver can help with communication. The GSM unit and the GPS receiver can also help with location tracking. Connect the L298N motor driver with DC motors for robot movement.
4. Provide power supply using a battery.
5. Upload the Arduino program using Arduino IDE.
6. Place the robot on the railway track, for testing and monitoring.

Operation

1. The robotic vehicle starts moving along the railway track.
2. IR sensors continuously monitor the track surface at all times.
3. Ultrasonic sensors detect any obstacles and track issues.
4. The Arduino controller. Processes all the sensor data.
5. If a crack is detected, the buzzer. The LED lights, up.
6. The GPS receiver identifies the location of the fault.
7. The GSM unit send a note are railway authorities when there is a problem. The railway authorities receive the message from the GSM module. Take action.
8. Repair and maintenance can be performed afterward..

Literature Review

Many researcher have worked on railway safety system creating system to keep railway tracks safe and monitor them effectively. In the past inspections were mostly done by people walking along the tracks checking everything manually. This method was slow. Required a lot of workers. Because of this it took a time to complete inspections and sometimes small cracks were missed. These old ways of checking were not very efficient. They needed people to do the job and it was hard to find small problems, especially on very long stretches of track. Now modern systems use sensors to detect cracks and other issues. Ultrasonic sensors are useful for spotting obstacles and faults in the track. Infrared sensors help find cracks and gaps on the surface of the railway. Technologies, like GSM and GPS are also used to send alerts and provide locations when a problem is detected. Arduino-based systems are popular because they are easy to build, affordable and work well in real-world situations. The project being proposed uses a combination of sensors and communication tools to improve how railway tracks are monitored. The important says detect problems decrease to chances the accidents & make to whole setup safer and more reliable.

Problem Statement

Railway track damage can cause accidents if it is not found in time. Checking railway tracks by hand takes a time. It requires human effort. I worry that small cracks are sometimes missed during the checks. Those missed cracks can create situations. I believe the main aim of this project aims to develop a mechanism that can automatically detect cracks, on railway tracks. This system will keep monitoring railway tracks all the time find any faults and send messages with location details to railway authorities.

Methodology

In the proposed system the complete set of sensors and communication component are connected an Arduino UNO controller. This controller is what makes the whole system function properly. The Arduino UNO controller plays a role because it allows all the sensors and communication modules to communicate with each other. So the Arduino UNO controller is linked directly to every sensor and communication module. A robotic vehicle is used for monitoring and inspecting railway tracks. While it is operating infrared sensors keep checking the railway track surface for cracks and gaps. Ultrasonic sensors are used to detect obstacles and measure distance changes. The Arduino UNO collects signals from these sensors. It continuously monitors the condition of the track. If any crack or fault is found the buzzer and LED indicators turn on immediately. At that time the GPS receiver unit determines a geographical position are fault & to GSM unit a send an alert note to are railway authorities. A movement are to vehicle is managed using the motor driver module. The entire system works on its own without any intervention. This automatic operation helps improve railway safety and reduces the need, for inspection work.

Limitations

In the proposed system the sensing and data-transmission components are connected an Arduino UNO controller. This controller is what makes the whole system function properly. The Arduino UNO controller plays a role because it allows all the sensors and communication modules to communicate with each other. So the Arduino UNO controller is linked directly to every sensor and communication module. A robotic vehicle is used for monitoring and inspecting railway tracks. While it is operating sensors keep checking the railway track surface for cracks and gaps. Ultrasonic sensors are used to detect obstacles and measure distance changes. The Arduino UNO collects signals from these sensors. Continuously monitors the condition of the track. If any crack or fault is found the buzzer and LED indicators turn on immediately. At the time the GPS receiver unit determines the exact position are fault the mobile communication module transmits an alert note are a railway authorities. A movement is the vehicle is managed using the motor driver module. The entire system works on its own without intervention. This automatic operation helps improve railway safety and reduces the need, for inspection work.

Results

Experimental testing of the proposed railway monitoring prototype was done under track conditions to check how well the system works. During the tests the robotic inspection unit moved smoothly along the railway track. It kept analyzing the track conditions using built-in sensing modules. The infrared sensing system worked well. Detected damaged parts and gaps on the railway surface. The ultrasonic sensing system helped identify obstacles and measured distances while the robot moved. Whenever a problem was found the warning lights turned on away. An alert message was sent through the GSM communication module. The GPS unit gave location data during all the testing operations. The prototype worked steadily responded quickly. Detected faults reliably. Overall the system showed performance. This means the proposed model can help railway authorities reduce the need, for inspections and improve safety monitoring.

Testing Parameter	Performance Status
Crack Detection	Successful
SMS Alert	Sent Successfully
GPS Tracking	Accurate
Sensor Response	Fast
Robot Movement	Stable

Conclusion

The railway track inspection system using internet-connected devices is an idea to spot track defects and let railway maintenance personnel know. It uses IR sensors, ultrasonic sensors, an Arduino UNO controller, GPS positioning and GSM communication to watch track conditions and send alerts when readings are abnormal. By giving location details with fault alerts the IoT-based railway track monitoring system can help maintenance teams find spots that need more inspection. The system also keeps a record of where each defect was found. This way the team can plan repairs carefully. This approach could lessen the need for routine manual checks and speed up fault reporting.. The effectiveness of the IoT-based railway track monitoring system relies on how accurate the sensors are, on the weather on GPS availability and on mobile network coverage. More testing, in controlled environments is needed to check its detection accuracy how fast it. How reliable it is. Future upgrades might add camera inspections, signal processing and cloud-based data monitoring to give a fuller railway track maintenance solution.

References

1. T. M. Thamizh Thentral, A. Geetha, S. Usha, B. Amrit, and P. Singh, "Railway Track Crack Detection System," International Journal of Advanced Science and Technology, vol. 29, no. 10s, pp. 3164–3171, 2020.
2. S. S. Benazer, M. S. Dawood, S. K. Ramanathan, and G. Saranya, "Efficient Model for IoT Based Railway Crack Detection System," Materials Today: Proceedings, vol. 45, part 2, pp. 2789–2792, 2021, doi: 10.1016/j.matpr.2020.11.743.
3. "Railway Track Crack Detection Using IoT Model," in 2023 IEEE International Conference on ICT in Business Industry & Government (ICTBIG), 2023, doi: 10.1109/ICTBIG59752.2023.10456116.
4. T. Jayananda Kumar, P. Kiran, R. Manohar, and S. S. V. S. Sarvarayudu, "Railway Track Crack Detection and Alert System Using GSM & GPS," International Journal for Modern Trends in Science and Technology, vol. 8, no. S06, pp. 220–224, 2022, doi: 10.46501/IJMTST08S0733.
5. C. Chellaswamy et al., "An IoT Based Rail Track Condition Monitoring and Derailment Prevention System," Journal of Reliable Intelligent Environments, vol. 11, no. 2, 2020, doi: 10.3233/RFT-190210.

-
6. "IoT Based Smart Railway Track Crack Detection and Monitoring System," in 2025 Third International Conference on Augmented Intelligence and Sustainable Systems (ICAISS), 2025, doi: 10.1109/ICAISS61471.2025.11041831.
 7. "Real-Time Railway Track Fault Detection and Environmental Monitoring System Using Arduino and GSM," in 2024 4th International Conference on Technological Advancements in Computational Sciences (ICTACS), doi: 10.1109/ICTACS62700.2024.10840621.
 8. Arduino, "Arduino UNO Rev3," Arduino Official Documentation.