

# Railway Track Fault Detection System Using GPS and GSM

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## ABSTRACT:

This project uses a system of Intelligent Railway Track Damage Identification and Tracking System to assist in the real-time detection of issues on the train tracks. The system will be equipped with a NodeMCU controller and the sensors including an ultrasonic sensor, an accelerator, and a flame sensor fixed on a small motorized car running on the track. The accelerator tracks the vibrations to detect the damaged or uneven sections, the flame sensor scans the area of the fire threats, and the ultrasonic one measures the distance to detect cracks. The gadget is able to raise a buzzer to provide a quick alert to the user when the warning is visible on an LCD display, and a more accurate GPS position is sent to take corrective measures in case of any issues detected. This is a clever and inexpensive solution because it prevents the need to have a human perform inspections on a wide scale, prevents mistakes, and enhances safety on the train.

**KEYWORDS:** Track damage identification, sensors, NodeMCU, GPS location.

## INTRODUCTION:

The railway tracks are one of the most significant components of the train travel. Railroad tracks also travel safely as trains move between locations with the assistance of railroad tracks just as cars are moving with the help of roads. Nevertheless, such tracks may sooner or later develop such issues as cracks or irregular surfaces, loose elements, or even fire hazards around. Such problems may happen during the process of expensive repairs or minor accidents or the inability to make the trains run on time in case they are not identified early. Previously, railroad workers were required to check the tracks by walking over them to ensure that the tracks were decreased. So much time and people are required to do this, even little problems can be overlooked. This requires a smarter way of looking along the railway tracks in this new era when technology is making our work safer and easier. The Intelligent Railway Track Damage Identification and Tracking System is a portable, automated device that can potentially be used to identify issues with tracks in real-time. It is run on a little motor and has an automatic system of identifying the state of the track. The system is controlled by a NodeMCU, a physiological component that plays the role of the brain of the device. It determines the presence of a wrong thing by combining information gathered by a few of its sensors. The system uses three key sensors in identifying various types of problems. Sound waves are transmitted on the track and the ultrasonic sensor which in turn determines the time taken by the sound wave to go back. In case this distance varies suddenly, there can be a crack, gap or other uneven surface. The significance of this sensor is that small cracks may become serious threats unless they are noticed on time. The accelerator gets the vibrations and tilts. Songs do not fade under normal conditions,

however, when they are loose or twisted, they may alter. The accelerator can pick up these odd vibrations and this can notify the users that something is wrong with the machine such as the loss or incorrect positioning of parts. The third sensor is the flame sensor which detects any smoke or flames near the track. Fire may occur due to electrical incidents, dry grass or even accidents that may destroy the track or even damage the trains that are on the track. The flame sensor will help to detect such dangers in time. The system automatically rings a buzzer when a threat is present be it fire, cracks, or strange pains so as to alert workers in the area. In addition, it presents the nature of a fault on a display whereby the employees can easily detect the fault. Also, the system provides the precise position of the leave in the form of GPS. The knowledge of its exact location aids maintenance personnel to get there on time to repair it since the train tracks are made of long distances. The whole thing is moved on the track automatically with the aid of some motor. This makes the process of checks faster and safer since the employees do not walk long distances. Hand checkup may be hazardous and tiresome, especially during peak season at a rail station or during adverse weather. This automated system eliminates these risks thus taking less time than usual.

### **LITERATURE SURVEY:**

Railway Tracks: A Swarm-driven AI Assisted Wheel Bot System Rosebell Paul et al. (2022) In this article, the authors present a university of a group of small robots (a swarm) that collaborate in order to detect cracks and other obstacles, animals, and faults on a railway track. These robots communicate with one another, as well as a base station through an android application. The system further has a smart functionality of self-detaching, thus allowing the robots to pull clear in the event of coming train. Limitations on the old methods of detecting cracks are addressed using the idea, e.g. the inability to detect the type of crack and whether it is a real crack or fake crack. [2]. A New Age of the Drones in Railroad Track Inspecting: Drone-based Image Processing Examined with IoT Alireza Mortezaei et al. (2024) this article describes the multifunctionality of inspecting railway tracks with the help of drones, cameras, and LiDAR. The system is more precise and efficient compared with hand checking. Each drone has their mission details, reported damages and health reports stored in a control centre. Nevertheless, the system is not yet equipped with drone-to-drone communication and long-term storage of data. [3]. Asset Monitoring and Optimization Railway System Husna Tabassum et al. (2024) the authors present an IoT-based railway safety system, which consists of detection of cracks, monitoring platforms, fire detection system, and automatic gates control. It applies such sensors as ultrasonic, IR, fire sensors, cameras, and NodeMCU. The system not only provides real-time hent, but it also supports inspection of drones to enable the efficiency and safety of railroad management to be even more efficient. [4]. Automation and Experimental Study of Railway Track Surface Fault Detection Noorain Mukhtiar et al. (2023) in this study MEMS sensors, GPS, and machine learning are used to detect the track faults automatically. The information is forwarded to the cloud (Thing Speak) to analyze. With K-means clustering, the accuracy of the system hit over 95 percent in the recognition of damaged and normal tracks. It is easy, quick, and able to operate with the current railways. [5]. IoT based Carriage linkage inspection and fire detection in railways D. Srinivasulu et al. (2023) the authors introduce a system that will check whether the train carriages are correctly linked and whether fire hazards exist. The system warns the train driver and other stations in the vicinity with the help of NodeMCU and sensors in case of a malfunction. It has also got automatic braking to avoid accidents. .[6] IoT based Smart Railway Track Crack Detection and Monitoring System Aakanksha Pal et al. (2025) This paper explains an IoT robot that uses ultrasonic sensors to find cracks or gaps in the railway track. These sensors send sound waves and check if something

interrupts them. The system helps avoid accidents caused by track damage and reduces the need for slow manual inspections.[7] Advanced IoT and Machine Learning Solutions for Railway Safety Rashmi Rani Samantaray et al. (2024) the authors propose a robot-based system that uses machine learning to identify cracks using camera images. The system also includes fire detection, platform monitoring, and real-time updates through IoT. A mobile app allows remote control of the robot and lets operators monitor track conditions instantly.

**EXISTING SYSTEM:**

The current railway inspection system primarily relies on employees walking the rails and using their eyes to look for cracks, loose parts, or misalignments. Although a simple trolley is sometimes working, human control is still needed. The method takes a long time, is slow, and only covers small distances. It can be expensive and involves a large workforce. Tiny fractures or gaps sometimes go unknown until they become costly because people are at risk of overlook minor flaws, particularly in poor weather or low light. Repairs are delayed since there is no real-time reporting. All things considered, traditional inspection is out of date and unsuitable for the move highly used railways of today.

**DISADVANTAGES:**

- Time-consuming processes
- High dependency on skilled personnel
- Inefficiency over long distances
- Delayed fault identification.

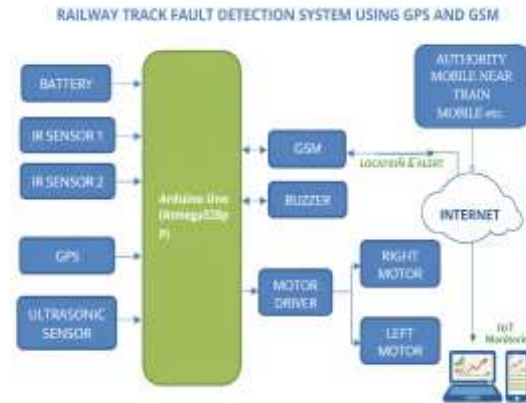
**PROPOSED SYSTEM:**

The fault detection system of the proposed railway track will detect cracks or discontinuities on tracks and report the same immediately with the location information. The system is constructed on the basis of Arduino Uno controller, which constantly gathers data of IR sensors and ultrasonic sensor, located close to the track surface. Provided that a gap, a crack, or some other obstacle has been identified, the controller receives the signal and initiates an alert. The GPS module will extract the precise geographical positions of the fault point and the GSM module will forward the same to the relevant railway authority through the SMS. Local alert is also triggered by use of a buzzer. The motor driver also follows the movement of the inspection unit along the track with the help of the left and right motors and allows pulling an inspection unit constantly without any manual control.

**ADVANTAGES:**

- real-time detection
- Portability
- cost-effectiveness
- improved safety

**BLOCK DIAGRAM:**



**FIG1: BLOCK DIAGRAM**

**HARWARE WORKFLOW:  
ARDUINO UNO**



**FIG 2: ARDUINO UNO**

The main processor of the system is the Arduino Uno. It accepts the sensor input data on IR and ultra sonic modules and processes this input data and then makes decisions based on its programmed constraints. On detection of fault, it gives commands to output devices such as GSM module and buzzer. It also manages the motor driver in order to regulate the movement of the robot in the railway track. The simplicity of its programming and that it can be connected to various peripherals make it appropriate and applicable to real-time embedded systems such as this system.

**IR SENSORS**



**FIG 3: IR SENSOR**

The IR sensors are utilized to locate the cracks or discontinuity in the railway track. These sensors operate under the principle of infrared light being emitted and the reflection on the sensors. Due to normal conditions, the reflection is stable however, with the occurrence of a gap or crack, the signal to be reflected

is altered. This variation is picked and transmitted to the Arduino. A sensor is placed over two filters to enhance reliability and to cross-check the signals to verify the existence of faults which will mitigate false detection during operation.

## ULTRASONIC SENSOR



**FIG 4: ULTRASONIC SENSOR**

The ultrasonic sensor helps in identifying a barrier or anomaly on the track. It operates by reflecting ultrasonic rays and timings of how long it will take to reach an object. In the case of the detection of an object that is not expected or a ribbed surface, the sensor relays data to the Arduino. This provides an extra level of protection in the case of debris or raised sections of track detection which might not be noted in IR sensors.

## GPS MODULE



**FIG 5: GPS MODULE**

The GPS module is used to give real time location information on the system. Once an error has been detected the Arduino asks the GPS module to provide the coordinates and the GPS module includes the values of latitude and longitude. These coordinates play an important role in determining the precise location of the problem in the railway line. This assists the maintenance teams in locating and repairing the problem very fast without having to inspect manually over a lengthy distance.

## GSM MODULE



**FIG 6: GSM MODULE**

Communication is done in the GSM module. On confirming a fault, the Arduino sends control commands to the GSM module to send an SMS notification to predetermined telephone numbers, including the

railway authorities. The message will generally contain data of the fault and its GPS position. This will see that there is timely communication and delay in maintenance activities is minimized.

## MOTOR DRIVER



**FIG 7: MOTOR DRIVER**

The motor driver is used as a connection point to the motors with the Arduino. The Arduino is not capable of providing the current required to power motors, and therefore the motor driver amplifies the signal, and sets the direction and velocity of the motors. It allows the robotic unit to move, turn, or move forward depending on the order of the Arduino.

## D.C MOTORS



**FIG 8: D.C MOTOR**

The motors are utilized in the movement of the inspection robot on the railway track. In the left and right motors, one can move the robot to the right or the left enabling it to move along the track effectively. This makes the sensors scan the track all the time as the movement is controlled by them.

## BUZZER



**FIG 9: BUZZER**

An instant local warning is the buzzer which fires in case a fault has been detected. It serves as a meter of sound, which can be used in the course of test or when the operators are close. This assists in timely detection of the problems without necessarily depending on far distance communication.

## BATTERY



**FIG 10: BATTERY**

The battery is used to power all the system components. It makes it portable and enables the system to work without any external power source. Constant power supply is paramount in correct sensor measurements and correct operation of communication modules.

## RESULT AND DISCUSSIONS:

The system that was developed was tested in the various track conditions to know how it would behave in fault detection and provide the information accordingly. The IR sensors had the capacity to detect discontinuities in reflected signals during the testing and pinpoint the cracks and gaps. The ultrasonic detector helped in successfully identifying objects that are positioned on the track making the system reliable. The Arduino responded to the inputs without apparent latency and sent alerts as planned. The location information was sent through the GSM module to a mobile device in form of a text message with a reasonable degree of accuracy through the GPS module.

The buzzer was reactive and local alert was verified with the function of the buzzer responding immediately in case any fault was detected. The motors and the motor driver provided the ability to make the system move along the track smoothly, which gave the opportunity to monitor the process continuously. Nevertheless, there were also slight variations on sensor readings in harsh radiations of light and irregular surfaces, which would give small errors of detection. In spite of these shortcomings, overall system exhibited a stable performance, fast response time and communication, and it can be used in simple railway track tracking purposes.

## CONCLUSION:

The system provides an easy and economical means of identifying a problem in a railway track and relaying the location information instantly. It also saves time used in inspecting manually and enhances safety by offering prevention in time. However, in the future, a system will be enhanced with using the increasingly sophisticated sensors, integrating IOT platforms to allow live monitoring, and increasing the accuracy with AI-associated fault detection. It can be also enhanced with solar power and camera modules to make it efficient and responsible.

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