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Railway Track Fault Detection & Alert System

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Abstract: *Railway transportation carries millions of passengers and heavy industrial freight each day. Continuous track monitoring has thus become imperative to prevent derailments and accidents. Traditional methods using manual checking, handheld ultrasonic devices, and drone surveys have disadvantages in terms of speed, cost, weather conditions, and inability to detect internal cracks in real time. This project, therefore, introduces an intelligent railway track fault detection and alert system with an unmanned on-track robotic unit.*

Vibration and ultrasonic sensors identify any crack, loose joint, or structural flaw with high accuracy. The position of the fault is provided as exact coordinates with the help of a GPS module. A SIM800A GSM and an RF module, such as the HC-12, have been used for immediate alerting of railway authorities without the use of cloud servers. Equipped with an ATmega2560 microcontroller, the robot processes all sensor data in real time and moves on the rail using 12V geared motors with an L293D driver for continuous coverage inside tunnels or under harsh weather conditions.

Experimental results show fast detection, low latency, reliable long-range communication, and significantly lower power and cost compared to fixed IoT-based trackside systems. The proposal improves safety and allows for predictive maintenance, while providing a scalable, low-cost alternative to monitor long and remote railway routes. This project demonstrates a practical and intelligent approach toward modernizing railway infrastructure and improving operational safety.

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Keywords: Railway Track Fault Detection, Robotic Vehicle, Wireless Communication HC12, Alert System

I. INTRODUCTION

Railway is one of the most significant transportation modes of our country but it's a matter of great anguish that rail tracks of our country are veritably prone. That's why, a vast number of accidents are passed every time due to this primitive type of rail tracks and as the consequences of those accidents we lose huge number of lives every time. These types of incidents motivate us to suppose over the below mentioned issue and take necessary way to cover those lives. Through our proposed system, we need to establish further ultramodern and secure rail system. Besides this, there's no similar 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. More over 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 steps to avoid accident. 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

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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 real time location or coordinates in the form of Short Message Service (SMS) to the nearest railway station. In India the railway network has a track length of 113,617 kilometers (70,598 mi) over a route of 63,974 kilometers (39,752 mi) and 7,083 stations. This is the fourth largest railway network in the world. The Rail transport is growing at a rapid pace in India. It is one of the major modes 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 rail accidents is due to derailments, recent statistics reveal that about 90% are due to cracks on the rails. Hence, it is not safer for Human Life. This is need 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 proximity sensors used, which will detect the crack accurately. The existing system is slow, tedious and time consuming. The system has GSM and GPS module which will give the real time location or coordinates in the form of Short Message Service (SMS) to the nearest railway station. The Railway service also uses machine-vision technology for the inspection, which consists of recording digital image of track elements analyzing those images using custom algorithms to identify defects or their symptoms. These machines are larger in size and are manually operated by a person. Proposed system is small and is efficient to use.

Fig. 1. Images of railway Track Fault

Objective of Project:

The main objective of the railway track fault detection and alert system is to ensure railway safety through the detection of track faults, such as cracks, loose joints, or vibrations, in real time, and to send alerts to the concerned authorities well before accidents can take place.

This work integrates sensors, microcontrollers, wireless communication, and GPS to construct a robotic system that can continuously monitor the track and prevent derailments of trains due to track faults that go unnoticed.

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II. LITERATURE SURVEY

 Indian railways is one of busiest network in the world covering track network of 1,27,000 sq.km. Almost 2/3rd of the population use the railway network in India. Almost 60% of the accidents are occurring at railway track crossing and due to crack in railway tracks resulting in loss of precious life and loss of economy. So in current scenario this problem has immense potential in having an ideal solution to this problem. Now I want to put some light on existing systems that railways in order to counter this problem. So, basically we have the manual surveying and maintenance of tracks done by person and other is systems that they use like SPURT Car and USFD manual machine that are used in detecting and monitoring of cracks. Basically in the both the methods, surveying and detection of cracks is been done but the limitation is basically maintenance people are required for both methods to monitor the crack in the track. Also this method is limited for certain routes and not all routes and divisions of railways can be covered. Also sometimes accuracy is faulted. Also eddy current method ultrasonic crack detector is also used in some instances. We have inferred the ideas in designing railway crack detection system using. Arduino Microcontroller and sensors in order to detect the cracks and location of cracks been given by GPS module and alert through messages through GSM module. We are committed in building such system which will give an optimal solution to the crack detection problem and also reach in achieving higher accuracy and precision than existing systems. Also our project aims in giving safety assurance to railways, whereas the existing systems lag it completely. India procures a major position in the list of quickly developing countries with notable and appreciable advancements in the field of railway network. Derailments contribute to several railway accidents that have been caused. This is mainly due to the cracks in the railway track. These cracks usually go unobserved due to irregular maintenance. Manual track monitoring also adds to this issue of railway accidents. In this work, an autonomous testing train has been proposed for examining and spotting the cracks that are formed in the railway track. It is capable enough to detect even the small cracks caused on the railway tracks. The proposed testing train moves along the alienated path, which is the railway track and detects the cracks and limits in the track the relevant officials are intimated with the exact location of the crack [1].

 In this paper, we present an automated system based on microcontroller and sensors to overcome the problem of faults in tracks and to identify the moving object or animal on the tracks. The system designed is an autonomous robot consist of PIR and Ultrasonic sensors, coupled with GPS and GSM for providing the real time alert. Global Mobile Communications System (GSM), GPS (Global Positioning) System) and broken rail track detection, based on the microcontroller, are an effective method of detecting cracks present on tracks, thus preventing train derailment. This device uses two stations to detect cracks on the path through TSOP sensors that transmit sinus waves to the ideal path. The crack detection on the railway line is used to locate the crack on tracks. The device proposed is used before 10 km to detect the railway crack [2].

 The proposed system utilizes CNN to detect the faults in the railway tracks with the help of images. Their characteristics are obtained to extract the default railway track. This model helps to reduce the manual inspection work. The CNN algorithm, the ground truth databases on images of masks are utilized. The algorithm improves the accuracy of railway crack detection effectively under convoluted conditions. The convolutional neural network (CNN) is mainly designed for recognizing. CNN is performed outstandingly including both MNIST and SVHN datasets. Broken Rail Detection System using RF Technology is proposed. Mainly this system is used to detect the broken rail and provide the information exactly about the tracks. This model presents a synthesis of the art of computer vision this mainly explains the categories of the methods in computer vision methods, they are used to automate the damage and process detection [3].

 The presented methodology is to monitor endlessly cracks in tracks, obstacles on rail tracks and any other train running on the same track oppositely by using sensors. When identified, the device will send an alert to the driver to prevent the accidents. The flame sensor detects it and sends a signal to the microcontroller and driver when the train compartment catches fire. With the help of this paper, we try to overcome few of the issues in railways as well as modernize the compartment. The crack detection track system has been designed to minimize rail traffic crack crashes.

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The paper describes the entire hardware framework and programmer architecture. The system accuracy and reliability are good for the identification of rail surface crack by experimentation [4].

 System has many techniques, such as Ultrasonic Techniques, Electromagnetic Techniques and GSM Techniques. For the propose of this research, we study characteristics of railway track using acoustic emission, the device which is widely used for application such as crack Nowadays, railway track crack detection in aerospace space grade steel, detection of defects in rolling element bearing, fatigue crack growth detection. And use the MFCC ('Mel – Frequency Cepstral Coefficients') method which is generally used for low frequency to extract the feature of each railway track. According to that, we chose to adjust the MFCC method for an acoustic feature extraction in order for condition to be suitable used for this system, because the railway track crack detection system, we are interested in concentrates at 100-400 kHz [5].

III. METHODOLOGY

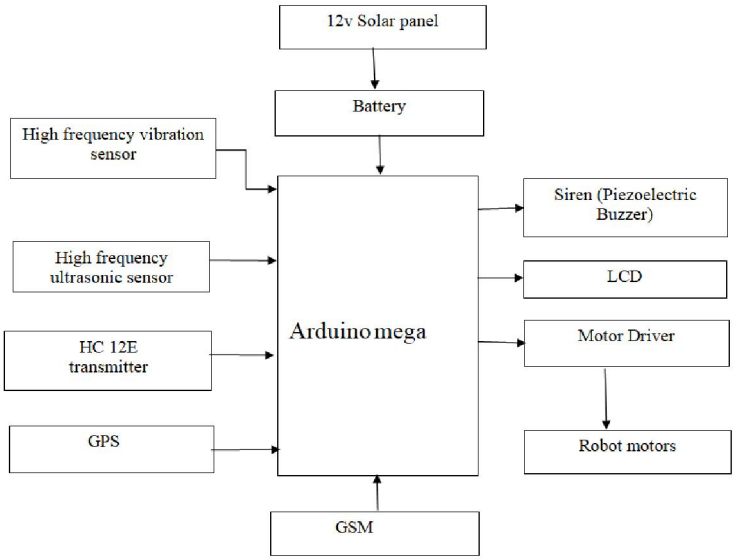

Fig. 2. Block Diagram of Robot Side

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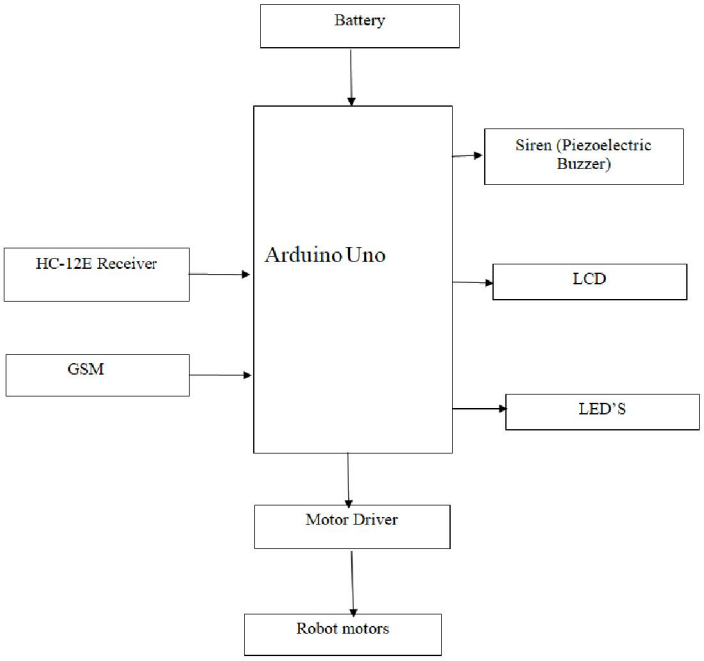

Fig. 3. Block Diagram of Railway Side

Functional Partitioning

ESP32 The entire Railway Track Fault Detection and Alert System is divided into six functional blocks with the aim of providing modularity, clarity of operation, and smooth integration between the field-level robotic system and the railway monitoring infrastructure. Each block describes whether it is performed on a robot or on the railway monitoring side to ensure that the separation of responsibilities is clear.

A. Sensing Unit Robot Side:

The Sensing Unit operates completely on the robot side, where all real-time physical measurements of the railway track are made. The vibration and ultrasonic sensors are mounted directly on the chassis of the robot for the measurement of contact-based and distance-based abnormalities, respectively. The vibration sensor picks up, in a continuous process, oscillation patterns generated due to the interaction between the wheels of the robot and the track. Smooth oscillations indicate that the rail is at normal conditions, while sharp peaks may indicate loose joints, cracked, misaligned rails, or worn-out sections. Complementary to this, the ultrasonic sensor sends high-frequency pulses towards the rail surface and identifies any gaps, dents, or discontinuity on the surface by analyzing the reflected echo. The dual-sensor system gives multi-dimensional insight into the structural integrity of the track and thus allows for the differential diagnosis of harmless irregularities from serious defects.

B. Processing Unit Robot Side:

All data processing, decision-making, and control logic execution are done on the robot side. The central processor is the microcontroller: Arduino Mega 2560 in the advanced design or Arduino Uno in the prototype. It gathers the vibration peaks, ultrasonic echo timings, and optional encoder feedback, filters out noise, performs value comparisons with predefined thresholds, and decides on track faults. Simultaneously, Mega's multiple hardware serial ports allow it to handle GPS data reception, GSM AT commands, and HC-12 wireless communication without collision. The

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processing unit also controls the operation of motors by commanding it to slow down or completely stop upon serious defects. It keeps sensor reading timing, robot speed, and communication in synch. In short, it is a sort of decision-making "brain" that transforms raw sensor inputs into actionable fault information.

C. Communication Unit Both Side:

The Communication Unit acts as the bridge between the robot and the railway-side monitoring personnel. It will house all modules for the transmission of fault data, robot status, and GPS coordinates to external systems.

On the robot side, three main communication systems operate simultaneously:

• GPS module determines the robot's exact latitude and longitude.

• The GSM module-SIM800A sends the SMS alerts with the fault detected and its accurate GPS location directly to railway authorities.

• HC-12 RF Module: Medium-range radio frequencies up to 500 m, to provide on-instant alerts to trains in the vicinity or to a local base station.

On the railway side, these alerts are received by the control room in two ways:

• GSM-based SMS alerts from the robot pop up on monitoring phones or systems.

• A stationary base unit placed near the track for real-time monitoring can receive the HC-12 signals.

This combined communication architecture grants data redundancy; it will ensure that every critical fault is reported even if one line of communication goes down.

D. Display Unit Robot Side:

The Display Unit is entirely on the robot's side for technicians and engineers during deployment or field inspection. The LCD module offers real-time information like vibration intensity, ultrasonic distance readings, GPS coordinates, GSM transmission status, and robot health indicators. LEDs give quick visual cues that allow users to understand system status without reading the display: green for safe operation, yellow for warning-level vibrations, and red for confirmed faults. A piezoelectric buzzer provides an audible alarm in case of a critical fault or when a communication module encounters an error. These features make on-site monitoring simple and effective, especially during testing, maintenance, or manual observation.

IV. ADVANTAGES

Applications of the Railway Track Fault Detection and Alert System are wide, ranging into the field of railway infrastructure safety and regular maintenance. The system can be implemented in various environments to improve track monitoring efficiency and to avoid accidents caused by track faults.

• Railway Track Monitoring

The system can be deployed for the continuous monitoring of railway tracks for cracks, loose joints, or misalignment in real time, thus guaranteeing safe and smooth movement of the trains.

• Prevention of Accidents

The system contributes to a reduction in casualties and property damage by way of offering early fault detection and immediate notification to the train driver and control rooms, thus preventing derailments and collisions.

• Automated Maintenance Planning

The GPS-based fault location data helps railway authorities in scheduling maintenance activities precisely where needed, saving manual inspection efforts and maintenance costs.

V. CONCLUSION

The Railway Track Fault Detection and Alert System developed in this project provides a practical and efficient solution to improve railway safety using basic electronic and communication components. The system successfully detects abnormal vibrations, cracks, and loose joints on the railway track by using vibration and ultrasonic sensors.

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When a fault is detected, the system immediately sends an alert message to the train driver and the railway control department through the GSM module, along with the GPS location of the fault.

During testing, the robot was able to move smoothly along the track while continuously monitoring its condition. In normal operating conditions, the system also sends regular update messages indicating that the train with a specific number is traveling safely from its source to destination. This ensures continuous communication and monitoring of the track's condition without human intervention.

The overall performance of the system proves that it can significantly reduce the risk of train accidents caused by track failures. It operates automatically, requires minimal maintenance, and offers a cost-effective approach for early fault detection.

In conclusion, the project successfully fulfils its objective of detecting railway track faults and providing timely alerts to prevent accidents. With future improvements such as stronger sensors, wireless data logging, and extended track coverage, this system can become an essential tool for enhancing railway safety and maintenance efficiency.

A. FUTURE SCOPE

The Railway Track Fault Detection and Alert System have great potential for further improvement and real-world implementation. Although the current design performs effectively using vibration and ultrasonic sensors with GSM and GPS communication, several enhancements can make the system more efficient, durable, and scalable.

In the future, the robot can be developed with a more compact and rugged design to withstand outdoor railway environments and longer operating distances. Additional high-sensitivity sensors can be integrated to detect a wider range of track defects such as misalignment, metal fatigue, or joint displacement. The power system can be improved by adding a solar-powered charging unit to allow continuous operation without frequent battery replacement.

Furthermore, the system can be modified to transmit data wirelessly to a control station through short-range radio modules (like RF or LoRa) for better monitoring coverage. The robot's movement can also be enhanced with automatic obstacle detection and navigation features for smoother operation along the tracks.

In the long term, multiple robots can be deployed on different railway sections to perform simultaneous track inspections, creating a network of automated monitoring units. This would help railway authorities maintain continuous safety checks and identify problem areas more quickly.

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REFERENCES

[1] Raghunandan Srinath, Jayavrinda Vrindavanam "Differential Sensor for Reliable Localization of Potential Cracks in Railway Tracks",2020

[2] Satya Srikanth Palle, Jijesh JJ. "Modernized compartment with safety measures in railway",2020

[3] Narate Vongserewattana, Wara Suwansin, Pattarapong Haruki, Punnavich Phatsornsiri "Validation of Acoustic Emission Railway Track Crack Analysis Using MFCC",2019

[4] Shubhankar Khaladkar, Srishti Gawande. "Internet of Trains – Oscillometer",2019

[5] FU Shengwen, Jiang Zhanjun. Research on Image-based Detection and Recognition Technologies for Cracks on Rail Surface",2019

[6] Sanket Salvi, Shashank Shetty. "AI based Solar Power Railway Track Crack Detection and Notification System with Chatbot Support",2019

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[7] Suhas BN, Sushen Bhagavat, V Vimalanand, Suresh P. "Wireless Sensor Network based Monitoring of Railway Tracks",2018

[8] Alexander M. Boronakhin, Daniil Yu. Larionov, Liudmila N. Podgornaya, Anna N. "Detection and Classification of Rail Track Flaws Using Inertial and Magneto metric Sensors",2018

[9] A. Rizvi, P. Khan and D. Ahmad, "Crack Detection In Railway Track Using Image Processing", International Journal of Advance Research, Ideas andInnovations in Technology., vol. 3, no. 4, 2017.

[10]S. Srivastava, R. Chaurasia, S. Abbas, P. Sharma and N. Singh, "Railway Track Crack Detection Vehicle", International Advanced Research Journal in Science, Engineering and Technology, vol. 4, no. 2,pp. 145-148, 2017.

[11]K.Bhargavi and M. Janardhana Raju "Railway Track Crack Detection Using Led-Ldr Assembly", International Journal of Advanced Research in Electronics and Communication Engineering (IJARECE), vol. 3, no. 9, pp. 1230-1234, 2014