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Railway Track Crack Detection Robotic Vehicle

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Abstract—

In India railways transportation service is the cheap and the majority convenient mode of passenger transport and also for long distance and suburban traffic. The main cause of the accidents happened in railways are railway track crossing and unrevealed crack in railway tracks. Therefore, there is a need to have new technology which will be robust, efficient and stable for both crack detection in railway track as well as object detection. This project discusses a Railway track crack detection using sensors and is a dynamic approach . messages and the geographical coordinate of location. Microcontrollers used to control and coordinate the activities of this device.

Keywords—

Railway Track Monitoring, Crack Detection, Obstacle Detection, Embedded Systems, Microcontroller, Sensor-based Detection, GPS and GSM Communication.

1.Introduction

Railway is one of the most significant transportation modes of our country but it is a matter of great sorrow that, railway tracks of our country are very prone. That's why, a vast number of accidents are occurred every year due to this primitive type of railway tracks and as the consequences of those accidents we lose huge number of lives every year. These types of incidents motivate us to think over the above-mentioned issue and take necessary steps to protect those lives. Through our proposed system, we need to establish more modern and secure railway system. Besides this, there is no such 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. Moreover, 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 3 to avoid accident. Figure1 depicts the crack on track. 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.

2.Literature Survey

Railway safety has been a critical area of research, especially in countries like India where rail is a primary mode of transport. Several studies and technological developments have been proposed and implemented to detect cracks, monitor track conditions, and avoid collisions. This literature survey highlights the major contributions and limitations of existing works in this domain:

1. Crack Detection using Ultrasonic Sensors

A study in [1] Researchers have utilized ultrasonic sensors to detect internal cracks in railway tracks. These systems transmit high-frequency sound waves and detect reflections to identify abnormalities.

2. Image Processing-Based Detection

In [2], Some systems rely on image processing and machine learning to detect cracks or obstacles by analyzing images or videos from cameras mounted on trains.

3. Vibration and Acoustic Signal Monitoring

Vibration analysis and acoustic sensors have been used to detect irregularities by analyzing changes in the frequency spectrum of a running train.

4. RFID-Based Detection Systems

Some projects use RFID tags placed on tracks and sensors on trains to ensure proper alignment and check for track presence.

5. IoT-Based Railway Monitoring Systems

Recent studies have introduced IoT-based solutions integrating GPS, GSM, and sensors to monitor track conditions and communicate alerts to control centers.

6. Microcontroller-Based Crack Detection

Microcontroller-based models using IR, ultrasonic, or piezoelectric sensors have been proposed for detecting cracks and reporting their coordinates via GSM.

3. Proposed System:

The proposed system provides a real-time, cost-effective solution for detecting crack and obstacles on railway tracks using sensors and embedded technology. An IR or ultrasonic sensor detects track cracks, while an ultrasonic sensor identifies obstacles. A microcontroller processes this data and, upon detection, uses a GPS module to get the location and a GSM module to send SMS alerts to railway authorities. The system is portable, battery-powered, and suitable for mounting on a small trolley, ensuring continuous monitoring and timely accident prevention.

3.1 Key Features of the System:

1. Dual Detection System

The system is designed to detect both cracks in the railway track and obstacles lying on the track, such as stones, fallen trees, or unauthorized persons. This dual functionality increases the safety coverage, reducing the chances of accidents from multiple causes.

2. Real-Time Monitoring

The sensors continuously scan track while the system is in operation. Real-time data processing ensures that any issue is immediately detected and processed, reducing delays in alert generation. This feature is crucial for instant fault detection and prevention.

3. Low-Cost Implementation

The project uses inexpensive components like ultrasonic sensors, IR sensors, GPS and GSM modules, and basic microcontrollers. This makes it highly suitable for deployment in large-scale railway networks, especially in developing regions like rural India.

4. Microcontroller-Based Automation

The entire system is controlled using microcontroller (e.g., Arduino). It handles sensors input, GPS data processing, GSM communication. The automated reduces need for human intervention and allows the device to function autonomously.

5. Easy to Update & Maintain

The design is simple and modular, making it easy to repair, replace, or upgrade individual components. Future upgrades can include features like camera integration, cloud data logging, AI-based fault prediction, or solar-powered operation.

Below is the block diagram for our proposed system.

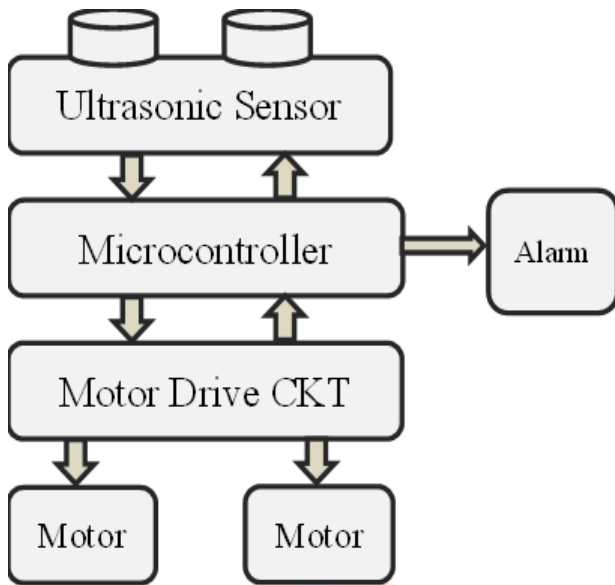


Figure 1. Block Diagram

3.2 Circuit-gram:

The Circuit-gram will be as follows-

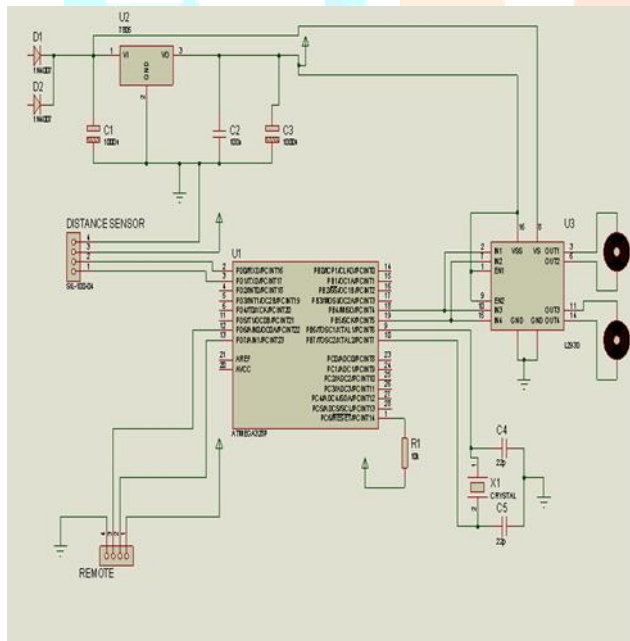


Figure 2. Circuit-gram of system

4. Future Scope:

The proposed system provides a low-cost and efficient solution for real-time crack and obstacle detection on railway tracks. However, there is significant potential to enhance and expand its capabilities in the future.

1. The current system can be improved by integrating AI-based image processing and machine learning algorithms to classify the

severity of cracks or identify different types of obstacles with higher accuracy. This would enable predictive maintenance and reduce false alarms.

2. The addition of camera modules or LiDAR sensors can provide visual confirmation of track conditions, which can be transmitted to monitoring centers via 4G/5G or LoRaWAN networks. This would help authorities to verify issues remotely without the need for immediate field visits.
3. The system can be upgraded to support cloud connectivity and IoT platforms, allowing continuous data logging, historical analysis, and dashboard-based monitoring for large railway networks. Such integration can help railway departments maintain detailed records of fault locations and frequency.
4. The system can be equipped with solar panels to make it self-sustainable in remote areas, eliminating the need for frequent battery replacement or manual charging.
5. In addition, the solution can be deployed on autonomous robotic trolleys that continuously patrol railway tracks, making the system more scalable and reducing human effort.

5. Conclusion:

As per the study the existing systems are time consuming as well as uneconomical. The proposed system is not only overcome these problems but also improve accuracy and crack detection in rails. It is the most economical solution provided in order to achieve good results of railways of our country in order to minimize the stats of accidents caused. There by possible to save precious lives of passengers and loss of economy. It also saves the time and money for identification of crack.

6. REFERENCES:

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