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Railway Track Safety System

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Abstract

Railway Track Safety System (RTSS) is a comprehensive monitoring system specifically designed for the Indian railways. It consists of three subsystems that target specific challenges faced by the railways. Our main focus is on addressing four key problems. The first two issues involve cracks in the rails and foreign objects on the tracks. Cracks can occur naturally or be intentionally created to derail trains. Objects like stones can accidentally roll onto the tracks, while some people deliberately place large objects that can cause accidents. To combat these problems, we have developed a crack and object detection system. This innovative solution uses radio frequency waves to analyze the railway lines and compare them with a reference wave. Whenever any irregularities are detected, an alert panel immediately notifies the authorities. Another critical problem we have identified is unauthorized tampering of lane changing levers. This can lead to catastrophic consequences if left undetected. To prevent tampering, we have introduced a lever tamper prevention system. This system continuously monitors the real-time position of each lever and transmits this information to alert panels at every railway station. This ensures that any unauthorized interference is promptly detected and addressed. The final problem we address is related to wildlife. Many railway tracks pass through areas with a high density of wildlife. To mitigate the risks associated with this, our third system uses motion detectors to identify the presence of wildlife. It then utilizes ultrasonic sounds and laser technology to deter animals from approaching the tracks, reducing the chances of accidents. By implementing the RTSS, we are confident that we can significantly improve the safety and efficiency of the Indian railways. By proactively addressing these four critical issues, we aim to create a secure and reliable railway system.

Keywords: Radio wave, Finite Element Analysis, Optical Fiber cable, Microcontroller

INTRODUCTION

The Indian railways is the largest railway network in Asia and fourth largest in the world. It is also employer of almost 1.5 million people. But Indian railways is facing some serious challenges. Since the railway tracks are open and accessible to anyone, they are vulnerable to malpractices. Recently two kilometers of railway track were stolen in Bihar. Also, there is a behavior of placing large metal objects and rocks in the tracks. These are all due to the absence of a continuous monitoring system. Railway accidents are a serious threat to human lives, wildlife and the environment. They can be caused by various factors, such as wildlife crossing, derailments, collisions, human errors, sabotage and natural disasters. These accidents not only result in casualties and injuries, but also damage the infrastructure, disrupt the transportation system and cause economic losses. Therefore, it is imperative to find effective solutions to prevent and mitigate the risks of railway accidents.

In this project report, we present a comprehensive solution, Railway Track Safety System (RTSS) that aims to address the main causes of railway accidents

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and enhance the safety and reliability of the railway system. Our solution consists of three components: (1) a network that monitors the railway tracks and detects any anomalies or obstacles; (2) a system that analyzes the sensor data and provides real-time lever position to the railway operators; and (3) a system that alerts the presence of wildlife in track and procedures to be taken in case of an emergency.

We believe that our solution can significantly reduce the frequency and severity of railway accidents, protect the lives of humans and animals, and improve the efficiency and sustainability of the railway system. We hope that our project report will inspire further research and innovation in this important field [1].

RTSS

The RTSS is an integrated continuous monitoring system that comprises of three subsystems whose objective is to address the four problems that we have identified in Indian railways. The first two problems are the cracks that occur in the rails and the presence of foreign objects in the railway tracks. The cracks may be occurring due to the deformation over time but in some cases anti socials tend to create cracks in rails aiming to derail the train. Also, apart from objects like stones that roll into the tracks due to some natural reasons sometimes people place objects large enough to cause an accident in the rails. To tackle these two problems, we introduce our first system, crack and object detection. This system works by propagating radio frequency waves through the railway lines and modelling them with a reference wave. Whenever a malpractice is detected the alert panel gives indication to authorities. Next problem is the tampering of lane changing levers by unauthorized personal. These acts can lead to large accidents and crashes if left unnoticed. To prevent tampering of the levers second system is introduced. Lever tamper prevention systems sends the real time position of each lever to the alert panel placed at each railway stations. The final problem we have identified is related to wildlife. There are many railway paths that pass-through wildlife dense areas. Third system uses motion detectors to identify the presence of wildlife and by producing ultrasonic sounds and with help of lasers system tries to scare off wildlife from tracks [2].

PROPOSED SYSTEM

There are some methods in place, in order to prevent the tamper with tracks. CCTV surveillance is a common method adopted where; cameras are installed in vulnerable places along the track to monitor activities. Track patrolling or regular inspections that are carried out manually by railway staff or authority is another major method. Our proposed system aims to address the practical and efficiency issues related to these methods by providing a continuous monitoring system.

Object and Crack Detection

The object and crack detection system works by transmitting radio frequency waves through the railway tracks. The frequency range of radio waves are between 3 kHz and 300 GHz. The frequency we have chosen for this system is 80 kHz [3]. A weather proof housing containing the frequency generating circuit will be attached to metal rails. Waves are propagated onto the rails through metallic probes. 80 kHz waves should travel up to 1500 meters. So, the next transceiver circuit is placed within that range. Here a microcontroller acts as a receiver and conducts the wave through the optical fiber cable that reaches the next railway station. The incoming wave is analyzed and compared with a model wave with perfect conditions. In case of any abnormalities to the wave form, signal is sent to the alert panel.

Wildlife Detection System

Wildlife detection system is only applicable for the tracks that passes through forest areas. A dual technology motion sensor is used to detect any motion. The sensors will be placed parallel to the railway tracks, at height similar to the fencing heights. The dual technology sensors are more accurate and reduces the chances of false triggering due to motion like leaf movements. Whenever the sensor is triggered alert panel gets the signal informing the presence of wildlife on tracks. At the same time the

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ultrasonic sound and laser lights will be used to scare away the animal. The signal only turns off when the animal is out of the track. In this system also data transmission is made possible by using microcontroller and optical fiber cables.

Lever Tamper Detection

Indian railways have many vulnerable lane changing levers that is accessible to anyone. There have been many unauthorized activities by people that could lead to accidents. The lever tamper prevention system gives the real time lever position. It is made possible by integrating a hall effect sensor connected to a microcontroller. Whenever the lever position is altered signal is send from the microcontroller. This system is also connected to the integrating microcontroller so that the data can be send to the control panel [4].

Alert Panel

Alert panels will be located in each railway stations. These will act as the integration system. All the optical fiber cable carrying the data from different tracks between two stations will be connected into this panel. The panel will have an interface with LED lights to indicate the output from each system. Internally the alert panel will have an Arduino uno that will receive inputs from the three safety systems and gives the output through LEDs. In case of the Object and Crack Detection system the incoming waveform will be analyzed through an algorithm that compares the input with the model wave and sends output accordingly (Figure 1).

INTEGRATION

The integration system at each railway station will be enhanced with the installation of alert panels.

These panels will serve as a central hub, connecting all the optical fiber cables that carry data from the various tracks between two stations. By consolidating the data from these cables, the alert panels will provide a comprehensive interface for monitoring and managing the railway system (Figure 2). To ensure efficient communication and visibility, the alert panels will be equipped with LED lights. These lights will serve as indicators, displaying the output from each system connected to the integration system [5–7]. This visual interface will allow railway personnel to quickly and easily identify any issues or abnormalities within the system. Internally, the alert panels will be powered by an Arduino Uno, a

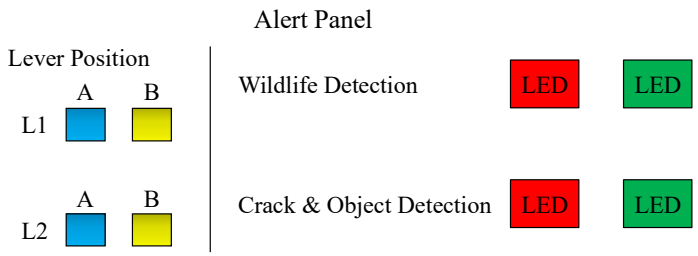

Figure 1. Alert Panel.

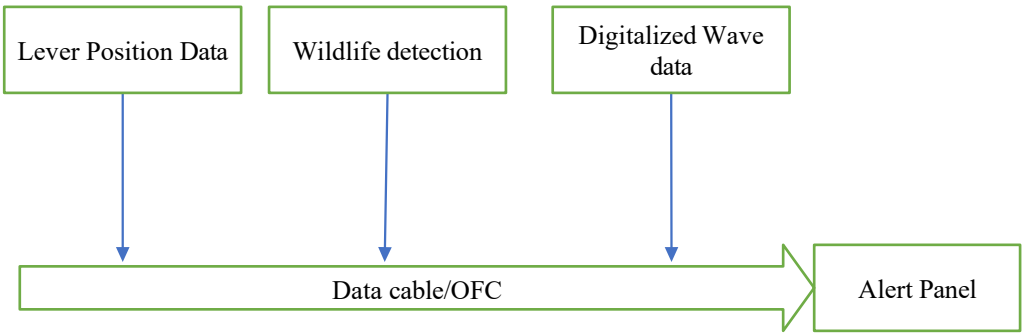

Figure 2. Integration.

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microcontroller board that will receive inputs from three different safety systems. These safety systems will be designed to detect and prevent potential hazards or malfunctions within the railway system. One of the safety systems integrated into the alert panels will be the Object and Crack Detection system. This system will utilize an algorithm to analyze the incoming waveform data and compare it to a model wave. By doing so, it will be able to identify any objects or cracks on the tracks that may pose a safety risk. Once the Object and Crack Detection system has analyzed the waveform data, it will generate an output based on the comparison with the model wave. This output will be sent to the Arduino Uno, which will then activate the corresponding LEDs on the alert panel. This visual indication will alert railway personnel to the presence of any objects or cracks on the tracks, allowing them to take immediate action to rectify the situation and ensure the safety of the railway system [8–10].

CONCLUSION

Railway Track Safety System (RTSS), introduces a holistic solution designed to tackle the primary causes of railway accidents and improve the overall safety and dependability of the railway system. Our solution comprises three key components: a network that constantly monitors the railway tracks, identifying any irregularities or obstructions; a system that analyzes sensor data and promptly relays lever positions to railway operators in real-time; and a system that promptly notifies the presence of wildlife on the tracks and outlines emergency protocols to be followed.

RTSS is an all-encompassing monitoring system consisting of three subsystems specifically developed to tackle challenges within the Indian railways. Our solution incorporates advanced technologies and innovative strategies to address the root causes of railway accidents. By implementing state-of-the-art sensors and monitoring systems, we can detect potential hazards and alert railway operators in real-time, allowing them to take immediate action to prevent accidents. This not only focuses on human safety but also takes into consideration the well-being of animals. By integrating animal detection systems and implementing measures to prevent animal collisions, we can significantly reduce the number of accidents involving wildlife on railway tracks. This not only protects animal lives but also prevents disruptions to train operations caused by collisions. In addition to enhancing safety, our solution also improves the efficiency and sustainability of the railway system. This not only benefits passengers and freight operators but also reduces energy consumption and greenhouse gas emissions, contributing to a more sustainable transportation system. We believe that our project report will serve as a catalyst for additional research and innovation in this crucial domain. By sharing our findings, methodologies, and technological advancements, we hope to inspire other researchers and industry experts to further explore and develop solutions to improve railway safety and efficiency. Collaboration and knowledge sharing are essential in driving progress and ensuring continuous improvement in the railway industry.

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