A DESCRIPTIVE ANALYSIS OF RAILWAY RISK ASSESSMENT AND FAULT DETECTION USING IOT BASED SYSTEM

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Abstract—Railway Track Tracer System for creature detection is a system for detecting cracks on the railway tracks. This system will help to avoid many accidents that occur on railways. This system frequently monitors the railway tracks using a camera, so that the presence of cracks ans any derailments can be easily identified and then necessary actions can be taken to prevent accidents.

Internet of Things is the most studied field with endless real life applications. Internet of Things (IOT) is implemented to give an up-to-date update on railways and their management. In this mode IR sensor is used for checking the availability of the platform. This system is used update the platform availability to the upcoming train to avoid the prevent accidents. To detect fire and automatic engine detachment. To update the platform availability.

Keywords - Railway Disasters, IOT, Deep Learning, Platform Availability Detection, Alert, Fire Detection, Railway Tracks.

I. INTRODUCTION

The sizeable role of railways in transporting people and goods is underscored by their importance to India's transportation network and economy. Yet, challenges like maintenance and safety persist as significant areas needing continuous attention and improvement. Effective maintenance and a focus on safety not only ensure efficient transportation but also guarantee the well-being of passengers and goods in transit. The integration of technology has been instrumental in advancing railway systems globally, introducing innovations in track monitoring, signaling, data analysis, and safety measures. These advancements play a crucial role in predicting and preventing issues before they escalate, thereby enhancing the overall reliability and safety of the system..

Utilizing cameras, the system swiftly identifies living creatures, effectively averting potential accidents. This comprehensive system encompasses train details, the locomotive operator's information (loco-pilot), an alert system, and camera setups.In this suggested framework, the process involves the capture of images through cameras, followed by their analysis using various image processing techniques.. Upon detecting an object in an image, a subsequent picture is rapidly taken within a fraction of a second, initiatinga secondary analysis process. Comparison between these images is conducted, and if any obstacle is detected in both instances, an immediate alert is triggered via the application. This instant notification reaches both the loco-pilot and the nearby control room, ensuring timely action

A. IoT in Track Monitoring and Disaster Prediction :

IoT sensors deployed alongside railway tracks continuously monitor several metrics, including track vibrations, temperature, and alignment. Any deviations from standard readings act as warning signs for possible track deformations, misalignments, or structural weaknesses. Moreover, sensors integrated into trains and railway infrastructure, leveraging IoT technology, gather real-time data on vital components like wheels, brakes, and engines. By employing predictive analytics on this data, potential failures can be anticipated beforehand, effectively averting accidents. Moreover, these sensors possess the ability to identify unfavorable environmental circumstances like intense rainfall and occurrences of landslides., or extreme temperatures that could endanger railway tracks or operations. Upon detecting these conditions, the sensors automatically activate alerts and initiate proactive measures, thus preempting potential disasters.

B. IoT in Collision Avoidance and Emergency Alert:

IoT devices like cameras, LiDAR, and radar installed within the trains and tracks have the capability to detect obstacles, other trains, or objects . IOT based railway systems can promptly alert train operators in real-time to take necessary measures and prevent collisions. However, there is room for integrating various IoT-based communication devices and alert systems into trains and railway stations to enhance safety during emergencies like accidents or derailments. The implementation of these systems holds significant potential to enhance response protocols and safety measures across railway networks.

C. IoT in Checking for Platform Availability and FireDetection:

The method used to ascertain platform availability relies on the principle where the infrared (IR) sensor doesn't detect reflected light when an object is present, causing the train to stop. Each platform is equipped with two IR sensors, and anLCD screens exhibit messages that communicate the platform's current status, such as "PLATFORM 1 AVAILABLE," "PLATFORM 2 AVAILABLE," "ALL PLATFORMS AVAILABLE," or "PLATFORM NOT AVAILABLE." In each train compartment, a fire sensor is installed. When it detects flames, it sends an alert to the controller, activating a relay that triggers the sprinkler system. Another motor is employed to separate the compartment, preventing the fire from spreading. The LCD screen shows messages like "FIRE" and "HELP," while a buzzer notifies passengers about the fire.

D. IoT in Training and Simulation for Creature and Wildlife Protection:

IoT technology is instrumental in training and simulation efforts aimed at safeguarding creatures and wildlife. One key application involves employing IoT-enabled satellite telemetry systems to track the movements of large animals, especially migratory species or those residing in expansive and secluded habitats. This technology consistently offers live updates regarding the whereabouts and behaviors of these animals. IoT collars, equipped with a diverse array of sensors, are employed to track vital health parameters in animals.

Moreover, IoT collars equipped with a variety of sensors are utilized to monitor essential health parameters in animals, such as heart rate, body temperature, and activity levels. These collars are designed to alert researchers or conservationists if any irregularities in an animal's vital signs are detected, indicating potential health issues.

II LITERATURE SURVEY

The compiled literature survey for this study is structured and presented in a tabular format., presenting a comprehensive overview of pertinent research. Within the table, crucial information like study titles, author(s), publication years, research objectives, and the primary advantages and disadvantages outlined in each work are systematically included..

Title	Authors	Year	Objectives	Advantages	Disadvantages
Utilizing Deep Learning for Railway Safety Risk Assessment.[1]	Hamad Alawad; Sak dirat Kaewunruen; Min An	2020	A fresh approach that combines computer vision and pattern recognition for risk management in railway systems involves employing a Convolutional Neural Network (CNN) as a supervised machine learning model to recognize potential hazards.	1. Stereo cameras were employed to collect motion data and generate a 3D skeleton model for identifying common unsafe behaviors. The efficiency, cost-effectiveness, and rapid acquisition of visual data have been emphasized through computer vision technology, showcasing its potential for vision-based methodologies.	1. CCTV and analog cameras are crucial in accurately identifying station areas, such as platforms. Escalators, and tunnels. Nonetheless, the human element operating these systems remains central, potentially introducing human errors into the process.
Assessing Risks in Rail Freight Transport Operations[2]	Lucyna Szaciłłoa , Marianna Jacynaa , Emilian Szczepańskia , Mariusz Izdebski a	2021	critical analysis of the literature on selected areas of risk assessment in transport system and on tools and methods for risk assessment in other areas is carried out. The second section involves identifying the research area. The authors have outlined the process of performance..	1. 1. Emphasizes showcasing the dependability of rolling stock through the Wei bull reliability model 2. , Addressing security concerns by examining methods in minimizing the adverse impacts on the system.	1. A general critical infrastructure may overlook specific railway features, such as the power supply system. The system's effectiveness might be limited to specific regions where the sensors are installed.
The Planning of Investment Activities in Field of Railway Transport with Support of Simulation Tools . [3]	Borna Abramović a, Denis Šipuš a, Danijel Jurešić	2021	1. This document delineates the outcomes derived from field research, encompassing a survey concerning the caliber of the existing public transportation system. Furthermore, commuters were polled regarding their perspectives on the newly implemented public transport management.	1. LED fixtures will be mounted on one rail side, while three groups of LDRs will be placed on the opposing side. In normal conditions, in the absence of any fractures... 2. Establishes cost-effectiveness relative to existing approaches. Additionally, when applied extensively over an extended duration, it aims to enhance safety norms for railway tracks and establish a more efficient testing infrastructure to yield improved outcomes.	1. It lacks the capability to inspect both the surface and the immediate subsurface of the rail track. 2. Due to its inability to be positioned on a touching robot panel, it was deemed unsuitable for practical implementation.
Improved Approach for Fire Detection using Deep Learning Models. [4]	Shafique, R.; Siddiqui, H.-U.-R.; Rustam, F.; Ullah, S.	2022	1. A presented automatic railway track inspection system has the ability to differentiate between three track conditions: wheel burn, superelevation, and normal track..	1. The system is designed to activate an alarm upon detecting any defects. Additional functionalities can be incorporated, such as fault localization and integration with IoT for remote fault detection comprehension, facilitating the identification of hot spots and providing reasoning capabilities..	1. The multilayer perceptron stands as a commonly utilized deep learning network employed across various tasks, encompassing image processing, object detection, and Natural Language Processing (NLP) assignments.

Title	Authors	Year	Objectives	Advantages	Disadvantages
Rail crack detection and evaluation at high speed based on differential ECT system . [5]	Peng Xu, ChenLu Zhu, HongMing Zeng, Ping Wang	2020	1. the effects of detection speed on eddy current testing (ECT) signals are studied, and the proposed method for quantitatively evaluating railway surface cracks at varying speeds is introduced. 2. The relationship comprising defect signal amplitude, the defect depth, and the detection speed is further obtained, which evaluate defect depth at different speed.	1. Addresses the challenge of achieving high detection rates across multiple databases. 2. Utilizes transfer learning and data augmentation to enhance the model performance. 3. Provides a clear model architecture involving data pre processing, augmentation, and classification.	1. the ultrasonic transducers must be in close link with the track to achieve ultrasonic transmission. This requirement limits the speed of the inspection train. 2. Implementing the models real-timescenario may pose logistical and regulatory challenges.
"Railway Track Defect Detection via Classification Utilizing Fiber Bragg Grating Ultrasonic Sensors". [6]	Dang, D.-Z.; Lai, C.-C.; Ni, Y.-Q.; Zhao, Q.; Su, B.; Zhou	2020	1. Structural health monitoring (SHM) is vital to the maintenance of civil infrastructures. 2. In rail transit systems, timely detection of defects in rail tracks can significantly mitigate the risk of severe accidents.Accidents like derailment. Non-destructive testing (NDT) has been implemented in railway online and offline monitoring systems using state-of-the-art sensing technologies	1. significant changes in waveform in time and frequency domains have been observed. It has been concluded that FBGs are consummate sensors are massively utilized in UGW inspection tasks, especially in complex environments with high-level EMI. 2. Uses sensors for comprehensive data collection.	1. Significantly great cost. 2. Potential false alerts due to line-of- sight issues.
Learning From Accidents , A Machine Learning for Safety at Railway Stations [7]	Hamad Alawad; Sakdirat Kaewunruen; Min An	2019	1. This paper explores the employment of the decision tree (DT) method in safety classification and the analysis of accidents at stations to predict the traits of passengers affected by accidents. 2. The critical contribution of this presentation of ML and an explanation of how this technique is applied for ensuring safety,	1. research shows the vast potential of the innovative application of ML in safety analysis for the railway industry. opportunity fordigital technologies to grant improved levels of safety	1. There are several variants of DTs such as classification and regression trees (CART), chi-squared automatic interaction detection (CHAID), and iterative dichotomies which did not give accurate results..

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Securing the Future Railway System: Technology Forecast, Security Measures, and Research Demands . [8]	Unger, S.; Heinrich, M.; Scheuermann , D.; Katzenbeisse r, S.; Schubert, M.; Hagemann, L.; Iffländer, L	2023	1. Defining Attack Graphs as a graphical solution for the security Analysis mitigates the disadvantages of other risk and security analysis solutions, i.e., table-based solutions. The first advantage of Attack Graphs is that a visual representation of the security landscape enhances the understanding and communication of complex risk information and simplifies the identification of patterns, trends, and relationships among threats and risks	1. Identifying future technologies that will be available until 2050 and It could be incorporated or integrated into the existing railway system.. 2. Advantages include centralized maintenance, backup resource availability, standard components, such as (commercial off-the-shelf (COTS)), and centralized personnel deployment.	1. Financial damage to the operator, an individual, or a customer; 2. Reputation damage to the operator, manufacturer, or an individual.
Improved LSTM-Based Time-Series Anomaly Detection in Rail Transit Operation Environments [9]	Yujie Wang; Xin Du; Zhihui Lu; Qiang Duan; Jie Wu	2022	1. Suggesting an enhanced anomaly detection scheme for time-series data using Long Short-Term Memory (LSTM) models. 2. The primary components of this proposed scheme comprise an improved LSTM model, tailored to enhance time-series predictions for diverse rail transit equipment, and a methodology for establishing a suitable error threshold. This threshold aids in detecting anomalies by leveraging prediction errors..	1. further enhance anomaly detection performance, we also propose a pruning algorithm for reducing false anomalies 2. rely on scarce anomaly labels but dynamically determines a threshold of prediction errors to identify anomalies	1. LSTM models have a percentage of error readings in the final call. 2. This system was difficult to implement in the available models.
Digital Railway: Trends and Innovative Approaches [10]	· Florin Codrut Nemtanu & Marin Marinov	2018	1. Digital railway is a new concept and new paradigm which is the way to change the architecture of the railway systems and to push a novel approach in designing and developing new railway systems optimize the hierarchical framework using a hyper parameter.	1. the integration of different systems and transport modes based on the exchange of data. The innovative approach is to link the railway vehicles to the infrastructure and to find the way to integrate infrastructures and vehicles from different transport modes. 2. Offers a multi-objective optimization approach for balancing accuracy and computational cost.	1. the integration of different systems and transport modes based on the exchange of data. The innovative approach is to link the railway vehicles to the infrastructure and to find the way to integrate infrastructures and vehicles from different transport modes.

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Keeping track of railway safety and the mechanisms for risk [12]	Junwei Xie, Fan Yu, Hanxiang Wang, and Haotian Zheng	2018	1. A significant project for many reasons and scheduled to be 2. complete within a five-year period (Network Rail 2015). The new control centres will be highly 3. automated and driven by the integration of computer-based information technology	1. values of posteriori and priori risks, it is possible to characterized and predictedsafety of the railway traffic.	1. Financial damage to the operator, an individual, or a customer; 2. No reliable system produced
Design of Temperature Monitoring for Wheel using Optical Sensor in Railway Safety System [13]	Deepa N; Preeta Sharan; Shwe tha K; Vaibhav Meshram	2022	1. In this work, wheel temperature warning range is taken between 150 °C to 300 °C and this range to observe the stress and strain behavior on railway wheel in ANSYS Workbench software 2. Sensing temperature distribution is performed by steady state thermal analysis.	1. The framework is taken from the thermal analysis to perform static structural analysis. 2. The result obtained gives a good understanding of temperature distribution on wheel with respect to stress and strain from structural analysis.	1. Sensitivity of Fiber Bragg Grating is observed to be 13.08pm/°C for this temperature range and Bragg's wavelength 1550nm.
Nondestructive Testing Technologies for Rail Inspection: A Review. [14]	Gong, W.; Akbar, M.F.; Jawad, G.N.; Mohame d, M.F.P.; Wahab	2022	1. The inspection of rail defects should feature high sensitivity since it is required to detect sub-surface oblique cracks and internal damages . 2. The inspection should cover the entire cross-section of the rail, from the contact surface, through the internal waist, to the rail bottom. Moreover, particular areas such as switch tips and welded joints represent a challenge complex structures and inherent changes in material properties.	1. speed and efficiency requirements, inspecting rails is non-contact. This way, the inspection can be carried out quickly and efficiently using movable inspection wagons .	Due to the complexity of the mechanisms that cause rail damage.
Experimental and Mathematical Study of Flexible–Rigid Rail Vehicle Riding Comfort and Safety . [15]	Sharma, S.K.; Sharma, R.C.; Choi, Y.; Lee, J	2023	1. This study investigates the dynamic behavior of a rail vehicle through a combined approach of experimental and simulation analyses using a multi- rigid–flex body model. Mathematical models are developed to encompass the car body, bogie frame, and wheel axle, Specially tailored for rail vehicles possessing both rigid-flexible and multi-rigid characteristics.	1. takes into account the deformation of the flexible components of the vehicle. 2. By analyzing the vehicle's behaviors under different conditions, engineers can optimize the vehicle's design to improve performance, safety, and efficiency.	1. Despite their efficacy in regulating flexible body modes, the approaches described above have marginal influence on controlling stiff body modes, which still affect ride comfort. 2. Despite their efficacy in regulating flexible body modes, the approaches described above have marginal influence on controlling stiff body modes, which still affect ride comfort.

III. CONCLUSION

In conclusion, The deployed creature detection system was utilized to oversee railway areas susceptible to accidents caused by events like wildlife crossings, vehicle collisions, or falling trees.. Placed inaccident-prone zones, the system utilized image processing technology to provide real- time imagery. We assessed the system's performance under actual conditions and utilized image processing algorithms to determine the The current condition or status of the train.and identify surrounding objects. This information servesas a valuable aid for train operators, enabling them tohalt the train and prevent accidents that endanger creatures on the track.

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