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RAILWAY TRACK FAULT DETECTION USING ML & IOT

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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 rails. This system frequently monitors the railway tracks using a camera, so that the presence of cracks can be easily identified and then necessary actions can be taken to prevent accidents. Internet of Things is the most studied field and its applications are endless. Internet of Things (IOT) is implemented to give an up-to-date update on the railway management. In this mode IR sensor is used for checking the availability of the platform. This system is used update the platform availabity to the upcoming train to avoid the prevent accidents. To detect fire and automatic engine detachment. To update the platform availability. There has been an upsurge in railway accidents, which are mostly caused by track quandaries. That might be a misalignment, an obstacle, a crack in one of the track's sides, or some other fault with the track. So, keeping track of all these difficulties is a time-consuming chore for a person. So, we engendered an IoTpredicated Railway Inspection System that includes a sensor-equipped robot car that can identify quandaries on the track which have potential for causing railway accidents, and the sensors utilized to detect this were tilt, ultrasonic, infrared, water, and fire sensors and the movement is controlled using the Relay. In this project we have built the train track security and Monitoring application in which we monitor the rails i.e. tracks of trains with an automated robot which we pass through the track, will detect and inspect the track status like curve and damages etc. We are controlling this bot remotely. So we are getting all these data via an android app. This way are monitoring the track in real time with the track fault detection. So with this data we can prevent accidents and train sleeping due to those faulty tracks.

IndexTerms - IOT,IR sensors,ML.

I.INTRODUCTION

We When going through the daily newspapers many accidents in railroad railings are found. Railroad-related accidents are more dangerous than other transportation accidents in terms of severity and death rate etc. Therefore, more efforts are necessary for improving safety. Destructive forces of a train are usually no match for any other type of vehicle. Train accidents cause a major catastrophe, as they cause severe damage to life and property. Railway safety is a crucial aspect of rail operation all over the world. Here the aim is to help the railway administrations concerned to strengthen their safety culture and develop the monitoring tools required by modern safety management. The first problem tackled is cracks in the railway track. Also railroad intersections are very unique, special, potentially dangerous and yet unavoidable in the world. During the normal operation, there is every possibility of accidents occurring even with very little negligence ins procedure and the result is of very high risk. A derailment is said to take place when a vehicle such as a train runs off its rails. This does not necessarily mean that it leaves its track. Although many derailments are minor, all result in temporary disruption of the proper operation of the railway system, and they are potentially seriously hazardous to human health and safety. In emergency situations, deliberate derailment with derails or catch points is sometimes used to prevent a more serious accident. So a method to detect any problem in the track is implemented. Each year, accidents at level crossings not only cause fatalities or serious injuries to many thousands of road users and railway passengers, but also impose a heavy financial burden in terms of disruptions of railway and road services and damages to railway and road vehicles. A very high number of these collisions are caused by the negligence, incompetence or incapacity of road vehicle drivers. This is the second problem tackled here. Since it is the railway which must bear the responsibility for ensuring that it is protected from the transgressions by road users (despite the fact that in many countries the law gives it priority of passage over road users), it is the railway which also has to shoulder most of the financial burden of providing this protection. In India, most of the commercial transport is being carried out by the railway network and therefore, any problems in the same has the capacity to induce major damage to the economy-notwithstanding the societal impact of loss of life or limb. Fire causes more damage in less amount of time.

II.OBJECTIVE

1.Enhance Safety Measures: Implement IR sensors for track monitoring to detect obstacles, potential hazards, and cracks, ensuring early identification and mitigation of safety risks. Integrate fire sensors to rapidly identify and respond to fire incidents within train compartments or the railway environment, prioritizing passenger safety.

2. Optimize Train Movement: Utilize DC motors for precise control over train acceleration, deceleration, and movement, enhancing overall operational efficiency and passenger comfort.

3. Automate Emergency Responses: Employ relays to automate the detachment of train compartments in the case of fire emergencies, preventing the spread of fire and minimizing potential damages.

4. Fire Suppression Mechanism: Integrate water pumps to activate automatically in response to fire incidents, contributing to the rapid suppression of fires within the railway premises.

5. Real-time Communication :Utilize NodeMCU for real-time communication, enabling immediate message intimation to relevant stake holders such as authorities, emergency services, and passengers during critical situations.

6. Seamless Connectivity with Zigbee: Implement Zigbee technology to establish seamless communication between different components of the railway system, facilitating remote monitoring and efficient data exchange.

7.Platform Availability Monitoring: Deploy IR sensors for continuous monitoring of platform occupancy and availability, streamlining train scheduling and optimizing passenger boarding processes.

8. Improve System Resilience: Design the system to be robust and resilient, ensuring its reliability under various operating conditions and minimizing downtime for maintenance.

9. Facilitate Remote Monitoring:Enable remote monitoring of the railway system to provide authorities with real-time updates on train positions, track conditions, and emergency situations through Zigbee-enabled device.

III.METHODOLOGY

This section describes the dataset acquisition technique and machine learning algorithms used for classification, along with the proposed methodology. All IoT systems have the fol- lowing generic architecture, as shown in Figure 2. A frame- work capable of detecting, responding, and acting/reacting whenever it is exposed to a change or stimulus from a situation in which it is kept without the need for human intervention.

1.System Design and Planning: Define the overall system architecture and identify the key components such as Arduino boards, sensors, actuators, and communication modules. Establish the system requirements, including safety features, emergency response protocols, and communication interfaces.

2.Sensor Deployment and Calibration: Install IR sensors along the railway tracks for crack detection and platform availability monitoring. Deploy ultrasonic sensors for object or human detection on the tracks. Calibrate sensors to ensure accurate readings and responses.

3.Fire Detection System Integration: Integrate fire sensors within train compartments and the railway environment. Develop algorithms to interpret sensor data and trigger emergency responses in the event of a fire.

4.DC Motor Control for Train Movement: Implement DC motors to control the movement of trains. Develop algorithms for precise acceleration, deceleration, and speed control.

5.Relay and Water Pump Integration: Integrate relays to automate the detachment of train compartments in case of a fire. Connect water pumps to the system to activate automatically during fire incidents.

6.NodeMCU for Real-time Communication: Incorporate NodeMCU for realtime communication between different system components. Develop protocols for message intimation, ensuring timely communication during emergencies.

7.Zigbee Communication Setup: Set up Zigbee communication for seamless connectivity between stationary and moving units. Develop communication protocols to exchange real-time data and updates.

8.Emergency Response Algorithms: Develop algorithms to initiate emergency responses based on sensor data, including fire suppression, train compartment detachment, and communication protocols.

9.Platform Availability Monitoring System: Deploy additional IR sensors for continuous monitoring of platform occupancy and availability. Integrate platform availability data into the overall system for efficient train scheduling.

IV. SYSTEM ARCHITECTURE

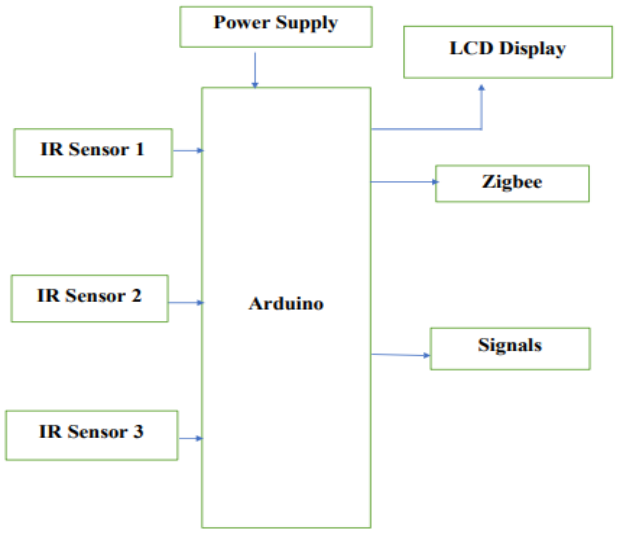

Figure1. Station Model

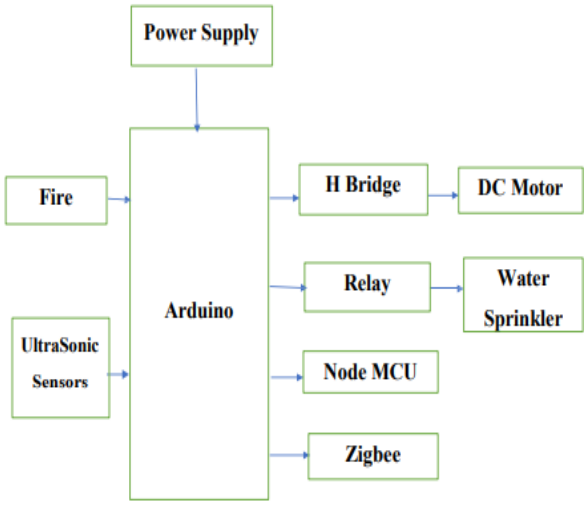

Figure2. Train Model

V .LITERATURE SURVEY

1.An Accident Casual Model for Railway Based on Operational Scenario Cognition Conflict

Authors: Fei Yan, Tao Tang, Junqiao Ma Publisher:

IEEE Traditionally, accident or incident analysis are focusing on the cause consequence chain methods, like Fault Tree or Event Tree, which are hard to find root cause of accidents. To solve this problem, some system safety analysis methods come out, like Accimap, FRAM and CAST based on STAMP. However, they are good at solving safety management issues, functional failure analysis or causal scenarios analysis, and can be used to capture safety requirements and help system designers to deep understand safety requirements. But the true logic of accident or incident do not analyzed, which is related to human or equipment cannot conceive the right status of train operational status on time. If so, it's easy to ensure safety by train stop. The objective of this paper is to present the mismatch or inconsistency among human cognition, equipment execution and train operation of railway train control system. Also, railway accident is a kind of expression of operational scenario conflict. Singapore metro accident is analyzed as case study.

2.Knowledge Graph Construction for Railway Electrical Accident Analysis

Authors: Xiaohong WANG, Jiao HAN Publisher:

IEEE Rail system's electrical accidents happen frequently; yet currently existing accident data are presented/stored as unrelated information, which makes it difficult for us to achieve data correlation. In order to discover hidden connection between different types of railway electrical accidents and integrate these seemingly independent data into a structured body of knowledge, a semiautomated construction process is explored to build a knowledge graph for all railway electrical accidents for the past 8 years in China. The experiment results show that CNN classifier can obtian perfect classification performance, and needn't diagnose the faulty equipment of accidents artificially,

which can greatly save time and effort. The knowledge graph we constructed in this paper is not only used to analyze and diagnose the faulty equipment of railway electrical accidents, but also can help us discover trends and changes of these accidents. In addition, the knowledge graph also lays a solid data foundation for the progressively intelligent railway electrical systems.

3. Computer Vision System for Railway Track Crack Detection using Deep Learning Neural Network Authors: R. Thendral, A. Ranjeeth Publisher: IEEE Description:

For better inspections and security, we need an efficient railway track crack detection system. In this research, we present a computer visionbased technique to detect the railway track cracks automatically. This system uses images captured by a rolling camera attached just below a self-moving vehicle in the railway department. The source images considered are the cracked and crack-free images. The first step is pre-processing scheme and then Gabor transform. In this paper, first order statistical features are extracted from the Gabor magnitude image. These extracted features are given as input to the deep learning neural network for differentiate the cracked track image from the non cracked track image. Accuracy of the proposed algorithm on the procured images is 94.9 % and an overall error rate of 1.5%.

4 "AUTOMATIC LEVEL CROSSING GATEWITH DATABASE COLLECTION"

Authors: . J.C. Priyanka, A. Saranya,Lc. Shanmathi, S. Baranikumar

Description: In the proposed system they have suggested of using a new rage in the field of Computer Science and interdisciplinary fields, known as M2M (Machine 2 Machine)/ IoT (Internet of Things) where things communicate with each other and based on this the decision is taken. In the proposed system, an onboard device is installed in train enabled with GPRS sensors and is able to communicate using internet of GSM-R standard. This onboard device will communicate with the server

using MQTT protocol which is the standard for communication in IoT field. With the help of this protocol we can communicate with sensors as well as server and hence making the communication much simpler. Once this message is received to server, the server will first send the location of the next location to the train device and once the location of the level crossing arrives it will update the location of the train and speed. Based on these the distance between the level crossing and train is determined and if the distance is at safety minimum it will ask the track device to update the status. Track devices are devices which are used to extract the information from the track circuit to send the values to the server about its current status as well its future course. If there is no train at the track it will check for the future status of the track. When such information of the track arrives it updates it to the server. When server receives all the track information it will calculate the estimated time of train to reach the next level crossing. Here track device plays an important role in the system as the future course of train is decided based on the values received from the track circuit. But that does not limit the system to predict the future time.course of train. This is done by logging the events and based on this events the decision can be made. Hence, this system will make the current system self reliant and independent of the external factors causing the delay. Once the estimated Time of Arrival is calculated it is sent to the next level crossing's device which will display the time and will start the countdown and it will also close the level crossing. That is as the countdown value decreases or as it approaches the value it will alert the next IP address. This system will help the road user in waiting as it has been seen in where it was found that countdown can increase the consciousness. The system proposed here will be more helpful to the Indian Railways as such work can also help them with their issues.

5. "AN EVOLUTION OF RFID GRIDS FOR CRACK DETECTION"

Authors: Jun Zhang, GuiyunTian

Description: This paper presents the concept of the detection of crack in metal using radio frequency identification (RFID) tag antenna based sensor (TABS) in ultra-high frequency (UHF) band. The major purpose of our work is to simulate and explore a feasibility, challenges and principles of crack detection based on RFID grids, which can promise the widespread adoption of a smart skin in the field of structural health monitoring (SHM), e.g. health monitoring in railway track. The process of implementing a damage identification strategy for aerospace, civil and mechanical engineering infrastructure is referred to as structural health monitoring (SHM). Monitoring the safety and functionality of such infrastructures is critical to improving maintenance practices, minimizing the cost associated with repair and ultimately improving public safety, which has resulted in the development of non-destructive testing and evaluation (NDT&E) methods for characterizing materials and detecting the presence of defects. However, among the possible failure modes, fracture associated with the formation of a single or a network of cracks is common in many engineering fields and is often associated with corrosion and fatigue ofmaterials for railways, bridges, pipelines, and aerospace structures. Therefore, many efforts have been made to develop practical NDT&E methods for crack detection.

6. Hafeez Ur Rehman Siddiqui 1 , (Student Member, Ieee), Adil Ali Saleem 1 , Muhammad Amjad Raza 1 , Kainat Zafar 1 , Kashif Munir1 , And Sandra Dudley 2 , (Member, Ieee)

The Rail is one of the most energy efficient and economical modes of transportation. Regular railway track health inspection is an essential part of a robust and secure train operation. Delayed investigations and problem discoveries pose a serious risk to the safe functioning of rail transportation. The traditional method of manually examining the rail track using a railway cart is both inefficient and susceptible to mistakes and biasness. It is imperative to automate inspection in order to avert catastrophes and save countless lives, particularly in zones where train accidents are numerous. This research develops an Internet of Things (IoT)-based autonomous railway track fault detection scheme to enhance the existing railway cart system to address the aforementioned issues. In addition to data collection on Pakistani railway lines, this work contributes significantly to railway track fault identification and classification based on acoustic analysis, as well as fault localization. Based on their frequency of occurrences, six types of track faults were first targeted: wheel burnt, loose nuts and bolts, crash sleeper, creep, low joint, and point and crossing. Support vector machines, logistic regression, random forest, extra tree classifier, decision tree classifier, multilayer perceptron and ensemble with hard and soft voting were among the machine learning methods used. The results indicate that acoustic data can successfully assist in discriminating track defects and localizing these defects in real time. The results show that MLP achieved the best results, with an accuracy of 98.4 percent.

VI .EXISTING SYSTEM

The existing system railway tracks are surveyed manually. LED (Light Emitting Diode) LDR (Light Dependent Resister) sensors cannot use on the slab of the tracks. Image processing input images are noisy system and it's not getting accurate output. This analysis is used to identify the crack in rail track under the bad whether condition which is not getting perfect output.

VII.PROPOSED SYSTEM

The proposed system is an enhanced technique for monitoring the object which uses Arduino uno micro controller, ultrasonic sensor, LCD, and fire module. The ultrasonic will get the distance from the object to detect crack on the railway track. Ultrasonic sensors work by emitting sound waves at a frequency too high for humans to hear. They then wait for the sound to be reflected back, calculating distance based on the time required. 16x2 LCD used to display the all information. Using fire sensor will detect fire. System will sprinkle and engine detachment during fire attack. Using IR sensors will detect the cracks. This system will check platform availability using IR sensor and send alert to the upcoming train.

VIII.APPLICATIONS

Used in daily track inspections to detect the flaws in the tracks. This can be used in many remote places where defects due to rail failure occurs. It can also be used commercially in amusement parks to check the tracks for a few rides. In long run safety standards .

Railway track damage detection application - This methodology is used at many places in the tracks where defects due to rail failure occur.

Wireless applications - This unit is used to intimate the appropriate message using WIFI module.

Can be implemented in large scale in long run to facilitate better safety standards and provide effective testing infrastructure for achieving better results in the future.

It can also be used commercially in amusement parks to check the tracks for a few rides.

IX.ADVANTAGES

1.Provides Safety – The chances of accidents and breakdown of railways are minimized to a greater extend. In case of accidents the system provides quality service.

2.Efficiently used in remote places – Because of large carrying capacity of trains the track may get damaged more frequently. By using this system, the rail is checked more accurately even in places where human can't work.

3. Effective use of time – Service is provided at faster rate due to which delay of the train can be minimized.

4. Reduced work – As most of the work is done automatically the workload of railroad brakeman will be reduced.

5.Accurate detection – With the help of IR sensors the exact side (right or left) of crack is detected.

6. Man power is reduced – Manual checking of tracks is not required as sensors do the work. And even automatic closure of level crossing is done without the help of gatekeeper.

X.CONCLUSION

In this project, a method to detect cracks in railway tracks has been presented using image processing techniques. The method replaces manual inspection of the track section, by automatic inspection. A video camera can be installed in separate sections of the track to take images of the track section and then it can be input to the suggested system to detect any cracks in the track section. This will help to detect cracks immediately and reduce the possibilities of any mishappening. Since the system would be automatic and will require less manual intervention, the utmost efficiency of the system can be ensured. System will help to reduce accidents caused due to railway cracks, fire and accidents happening while arriving train to the platform. An automatic method is used to inspect in railway track for crack detection which helps in maintenance and monitoring the condition of railway tracks without any errors. Automatic opening and closing of gate will reduce the rate of accidents and there is no need for an operator. System uses a fire sensor to detect the fire. Quick actions are taken to avoid spreading of fire to other compartments and alert the passengers.

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