Literature Survey on Advanced IOT-Railway Accident Prevention & Detection Techniques

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Abstract — Rail accidents significantly threaten human life and infrastructure, prompting a focus on sensor technologies for prevention. With railways being a vital mode of transportation—carrying over 10 billion passengers and freight worldwide annually—the need for safety is paramount. This paper presents a railway accident prevention system utilizing ultrasonic and vibration sensors for real-time monitoring and early detection of potential threats, such as obstacles on the track. By implementing an Arduino-based safety system, the proposed solution aims to minimize accidents, reduce response times, and enhance overall railway safety. Simulations in Proteus demonstrate that this innovative technology can significantly improve the reliability of safety systems, making it essential for the integrated railway operations of India.

Keywords: Ultrasonic Sensors, Vibration Sensor, Arduino

I. INTRODUCTION

Railway accidents have been a cause of concern for both passengers and authorities, leading to a dire need for effective accident prevention measures. In recent years, the advancements in sensor technology have provided a promising solution to enhance railway safety. By utilizing sensors, we can eliminate or reduce the risk of accidents by detecting potential hazards and warning the concerned parties in real-time. The Indian Railways has the world's fourth largest railway network in the world, after that of the United States, Russia and China .The railways traverse the length and breadth of the country and carry over 20 million passengers and 2 million tons of freight daily. It is one of the world's largest commercial or utility employers, with more than 1.6 million employees. About 15000 trains work every day. Unfortunately there have been many accidents involved in the railways. Indian Railways not only transports passengers and goods, but it also connects the entire nation into a common thread. But till now railway transportation system are not safe. Because of huge Indian railways network, detecting a fault is biggest issue and implementing a new technology comprises with high cost, efforts and time. Not only in India, a lot of countries railway faces many collisions during travelling in every year as a result happened lot of damages, harm and mortalities. But if we add Anti Collision Technology (ACT) in railway then we can prevent any types of collision. It is an modern technology which can be detect collision obstacle from particular distance of train and prevent collision energetically and efficiently by using aurdino microcontroller, ultrasonic sensor and vibration sensor with embedded system. The railway accident is one of the most hazardous accidents ever. This innovative approach involves deploying a network of sensors along railway tracks. These sensors are designed to continuously monitor the track conditions, train behavior, and nearby surroundings to identify any potential dangers that could lead to accidents. For instance, by using vibration sensors, we can detect abnormalities in railway tracks, such as cracks or breaks that could cause derailment or accidents. Enables immediate alerts and notifications to be sent to relevant stakeholders, including train operators, signaling systems, and maintenance teams prevention is crucial to enhance the safety and security of railway systems. With real-time monitoring and quick response capabilities, these sensors provide a proactive approach to identify and eliminate potential hazards, thereby minimizing the risk of accidents and ensuring the well-being of passengers and personnel involved in the railway industry.

II. LITERATURE SURVEY

1) Adoh Lucky Ugochukwu, Akello Fiona Mercy, Nyangassa Faraja, Ishimwe Pascasie (2019) proposed a railway accident prevention system using an Arduino-based safety system. The study focused on the Addis Ababa Light Rail Transit, highlighting the critical role of sensor technology in enhancing railway safety. The authors utilized ultrasonic and vibration sensors for real-time monitoring and early detection of potential obstacles on the track. Their system aims to reduce accidents and improve response times through immediate detection and notification. Simulations conducted in Proteus demonstrated the reliability of this approach, emphasizing its potential integration into existing railway infrastructure to ensure safer transportation.
2) Kumar, R., & Singh, S. (2016). "Real-time monitoring system for railway accident prevention using wireless sensor networks." International Journal of Engineering Research and Applications. The study presents a real-time monitoring system leveraging wireless sensor networks (WSN) to prevent railway accidents. It focuses on early detection of track anomalies and obstacles through sensor-based monitoring. The system aims to improve railway safety by providing real-time data transmission, enabling prompt preventive actions. This approach addresses limitations in traditional monitoring methods, offering an efficient and scalable solution for accident prevention in rail transportation systems.
3) Jia, L., & Li, X. (2018). "IoT-based railway track condition monitoring system." IEEE Internet of Things Journal. The paper introduces an IoT-based system for monitoring the condition of railway tracks in real-time. The authors focus on using IoT-enabled sensors to detect track irregularities and wear, improving the maintenance and safety of railway operations. The proposed system provides continuous data on track conditions, allowing early identification of issues and reducing the risk of accidents. This approach aims to enhance the efficiency

of railway maintenance and ensure the safe operation of trains through proactive monitoring.

4) N. Pavithra, K. Tamil selvi, M. Kowsalya,UG Scholar(2019) "Railway Track Monitoring and Accident Avoiding System". International Journal of Engineering Research & Technology (IJERT). The paper titled "Railway Track Monitoring and Accident Avoiding System" by N. Pavithra, K. Tamil Selvi, and M. Kowsalya (2019) focuses on enhancing railway safety through real-time monitoring of tracks to prevent accidents. The authors propose a system that detects faults in railway tracks using sensors and notifies authorities immediately, thus enabling timely intervention. Their system employs technologies such as GPS and GSM to provide accurate location information of the faulty track segments, helping reduce human errors and delays in detection. The findings suggest that implementing such systems can significantly improve the safety of rail transport, reducing the risk of derailments and accidents caused by track defects.
5) Sarika R. Gujar and Prof. A. R. Itkikar has focused on "Advanced Embedded System of Vehicle Accident Detection and Tracking System". published by IEEE. focuses on developing a system for detecting vehicle accidents in real time and tracking the location of the incident. The authors propose an embedded system that utilizes sensors to detect abrupt changes, such as a collision, and automatically sends alerts to emergency services. The system integrates GPS for tracking the vehicle's location and GSM for transmitting this information. This approach is aimed at reducing response time in emergencies, enhancing road safety, and minimizing fatalities by ensuring quick assistance.
6) The paper titled "Prevention of Railway Accidents by Track and Fire Detection Using IoT" by Y. Pushpa, H. Mahalakshmi, J. Nikhitha, and B. Varsha (2018), published in The International Journal of Novel Research and Development (IJNRD), explores the use of IoT technology for improving railway safety. The authors propose a system that utilizes sensors to detect potential hazards such as track abnormalities and fire incidents. By integrating IoT, the system can continuously monitor these conditions and send real-time alerts to authorities, allowing for prompt intervention. This solution aims to enhance the overall safety of railways by preventing accidents related to faulty tracks and fire outbreaks, thereby reducing the risks to passengers and railway operations.
7) The paper titled "A Review on Accident Prevention Methods at Railway Line Crossing" by Shobhit Gakkahar and Bhupendra Panchal (2018), published in IRJET, provides a comprehensive review of various methods aimed at reducing accidents at railway crossings. The authors highlight the importance of railway crossings as critical points where road and rail traffic intersect, posing significant safety risks. They review traditional methods like gate systems and signage, along with advanced technologies such as automated barriers, sensor-based warning systems, and GPS-enabled tracking to enhance safety. The paper emphasizes the role of technological advancements in minimizing human error, improving response times, and preventing collisions between trains and vehicles at crossings.
8) The paper titled "A Review Paper on Smart Railway Crossing Using Microcontroller" by Sushant M. Gajbhiye, Zen P. Raut, and R. Raju A. Bondre (2020), published in IJERT, focuses on enhancing the safety of railway crossings through the use of microcontroller-based systems. The authors review various smart railway crossing mechanisms that leverage microcontrollers to automate the opening and closing of gates based on real-time detection of approaching trains. These systems utilize sensors and communication technologies to detect train movement and control the barriers without human intervention, thus reducing the risk of accidents caused by human error or delays. The review highlights the efficiency, cost-effectiveness, and reliability of microcontroller-based solutions for improving railway crossing safety.

III. PURPOSED SYSTEM

The purpose of railway accident prevention using sensors is to enhance the safety of railway operations by minimizing the risk of accidents or collisions. By utilizing sensors, the railway system can detect and monitor various parameters in real-time, such as train position, speed, track conditions, and the presence of any obstacles or hazards. These sensors can be installed on the rail tracks, trains, and other relevant locations to provide continuous data on the state of the railway system. The data collected by sensors can be processed and analyzed using advanced algorithms and artificial intelligence to identify potential risks or deviations from the normal operating conditions. This information can then be used to activate automated safety measures, such as signaling warnings, emergency braking systems, or even stopping the train to prevent accidents. Additionally, sensors can also be used to monitor the condition of railway infrastructure, such as track wear and tear, bridge stability, or equipment malfunction. This enables maintenance crews to identify and address potential issues before they lead to accidents or disruptions. The use of sensors for railway accident prevention aims to improve the overall safety, reliability, and efficiency of railway systems, ensuring the protection of passengers, crew members, and the surrounding communities.

IV. EXISTING SYSTEM

In existing system, detects the train by using IR sensors. The DC motor is driven by using an L293d (motor driver) and an Arduino Nano with Atmega328P microcontroller is used to control the device. The arrival of the train is detected by an IR sensor which is placed 1.5km away from the railway gate, then the microcontroller will issue a command to close the gate with an alarm/siren. Upon receiving the information about the arrival of the train the system checks for obstacles that are preventing the closure of gates, then the micro-controller will issue a command to the railway signal which alerts the train and the speed of the train is mechanically decreased or if the gap is implausibly less the train is stopped. So we prefer to suggest an automated system to sense the train

by using two IR sensors and operate railway gates appropriately.

V. METHODOLOGY

The main elements of the prototype model of an Accident prevention system using Sensors for Railway safety messaging are GSM module and Arduino UNO. The proposed system consists of several sensors, Vibration Sensors, Ultrasonic Sensors. The detection of the train is tracked via round trip time of the ultrasonic sensor and a micro-controller is used together with a GPS module to detect accidents. Hence there is two-way communication between the train and the control room. The proposed system is implemented by controlling the automated doors according to the reading of the sensors. When the sensors detect the movement of the rail, they can indicate this in real time through a buzzer and the message, which will eventually close the doors installed at the level crossing. In addition, the coordinates of the rail are transmitted via the GPS module, the GPS module continuously monitors the location. Ultrasonic sensors can also detect the presence of any objects or obstructions on the tracks, allowing train operators to react in a timely manner. This sensor is fitted in front of train engine to detect any obstacle present on track with in the line of sight. It sends appropriate signal to train control system, which in-turn stops train immediately if an obstacle is detected. If obstacle is detected then buzzer will be ON else the buzzer will be OFF Therefore, the stated goal is achieved through real-time two-way communication between the control room and the rail via GPS modules. In this research, a prototype is designed and tested in real time for various scenarios to demonstrate the effectiveness of the proposed system.

VI. FUNCTIONS

A. Location Tracking

Location identification can be done using the Global positioning system which will be attached to the Train. On the detection of an accident, the GLOBAL POSITIONING SYSTEM will trigger and the current location of the Train along with the latitude and longitude will be sent to the control room. In this way, a person related to the control room will get the message as soon as the accident happens and can save the person's life with an immediate rescue.

B. Providing Alert

Sometimes an accident occurs at a remote location where medical help is not provided within the required amount of time and many lives are lost. To avoid this, we fixed a transmitter in the vehicle, which continuously sends the signal to the nearest receiver station. If a sudden accident occurs, the transmitter stops working and the receiver station does not receive any signal. A help message would be sent to the nearest control room with the help of the GSM module. So the accident location can be predicted between two stations and medical help can be provided as exact locations with longitude and latitude are traced.

C. Detect obstacles:

The system needs to identify any potential obstacles on or near the railway tracks, such as fallen trees, debris, or vehicles that may hinder the safe passage of trains. It should be able to detect these obstacles well in advance and send instant alerts to the train operator or control center.

D. Alerting the User

A buzzer is used here to alert the control room if front of train engine to detect any obstacle present on track with in the line of sight. It sends appropriate signal to train control system, which in-turn stops train immediately if an obstacle is detected

VII. BLOCK DIAGRAM

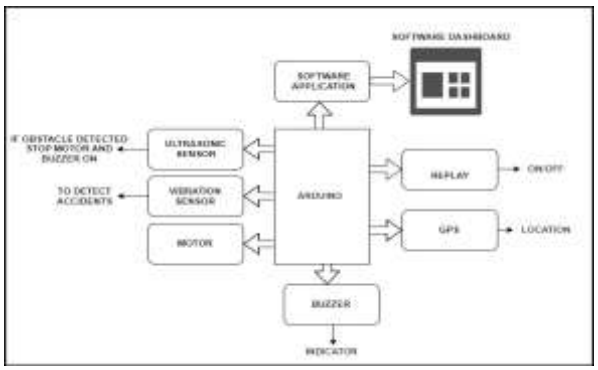

Fig. 1: Block Diagram

VIII. SYSTEM ARCHITECTURE

IX. TECHNOLOGY

A. Java

Java is a class based general-purpose, object-oriented programming language. It is a high-level, strongly typed language with garbage collection that incorporates concepts from several languages including C and C++, but it is not entirely the same. For example, Java does not allow writing unsafe code that might cause vulnerabilities and unexpected behavior. The main building blocks of a Java application are classes, interfaces and packages.

B. Arduino UNO

Arduino UNO is a micro-controller board based on the ATmega328P.It has 14 digital input/output pins, out of which 6 can be used as PWM outputs, 6 analog inputs, a 16MHz

quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. The Arduino Uno can be powered via the USB connection or with an external power supply. The power source is selected automatically. The board can operate on an external supply of 6 to 20 volts thought the recommended range is 7 to 12 volts. 3, 5, 6,9,10 and 11. Provide 8-bit PWM output with the analog write () function. External (non-USB) Power can come either from an AC to DC adapter (wall-wart) or battery. The adapter can be connected by plugging a 2.1 mm center-positive plug into the board's power jack. Leads from a battery can be inserted in the Gnd and Vin pin headers of the POWER connector.

C. GPS

The Navigation System with Timing and Ranging (NAVSTAR) Global Positioning System (GPS) was conceived as a ranging system from known positions of satellites in space to unknown positions on land, sea, in air and space. The GPS constellation consists of 24 satellites in 6 orbital planes with 4 satellites in each plane. The ascending nodes of the orbital planes are separated by 60 degrees and the planes are inclined 55 degrees. Each GPS satellite is in an approximately circular, semi-synchronous (20,200 km altitude) orbit. The orbits of the GPS satellites are available by broadcast - superimposed on the GPS pseudorandom noise codes (PRN), or after post-processing to get precise ephemerides, they are available from organizations such as the Jet Propulsion Lab (JPL) or the International Geodetic Service (IGS) among others. The GPS receivers convert the satellite's signals into position, velocity, and time estimates for navigation, positioning, time dissemination, or geodesy.

X. SENSORS

A. Ultrasonic Sensor

An ultrasonic sensor is an instrument that measures the distance to an object using ultrasonic sound waves. An ultrasonic sensor uses a transducer to send and receive ultrasonic pulses that relay back information about an object's proximity.

B. Vibration Sensor

Vibration sensors are piezoelectric accelerometers that sense vibration. They are used for measuring fluctuating accelerations or speeds or for normal vibration measurement. Maintenance professionals use the sensors in order to predict the maintenance of the machinery, to reduce overall costs and increase the performance of the machine.

C. Relay

A relay is an electrically operated switch. It consists of a set of input terminals for a single or multiple control signals, and a set of operating contact terminals. The switch may have any number of contacts in multiple contact forms, such as make contacts, break contacts, or combinations thereof.

D. Buzzer

The Buzzer used is 1-8S LiPo Battery Voltage Tester low volt alarm buzzer and LED. It is used for testing 1-8S Lipo/Li-ION/LiMn/Li-Fe. The voltage display range: 0.5-4.5V. The 1S Test Mode voltage range: 3.7-30V and there is a low voltage alarm mode for 2-8S. The Alarm set value rang is OFF-2.7-3.8V.In our project the buzzer is used for beep sound indicating the entry of wrong password.

E. Motor

The DC motors are used to operate the gates forward and backward. The principle of working of a motor is that the electrical energy is converted to mechanical energy.

XI. MODULES

A. Control Room:

1) Login
2) Add Trains
3) View Trains
4) Delete Trains
5) View live location of train
6) View obstacle logs with location details
7) View accident logs with location details

B. Users:

1) Register
2) Login
3) View train live location details
4) Add/View /Delete Complaints
   a) Train No.
   b) Train Name
   c) Ticket Photo
   d) Complaint Title
   e) Complaint Description
   f) Complaint Attachments

XII. CONCLUSION

We have proposed system for accident prevention and making the world a much better and safe place tolive. In conclusion, the use of sensors for railway accident prevention has proven to be highly effective in enhancing safety and reducing the occurrence of accidents. The implementation of various types of sensors, such as proximity sensors, speed sensors, and obstacle sensors, has significantly improved the detection and response capabilities of railway systems. These sensors have allowed the detection of potential hazards, such as obstacles on the tracks or trains approaching each other, in real-time, allowing for immediate action to be taken. The use of sensors has also enabled the integration of advanced technologies, such as automatic braking systems and collision avoidance systems, which further enhance safety measures. These systems can automatically apply brakes or divert trains to avoid collisions, minimizing the risk of accidents caused by human error or equipment failure. The implementation of sensors in railway accident prevention has revolutionized the industry by providing real-time information, enhancing safety measures, and improving the overall efficiency of operations.

REFERENCE

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