PLC BASED RAILWAY ACCIDENT AVOIDANCE SYSTEM

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ABSTRACT :-

The paper presents a comprehensive framework for enhancing railroad security by integrating technologies such as signalling arrangements, train closure security systems, automatic railroad gate control, intrusion detection, obstacle detection, tunnel control, and automatic blockade systems. These systems utilize sensors and advanced controls to detect and mitigate potential threats, enhancing security measures and reducing the risk of accidents. Programmable Logic Controllers (PLCs) in railroad systems manage several security protocols, including emergency brake, over-speed control, train door control, and fire detection. They also ensure passenger and train safety by monitoring temperature, pressure, and voltage parameters. In the event of any anomalies, the PLC triggers an alert and takes necessary actions to prevent accidents.

Key Words: : Automatic Barricade System, Automatic Railway Gate Controlling, Crack Detection System, Obstacle Detection, PLC, Signalling Deployment System, Tunnel Power Saving System.

1. INTRODUCTION

The majority of travelers in our country prefer traveling by train due to comfort & affordability it offers.

Even with the implementation of safety standards rail accidents still occur, resulting in loss of lives and property due to poor maintenance and negligence.

On June 2, 2023, three trains collided in Balasore district in Odisha state of eastern India. The Coromandel Express went into a loop at high speed on the main line near Bahanaga Bazar railway station and collided with a freight train. As the Coromandel Express was traveling too fast, 21 of its coaches derailed and three collided with the adjacent SMVT Bangalore Howrah Super Express.[1].

The Ministry of Railways has acknowledged a signaling error as the cause of the tragic triple-train crash in Odisha, resulting in 295 fatalities. Lapses in the signaling-circuit-alteration process at North Signal Goomty station led the Coromandel Express onto the loop line instead of the main line, causing a collision with a stationary goods train.[2].

The error was attributed to previous shortcomings during the execution of work related to replacing Electric Lifting Barrier for a level crossing gate. As a response, the Railway Ministry has implemented various safety measures, including enforcing protocols for system alterations, planning maintenance in advance, verifying signaling gear details, launching a data logging drive, ensuring double locking arrangements, and establishing a system for Signaling & Telecommunication equipment. [3]

To address these challenges, a comprehensive railroad security framework has been presented. It centers on relieving mischances by consequently identifying track deficiencies and impediments, executing measures such as:

1. **Enhanced Signaling Frameworks:** Utilizing trackside sensors and onboard computers to screen prepare positions and conditions, empowering programmed speed alterations for secure separations between trains. 2. Regular Upkeep and Reviews: Actualizing condition observing frameworks and electronic support planning to persistently evaluate the wellbeing of signaling hardware and tracks.
2. **Speed Control Measures**: Introducing onboard speed control frameworks utilizing GPS and accelerometers to uphold speed limits and alter speeds as necessary.
3. **Emergency Reaction Arranging:** Creating electronic crisis plans available by means of onboard computers and preparing trains with communication frameworks for speedy cautions in case of accidents.
4. **Improved Communication Frameworks:** Overhauling communication framework with remote systems and

introducing electronic show sheets for real-time data dispersal to travelers and staff.

2. LITERATURE SURVEY

1. **The Train Accident Prevention System,** developed by Yash Verma, Vineet Kesharwani, Tushar Kesharwani, and Vaibhav Agrawal, aims to enhance railway safety by detecting obstacles on tracks, such as animals and boulders. Utilizing piezoelectric and PIR sensors interfaced with a microcontroller, the system can accurately identify hazards. GPS technology assists in pinpointing the location of obstacles, allowing for timely alerts to nearby stations and trains. Notably, the system can differentiate between various obstacles like landslides and animals, achieving a commendable 95% accuracy rate. Suggestions for improvement include covering PIR sensors and incorporating multiple piezoelectric sensors. Successful deployment of this innovation promises significant benefits, including saving numerous animal lives and mitigating train accidents in a cost-effective manner.

2. **Prevention of wild-life collision in railway tracks using image processing,** Kalaivani A and Hemalatha J have proposed a solution to address the prevalent issue of wildlife collisions on railway tracks in India. Their approach involves leveraging computer vision technology, particularly YOLO object detection, to detect wild animals near railway lines. With an impressive accuracy rate of 98.8%, this system offers a cost-effective and adaptable solution that can be tailored to specific regions. While existing mitigation strategies include wildlife crossing structures, vegetation management, and acoustic warning systems, continued research and implementation efforts are needed due to the expanding rail networks. Early detection and continuous monitoring of wildlife using advanced technology can significantly reduce wildlife-train collisions and their adverse effects on both wildlife and humans. However, further exploration and adoption of additional mitigation measures may be necessary to achieve optimal results.

3. Chethan S, Sebin Mathew, Vivek Purushotham, and Raghu J have developed a system aimed at detecting cracks in railway tracks efficiently and cost-effectively. Their proposed solution involves utilizing sensors such as IR and ultrasonic sensors, along with an Arduino Uno microcontroller, GPS module, GSM module, and LED signaling system. When a crack is detected, the system immediately halts the vehicle and sends a text message to the maintenance department containing the GPS location. This automated process is not only inexpensive and consumes low power but also significantly reduces analysis time compared to manual inspections. By swiftly identifying cracks, this system facilitates prompt repairs, enhancing railway safety and potentially saving lives.

3. Methodology

3.1 Proposed System :-

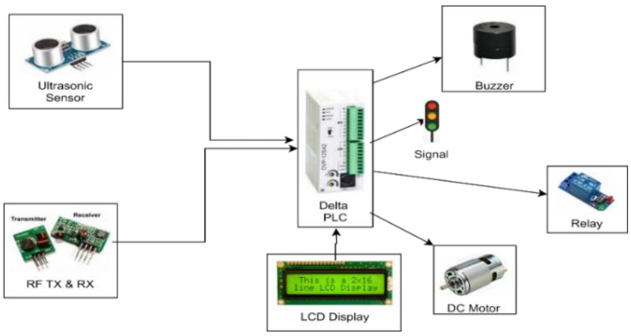

Fig. 3.1 Block Diagram of Proposed System

1. **Ultrasonic Sensor:** Utilizes ultrasonic waves to detect objects and measure distances, useful for obstacle detection on tracks or determining train positions.
2. **RF TX & RX (Radio Frequency Transmitter & Receiver):** Enables wireless communication for remote control or data transmission between different railway system components.
3. **Delta PLC (Programmable Logic Controller):** Robust industrial computer used for automating control processes, managing signaling, gate operations, and safety protocols in railway systems.
4. **Buzzer:** Audio signaling device that emits sound alerts upon detecting issues or obstacles, providing warnings to nearby personnel or passengers.
5. **Relay:** Electrically operated switch for controlling high-power circuits, essential for operating railway signals, crossings, and track switches with low-power signals.

6. **LCD Display (Liquid Crystal Display):** Shows information such as train schedules, warnings, and diagnostics, used in control rooms or on trains to convey important data.

3.2 DC Motor: Direct Current motors with variable speed and torque capabilities, employed in railway systems to control mechanisms like gate operations at crossings or adjust camera/sensor orientations.

3.3 Anti Collision System:

Two independent systems have been developed to prevent train collisions

1. **Signaling Deployment system:-** Utilizes IR sensors positioned at incoming and outgoing paths of loop lines. When the train is detected, signals are sent to the signaling system and displayed on an LCD at the entry point. It provides real-time information to train operators that helps in decision-making and ensuring safer train movements.

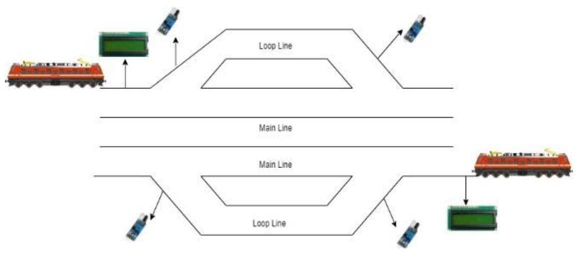

Fig.3.2.1 Signal Deployment System

1. **Train End Safety System :-** It employs ultrasonic sensors at first and last coaches of train. It measures distance between trains And approaching or departing trains on same track. It displays real time distance data in train cabin, enabling loco pilot to manage speed and maintain safe distance. It enhances safety by providing critical information to prevent collisions and enable proactive measures [4] .

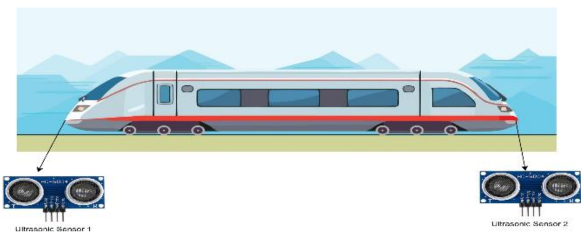

Fig. 3.2.2 Train End Safety System

3.3 Automatic Railway Gate Controlling :

It employs sensors to detect arrival of train 5km from the crossing. Upon detection, signals are sent to controller to check for vehicles between gates. Buzzer indications and light signals alerts road users of train arrival and if no vehicles are detected gates are closed via motor activation. In case of obstacle, system informs the loco pilot via RF trans-receiver before train reaches 2 km from gate.[5]

3.4 Crack Detection System:

It utilizes IR sensor mounted at front end of train facing the track. As the train moves, IR sensor continuously emits IR light onto the track, which is then reflected back to sensor. When emitted light encounters a crack or irregularity in track, it reflects differently, allowing sensor to detect variations. Upon detecting a crack the IR sensor sends signal to controller, activate emergency breaks and stopping train automatically. This system enhances railway safety by identifying track defects and preventing potential accidents. [6]

Fig. 3.4.1 Placement Of IR sensor to crack detection

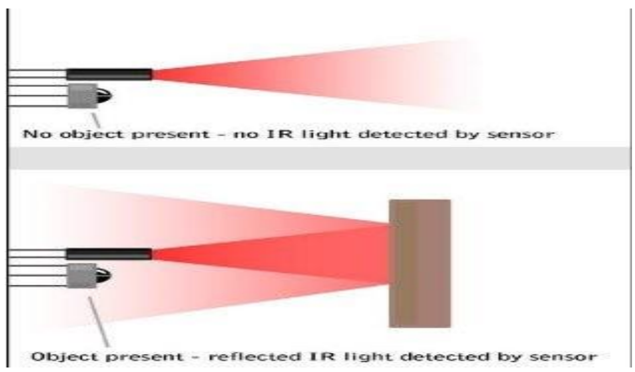

Fig. 3.4.2 Working Principle of IR sensor to detect Crack.

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3.5 . Obstacle Detection :-

Train employs ultrasonic sensors that emits sound waves to detect obstacles. When obstacle is present waves are reflected back to sensor, allowing it to calculate distance to obstacle. If obstacle is detected system notifies user and automatically reduces train speed to avoid collision.[7]

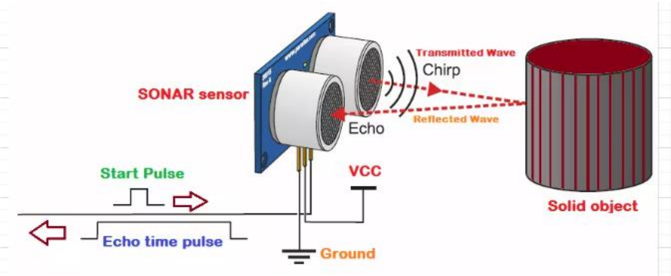


Fig. 3.5 Working Principle of Ultrasonic Sensor for obstacle detection

3.6 Tunnel Power Saving System:-

It utilizes two pairs of IR sensors placed at entrance and exit of tunnel. When train crosses line of sight of IR at tunnel entrance a signal is sent to controller which activates lights inside the tunnel. When train passes IR sensor at tunnel exit, another signal is sent to PLC to switches of the lights. This system ensures efficient use of power by illuminating tunnel only when train is passing through it, enhancing energy conservation and reducing electricity consumption. [8]

3.7 Automatic Barricade System:-

Installed at train station feature a barrier positioned between platform and train. Barrier remains upright to prevent passengers from accessing tracks. When IR sensors detect trains arrival at station, barrier automatically moves to horizontal position, enabling passengers to enter train safely. Upon departure of train, barrier returns to upright position. Movement of fence is facilitated by servo motor, ensuring seamless operation. Overall system enhances safety at station by controlling passenger access to tracks during arrival and departure.[9]

4 Software Used

4.1 ISPSoft :- ISPSoft is a software development tool designed for Delta's latest programmable logic controllers. It adheres to the IEC 61131-3 standard, offering support for seven programming languages and incorporating numerous applied instructions. Besides fundamental programming capabilities, ISPSoft also features various auxiliary tools. Its multilingual interface and user-friendly design aim to provide developers with a convenient and efficient development environment.

4.2 Ladder Programming

4.2.1 Automatic gate control system

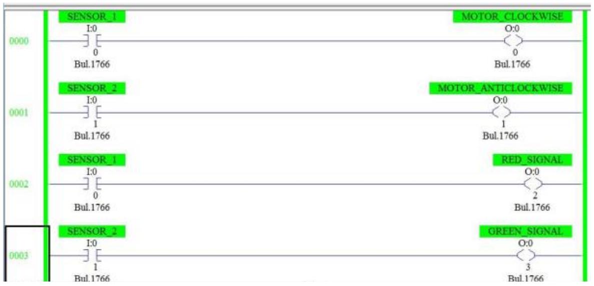


Fig. 4.2.1 Ladder Diagram For Automatic Gate Control System.

Rung 0,1 :- When train arrives near IR sensor 1, motor gets on and rotate clockwise to close level gate. At rung 2 traffic light indicators RED Light when sensor 1 gets on.

Rung 1,3 :- When train passes IR sensor 2, motor gets on to open the gate. At rung 3 green signal is turned on.

4.2.1 Tunnel Power Saving :-

Fig. 4.2.2 :- Ladder Diagram For Tunnel Power

Rung 0 :- When train arrivals at IR 1 Light gets turned on in the tunnel.

Rung 1:- When train passes the IR 2 Lights in tunnel gets turned OFF.

Rung 2:- When there is any fire is detected by the smoke sensor, smoke sensor gets on that will turns on exhausted fan

4.3.1 Anti-collision System.

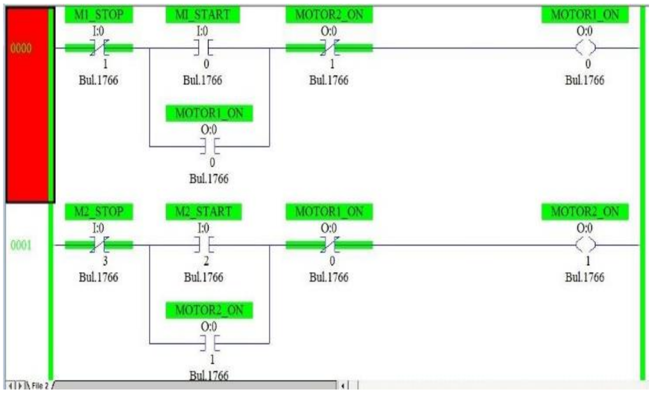


Fig. 4.3.1 : - Ladder Diagram For Anti-Collision System

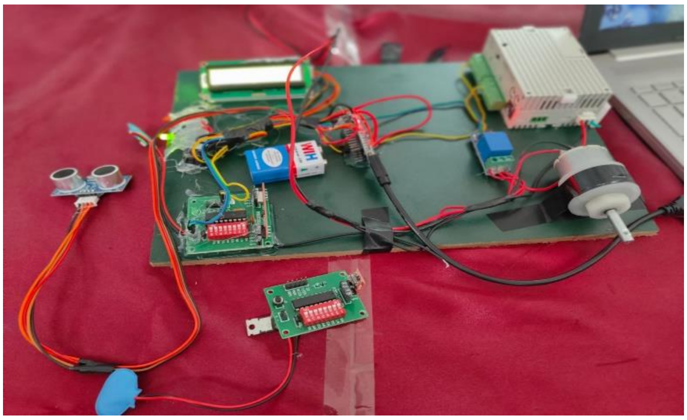
Rung 0 :-

When start PB 1 gets ON Motor 1 gets turned ON & Motor 2 gets turned OFF.

Rung 1 :-

When start PB 2 gets ON Motor 2 gets turned ON & Motor 1 gets turned OFF.

4.4 Proposed Model



5 Conclusion

The paper introduces a comprehensive accident prevention system tailored for railways, designed to identify three critical hazards: cracks in tracks, obstacles on the tracks, and fires in train bogies. By automatically detecting these issues, the system aims to enhance railway safety significantly. Upon detection, the system promptly notifies authorities, enabling them to take immediate action. Additionally, the system's applicability extends beyond railways; it can be adapted for use in other vehicles to minimize accidents. In essence, the proposed system offers a proactive approach to safety, leveraging advanced technology to mitigate risks and ensure timely intervention for the prevention of accidents.

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