Automatic Platform Bridge Connector in Railways Using Embedded System

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Abstract- *The project "Automatic Platform Bridge Connector in Railways Using Embedded System" is designed to improve passenger safety and operational efficiency at railway stations. The system utilizes an Arduino microcontroller to control a DC motor that automatically connects two platforms through a movable bridge. Infrared (IR) sensors detect the arrival and departure of trains, triggering automatic bridge operation to ensure safe timing. An LED indicator alerts passengers about approaching trains, while a relay module ensures precise motor control for bridge movement. A 16x2 LCD display provides real-time updates on train detection and bridge status. By eliminating manual operation, this system reduces the risk of accidents, enhances passenger convenience, and ensures safe and intelligent platform connectivity in railway environments. The system's design emphasizes automation, reliability, and safety integration. When an incoming train is detected by the IR sensors, the Arduino immediately deactivates the bridge by controlling the DC motor through the relay module, preventing passengers from crossing. Once the train safely departs and the sensors confirm a clear track, the Arduino reactivates the motor to reconnect the bridge automatically, allowing safe passage between platforms. The LCD display continuously updates the bridge and train status, while the LED indicator visually warns passengers of train movements. This automated mechanism not only minimizes human error but also ensures efficient station management, making it a cost-effective and intelligent solution for modern railway infrastructure.*

Keywords: Railway bridge, passengers, crossing bridge, infrastructure, transportation, automation

I. INTRODUCTION

Railway transportation plays a crucial role in connecting cities and facilitating passenger movement. However, one of the common safety concerns at railway stations is the gap between platforms and train doors, which can cause serious accidents, especially for elderly or disabled passengers. Traditional methods rely on manual bridge placement or warning announcements, which are often unreliable and prone to human error. In India, the railway system mainly depends on manual operations, which makes it challenging for elderly and disabled passengers to travel . At many railway stations, passengers use bridges and stairs to move between platforms. This can be particularly tough for those who have difficulty in climbing stairs or balancing. Although there are lifts and escalators, they can still be inconvenient and take extra time, making travel a frustrating experience for older adults and people with disabilities.

To overcome these challenges, the project "Automatic Platform Bridge Connector in Railways Using Embedded System" introduces an automated mechanism that connects the gap between two platforms using a movable bridge controlled by an Arduino microcontroller. The system employs Infrared (IR) sensors to detect the arrival and departure of trains.

When a train approaches, the IR sensor detects its presence, and the Arduino deactivates the bridge movement to ensure safety. Once the train departs, the system automatically activates the DC motor to move the bridge back into position, reconnecting the platforms.

II. PROBLEM STATEMENT

In many railway stations, passengers face significant risks when crossing between platforms, particularly where foot over bridges or subways are unavailable or overcrowded. Manual operation of movable bridges can lead to unsafe timing, delayed responses, and potential accidents due to human negligence. There is a lack of a reliable, automated mechanism to detect train movement and control the bridge operation accordingly. Therefore, a system is required that can automatically detect train arrivals and departures and control the bridge movement to ensure the safety of passengers at all times.

III. OBJECTIVES

- To design and develop an automatic platform bridge connector system using an Arduino microcontroller.
- To implement IR sensors for detecting train movement accurately.
- To control the bridge operation using a DC motor and relay module for safe and efficient movement.

- To provide real-time status updates on an LCD display for user awareness.
- To enhance passenger safety and reduce human intervention in bridge control operations.

IV. SCOPE OF THE PROJECT

The proposed system can be implemented in railway stations where there is a need for automatic control of movable platform bridges. It provides a cost-effective, low-maintenance, and scalable solution suitable for both small and large stations. The system can be further expanded with IoT integration for remote monitoring and control. It ensures complete automation of bridge operation, real-time status display, and visual alert indications, contributing to a safer and smarter railway environment.

V. PROPOSED METHODOLOGY

The system is based on an embedded control mechanism using an Arduino microcontroller. IR sensors are placed near the railway track to detect the arrival and departure of trains. When a train approaches, the sensors send a signal to the Arduino, which triggers the relay module to deactivate the DC motor and retract the bridge. Once the train passes and the track is clear, the sensors detect the absence of the train, and the Arduino commands the motor to reconnect the bridge. The LCD displays train and bridge status, and an LED indicator provides visual alerts for passengers. The design combines hardware control, real-time sensing, and automated decision- making for safe and efficient operation.

A relay module is used to control the direction of the motor, while an LED indicator alerts passengers about an incoming train. A 16x2 LCD display provides real-time information such as “Train Detected,” “Bridge Retracted,” or “Bridge Connected.” This intelligent system minimizes manual intervention, ensures passenger safety, and enhances the efficiency of railway operations. The proposed embedded system can be easily integrated into existing railway infrastructure, making it a cost-effective and scalable solution for modern railway automation. Its combination of sensor-based detection, automatic control, and user alerts helps create a safer and smarter transportation environment.

VI. PROPOSED SYSTEM DESIGN

The proposed system introduces a fully automated platform bridge connector using an Arduino microcontroller, IR sensors, and a DC motor controlled via a relay module. The IR sensors continuously monitor train movement. When a train is detected approaching the station, the Arduino receives the sensor input and automatically commands the motor to retract the bridge, preventing passengers from crossing. Once the train departs and the track is clear, the system extends the bridge back to its connected position.

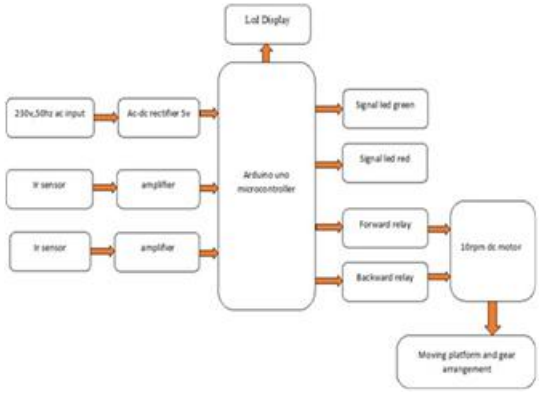

Figure 1: Proposed System Block Diagram

An LED indicator and a 16x2 LCD display provide real-time updates and visual alerts to passengers, showing train status and bridge position. This intelligent automation ensures precise control and improved safety without requiring manual intervention.

VII. DESIGN AND IMPLEMENTATION

The working of the Automatic Platform Bridge Connector system follows a structured and automated sequence controlled by the Arduino microcontroller. Initially, the system remains in a standby state where the movable bridge is connected between platforms, allowing passengers to cross safely. The IR sensors continuously monitor the railway track for train movement.

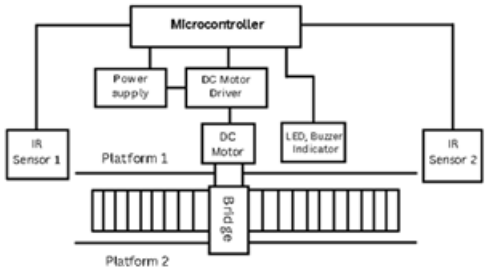

Figure 2: System Implementation

When a train approaches the station, the IR sensor detects the obstruction of the infrared beam and immediately sends a signal to the Arduino. Upon receiving this signal, the Arduino executes the programmed control logic to ensure passenger safety. The controller activates the relay module, which cuts off or reverses the DC motor operation, causing the bridge to retract from its connected position. Simultaneously, the LED indicator is turned ON to alert passengers, and the

LCD display updates the status to indicate "Train Detected – Bridge Disconnected." During the presence of the train, the bridge remains in the retracted position, preventing any accidental crossing between platforms. The system continuously checks the sensor output to confirm train movement.

Once the train has completely departed and the IR sensors no longer detect any obstruction, the Arduino identifies that the track is clear. The controller then deactivates the warning state and triggers the relay module to operate the DC motor in the opposite direction. This action reconnects the movable bridge between the platforms. The LED indicator is turned OFF, and the LCD updates the status to "Track Clear – Bridge Connected." This fully automated sensing and control mechanism eliminates the need for manual intervention, reduces human error, and ensures precise timing of bridge operation. By integrating real-time sensing, embedded decision-making, and electromechanical control, the system enhances passenger safety and improves operational efficiency in railway stations.

VIII. HARDWARE CIRCUIT DESCRIPTION

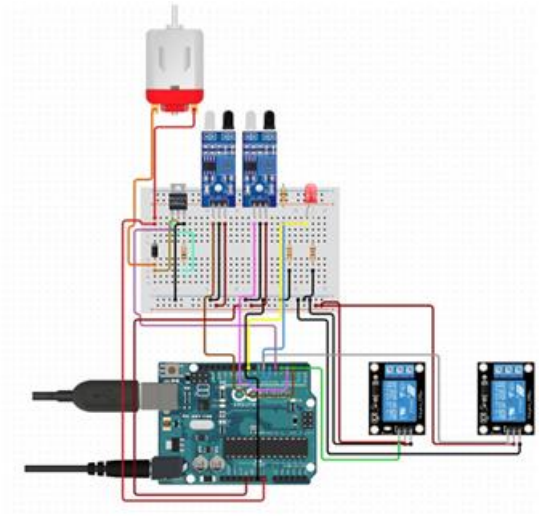

Figure 3: Circuit Diagram of Hardware

The circuit of the proposed Automatic Platform Bridge Connector in Railways Using Embedded System is centered around an Arduino microcontroller, which acts as the main control unit. The Arduino is responsible for processing sensor inputs, executing decision logic, and controlling output devices such as the DC motor, relay module, LCD display, and LED indicators.

Infrared (IR) sensors are installed near the railway track at strategic locations to detect the arrival and departure of trains. These sensors consist of an IR transmitter and receiver pair. The output pins of the IR sensors are connected to the digital input pins of the Arduino. When a train interrupts the IR beam, a logic signal is generated and sent to the controller.

A relay module is interfaced with the Arduino to provide isolation and safe switching for the DC motor. Since the DC motor operates at a higher current than the Arduino can supply directly, the relay acts as an electromechanical switch. The relay control pin is connected to a digital output pin of the Arduino, enabling the controller to turn the motor ON or OFF based on sensor inputs. The DC motor is mechanically coupled to the movable platform bridge. Depending on the relay activation, the motor either retracts the bridge to disconnect the platforms or extends it to reconnect them after the train has passed. A 16×2 LCD display is connected to the Arduino using either parallel or I²C communication lines. The LCD provides real-time visual feedback regarding train detection status and bridge position, such as "Train Approaching," "Bridge Disconnected," or "Bridge Connected."

An LED indicator is connected to one of the digital output pins of the Arduino through a current-limiting resistor. This LED serves as a visual warning signal for passengers, indicating the presence or movement of a train. The entire circuit is powered using a regulated DC power supply. The Arduino provides logic-level voltages to sensors and display modules, while the motor power is supplied through the relay circuit, ensuring electrical safety and system reliability.

IX. RESULT AND DISCUSSION

The implemented Automatic Platform Bridge Connector successfully demonstrates the concept of railway safety automation using embedded systems. The project effectively utilizes IR sensors to detect train movement and triggers automatic bridge control through the Arduino microcontroller. During testing, when a train (simulated object) passed the entry IR sensor, the system instantly detected its presence. The relay turned off the DC motor, retracting the bridge to prevent accidents. The LED indicator glowed to warn passengers, and the LCD display showed the real-time message "Train Detected – Bridge Retracting.". Once the train cleared the platform, the exit IR sensor detected the departure, and the Arduino activated the motor again to reconnect the bridge automatically. The LCD displayed "Train Left – Bridge Connecting." The bridge returned to its original position, ensuring safe crossing for passengers.

The system was tested under different lighting and environmental conditions, and the IR sensors responded

reliably. The bridge's response time was minimal, ensuring safety without delay. Compared to manual bridge operation, this automated solution eliminated human errors, improved accuracy, and increased passenger safety and convenience. This design can be expanded by adding IoT connectivity for remote monitoring or voice announcements for visually impaired passengers. The system proves that embedded automation can be an effective, cost-efficient, and scalable solution for modern railway stations.

Test Results

- The bridge initially extends from inside the platform, forming a connection between the two platforms.
- Upon detection of an oncoming train by the first IR sensor, it sends a signal to the microcontroller.
- The microcontroller then directs the DC motor to initiate the sliding movement of the bridge, retracting it back inside the platform.
- As the train passes through the second IR sensor, signaling clearance, the microcontroller commands the DC motor to extend the bridge towards the platform's edge, reconnecting the platforms.
- This extended position is maintained until the first IR sensor detects another oncoming train, prompting the need for retraction.
- The cycle repeats continuously, with the bridge extending to connect the platforms when a train approaches and retracting when no train is detected.
- This automated process ensures efficient and timely platform access, specifically tailored for train arrivals and departures.
- It enhances accessibility and convenience for users, particularly elderly and handicapped individuals, during railway operations.

X. CONCLUSION

The project "Automatic Platform Bridge Connector in Railways Using Embedded System" provides an innovative and practical solution to enhance passenger safety and operational efficiency in railway platforms. By using Arduino,

IR sensors, DC motor, and relay modules, the system achieves automatic detection of trains and real-time control of the platform bridge without manual intervention.

The results show that the system operates accurately in detecting train movements, retracting the bridge during train arrival, and reconnecting it after the train departs. This automation minimizes accidents, saves manpower, and improves passenger convenience.

In conclusion, the proposed system demonstrates the potential of embedded technology to create a safer and smarter railway infrastructure. It can be further developed by integrating IoT for remote supervision, solar power for energy efficiency, and wireless alerts for enhanced functionality in future implementations.

XI. ADVANTAGES

- Enhanced passenger safety through automatic detection and bridge control.
- Elimination of human error by using sensor-based automation.
- Real-time display of train and bridge status via LCD for user awareness.
- Efficient and quick response to train arrivals and departures.
- Reduced manpower requirement, minimizing operational costs.
- Improved system reliability with consistent, repeatable operation.
- Scalable design, allowing integration with IoT or cloud-based monitoring in future enhancements.

REFERENCES

[1] M. Ramesh and K. Kumar, "Automation of Railway Platform Gate System Using IR Sensors and Microcontroller," IEEE Access, vol. 9, pp. 12045–12052, 2021.

[2] S. Priya and M. Anitha, "Smart Railway Crossing Control Using Embedded Systems," IEEE Transactions on Intelligent Transportation Systems, vol. 23, no. 5, pp. 4256–4264, 2022.

[3] P. Ranjith, K. S. Babu, and R. Dinesh, "IoT-Based Train Detection and Passenger Safety System," IEEE Internet of Things Journal, vol. 8, no. 9, pp. 7891–7898, 2021.

[4] K. Divya and R. Suresh, "Automatic Railway Platform Safety System Using Embedded Technology," IEEE Sensors Journal, vol. 22, no. 14, pp. 14380–14387, 2023.

[5] A. John, P. Verma, and R. Thomas, "Microcontroller-Based Railway Automation System," IEEE Transactions on Industrial Electronics, vol. 68, no. 11, pp. 10940–10948, 2019.

[6] R. Patel and A. Desai, "Design and Implementation of an Intelligent Railway Platform Bridge System," IEEE International Conference on Smart Technologies (ICST), pp. 275–280, 2022.

[7] S. Mehta and B. Rao, "Embedded System-Based Railway Safety Monitoring Using IR Sensors," IEEE Conference on Automation, Control and Intelligent Systems, pp. 110–114, 2020.
[8] T. Venkatesh, N. Raj, and M. Devi, "Wireless Sensor-Based Railway Safety Monitoring System," IEEE Sensors Applications Symposium (SAS), pp. 221–225, 2021.
[9] P. Kumar and D. Banerjee, "Automation in Railway Platform Systems Using Arduino," IEEE International Conference on Emerging Trends in Engineering and Technology, pp. 94–98, 2020.
[10] S. Gowri and J. Mohan, "Microcontroller-Based Safety Bridge Connector for Railway Platforms," IEEE Smart Infrastructure Conference, pp. 55–60, 2023.
[11] L. Joseph and A. Rajesh, "Sensor-Assisted Railway Automation Using IoT and Embedded Systems," IEEE IoT Journal, vol. 7, no. 12, pp. 12001–12010, 2020.
[12] P. Arul and G. Nandhini, "Automatic Train Detection and Barrier Control Using Infrared Sensors," IEEE Region 10 Symposium (TENSYMP), pp. 250–255, 2022.