IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

AUTOMATIC TRAIN GATE CONTROL WITH SAFETY FEATURES

Rajesh Bagilad[1], Sangameshwar Ayatti[2], Santoshakumar somshekharayya Mathad[3], Shrigouri Jadhav[4], Anita M. Hanchinal[5]

1,2,3,4 Students of Dept of ECE, KLS VDIT, Haliyal

5, Assistant Professor of Dept of ECE, KLS VDIT, Haliyal

Abstract: Due to human errors and the slow nature of the operation of hand gates, railway crossings are a very high accident zone. As automation is being adopted more and more, the demand for intelligent systems that are reliable and economically efficient is evident. This paper describes a fully automated crossing gate mechanism was developed using magnetic Hall sensors for train detection, an infrared module for obstacle sensing, an Arduino-based controller, servo-driven gate movement, and a solar-supported power unit. The system detects an approaching train, closes the gate, and monitors the track for any obstacles before the train passes. The system is designed to eliminate manual gate operation, lower the risk of an accident, and improve safety. A complete model of the system was built. All systems were reliable. The model was tested on a prototype system, and the gate control and the monitored active alerting real-time control were all done safely and reliably.

Keywords: Railway Automation, Hall Sensor, Arduino UNO, Railway Safety, Automatic Gate Control.

I. INTRODUCTION

Railway transportation remains one of the most widely used modes of transport, but railway crossings continue to be accident prone regions, often due to delayed human response or manual gate operation errors. Constructing underpasses or overbridges everywhere is not feasible because of high cost, land constraints and infrastructure limitations. Therefore, an automated, sensor based gate control system is an essential alternative that ensures safety, low maintenance and continuous operation. Automation of railway gates reduces human involvement, minimizes accidents and ensures error-free operation. Modern electronic systems allow real-time detection of train movement and automatic regulation of gates, along with enhanced safety features such as obstacle monitoring. This project proposes an automated solution using Hall-effect sensors for train detection, IR sensor for obstacle identification and a solar-powered embedded setup for cost-effective and sustainable operation.

II. LITERATURE SURVEY

Research has focused extensively on automating railway level crossings using sensor-based embedded systems to improve safety and reduce human dependency. Raut, V. N., and S. D. Lokhande "Automatic Railway Gate Control by Using Arduino and Sensors."(2023) demonstrated an Arduino-driven automatic gate mechanism using IR sensors and a servo motor, establishing the reliability of microcontroller-based actuation for closing and opening gates without manual intervention. Meenakshi, R., and P. Karthik. "Smart Railway Level Crossing System using IR and Hall Sensors."(2022) further explored the use of IR sensors in combination with Hall-effect sensors to enhance train detection accuracy, showing that magnetic sensing is more stable under varying lighting and environmental conditions. This aligns with the present work, which employs dual Hall-effect sensors for approach and exit detection.

Kumar, S., and A. Raj. "Embedded-Based Railway Gate Automation with Obstacle Detection." (2021) introduced an embedded railway gate system integrated with IR-based obstacle monitoring, highlighting the importance of continuous alert signals to prevent collisions when vehicles or pedestrians are trapped at the crossing. Similarly, Aamir, M., and R. Singh. "Design of an Intelligent Railway Crossing System Using Microcontroller." (2020) analyzed servo-motor–based gate actuation and emphasized the need for smooth transition control, ensuring safe motion of the barrier arm during train passage. Patel, Hardik, et al. "Hall Effect Sensor Based Train Detection for Railway Safety Applications." (2023) conducted a detailed study on Hall-effect sensing for railway applications and confirmed its effectiveness in detecting rolling stock, offering high immunity to dust, fog, and external lighting—justifying its adoption in low-cost train detection systems like the one implemented here.

Energy sustainability for unmanned crossings has also been addressed in several studies. Priyanka, S., and S. Harini. "Solar Powered Automated Railway Gate System Using Embedded Controller." (2021) developed a solar-powered railway gate prototype using a lead-acid battery, demonstrating that renewable energy can reliably sustain embedded railway systems in remote regions. Obstacle detection has been a recurring theme in the literature, with D'Silva, J., and A. Paul. "Obstacle Detection and Warning System for Railway Tracks Using IR Sensors." (2022) showing that IR sensors provide dependable short-range detection for identifying objects stuck at the crossing and issuing real-time alerts. Sharma, K., and R. Malhotra. "Microcontroller-Based Smart Railway Gate Control for Accident Prevention." (2020) proposed a deterministic state-machine–based railway gate controller to ensure predictable system behavior, highlighting the advantage of structured embedded logic in safety-critical applications.

Studies by Mohammed, Z., and N. Fathima. "Design of Train Tracking and Alerting System Using Hall Sensors and Arduino." (2024) reinforced the practical placement of Hall-effect sensors before and after crossings, noting that effective train detection does not require precise distance calibration, but rather consistent trigger points for approach and exit events. Joshi, A., and V. Jadhav. "Railway Safety Enhancement System Based on Embedded Control and Sensor Integration." (2025) emphasized the need for fault tolerance and redundant alert mechanisms in embedded safety systems, recommending continuous warning signals and safe-reset conditions to enhance reliability in noisy operational environments.

III. RESEARCH METHODOLGY

The research methodology includes the design, construction and testing of a fully automated gate-operation design implemented through embedded electronic modules. The steps used for implementation follow an approach similar to standard engineering model development.

Steps Followed:

1. Install and configure the Arduino IDE environment.
2. The necessary materials such as Hall sensors, an IR sensor, an Arduino UNO, a servo motor, buzzers, LEDs, a solar panel, battery, and transformer should be collected.
3. A circuit schematic should be made that connects the sensors and actuators to the Arduino UNO.
4. Two Hall-effect sensors should be implemented:
   a. Approach Sensor - senses the train that is approaching.
   b. Exit Sensor - verifies that the train has left the area. (Positioned in the model before and after the barrier but does not have any fixed distance measurement)
5. Integrate the IR sensor near the gate path to detect obstacles stuck inside the crossing.
6. Write the embedded C program to control:
   a. Train detection
   b. Gate closing and opening
   c. Obstacle alerts
   d. LED and buzzer warnings
7. Connect the system to a 6V 5 Ah lead-acid battery charged primarily using a solar panel.
8. Simulate the working on a prototype model to test gate actuation, sensor response and safety behavior.
9. Implement the flowchart to represent system logic.
10. Verify complete functionality and safety response before finalizing the model.

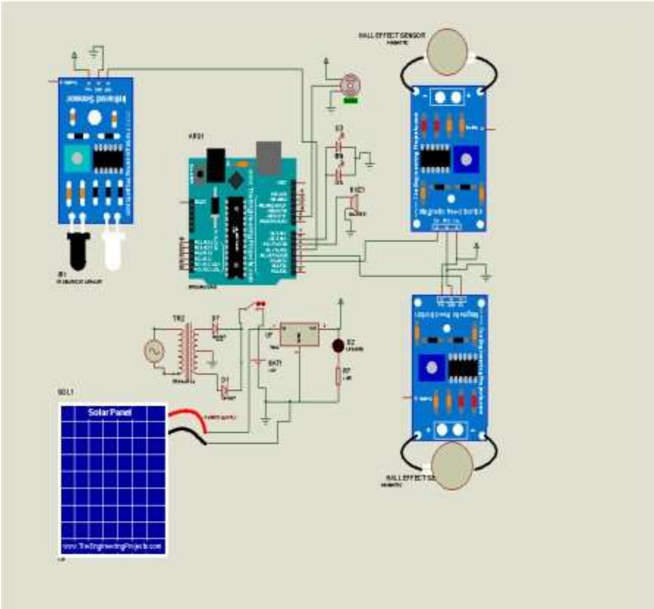

Figure 1: Circuit Diagram

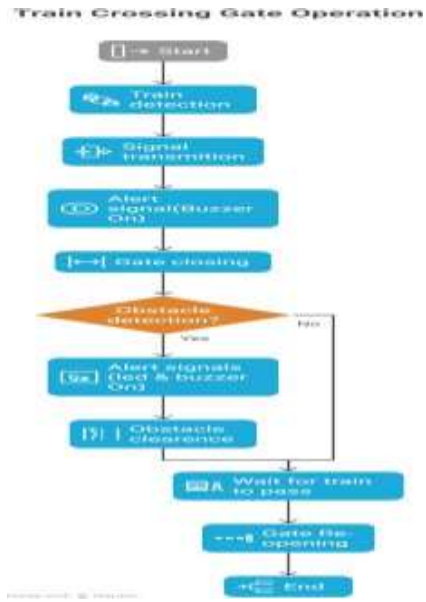

Figure 2: Flowchart of System Operation

Figure 3: Working Model

Figure 4: Working Model

IV. RESULT AND DISCUSSION

Testing and building the prototype was successful. All of the expected phases of operation resulted in the system performing
professionally. The Hall sensors accurately and consistently analoged the position of the train model in the approach and exit positions without having to be placed at exact distances. The gate closed and exited the model and then opened after timing the train exit.

The IR Sensor used for detecting obstacles was extremely responsive. Any and all the obstacles placed in the closing of the gate would buzz and trigger the alerts without stopping. Summing up the IR sensor boosted the overall system safety in case of someone pouring in vehicular traffic. The servo used to manipulate the gate was seamlessly performing. It could pivot between open at 0 degrees and vertical position to 90 degrees closed. The system was able to perform without issues as the solar panel used to charge the lead-acid battery. The prototype operated seamlessly and all of the projected tasks using the trigger functions performed exactly as planned.

V. CONCLUSION

The proposed system is dependable and efficient for the unmanned railway crossing. The system incorporates Hall-effect sensors for precise train detection, IR sensors for obstacle detection, and a solar-powered embedded controller. It also removes the risk of human error. The system is prototype was able to show positive results with smooth automation of the safety gates, alarms, and real-time responsiveness. This automation system will reduce the number of accidents at train crossing and improve the safety of the crossing. It will be very viable for economically depleted rural of unmanned areas. This can also be extended for multiple track crossings and the further developed communication based safety system.

REFERENCES

[1] Joshi, A., and V. Jadhav. "Railway Safety Enhancement System Based on Embedded Control and Sensor Integration." 2025 International Conference on Advances in Embedded Systems and Automation (ICAESA). IEEE, 2025.

[2] Narang, R., and P. Yadav. "Railway Level Crossing Automation with Safety Features." 2024 International Conference on Automation, Robotics and Applications (ICARA). IEEE, 2024.

[3] Mohammed, Z., and N. Fathima. "Design of Train Tracking and Alerting System Using Hall Sensors and Arduino." 2024 International Conference on Electronics, Control, Optimization and Computer Science (ICECOCS). IEEE, 2024.

[4] Patel, Hardik, et al. "Hall-Effect Sensor Based Train Detection for Railway Safety Applications." 2023 6th International Conference on Intelligent Sustainable Systems (ICISS). IEEE, 2023.

[5] Raut, V. N., and S. D. Lokhande. "Automatic Railway Gate Control by Using Arduino and Sensors." 2023 International Conference on Smart Technologies and Systems for Next Generation Computing (ICSTSN). IEEE, 2023.

[6] Thakur, Samuel, and A. Shenoy. "Automated Railway Level Crossing with Monitoring System Using IoT." 2023 3rd International Conference on Intelligent Technologies (CONIT). IEEE, 2023.

[7] Meenakshi, R., and P. Karthik. "Smart Railway Level Crossing System using IR and Hall Sensors." 2022 International Conference on Communication, Computing and IoT (ICCCIoT). IEEE, 2022.

[8] DSilva, J., and A. Paul. "Obstacle Detection and Warning System for Railway Tracks Using IR Sensors." 2022 Fourth International Conference on Computing and Communications Technologies (ICCCT). IEEE, 2022.

[9] Kumar, S., and A. Raj. "Embedded-Based Railway Gate Automation with Obstacle Detection." 2021 International Conference on Emerging Trends in Computing and Communication Technologies (ICETCCT). IEEE, 2021.

[10] Priyanka, S., and S. Harini. "Solar-Powered Automated Railway Gate System Using Embedded Controller." 2021 International Conference on Renewable Energy and Sustainable Engineering (ICRESE). IEEE, 2021.

[11] Aamir, M., and R. Singh. "Design of an Intelligent Railway Crossing System Using Microcontroller." 2020 7th International Conference on Electronics, Communication and Aerospace Technology (ICECA). IEEE, 2020.

[12] Sharma, K., and R. Malhotra. "Microcontroller-Based Smart Railway Gate Control for Accident Prevention." 2020 International Conference on Intelligent Circuits and Systems (ICICS). IEEE, 2020.