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Automatic Train Ramp System for Physically Challenged People

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Abstract* - Railway transportation plays a vital role in public mobility however, accessibility remains a major concern for physically challenged individuals, elderly passengers, and wheelchair users. The gap and height difference between train doors and station platforms often make boarding and alighting difficult, leading to safety risks and reduced independence. To address these challenges, various automated boarding assistance systems have been proposed in recent years. Among them, automatic ramp mechanisms have gained significant attention due to their ability to provide safe and convenient access without requiring manual intervention. The base study presents an automated sliding ramp system integrated with train door operations. The system employs sensors micro controller based control units, and motor driven rack and pinion mechanisms to automatically deploy and retract the ramp. When passengers are detected near the train entrance, the control system activates the ramp creating a smooth transition between the platform and the train. The design incorporates multiple sliding sections and hinged arrangements to ensure stability, load bearing capability, and adaptability to different platform heights. After passenger movement is completed, the ramp automatically retracts to its stored position.The proposed technology enhances passenger safety, accessibility, and operational efficiency while reducing dependence on railway staff. This study demonstrates the feasibility of implementing intelligent boarding assistance systems in modern railway transportation, thereby promoting inclusive mobility and improving travel experiences for physically challenged passengers.

Keywords - Automatic Train Ramp System; Low-Floor Train Accessibility; Arduino Uno; Infrared Sensor

I. INTRODUCTION

Railway transportation plays a vital role in public mobility; however, boarding trains can be difficult for elderly passengers, persons with disabilities, wheelchair users, and travelers carrying heavy luggage due to the height difference between train floors and station platforms. Existing boarding assistance systems, such as bridge plates and manual ramps, often require human intervention and may not provide sufficient convenience and safety. To overcome these limitations, this paper proposes an Automated Sliding Ramp for Low-Floor Trains using an Arduino Uno, IR sensor, and motor-driven rack-and-pinion mechanism. The system automatically detects passengers near the train door, extends the ramp to facilitate safe boarding, and retracts it after a specified time. The proposed design enhances accessibility, passenger safety, and operational efficiency while supporting the development of inclusive and smart railway transportation systems.

II. EASE OF USE

A. proposed system

The proposed system is an automatic sliding ramp designed to assist elderly people, physically disabled passengers, and passengers carrying luggage while boarding and alighting from trains. The system uses an Arduino Uno, IR sensor, servo motor, RFID module, LCD display, and power supply unit. When a passenger is detected near the train door, the IR sensor sends a signal to the Arduino. The controller activates the motor, which extends the ramp automatically. The ramp provides a safe and smooth path between the train and platform. After a predefined time, the ramp retracts automatically and returns to its original position. This system improves accessibility, passenger safety, convenience, and independence while reducing the need for manual assistance.

B. OBJECTIVES

- To provide easy access for physically disabled and elderly passengers.
- To reduce the gap between the train and platform.
- To automate ramp operation using sensors and a micro controller.

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- To improve passenger safety and comfort.
- To minimize manual assistance.

III. METHODOLOGY

Three primary structural pieces and a few auxiliary parts for these structural elements movement will make up the ramp. When the door is open passengers must stand in front of the IR sensor which sends signals to the Arduino Uno to cause the ramp to automatically expand and wait for people to board the train. After a short while the ramp returns to its initial position the major body, second plate and first plate are these three sections. The first and second moveable plates of the ramp can both slides linearly inside the main body. One part of the main and second plates is the rack and pinion system that moves the plates one and two. To ensure that the plates move smoothly guidelines are included the main plate to which the secondary plate is fastened. The second plate slides within the main body of the rack while the pinion coupled to the motor moves. The rack remains stationary during this process. For the purpose of moving the first plate the motor is situated in the middle of the main body. The first plate slides easily into the second because of the guide ways and it has a rack at its right end that is hooked to the pinion of the motor. When the motor starts to spin the stationary pinion the rack will move linearly as a result. The first plate will therefore advance

A. Abbreviations and Acronyms

The proposed Automatic Train Ramp System incorporates various electronic and communication components to ensure safe and efficient operation. Radio Frequency Identification (RFID) is used for passenger identification and system control, while Infrared (IR) sensors are employed for platform and obstacle detection. A Liquid Crystal Display (LCD) is used to display system status and operational messages. The system is powered using a Regulated Power Supply (RPS) that converts Alternating Current (AC) into Direct Current (DC) suitable for electronic circuits. Integrated Circuits (ICs), Light Emitting Diodes (LEDs), and a Microcontroller Unit (MCU) are used for processing and control functions. The motor speed is measured in Revolutions Per Minute (RPM), and communication between modules is achieved through Transmitter (TX) and Receiver (RX) units. The software is developed using the Arduino Integrated Development Environment (IDE). These abbreviations are used throughout the paper for simplicity and consistency.

B. Units

- Voltage (V): Voltage is measured in Volts (V) and represents the electrical potential supplied to the system components. In this project, a regulated 5V supply is used for the Arduino, RFID module, LCD display, and sensors, while 12V may be used for motor operation.
- Current (A): Current is measured in Amperes (A) and indicates the flow of electric charge through the circuit. Monitoring current consumption helps ensure the safe operation of electronic components and prevents overload conditions.
- Power (W): Power is measured in Watts (W) and represents the rate at which electrical energy is consumed by the system. The total power requirement depends on the Arduino controller, sensors, motor driver, and motor used in the ramp mechanism.
- Frequency (Hz): Frequency is measured in Hertz (Hz) and refers to the number of cycles occurring per second. It is important in power supply circuits and communication modules used within the project.
- RFID Frequency (MHz): RFID communication operates at a specific frequency measured in Megahertz (MHz). The RFID reader and tag exchange data through radio waves, enabling automatic identification and access control.
- Distance (m): Distance is measured in Meters (m) and is used to represent the gap between the train coach and platform. Proper distance measurement ensures effective ramp deployment and passenger safety.
- Ramp Dimensions (cm): The physical dimensions of the ramp such as length, width, and height are measured in Centimeters (cm). These dimensions determine the stability and accessibility of the ramp system.
- Weight Capacity (kg): Weight is measured in Kilograms (kg) and indicates the maximum load the ramp can support. The ramp is designed to safely carry passengers, wheelchairs, and luggage without structural failure.
- Motor Speed (RPM): Motor speed is measured in Revolutions Per Minute (RPM). It defines how fast the motor rotates to extend or retract the ramp. A controlled RPM ensures smooth and safe ramp movement.
- Torque (kg-cm): Torque is measured in Kilogram-centimeter (kg-cm) and represents the rotational force produced by the motor. Adequate torque is necessary for lifting and moving the ramp under load conditions.
- Resistance (Ω): Resistance is measured in Ohms (Ω) and determines the opposition to current flow in electrical circuits. Resistors are used for voltage regulation, current limiting, and sensor interfacing.
- Capacitance (μF): Capacitance is measured in Microfarads (μF) and is used in filtering circuits of the regulated power supply. Capacitors help reduce voltage fluctuations and provide a stable DC output.
- Time Delay (ms): Time is measured in Milliseconds (ms) and is used to define sensor response times, motor activation delays, and system processing intervals for accurate operation.
- Temperature (°C): Temperature is measured in Degrees Celsius (°C) and is considered when evaluating the operating conditions of electronic components to ensure reliable performance.
- Angle (°): The movement of the servo motor and ramp positioning is measured in Degrees (°). Accurate angular control ensures proper opening and closing of the ramp mechanism.

C. Equations

1. Transformer Turns Ratio Equation

\frac{V_p}{V_s}=\frac{N_p}{N_s}

Where:

= Primary Voltage (V)

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= Secondary Voltage (V)

= Number of turns in Primary Coil

= Number of turns in Secondary Coil

This equation is used to determine the output voltage of the step down transformer used in the regulated power supply section of the project.

2. Capacitor Filter Equation

$$C=\frac{1}{4\sqrt{3}frR_L}$$

Where:

= Capacitance (F)

= Supply Frequency (Hz)

= Ripple Factor

= Load Resistance (Ω)

This equation is used to calculate the capacitor value required for filtering the rectifier output and reducing ripple voltage in the regulated power supply circuit. In this project, a 1000 µF capacitor is used to obtain a smoother DC output.

D. Working

When a physically disabled passenger approaches the train door, an IR sensor detects their presence and automatically activates the sliding ramp. The ramp extends using a rack-and-pinion mechanism driven by a DC motor. The second plate first moves outward, followed by the first plate, creating a safe inclined surface between the train and platform. Hinges provide the required tilt angle for smooth boarding. After boarding, the motor rotates in the opposite direction to retract the ramp automatically. The system is controlled through a motor driver, which regulates motor speed and direction. The IR sensor ensures automatic operation, improving accessibility, safety, and convenience for elderly and disabled passengers.

IV. ALGORITHM

Step 1: Start the system.

Step 2: Monitor train status continuously.

Step 3: Check whether the train has reached a station and stopped completely.

- If No, keep monitoring.
- If Yes, proceed to Step 4.

Step 4: Detect platform alignment using sensors.

- If platform is not detected, generate an alert and wait.
- If platform is detected, proceed to Step 5.

Step 5: Activate motor to extend the drawbridge.

Step 6: Verify full extension using limit switches.

- If not fully extended, continue extension.
- If fully extended, proceed to Step 7.

Step 7: Allow passengers to board and alight safely.

Step 8: Monitor for departure signal.

- If departure signal is not received, keep bridge extended.
- If departure signal is received, proceed to Step 9.

Step 9: Activate motor to retract the drawbridge.

Step 10: Verify complete retraction using sensors.

- If not fully retracted, continue retraction.
- If fully retracted, proceed to Step 11.

Step 11: Enable train movement.

Step 12: Return to monitoring mode.

Step 13: Stop.

A..MODULES DEVELOPED

Module 1: RFID Station Detection

- Reads RFID tags placed at railway stations.
- Identifies the station by comparing tag IDs with stored values.

Functions Used:

ReadRFID();

Match();

Compar();

Module 2: Drawbridge Control System

- Controls servo motor movement.
- Extends and retracts the drawbridge automatically.

Servo Positions:

Base_servo.write(180);

Bridge Open Position

Base_servo.write(0);

Bridge Closed Position

Module 3: Passenger Alert System

- Activates buzzer during bridge deployment.
- Alerts passengers when boarding is permitted.

digitalWrite(Buz,LOW);

delay(3000);

digitalWrite(Buz,HIGH);

Module 4: LCD Information Display

- Displays station information.
- Shows access status and operational messages.

Example:

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```
lcd.setCursor(0,1);
lcd.print("Sta:Bengaluru");
```

Module 5: Bluetooth Communication

- Enables future expansion for remote monitoring and control.

```
SoftwareSerial Blue(RXPin,TXPin);
```

B.Figures and Tables

Fig. 1. Need for an Automated Boarding Assistance Ramp in Railway Coaches

The proposed Automatic Train Ramp System for Physically Challenged People is designed to assist elderly, disabled, and luggage-carrying passengers in boarding and alighting from trains safely. The model consists of an Arduino Uno, RFID reader (EM-18), servo motor, 16×2 LCD display, and a regulated power supply. The RFID reader detects the authorized passenger or station condition, and the Arduino processes the received data. Based on the programmed instructions, the servo motor automatically extends or retracts the ramp. The LCD display provides system status and operational messages. This automated system reduces the gap between the train and platform, improves accessibility, and enhances passenger safety and convenience.

Fig.1.Structural Analysis Results of the Proposed Train Drawbridge Ramp

ANALYTICAL RESULTS		
SL.NO	***PROPERTIES***	***VALUES***
1	Load applied	1.308x10^-06MPa
2	Maximum Equivalent Elastic Strain	4.5015x10^-08mm/mm
3	Maximum Equivalent Elastic Stress	0.0030511MPa
4	Maximum Principal Stress	0.0012552MPa
5	Total Deformation	6.0202x10^-05mm

C.RESULT AND DISCUSSION

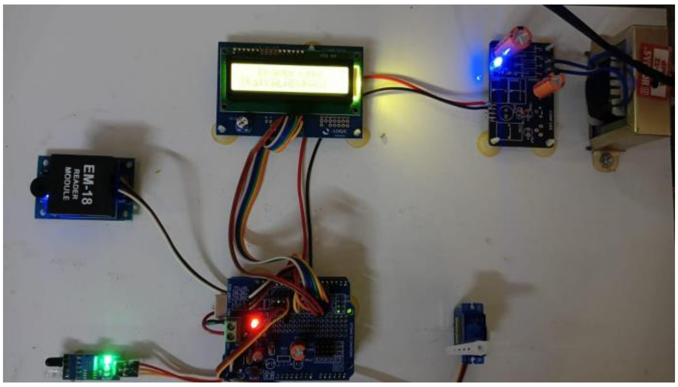

Fig. 1. Experimental Setup of the Automatic Train Ramp System Using Arduino and RFID

The developed RFID-Based Automated Drawbridge System for Physically Disabled Train Passengers was tested under different operating conditions.

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