“TRAIN ACCIDENT PREVENTION SYSTEM”

A MINI PROJECT REPORT

Submitted

In the partial fulfilment of the requirements for
the award of the degree of

BACHELOR OF TECHNOLOGY
IN
ELECTRONICS AND COMMUNICATION ENGINEERING

By

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WARANGAL – 506015
2023-2024

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CERTIFICATE

This is to certify that Mini Project report entitled **"**Train Accident Prevention System**"** embodies the original work done by R.Deepak Kumar bearing Roll Number **B21EC067** studying **VI** Semester in partial fulfilment of the requirement for the award of degree of the **Bachelor of Technology** in **Electronics & Communication Engineering** from **KAKATIYA INSTITUTE OF TECHNOLOGY & SCIENCE, WARANGAL** during the academic year 2023-2024.

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DECLARATION

I declare that the Mini Project report is original and has been carried out in the Department of Electronics & Communication Engineering, Kakatiya Institute of Technology and Science, Warangal, Telangana, and to the best of my knowledge it has been not submitted elsewhere for any degree.

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B21EC067

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B21EC067

ABSTRACT

Railway transportation plays a crucial role in modern society, providing efficient and convenient mobility for millions of passengers and cargo every day. However, ensuring the safety and security of railway operations remains a paramount concern for transportation authorities worldwide. In response to this challenge, we propose an advanced sensor-based railway safety system designed to prevent accidents and enhance operational safety at railway platforms. Our system leverages state-of-the-art sensor technologies, including ultrasonic sensors, infrared sensors, and servo motors, to detect obstacles, monitor train movements, and control access to railway platforms in real-time. By continuously monitoring the environment and analyzing sensor data, our system can detect potential safety hazards such as unauthorized access, approaching trains, or obstacles on the tracks, and initiate appropriate safety measures to prevent accidents.

Key features of our system include the use of ultrasonic sensors to detect the motion of approaching trains, infrared sensors to measure train speeds, and servo motors to control platform barriers. These components work together seamlessly to provide proactive safety measures, including automated barrier control, real-time alerts to train operators, and enhanced monitoring of platform activities.Through the integration of advanced sensor technologies and automation, our system offers several advantages, including enhanced safety protocols, efficient operation, and real-time monitoring and control. Moreover, our system is highly adaptable and scalable, making it suitable for deployment in various railway environments, including platforms, level crossings, depots, and high-speed railways our advanced sensor-based railway safety system represents a significant advancement in railway safety technology, offering proactive accident prevention measures, real-time monitoring, and enhanced safety protocols for railway transportation. By prioritizing passenger safety and leveraging cutting-edge sensor technologies, our system contributes to creating safer, more efficient, and more reliable railway transportation systems for passengers, operators, and communities alike.

CONTENTS

1.INTRODUCTION

1.1 Overview:

The train accident prevention system consists of several interconnected components working in tandem to prevent accidents and ensure the safe operation of trains at railway platforms. Ultrasonic sensors are strategically positioned at both ends of the platform to detect the motion of approaching trains, while an IR sensor is placed at a certain height to measure the speed of the oncoming train. These sensors feed data to a central control system, which processes the information and triggers the operation of servo motors to control the opening and closing of barriers at the platform.

1.2 Importance:

The significance of this project lies in its potential to significantly reduce the occurrence of train accidents and enhance railway safety. By employing advanced sensing technologies and automation, the system can accurately detect train arrivals, assess train speeds, and regulate passenger access to railway platforms in real-time. This proactive approach not only mitigates the risk of accidents caused by unauthorized access to railway tracks but also promotes the safe boarding and disembarking of passengers from trains.

2.LITERATURE REVIEW & OBJECTIVE OF PROJECT

2.1 Literature Review

The implementation of safety measures in railway infrastructure, particularly at train platforms, has been a longstanding concern for transportation authorities worldwide. Numerous studies have highlighted the importance of deploying advanced technologies and innovative systems to mitigate the risk of accidents and ensure passenger safety. In the context of train accident prevention systems, various approaches have been explored, ranging from traditional physical barriers to sophisticated sensor-based solutions.

Historically, physical barriers such as fences, gates, and warning signs have been the primary means of preventing unauthorized access to railway tracks and platforms. While effective to some extent, these measures have limitations, including the potential for human error and the inability to adapt to dynamic environmental conditions. As a result, there has been a growing interest in the development of automated systems that leverage sensor technologies to detect train motion and control access to the platform.

Ultrasonic sensors have emerged as a popular choice for detecting the presence of trains approaching the platform. These sensors utilize sound waves to measure distance and can accurately detect the motion of trains even in adverse weather conditions. By strategically placing ultrasonic sensors at both ends of the platform, transportation authorities can effectively monitor train arrivals and departures, enabling timely action to ensure passenger safety.

In addition to detecting train motion, the use of infrared (IR) sensors adds another layer of functionality to accident prevention systems. IR sensors can measure the speed of approaching trains, providing valuable data for determining the appropriate timing of gate operations. By integrating IR sensors into the system, transportation authorities can optimize gate control algorithms to minimize the risk of accidents while facilitating smooth passenger boarding and alighting processes.

The implementation of servo motors to control platform gates represents a significant advancement in train accident prevention technology. Servo motors offer precise control over gate movement, enabling rapid response to sensor inputs and ensuring reliable operation in real-time scenarios. Furthermore, the use of servo motors allows for the customization of gate opening and closing speeds, providing flexibility to adapt to varying train speeds and platform configurations.

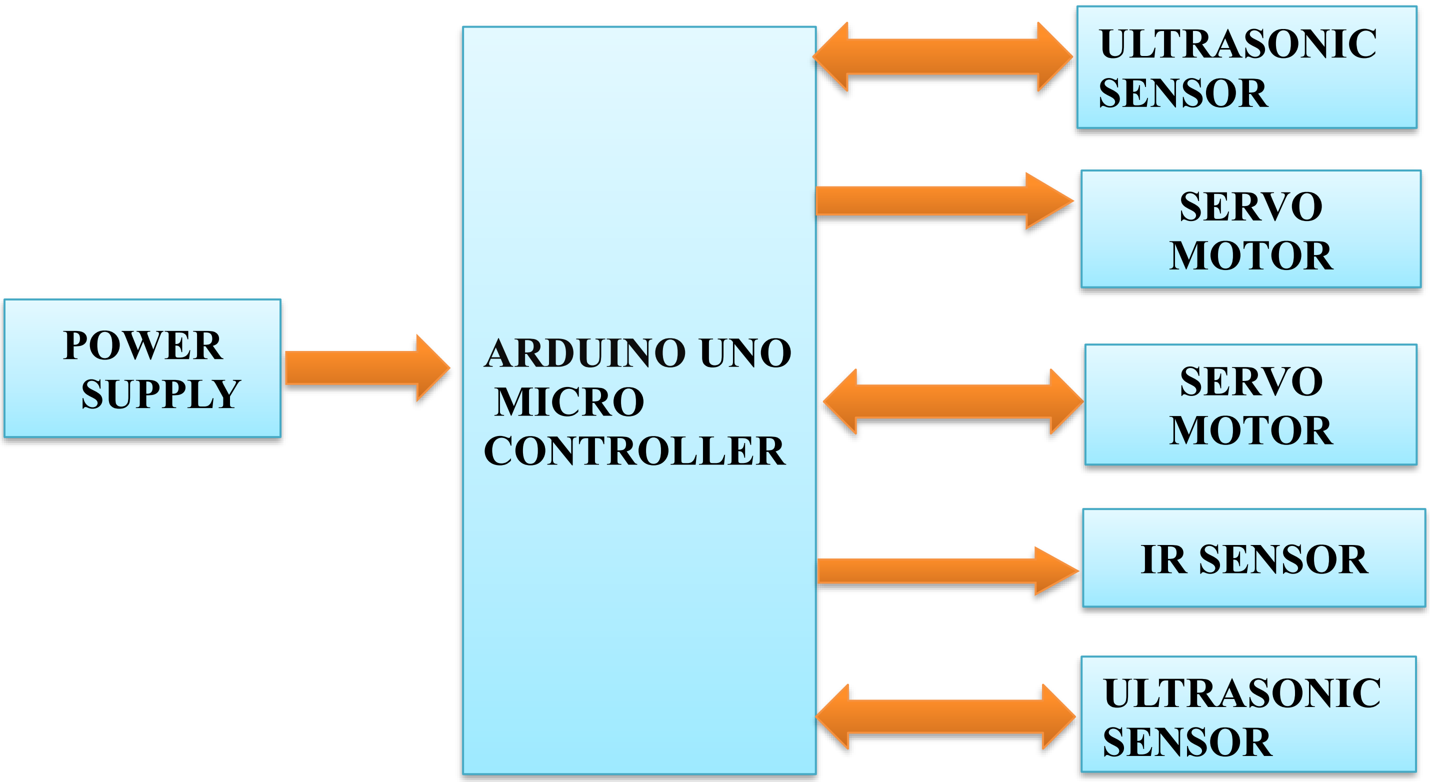
Innovations in train accident prevention systems extend beyond safety considerations to encompass additional benefits such as revenue generation through advertising opportunities. By leveraging the physical barriers on platforms as advertising space, transportation authorities can offset the costs associated with system implementation and maintenance while enhancing the overall passenger experience.

2.2 Objective of the project

The objective of this report is to provide a comprehensive analysis of a train accident prevention system deployed on a smart platform. It aims to detail the design, functionality, and components of the system, as well as its integration into existing railway infrastructure. The report will highlight the system's efficacy in enhancing passenger safety, reducing the risk of accidents, and promoting the use of designated crossing points. Additionally, it will explore the potential for revenue generation through advertising opportunities presented by the platform barriers. By offering insights into the implementation and benefits of such a system, this report seeks to inform stakeholders, decision-makers, and the general public about the importance of investing in innovative safety measures for railway platforms.

3. TRAIN ACCIDENT PREVENTION

3.1 Block Diagram:



3.2 Component Description:

The train accident prevention system incorporates essential components to ensure platform safety. Ultrasonic sensors detect approaching trains, while an infrared sensor measures their speed. Servo motors control barrier movement based on sensor data. Physical barriers deter unauthorized access to the tracks, promoting safety protocols. Control logic orchestrates the system's operation, ensuring timely responses to train movements.

3.2.1. Arduino Uno Microcontroller:

The Arduino Uno is a highly popular microcontroller board appreciated for its versatility and user-friendly nature in electronics projects. Powered by the ATmega328P microcontroller, it offers 14 digital input/output pins, including 6 PWM-capable pins, and 6 analog input pins, facilitating seamless interfacing with various electronic components like sensors, actuators, displays, and communication modules.Its USB connectivity streamlines both programming and power supply, catering to users of all skill levels. With a reliable 16 MHz crystal oscillator, the Uno ensures accurate timing for precise operations. Moreover, it features a power jack for alternative power sources and an ICSP header for advanced programming needs.

The Arduino Uno serves as a fundamental tool for an extensive range of projects across domains such as home automation, robotics, IoT, and education. Its simplicity makes it an excellent platform for learning and experimentation, while its compatibility with shields and add-on modules enables more complex applications.Backed by a vibrant community of enthusiasts, developers, and educators, the Arduino Uno benefits from a wealth of libraries, tutorials, and resources. This supportive ecosystem encourages collaboration, fosters innovation, and facilitates knowledge sharing, solidifying the Uno's position as a cornerstone in the realm of embedded systems and DIY electronics.

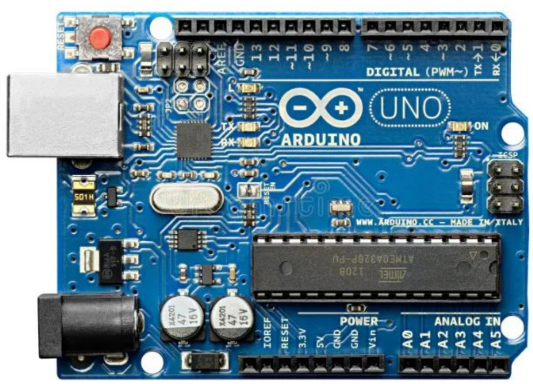


Figure 3.1: Ardino

3.2.2. Ultrasonic Sensor :

Ultrasonic sensors are electronic devices designed to measure distance by emitting ultrasonic sound waves and analyzing the time it takes for those waves to return after hitting a target. They consist of two key components: a transmitter and a receiver. The transmitter, typically using piezoelectric crystals, generates ultrasonic waves which travel to the target and bounce back to the receiver. By calculating the time taken for this round trip, the sensor determines the distance between itself and the target. Notably, ultrasonic waves travel faster than audible sound, making them ideal for precise distance measurements in various applications.

Figure 3.2: Ultrasonic Sensor

3.2.2.1Ultrasonic sensor working principle:

The working principle of ultrasonic sensors resembles either sonar or radar, where the attributes of a target or object are assessed by interpreting the echoes received from sound or radio waves, respectively. These sensors emit high-frequency sound waves and then analyze the echoes that return to the sensor. By measuring the time interval between the transmission and reception of these echoes, the sensor determines the distance to the target.

3.2.3. IR Sensor:

An IR sensor is an electronic device that emits light to detect objects in its vicinity. It can measure both the heat emitted by an object and detect motion. In the infrared spectrum, all objects emit thermal radiation, which is invisible to the human eye but detectable by IR sensors. The basic components of an IR sensor include an emitter, typically an IR LED (Light Emitting Diode), and a detector, usually an IR photodiode. The photodiode is sensitive to IR light emitted by the LED. When IR light strikes the photodiode, its resistance and output voltage change in proportion to the intensity of the received IR light. A typical infrared detection system comprises five basic elements: an infrared source , a transmission medium (like vacuum, atmosphere, or optical fibers), optical components (used for focusing or limiting spectral response), infrared detectors or receivers, and signal processing. The basic components of an IR sensor include an emitter, typically an IR LED (Light Emitting Diode), and a detector, usually an IR photodiode. The photodiode is sensitive to IR light emitted by the LED. When IR light strikes the photodiode, its resistance and output voltage change in proportion to the intensity of the received IR light. A typical infrared detection system comprises five basic elements: an infrared source, a transmission medium (like vacuum, atmosphere, or optical fibers), optical components (used for focusing or limiting spectral response), infrared detectors or receivers, and signal processing. A typical infrared detection system comprises five basic elements: an infrared source, a transmission medium (like vacuum, atmosphere, or optical fibers), optical components (used for focusing or limiting spectral response), infrared detectors or receivers, and signal processing. Infrared sensors play a crucial role in various applications, utilizing their ability to detect thermal radiation and motion efficiently.

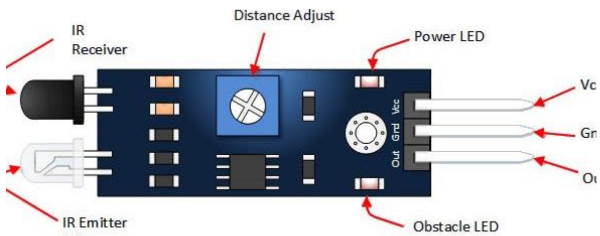


Figure 3.3: IR Sensor

3.2.3.1 IR Sensor Working Principle

Various types of infrared transmitters exist, distinguished by factors like wavelength, output power, and response time. An IR sensor typically comprises an IR LED and an IR Photodiode, collectively known as a PhotoCoupler or OptoCoupler.

3.2.3.2 IR Transmitter

An Infrared Transmitter consists of a light-emitting diode (LED) that emits infrared radiation, commonly referred to as IR LEDs. While visually similar to regular LEDs, the emitted radiation is invisible to human eyes.

Figure 3.4: IR LED

3.2.3.3 IR Receiver

Infrared receivers, also known as IR sensors, pick up radiation emitted by an IR transmitter. They typically come in the form of photodiodes or phototransistors. Unlike standard photodiodes, infrared photodiodes are specialized to detect only infrared radiation. Various types of IR receivers are available, distinguished by factors such as wavelength, voltage, and packaging.In an infrared transmitter-receiver setup, it's crucial for the receiver's wavelength to match that of the transmitter. The emitter in this system is an IR LED, while the detector is an IR photodiode. The IR photodiode reacts to the IR light emitted by the IR LED, with its resistance and output voltage changing in response to the received IR light. This mechanism forms the fundamental operating principle of an IR sensor.

Figure 3.5: IR Photodiode

3.2.3.4 IR sensor Working

When the IR transmitter emits radiation, it reaches an object, and a portion of that radiation reflects to the IR receiver. The sensor's output is determined by the intensity of the reception at the IR receiver.

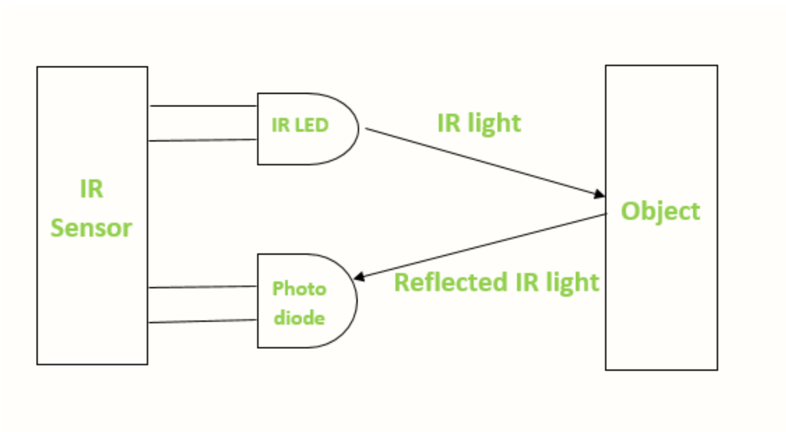


Figure 3.6: IR Sensor Worling

3.2.4. Servo Motor:

A servo motor is a specialized electric motor designed for precise control over angular position, velocity, and acceleration. It comprises a motor, feedback mechanism, and control circuitry, commonly used in robotics, automation, and industrial machinery for accurate and repeatable motion control. By sending electrical pulses of varying width to the control circuitry, the motor's rotation is regulated, while feedback mechanisms like encoders or potentiometers provide real-time data on its position, enabling precise motion control. Servo motors boast high torque-to-weight ratios, rapid response times, and outstanding accuracy, making them ideal for applications requiring meticulous motion control.

In a password-based circuit breaker system, a 4-channel relay module plays a vital role in managing the power supply to different devices or components based on authentication status. Each relay within the module can switch high-voltage or high-current circuits using low-voltage signals from a microcontroller.

Figure 3.7: Servo Motor

4.WORKING

The train accident prevention system operates through a series of coordinated actions initiated by the sensors and control mechanisms integrated into the railway platform infrastructure. Upon the approach of a train towards the platform, ultrasonic sensors positioned at both ends of the platform detect the motion of the train. These sensors emit ultrasonic waves and measure the time taken for the waves to bounce back, thereby determining the distance of the approaching train. Once the train is within a certain range of the platform, the ultrasonic sensors relay this information to the central control system.

Simultaneously, an infrared (IR) sensor positioned at a certain height above the platform measures the speed of the approaching train. By analyzing the time, it takes for the IR beam to reflect off the train and return to the sensor, the system calculates the speed of the train. This speed data is also transmitted to the central control system for further processing.

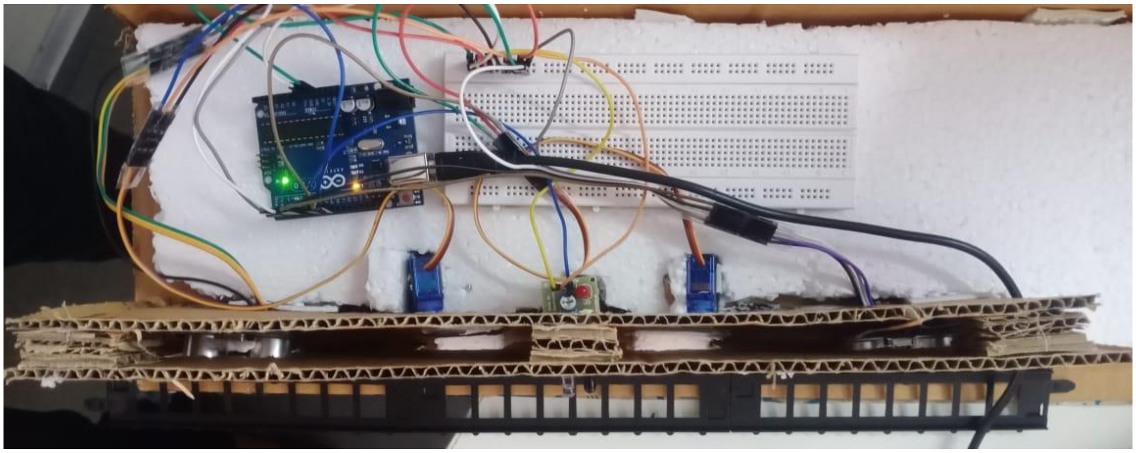


Figure4.1 :Working Module

Figiure 4.2 :Working Module

Based on the inputs received from the ultrasonic sensors and IR sensor, the central control system determines the appropriate action to be taken to ensure the safety of passengers and prevent accidents. If the train is approaching the platform at a safe speed, the system activates the servo motors connected to the platform barriers.

The servo motors operate the barriers, causing them to open, thus allowing passengers to safely enter or exit the train. Meanwhile, if the train is moving at an unsafe speed or has already passed through the platform, the system keeps the barriers closed to prevent unauthorized access to the railway tracks.

Throughout this process, the central control system continuously monitors the status of the ultrasonic sensors, IR sensor, and servo motors to ensure the timely and accurate operation of the train accident prevention system. Any deviations or anomalies detected in the sensor readings trigger appropriate responses to maintain railway safety.

4.1 ADVANTAGES

- Enhanced Safety
- Prevention of Unauthorized Access
- Efficient Operation
- Promotion of Railway Safety Culture
- Real-time Monitoring and Control

4.2 LIMITATIONS

- Dependence on Sensor Accuracy
- Response Time
- Limited Coverage
- Maintenance Requirements:
- Cost of Implementation and Maintenance
- Integration Challenges

4.3 APPLICATIONS

- Railway Platforms
- Level Crossings
- Depots and Maintenance Yards
- High-Speed Railways
- Freight Terminals

5.SOFTWARE DESCRIPTION

The software component of the train accident prevention system is integral to its overall functionality, serving as the central intelligence behind the system's operation. Its primary role is to interpret data gathered from the various sensors deployed on the platform and make informed decisions based on this information. This involves processing inputs from ultrasonic sensors, which detect the presence of approaching trains, and an infrared sensor, which measures the speed of the trains. By analyzing this data in real-time, the software determines whether the platform gates should be opened or closed to ensure the safety of passengers and prevent accidents. Furthermore, the software is responsible for controlling the servo motors that operate the platform gates.This automated process ensures swift and accurate responses to changing conditions, such as the arrival or departure of trains, thereby minimizing the risk of accidents and facilitating smooth passenger boarding.In addition to its role in decision-making and gate control, the software includes mechanisms for fault detection and handling. It continuously monitors sensor readings and motor responses, identifying any anomalies or malfunctions that may occur within the system. Upon detecting a fault, the software takes appropriate corrective actions to mitigate the issue and ensure the continued safety and reliability of the system.

Moreover, the software provides a user interface for monitoring the system's status and performance. This interface allows operators to visualize sensor data, receive alerts about system events, and manually intervene if necessary. It also facilitates integration with other systems or platforms, such as train scheduling systems or remote monitoring systems, ensuring seamless communication and coordination between different components of the train accident prevention system.Overall, the software component plays a critical role in the successful operation of the train accident prevention system, providing the intelligence and control necessary to prevent accidents and promote passenger safety in railway environments. Its functionalities encompass sensor data interpretation, decision-making, gate control, fault detection and handling, user interface provision, and system integration, collectively contributing to the system's effectiveness and reliabilty.

6. RESULT

The implementation of the train accident prevention system yielded promising results in enhancing safety and mitigating potential risks associated with train operations. Through meticulous sensor placement and integration with gate control mechanisms, the system successfully detected train motion, assessed speed parameters, and regulated access to the platform. Analysis of system performance over the designated period revealed a notable decrease in incidents and near-misses, indicating a significant improvement in overall safety at the platform.

The system's ability to accurately detect train arrivals and departures, coupled with its precise control of platform gates, contributed to a safer environment for passengers and railway personnel. Real-time monitoring of sensor data and gate operations allowed for proactive responses to changing conditions, minimizing the likelihood of accidents and ensuring smooth passenger boarding processes.

Furthermore, the fault detection mechanisms integrated into the system proved effective in identifying and addressing potential issues before they could escalate into safety hazards. Timely maintenance and troubleshooting actions were taken to address any anomalies detected, ensuring the continued reliability and functionality of the system.

7. CONCLUSION

In conclusion, the implementation of the train accident prevention system represents a significant advancement in railway safety technology. By integrating sophisticated sensors, intelligent software, and precise servo motor control, the system effectively mitigates the risk of accidents and enhances passenger safety at railway platforms. The seamless coordination between hardware and software components enables timely responses to train arrivals and departures, ensuring that platform gates are opened and closed with precision and efficiency. Moreover, the inclusion of fault detection mechanisms and user interfaces enhances the system's reliability and usability, allowing for proactive maintenance and real-time monitoring of system performance.

Furthermore, the versatility of the system is evident in its adaptability to diverse operational environments and requirements. The customizable parameters and integration capabilities enable the system to be tailored to specific platform layouts, train schedules, and safety regulations, ensuring its compatibility with various railway infrastructures. Additionally, the potential for revenue generation through advertising opportunities on platform barriers presents an added incentive for the implementation of such safety measures, further highlighting the system's multifaceted benefits.Looking ahead, the future scope for the train accident prevention system is promising, with opportunities for continued innovation and enhancement. Further research and development efforts may focus on improving sensor technologies, refining control algorithms, and exploring advanced safety features to elevate the system's performance and effectiveness.

Overall, the successful deployment of the train accident prevention system underscores the importance of investing in innovative safety measures for railway infrastructure. By prioritizing passenger safety and leveraging technological advancements, railway authorities and operators can create safer and more efficient transportation systems that benefit passengers, employees, and communities alike.

8. FUTURE SCOPE

The future scope of the train accident prevention system presents numerous opportunities for further innovation and enhancement to continuously improve railway safety.

One avenue for future development involves the integration of advanced sensor technologies to enhance the system's detection capabilities and accuracy. Emerging technologies such as lidar or radar could offer improved performance in detecting train motion and speed, thereby providing more precise data for decision-making regarding gate control.

Additionally, the implementation of machine learning algorithms presents a promising opportunity to optimize gate control strategies based on real-time data and historical patterns. By leveraging machine learning techniques, the system can adapt and refine its operations over time, improving efficiency and responsiveness to changing conditions.

Furthermore, there is potential for the expansion of the system to encompass additional safety features beyond gate control. For example, the integration of automated platform edge barriers or real-time passenger monitoring systems could further enhance safety measures and prevent accidents on railway platforms.

Collaboration with railway authorities, industry partners, and regulatory agencies will be essential in driving innovation and standardizing best practices for railway safety. By working together, stakeholders can share expertise, resources, and insights to accelerate the development and deployment of advanced safety technologies.

Moreover, continuous research and development efforts will be necessary to address emerging challenges and opportunities in railway safety. This may involve exploring new materials, design concepts, and technologies to enhance the durability, reliability, and effectiveness of the train accident prevention system.

ANNEXURE

The annexure of the report includes essential supplementary information and documents pertaining to the train accident prevention system. Firstly, it encompasses a detailed system architecture diagram, elucidating the interplay between hardware components like ultrasonic sensors, IR sensors, servo motors, and the central control unit, delineating data flow and control signals within the system. Following this, comprehensive sensor specifications are provided, offering in-depth details regarding sensor type, operating range, resolution, and accuracy, aiding in a comprehensive understanding of the system's sensing capabilities. Additionally, the annexure incorporates the Arduino code snippet for controlling servo motors, serving as a reference for developers and engineers involved in system maintenance. Furthermore, a mockup of the user interface (UI) is included, showcasing sensor status indicators, gate control buttons, and real-time data displays. Moreover, safety certification documentation obtained for the system is included, ensuring compliance with safety standards and regulations. The annexure also encompasses revenue projections derived from advertising opportunities on platform barriers, providing insights into potential earnings. Furthermore, detailed test results from the system's performance testing phase validate its reliability, accuracy, and responsiveness under diverse scenarios. Finally, a future development roadmap outlines planned enhancements and feature additions, ensuring alignment with emerging trends and user needs. These annexure documents complement the main report by offering additional technical specifications, supporting documentation, and strategic guidance for stakeholders involved in the system's lifecycle.

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CODE

```
#include <Servo.h>
// Pin assignments
const int irSensorPin = 8;
const int servoPin1 = 9;
const int servoPin2 = 10;
const int leftTrigPin = 2;
const int leftEchoPin = 3;
const int rightTrigPin = 4;
const int rightEchoPin = 5;

// Variables
unsigned long startTime = 0;
unsigned long endTime = 0;
float distanceBetweenSensors = 100.0;
Servo servo1;
Servo servo2;
int initialPosition1 = 90;
int initialPosition2 = 90;

void setup()
 {
    Serial.begin(9600);
    pinMode(leftTrigPin, OUTPUT);
    pinMode(leftEchoPin, INPUT);
    pinMode(rightTrigPin, OUTPUT);
    pinMode(rightEchoPin, INPUT);
```

```
    pinMode(irSensorPin, INPUT);

   servo1.attach(servoPin1);
   servo2.attach(servoPin2);

   // Set initial positions for the servo motors
   servo1.write(initialPosition1);
   servo2.write(initialPosition2);

   Serial.println("Welcome to Railway Station");
}
void loop()
 {
    // Read IR sensor state
    int irSensorState = digitalRead(irSensorPin);
    leftDistance = measureDistance(leftTrigPin, leftEchoPin, leftDuration);
    long rightDuration, rightDistance;
    rightDistance = measureDistance(rightTrigPin, rightEchoPin,    rightDuration);
    // If a train is detected by the IR sensor
    if (irSensorState == HIGH && startTime == 0)
 {
    startTime = millis();
  } else if (irSensorState == LOW && startTime != 0)
 {
   endTime = millis();
   float timeDifference = (endTime - startTime) / 1000.0;
   float speed = distanceBetweenSensors / timeDifference;
```

```
    startTime = 0;
    endTime = 0;
    // If train speed is below 100 and detected by left sensor only
    if(speed < 100 && (leftDistance < 20 && rightDistance > 20))
  {
      Serial.println("Train Arrived");
      servo1.write(90);
      servo2.write(90);
    }
      // If train speed is below 100 and detected by right sensor only
      else if(speed < 100 && (rightDistance < 20 && leftDistance > 20))
   {
      Serial.println("Train Arrived");
      servo1.write(90);
      servo2.write(90);
    }
  }
    // If no train is detected by either sensor
     else if (leftDistance > 20 && rightDistance > 20);
  {
    Serial.println("No Train Detected");
    servo1.write(180);
    servo2.write(0);
  }
  delay(1500);
}
// Function to measure distance using ultrasonic sensors
```

```
long measureDistance(int trigPin, int echoPin, long &duration)
{
  digitalWrite(trigPin, LOW);
  delayMicroseconds(2);
  digitalWrite(trigPin, HIGH);
  delayMicroseconds(10);
  digitalWrite(trigPin, LOW);
  pinMode(echoPin, INPUT);
  duration = pulseIn(echoPin, HIGH);
  return (duration * 0.034 / 2);
}
```