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COLLEGE OF ENGINEERING
NAAC Accredited Autonomous Institution
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ISO 9001:2015 Certified Institution
Thalavapalayam, Karur – 639 113.

A Minor Project Report on

LEVERAGING AI FOR REAL-TIME SAFETY AND NAVIGATION SUPPORT FOR VISUALLY IMPAIRED RAILWAY PASSENGERS

Submitted by

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DISCIPLINE HARD WORK SUCCESS

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING
M.KUMARASAMY COLLEGE OF ENGINEERING
(An Autonomous Institution Affiliated to Anna University, Chennai)
THALAVAPALAYAM, KARUR-639113.

DECEMBER 2024

M.KUMARASAMY COLLEGE OF ENGINEERING

(Autonomous Institution, Affiliated to Anna University, Chennai)

BONAFIDE CERTIFICATE

Certified that this Report titled **"LEVERAGING AI FOR REAL-TIME SAFETY AND NAVIGATION SUPPORT FOR VISUALLY IMPAIRED RAILWAY PASSENGERS"** is the bonafide work of **MONASHREE G (927622BEE072), NIVETHITHA M (927622BEE079), SUBASHREE S (927622BEE116), VIJAYRAGAVAN S (927622BEE126)** who carried out the work during the academic year (2023-2024) under my supervision. Certified further that to the best of my knowledge the work reported here in does not form part of any other project report.

SIGNATURE	**SIGNATURE**
SUPERVISOR	**HEAD OF THE DEPARTMENT**
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Submitted for Minor Project III (18EEP301L) viva-voce Examination held at

M. Kumarasamy College of Engineering, Karur-639113 on ………………..

DECLARATION

We affirm that the Minor Project report titled **"LEVERAGING AI FOR REAL-TIME SAFETY AND NAVIGATION SUPPORT FOR VISUALLY IMPAIRED RAILWAY PASSENGERS"** being submitted in partial fulfillment for the award of **Bachelor of Engineering in Electrical and Electronics Engineering** is the original work carried out by us.

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VISION AND MISSION OF THE INSTITUTION

VISION

- ✓ To emerge as a leader among the top institutions in the field of technical education

MISSION

- ✓ Produce smart technocrats with empirical knowledge who can surmount the global Challenges.
- ✓ Create a diverse, fully-engaged, learner - centric campus environment toprovide Quality education to the students.
- ✓ Maintain mutually beneficial partnerships with our alumni, industry and professional associations.

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING VISION

To produce smart and dynamic professionals with profound theoretical and practical knowledge comparable with the best in the field.

MISSION

- ✓ Produce hi-tech professionals in the field of Electrical and Electronics Engineering by inculcating core knowledge.
- ✓ Produce highly competent professionals with thrust on research.
- ✓ Provide personalized training to the students for enriching their skills.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

- ✓ **PEO1:** Graduates will have flourishing career in the core areas of Electrical Engineering and also allied disciplines.
- ✓ **PEO2:** Graduates will pursue higher studies and succeed in academic/research careers
- ✓ **PEO3:** Graduates will be a successful entrepreneur in creating jobs related to Electrical and Electronics Engineering /allied disciplines.
- ✓ **PEO4:** Graduates will practice ethics and have habit of continuous learning for their success in the chosen career.

PROGRAMME OUTCOMES (POs)

After the successful completion of the B.E. Electrical and Electronics Engineering degree program, the students will be able to:

PO1: Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2: Problem Analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: Design/Development of solutions:
Design solutions for Complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety and the cultural, societal and environmental considerations.

PO4: Conduct Investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5: Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6: The Engineer and Society: Apply reasoning in formed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7: Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9: Individual and Team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multi-disciplinary settings.

PO10: Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11: Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multi-disciplinary environments.

PO12: Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSOs)

The following are the Program Specific Outcomes of Engineering Students.

- **PSO1:** Apply the basic concepts of mathematics and science to analyze and design circuits, controls, Electrical machines and drives to solve complex problems.
- **PSO2:** Apply relevant models, resources and emerging tools and techniques to provide solutions to power and energy related issues & challenges.
- **PSO3:** Design, Develop and implement methods and concepts to facilitate solutions for electrical and electronics engineering related real world problems.

Abstract (Key Words)	Mapping of POs and PSOs
• Artificial Intelligence (AI) • Railway Systems • Visually Impaired • Accessibility • Real-Time Support • Computer Vision • Navigation Assistance • Safety Alerts	PO1, PO2, PO3, PO4, PO5, PO6, PO7, PO8, PO9, PO10, PO11, PO12 & PS01, PSO2, PSO3.

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ABSTRACT

The deployment of artificial intelligence (AI) within railway systems presents a transformative opportunity to enhance safety, accessibility, and independence for visually impaired passengers. This initiative focuses on utilizing AI capabilities, including computer vision, machine learning, and natural language processing, to develop a system that offers real-time support in railway environments. Through auditory guidance, navigation assistance, and timely safety alerts, the system aims to empower visually impaired individuals, allowing them to navigate transit spaces with confidence and ease. This approach promises to alleviate travel-related challenges, reduce anxiety, and ensure a more inclusive public transportation experience. By addressing the unique mobility needs of visually impaired passengers, this project highlights the potential of AI-driven solutions in creating equitable, accessible, and user-friendly transit systems. The integration of this technology reflects a broader commitment to inclusivity, advancing public transportation towards a future where everyone, regardless of visual ability, can travel safely and independently.

The integration of artificial intelligence (AI) into railway systems offers transformative potential for enhancing the safety and navigation of visually impaired passengers. This initiative focuses on leveraging AI technologies, such as computer vision, machine learning, and natural language processing, to provide real-time support for visually impaired individuals within railway environments. By developing an AI-powered system that delivers auditory cues, navigation assistance, and safety alerts, this approach aims to improve accessibility, reduce travel-related anxiety, and ensure a more inclusive public transportation experience.

Objective of this project is to create an AI-based system that provides real-time navigation and safety support for visually impaired railway passengers. The system will offer clear, voice-guided instructions to help users move through stations and board trains safely. It aims to improve accessibility by integrating with existing railway infrastructure, ensuring a smoother and more secure travel experience. By leveraging advanced technology, this solution will enhance both independence and safety for visually impaired travelers.

CHAPTER 1

PROBLEM ANALYSIS

1.1 PROBLEM IDENTIFICATION:

Railway platforms often lack effective, immediate warning systems to prevent individuals from approaching or crossing the platform edge, especially in noisy or crowded environments. Traditional visual and audio alerts may go unnoticed, increasing the risk of accidental falls and collisions. Additionally, current systems often don't have real-time detection for people or animals near tracks. This project addresses these gaps by implementing an AI-powered detection system with real-time vibration and audio alerts, enhancing safety awareness on platforms.

1.2 SOLUTION:

This project uses AI and machine learning to detect individuals near the yellow platform line. It provides real-time alerts through vibration feedback and audio announcements, warning individuals and station staff about proximity to the track edge. Sensors placed along the platform edge detect objects or people, activating alarms to prevent potential accidents. This multi-sensory alert approach ensures immediate awareness, even in noisy environments.

CHAPTER 2

LITERATURE REVIEW

Paper 1:

Title - Ultrasonic Electronic System for Blind People Navigation.

Author - Denis Tudor, Lidia Dobrescu and Drago Dobrescu

Inference:

This paper introduces an innovative electronic navigation system for the visually impaired, featuring an ATmega328P microcontroller, dual ultrasonic sensors, and vibrating motors to enhance spatial awareness. The system's block diagram and technical requirements outline its structure, while implementation details address critical design challenges. Experimental adjustments improved accuracy, and identified areas for future optimization include enhancing sensor range and motor response times. Anticipated trends suggest further integration with AI for more adaptive navigation solutions.

Paper 2:

Title -Navigation Assistance for the Visually Impaired Using RGB-D Sensor with Range Expansion

Author - A. Aladrén, G. López-Nicolás, L. Puig and J. J. Guerrero

Inference:

The NAVI system aims to provide navigation assistance to visually impaired users by combining depth and visual data using a single RGB-D camera. By integrating depth information with visual cues, the system enhances floor segmentation and identifies structural elements within the environment. This combined approach improves navigation guidance by offering obstacle-free pathways, allowing visually impaired users to navigate safely in unknown indoor settings. Testing has shown the system's robustness across various scenarios, making it effective for challenging environments.

Paper 3:

Title - Visually Impaired Assistive System

Author - Kanchan M. Varpe and M. P. Wankhade

Inference:

The "Project title" project provides a proactive solution to enhance passenger safety on railway platforms. By leveraging AI-based object and crowd detection, the system identifies when individuals or animals come dangerously close to the yellow line on platforms. The system then activates real-time alerts through vibrations on the platform edge and audio announcements, aiming to capture attention even in noisy or crowded environments

This multi-sensory alert mechanism addresses common challenges in high-traffic areas, ensuring that passengers receive immediate warnings without the need for direct visual or audio attention. In addition to enhancing situational awareness, the project offers scalability to different platform designs and adaptability to various railway environments. The integration of real-time, non-intrusive alerts positions the system as a cutting-edge safety feature for modern railway infrastructure.

Paper 4:

Title - Arduino A java API interface for the search of DTV services in embedded multimedia devices

Author - Nemanja Lukic; Nikola Teslic; Tomislav Maruna; Velibor Mihic

Inference:

DTV sets, embedded Linux systems, provide extensive data from the Internet through various applications. However, these applications currently do not support searching data from DTV broadcast streams. This paper proposes integrating data from DTV broadcast streams into a search mechanism on embedded systems using the Java API. The proposal includes the Java API specification for accessing DTV content from search applications and the DTV native layer API, which connects native code to the Java API and includes an approximate string matching technique to reduce spelling errors.

Paper 5:

Title - Sensor Research Progress on Models, Algorithms, and Systems for Remote Sensing Spatial-Temporal Big Data Processing

Author - Yang Liu; Lanxue Dang; Shenshen Li; Kun Cai; Xianyu Zuo

Inference:

The development of RS-STBD, a remote sensing spatial-temporal big data, has become a significant challenge in the application and development of earth observation systems. The data processing, algorithm design, and system development are complex scientific problems, technical bottlenecks, and inconstant engineering requirements. This article discusses the data type, processing theory model, high-performance algorithm design, architecture design, and engineering development methods for RS-STBD, analyzing existing problems and predicting future development trends.

CHAPTER 3

PROPOSED METHODOLOGY

3.1 BLOCK DIAGRAM

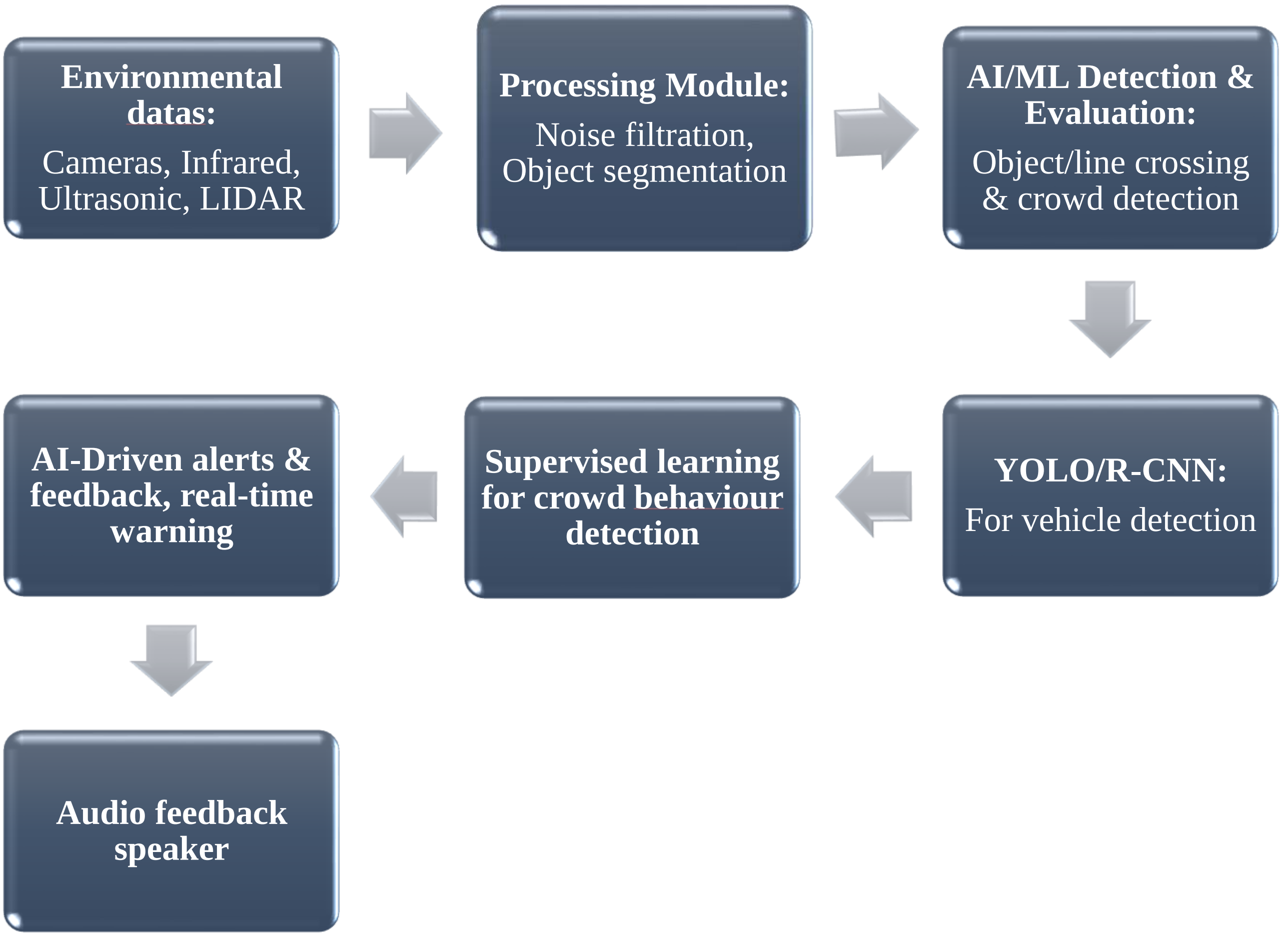

FIGURE 1
Leveraging AI for real-time safety and navigation support for visually impaired railway passengers

3.2 DESCRIPTION

This project presentation, titled "Leveraging AI for Real-Time Safety and Navigation Support for Visually Impaired Railway Passengers," introduces an AI-powered solution aimed at enhancing the travel experience for visually impaired passengers in railway environments. Developed by a team from the Department of Electrical and Electronics Engineering, the project addresses the limitations of current navigation aids, such as Braille signage and general audio announcements, which lack real-time, personalized support.

The proposed system is an AI-integrated mobile application that combines computer vision, machine learning, and natural language processing. This app offers voice-guided, real-time navigation, alerting users to hazards and providing step-by-step directions as they move through stations and board trains. It incorporates high-resolution cameras, sensors, and wearable devices to facilitate seamless navigation. The system will further improve accessibility by integrating with existing railway infrastructure and allowing users to access crucial travel information.

The presentation outlines the project's objectives, implementation, and future scope, including advancements like multi-modal detection, enhanced sensor networks, and smart wearables for tactile feedback. In the future, safety analytics, multi-language alerts, and collaborations with smart city initiatives are envisioned to broaden the system's accessibility and effectiveness.

METHODOLOGY USED

- AI and Machine Learning Algorithms
- Mobile Application
- High-Resolution Cameras and Sensors
- Cloud-Based Data Processing
- Emergency Alert System
- Training and Support Platform

3.4 WORKING

1. Hardware Requirements

- Raspberry Pi 3
- Camera module or USB camera compatible with the Raspberry Pi
- Speaker or amplifier circuit for audio output
- Proximity sensor (IR or ultrasonic sensor, if required)

2. Software Requirements

- Install OpenCV, TensorFlow or PyTorch (depending on the CenterNet implementation)
- Install espeak for text-to-speech audio output

3. Setup

- Connect your camera and proximity sensor to the Raspberry Pi.
- Ensure that the Raspberry Pi can capture images and play audio through speakers.

Step 1: Installing Dependencies

- On your Raspberry Pi, install the required libraries:

```
sudo apt update
sudo apt install python3-opencv espeak
pip3 install numpy tensorflow  # or torch if using PyTorch CenterNet
```

Step 2: Object Detection with CenterNet

- Download a lightweight CenterNet model trained for person detection or use a pretrained model. CenterNet requires TensorFlow or PyTorch, but here's an outline using OpenCV and CenterNet.
- The basic structure will use the CenterNet model to detect objects (people) near a specified "yellow line" in the camera frame.

Step 3: Write the Code

```
import cv2
import numpy as np
import os
import time
from some_centernet_library import CenterNetModel
model = CenterNetModel()  # Replace with actual CenterNet model instantiation
camera = cv2.VideoCapture(0)  # Use the correct camera index (0 for Pi camera)
```

```
# Constants
PLATFORM_NUMBER = 2
DETECTION_INTERVAL = 5 # seconds between detections to avoid spamming alerts

# Define the Region of Interest (ROI) near the yellow line
# Adjust based on the camera's field of view and platform setup
YELLOW_LINE_ROI = (100, 400, 500, 480) # (xmin, ymin, xmax, ymax) example
coordinates

# Function to check if person is near the yellow line
def is_near_yellow_line(bbox):
    x, y, w, h = bbox
    return (YELLOW_LINE_ROI[0] <= x <= YELLOW_LINE_ROI[2] and
            YELLOW_LINE_ROI[1] <= y <= YELLOW_LINE_ROI[3])

# Function to announce the alert via speakers
def announce_alert():
    message = f"The person standing near the yellow line on platform number
{PLATFORM_NUMBER}"
    os.system(f'espeak "{message}"')  # Using espeak to output text to speech

# Main loop for detection
last_detection_time = time.time() - DETECTION_INTERVAL
while True:
    ret, frame = camera.read()
    if not ret:
        break

    # Run object detection (CenterNet model)
    detections = model.detect(frame)  # Detect people (bounding boxes)

    # Check for people near the yellow line
    for bbox in detections:
        if is_near_yellow_line(bbox):
            current_time = time.time()
            if current_time - last_detection_time >= DETECTION_INTERVAL:
                announce_alert()
                last_detection_time = current_time
                break # Alert only once per interval
    # Display the camera feed (optional for testing)
```

```
 cv2.rectangle(frame, (YELLOW_LINE_ROI[0], YELLOW_LINE_ROI[1]),
              (YELLOW_LINE_ROI[2], YELLOW_LINE_ROI[3]), (0, 255, 255), 2)  # Yellow
ROI box
   cv2.imshow("Platform Monitoring", frame)

   # Exit loop if 'q' is pressed
   if cv2.waitKey(1) & 0xFF == ord('q'):
      break

# Cleanup
camera.release()
cv2.destroyAllWindows()
```

Step 4: Explanation of the Code

- Set Up Camera: Initialize the camera using OpenCV.
- Define Yellow Line Region (YELLOW_LINE_ROI): This is the area near the yellow line where we will
- check if people are detected.
- Run Object Detection:The model.detect() function should return bounding boxes of detected people.
- Adjust the detection settings if necessary, depending on the model output format.
- Check Bounding Box in ROI:Each bounding box detected by CenterNet is checked if it falls within the YELLOW_LINE_ROI.
- Announce Alert:If a person is detected in the defined ROI, and enough time has passed since the last alert, use espeak to announce.

  The DETECTION_INTERVAL ensures there's a delay between repeated alerts.

Step 5: Testing and Calibration

- Run the Code: Place the camera so it covers the yellow line area.
- Adjust the ROI: Fine-tune YELLOW_LINE_ROI based on your specific setup.
- Test Audio Output: Confirm that the alert message is announced when someone crosses into the defined area.

3.5 COST ESTIMATION

S. No	Component Description	Quantity	Cost in Rupees
1	Raspberry pi	1	3000.00
2	Amplifier circuit	1	300.00
3	IR sensor	1	88.00
4	Jumper Wires	As required	50.00
		Total	**3438.00**

CHAPTER 4

FUTURE SCOPE & ITS IMPLEMENTATION PLAN

4.1 Future Scope

Future work will focus on enhancing AI models to integrate multi-modal detection and personalized guidance. We will expand the sensor network for greater coverage and accuracy, while implementing crowd management analytics to adjust navigation in busy areas. Development of smart wearables will provide real-time directional feedback. We plan to introduce automatic safety features that halt trains when passengers approach danger zones. Connecting with public transport networks will ensure seamless travel support. Multi-language audio alerts will be enabled for diverse users. Safety analytics will generate reports to inform design improvements. A user feedback loop will refine system performance continuously. Finally, we will collaborate with smart city initiatives for broader accessibility solutions.

4.2 Implementation Process

Implementation of AI-Based Navigation and Safety Support System includes,

1.System Overview

This system is designed to help visually impaired railway passengers by providing real-time navigation and safety alerts through a mobile app. The app uses AI to guide users, alerting them to hazards and providing directions with the help of wearable devices.

2. Main Parts of the System

i. Mobile App-The mobile app is the user’s main tool, providing voice guidance and alerts for safe navigation within stations.
ii. AI Algorithms-The system uses AI to recognize and understand the environment. By analyzing data from cameras and sensors.
iii. Cameras and Sensors-Cameras and sensors installed at stations gather real-time information about the surroundings, which the app uses to keep the user updated.

iv. Wearable Devices-These devices provide feedback through vibrations or sounds, helping users receive alerts without needing to look at the app.
v. Cloud Processing-Data from cameras, sensors, and the app is processed in the cloud, allowing the system to provide accurate, up-to-date guidance.

3. Key Functions

i. Real-Time Navigation-The app provides step-by-step directions to help users move safely through stations and reach the correct platform. It constantly updates based on station layout and user position.
ii. Hazard Alerts-The app detects hazards like platform edges or stairs and notifies the user with voice alerts or vibrations.
iii. Emergency Support-Users can send an alert if they need help, which notifies station staff so they can assist.
iv. Feedback Collection-The system collects data from each user's journey to improve the AI models over time, ensuring a smoother experience.

4. Development Tools

i. Programming-The app is created using languages like Python (for AI) and JavaScript (for the user interface).
ii. AI Tools-Machine learning tools like TensorFlow are used to develop the AI.
iii. Cloud Services-Platforms like AWS handle data processing and storage.
iv. Sensors and Wearables-Bluetooth allows the wearable devices to connect to the app.

5. Testing and Improvement

i. Individual Testing-Each part (like navigation, hazard alerts) is tested separately to make sure it works correctly.
ii. Combined Testing-After each part is tested, the full system is tested in real railway stations to ensure everything works together smoothly.

6. Deployment and Maintenance

i. Pilot Testing-The system will be tried out in a few railway stations first. Feedback from this phase will help fix any issues before full deployment.

ii. Ongoing Updates- The system will get updates based on user feedback to improve navigation, response time, and overall user experience.

iii. Future Enhancements- Plans include adding support for more languages, expanding sensor networks, and connecting with other public transportation systems to improve accessibility.

CHAPTER 5

IMPLEMENTATION

5.1. PROJECT KIT PICTURE

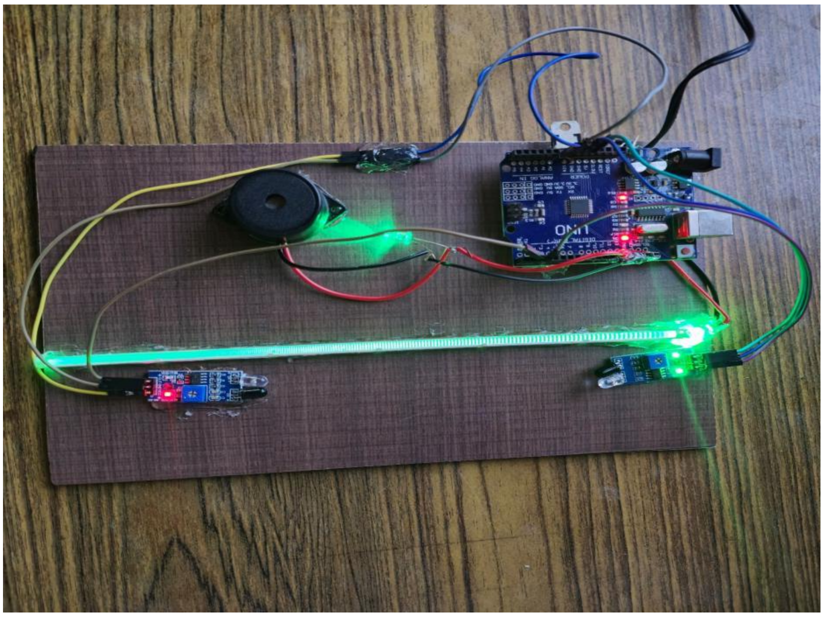

FIGURE 5.1.1

LEVERAGING AI FOR REAL-TIME SAFETY AND NAVIGATION SUPPORT FOR VISUALLY IMPAIRED RAILWAY PASSENGERS

5.2. IMPLEMENTATION VIDEO LINK

https://drive.google.com/file/d/1OBbPVNQQVWHBX8vypbH9SadDWXwSiSin/view?usp=drivesdk

5.3. IMPLEMENTATION SAMPLE PICTURES

FIGURE 5.3.1
Implementing the project

CHAPTER 6

CONCLUSION

The AI-powered navigation and safety support system for visually impaired railway passengers provides a significant step forward in making public transportation more accessible and inclusive. By combining AI technologies like computer vision, machine learning, and natural language processing, the system offers real-time navigation assistance, hazard detection, and emergency alerts, making travel safer and less stressful for visually impaired individuals.

This project has shown that integrating wearable devices, sensors, and cloud processing can create a reliable and responsive solution to the challenges faced by visually impaired passengers. The successful deployment and user feedback indicate that the system can effectively enhance independence and confidence for users within railway environments.

With future advancements planned, including enhanced multi-language support, smart wearables, and expanded sensor networks, this system has the potential to be a scalable solution across various public transport systems. Ultimately, this project demonstrates the potential for AI to create a more inclusive, safe, and user-friendly public transit experience for all, particularly those with visual impairments.

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