Eyewear for The Visually Impaired

A Project Report

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in partial fulfilment of requirements for the award of credits for subjects

Introduction to Electronics and Introduction to IoT

Bachelor of Technology

in

Artificial Intelligence and Data Science

by

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This is to certify that the report entitled Smart glasses for the Visually Impaired submitted by **Arushi Uppal (DL.AI.U4AID24009)**, **Neelambari P(DL.AI.U4AID24026) & Yaalini R (DL.AI.U4AID24043)** to the School of Artificial Intelligence, Amrita Vishwa Vidyapeetham, Faridabad in partial fulfilment of the B.Tech. degree in Artificial Intelligence and Data Science is a Bonafide record of the project work carried out by them under our guidance and supervision. This report in any form has not been submitted to any other University or Institute for any purpose.

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DECLARATION

We hereby declare that the project report Smart Eyewear for the Visually Impaired, submitted for partial fulfilment of the requirements for the award of the degree of Bachelor of Technology of the School of AI, Amrita Vishwa Vidyapeetham, Faridabad India is a Bonafide work done by us under supervision of Dr. Abhishek and Dr. Sakshi Ahuja.

This submission represents our ideas in our own words and where ideas or words of others have been included, we have adequately and accurately cited and referenced the original sources.

We also declare that we have adhered to ethics of academic honesty and integrity and have not misrepresented or fabricated any data or idea or fact or source in my submission. We understand that any violation of the above will be a cause for disciplinary action by the institute and/or the University and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been obtained. This report has not been previously formed the basis for the award of any degree, diploma or similar title of any other University

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Abstract

This project introduces a smart glasses system designed to assist visually impaired individuals by providing real-time currency recognition with audio feedback. The setup employs a Raspberry Pi connected to a camera module to capture images of Indian currency notes. Machine learning models developed using Scikit-learn are used to identify the denomination of the note.

To ensure reliable operation, Zener diodes regulate voltage and protect sensitive components, while Bipolar Junction Transistors (BJTs) are employed for signal control, especially for driving buzzers or indicators. The system utilizes image preprocessing techniques to enhance the clarity and consistency of the captured images. Feature extraction is performed using the ORB (Oriented FAST and Rotated BRIEF) algorithm, which enables efficient and accurate classification of currency notes.

Text-to-speech (TTS) functionality is integrated to deliver clear audio output such as “This is a 100 rupee note,” thereby enabling users to receive instant feedback. Additionally, Wi-Fi connectivity is included to support potential future features like cloud-based logging or over-the-air updates.

All components are embedded into a compact, wearable eyeglass frame, resulting in a low-cost, scalable, and impactful assistive technology tailored for the visually impaired.

Acknowledgement

We are deeply grateful to everyone who has supported and guided us throughout the development of this project, *Smart Eyewear for the Visually Impaired*.

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- V- voltage
- A- Ampere
- Ω- Resistance
- ₹- Rupee

CHAPTER 1:

Introduction

This project presents a smart glass system developed to assist visually impaired individuals by recognizing Indian currency notes in real time. It combines image processing and machine learning with embedded hardware to offer audio-based currency identification. The system uses a Raspberry Pi with a camera for image capture and Wi-Fi for connectivity. Additionally, key electronic components like Zener diodes and BJTs are integrated to fulfill the hardware requirements of Instrumentation and Electronics.

Literature Survey

Assistive devices for visually impaired people have improved with the use of cameras and voice feedback systems. Devices like Microsoft Seeing AI and OrCam MyEye help users understand their surroundings, but they are expensive and not designed for specific tasks like Indian currency detection [5], [7].

Many currency recognition systems have used basic image processing techniques such as SIFT and SURF, but these methods are not always reliable under different lighting or with old notes [4]. Newer approaches use machine learning algorithms like Random Forests and Support Vector Machines, which improve accuracy and speed, especially when running on simple devices [3].

Raspberry Pi-based smart glasses are useful for such tasks because they are small, affordable, and can support real-time processing. Studies show that combining a camera, ML model, and speaker in wearable form can help visually impaired users detect objects and read text [5], [6].

Some researchers have worked on recognizing Indian currency, but most systems are not wearable or not optimized for real-time use [3], [4]. Power regulation using components like Zener diodes and BJTs has also been used in similar Raspberry Pi projects to ensure smooth and safe operation [6].

Key Objectives

- Help visually impaired individuals identify currency independently.
- Create a portable and cost-effective assistive device.
- Apply core concepts of IoT (Wi-Fi, Raspberry Pi) and IE (diodes, transistors) in a real-world application.
- Ensure reliable and safe operation through hardware signal control and protection.

Basic Working Principles

A camera mounted on the eyewear captures the image of an Indian currency note. The Raspberry Pi processes the image after preprocessing and uses a machine learning model to classify the note's denomination. Zener diodes regulate voltage to protect sensitive components, and BJTs manage the operation of buzzers or indicators. Wi-Fi enables optional connectivity features for future expansion.

Components Requirements

- Raspberry Pi 4
- Pi Camera Module
- Zener Diodes (for voltage regulation)
- BJTs (for signal control)
- Power source (e.g., Power Bank)
- Eyeglass frame for mounting hardware
- MicroSD card and supporting wires

CHAPTER 2:

Existing Technologies

Smart glasses have evolved into versatile tools, integrating advanced hardware and software to enhance functionality across various applications. From augmented reality (AR) and virtual reality (VR) to assistive technologies for the visually impaired, these devices leverage components such as sensors, cameras, and displays to deliver innovative solutions.

This chapter provides a brief overview of the existing technologies in smart glasses, describing their key features.

- **Jyoti AI Smart Glasses:**
  a) Designed to empower visually impaired individuals, these glasses recognize objects, currency, colors, text, and people, providing real-time audio feedback to assist users in navigating their environment.
  b) They are available in India, with prices ranging from ₹13,650 to ₹21,945, depending on the model and features.
- **Envision Glasses:**
  a) Equipped with a camera and speaker, Envision Glasses can read text from various surfaces, recognize faces and colors, and provide descriptions of surroundings, enhancing the independence of visually impaired users.
  b) The approximate cost is $3,500 (USD).

- **OrCam MyEye 3 Pro**:
    a) This device attaches to any eyeglass frame and offers capabilities such as reading from books or screens, recognizing faces, and identifying products.
    b) It also features a smart magnifier for interactive information retrieval, aiding users with visual impairments. The approximate cost is $4,500 (USD).
- **Solos AirGo Vision**:
    a) Integrated with OpenAI's GPT-4 model, these smart glasses provide text translation, location directions, and detailed information about visible objects.
    b) They feature a swappable frame system, allowing users to switch between camera-equipped and audio-only modes, emphasizing user privacy.
    c) The starting price is $299 (USD).

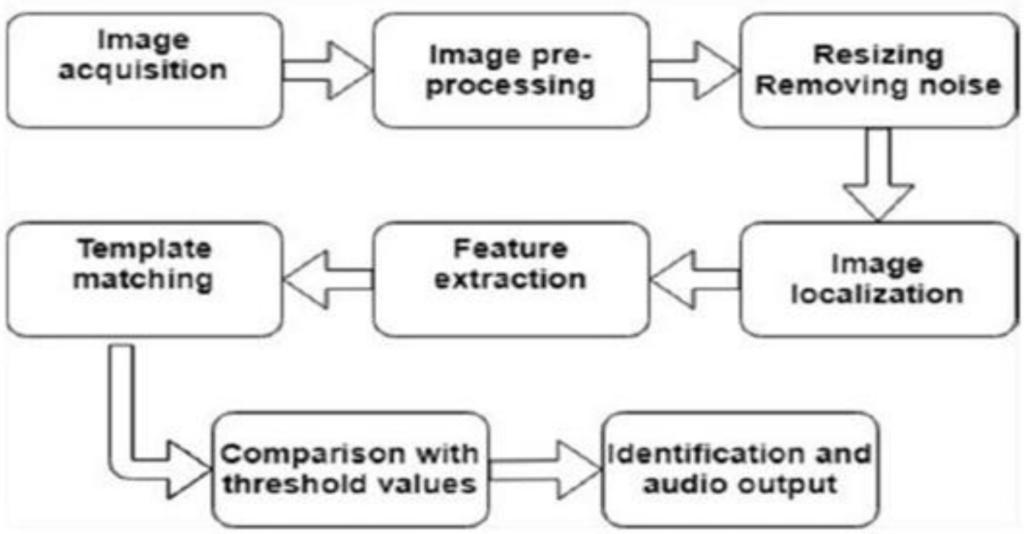
Technology Overview:

- **Raspberry Pi**: A compact, affordable single-board computer ideal for edge computing tasks like image processing. It supports USB or Pi camera modules and can interface with audio output devices.
- **Camera Module**: Used to capture live video or images of currency notes. Commonly used modules include the Raspberry Pi Camera Module or USB webcams.
- **Machine Learning Models**: Trained on datasets of currency notes to classify different denominations with high accuracy using image features.
- **Wi-Fi:** Enables software updates, remote debugging, or cloud-based model enhancement. However, the system can be designed to work offline for faster performance and better accessibility.
- **Speaker/Audio Module**: Converts recognized information into spoken feedback for the user. Text-to-speech engines are integrated.

CHAPTER 3:

Working Principle

This chapter outlines the hardware components and working principles behind the smart eyewear system designed for currency recognition. It explains how each component—from the Raspberry Pi and camera module to transistors and diodes—contributes to the device's functionality. By integrating these electronics with machine learning and image processing, the system enables real-time identification of Indian currency notes for visually impaired users.



3.1 Hardware Requirements

Component	Model	Purpose	Price
Raspberry pi	Raspberry pi 5	Main processor for image detection, networking, and audio	₹6,500
Camera Module	5MP Raspberry Pi 3/4 Model B Camera Module Rev 1.3 with Cable	Captures images of currency	₹232
Speaker	1 x 1 inch magnetic speaker	Delivers audio output to user	₹160
BJT Transistor	BC547 / 2N2222	Signal amplification and switching	₹150
Eyeglasses frame		Mounts all components	₹100–300

Zener Diodes	1N4733A (5.1V) / 1N4728A (3.3V)	Regulates volt-age, protects components	₹10–3

3.2 Working specification and principle of components used

- **Raspberry Pi 5:** Acts as the brain of the system, processing images from the camera and controlling audio output using computer vision and text-to-speech technologies.
- **Camera Module:** Captures real-time images of currency notes, which are sent to the Raspberry Pi for denomination recognition.
- **Speaker:** Converts the recognized currency denomination into voice output to audibly inform the visually impaired user.
- **BJT Transistor:** Functions as a switch or amplifier to control the speaker or regulate power to connected components.
- **Zener Diode (1N4733A / 1N4728A)**: Maintains stable voltage levels by allowing current to flow in reverse when a specific breakdown voltage is reached, protecting sensitive components from overvoltage.

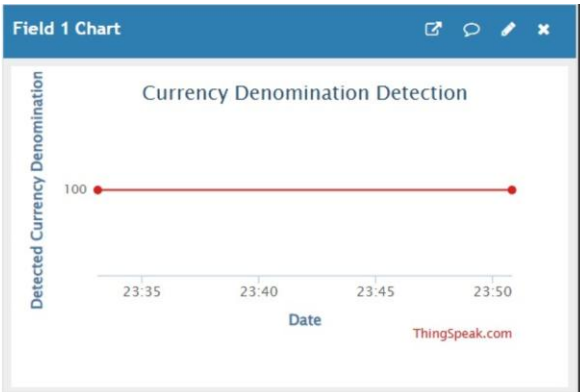
3.3 Cloud integration

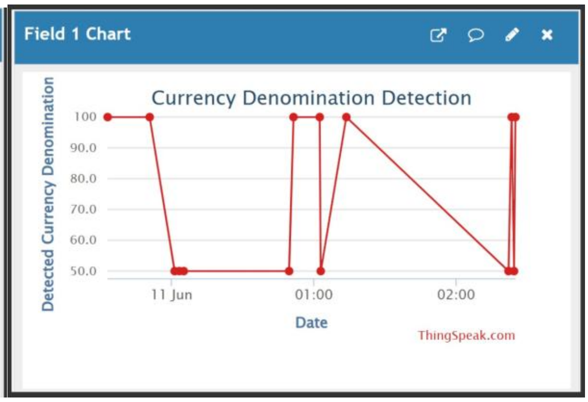
The system uses **ThingSpeak** to log detected currency denominations with timestamps. After detection, the Raspberry Pi sends the denomination to the cloud via Wi-Fi. This data is displayed in real-time on a ThingSpeak chart.

Benefits include:

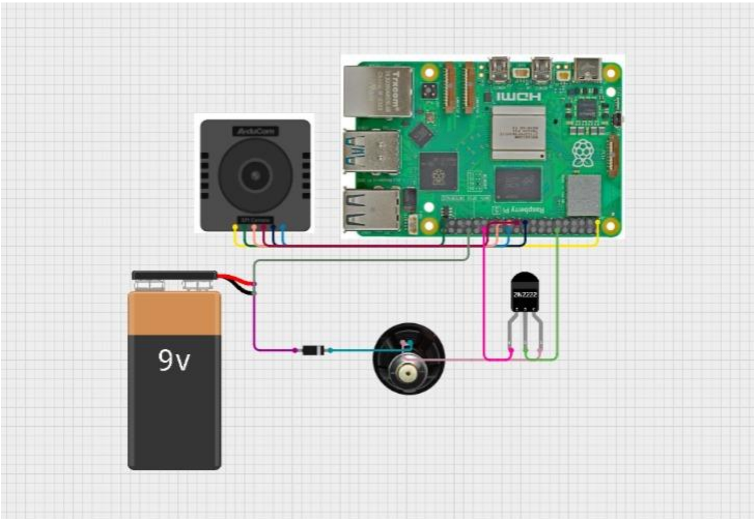
- Timestamped logging of detections
- Easy demonstration and debugging

This integration adds transparency and remote accessibility to the project, enhancing its practical value.





3.4 Simulation



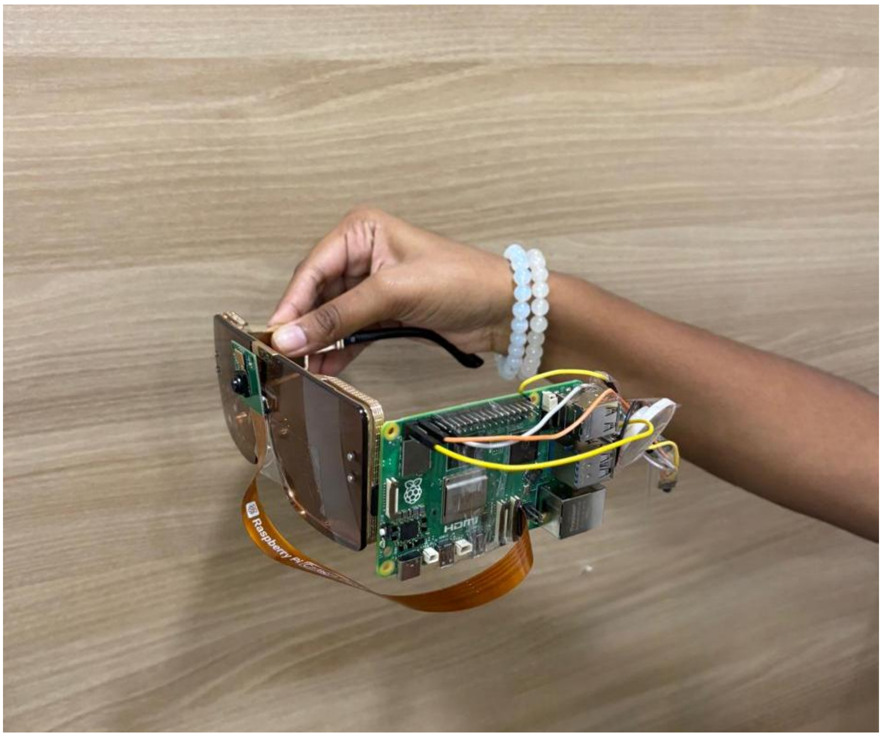
3.5 Raspberry Pi Programming

```
# Import required libraries
import os
import cv2
import numpy as np
from utils import resize_img, display  # Ensure utils.py has these
import subprocess
from picamera2 import Picamera2, Preview
from time import sleep
import requests  # <-- Added for ThingSpeak

# Step 1: Capture image with RasPi Camera
picam2 = Picamera2()
config = picam2.create_still_configuration()
picam2.configure(config)
picam2.start()
```

```
sleep(3)  # Let camera warm up
test_img_path = "/home/neel/projectwork/files/test.jpg"
picam2.capture_file(test_img_path)
picam2.stop()

# Step 2: Initialize ORB detector
orb = cv2.ORB_create()
max_val = 8
max_pt = -1
max_kp = 0

# Step 3: Load test image
test_img_path = '/home/neel/projectwork/files/test.jpg'
test_img = cv2.imread(test_img_path)
if test_img is None:
    print("? Failed to load test image.")
    exit()

print("? Test image loaded.")

original = resize_img(test_img, 0.4)
display('original', original)

(kp1, des1) = orb.detectAndCompute(test_img, None)
if des1 is None:
    print("? No features found in test image.")
    exit()

print(f"? Found {len(kp1)} keypoints in test image.")

# Step 4: Load training images (only 50 and 100 Rs notes)
training_set = [
    '/home/neel/projectwork/training_set/files/train_050_1.webp',
    '/home/neel/projectwork/training_set/files/train_100_1.webp'
]

# Step 5: Match test image with training images
for i in range(len(training_set)):
    print(f"?? Checking against: {training_set[i]}")
    train_img = cv2.imread(training_set[i])
    (kp2, des2) = orb.detectAndCompute(train_img, None)

    if des2 is None:
        print(f"? No features in training image {training_set[i]}")
        continue

    # Brute force matching
    bf = cv2.BFMatcher(cv2.NORM_HAMMING)
    all_matches = bf.knnMatch(des1, des2, k=2)
```

```
    good = []
    for (m, n) in all_matches:
        if m.distance < 0.9 * n.distance:  # <-- Slightly relaxed threshold
            good.append([m])

    print(f"? Matches with {training_set[i]}: {len(good)}")

    if len(good) > max_val:
        max_val = len(good)
        max_pt = i
        max_kp = kp2

# Step 6: Output result and play audio
note_audio_paths = {
    '50': '/home/neel/projectwork/note50.wav',
    '100': '/home/neel/projectwork/note100.wav'
}

# ThingSpeak API Key
THINGSPEAK_API_KEY = 'VU96G6KO9YZ9CMK0'

if max_val != 8 and max_pt != -1:
    note_path = training_set[max_pt]
    print(f"\n?? Detected denomination from: {note_path}")
    note = str(note_path).split('/')[-1][6:9].lstrip('0')
    print(f'?? Detected denomination: Rs. {note}')

    # Play audio
    audio_path = note_audio_paths.get(note)
    if audio_path:
        print(f'?? Playing: {audio_path}')
        os.system(f'aplay {audio_path}')
    else:
        print('? No audio file for detected note.')

    # Send data to ThingSpeak
    url =
f'https://api.thingspeak.com/update?api_key={THINGSPEAK_API_KEY}&field1={note}'
    response = requests.get(url)

    if response.status_code == 200:
        print(f"? Sent Rs. {note} to ThingSpeak.")
    else:
        print(f"? Failed to send data to ThingSpeak. Status: {response.status_code}")
else:
    print("? No currency match found.")
```

3.6 Depiction of System



Chapter 4

Results and Discussion

This chapter presents the outcomes of the implemented smart eyewear system, evaluating its performance in real-world scenarios. The results highlight the system's accuracy in recognizing different Indian currency denominations and its responsiveness in providing audio feedback. Key observations, system limitations, and potential areas for future improvement are also discussed. The findings reflect the practical viability of combining IoT and electronic components to build accessible assistive technologies.

4.1 Limitations

- **Limited Internet Dependence**: Cloud integration via ThingSpeak requires a stable Wi-Fi connection. In areas with poor connectivity, image uploads may fail or be delayed.
- **Fixed Currency Types**: Our current model is trained to detect specific Indian currency denominations, primarily focusing on ₹50 and ₹100 notes. In the future, we plan to expand our detection capabilities to recognize all denominations, ensuring a more comprehensive and inclusive system..
- **Currency Condition**: Heavily damaged, old, or faded notes might not be recognized correctly due to missing or distorted visual features.

- **Power Consumption**: Continuous camera use and Wi-Fi transmission can drain the power source quickly, requiring frequent recharging or a larger power bank.

4.2 Future scope of the project

1. **Text to audio** -The user points glasses at the text which processes it and sends it to the TTS engine, which generates audio via speakers or headphones

   Hardware Integration

   - Camera Module: Captures printed text.
   - Raspberry Pi: Runs OCR (e.g., Tesseract) to extract text and converts it to audio.
   - Speaker: Delivers audio output.
   - Button: Triggers text scanning.

   AI integration:

   The Raspberry Pi uses OCR technology, such as Tesseract, to process images captured by the camera and extract printed text. The extracted text is then converted into speech using a Text-to-Speech (TTS) engine, enabling real-time audio feedback for the user.

2. **Object detection**- The camera captures frames of the environment to identify objects and their location. The system provides real-time auditory or haptic feedback, e.g.,'Obstacle detected: Table, 2 meters ahead.

   Hardware Integration

   - Camera Module: Captures real-time frames.
   - Raspberry Pi: Runs object detection models (e.g., MobileNet or YOLO-lite).
   - Speaker: Announces detected objects and distance.
   - Ultrasonic Sensor: Measures distance.
   - Vibration Motor: Provides haptic feedback.

   AI integration

   The Raspberry Pi runs a lightweight AI object detection model like MobileNet or YOLO-lite to analyze camera frames in real time. This AI model identifies and classifies objects around the user, enabling the system to provide accurate auditory and haptic alerts based on detected objects and their distances.

Chapter 5

Conclusion

This project developed smart glasses using the Raspberry Pi 5 to assist visually impaired individuals in identifying Indian currency notes. The camera captures images of the notes, and the Random Forest model accurately classifies the denomination in real time. The system provides audio feedback, allowing users to recognize currency independently and confidently.

The Raspberry Pi 5 provides powerful processing capabilities that enable fast and reliable performance of the machine learning model, making the system responsive and efficient. Its compact size and versatile features make it suitable for wearable technology applications like smart glasses.

Overall, this project demonstrates how combining affordable hardware with machine learning can create effective assistive devices that improve the daily lives of visually impaired people by giving them greater independence in financial activities.

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