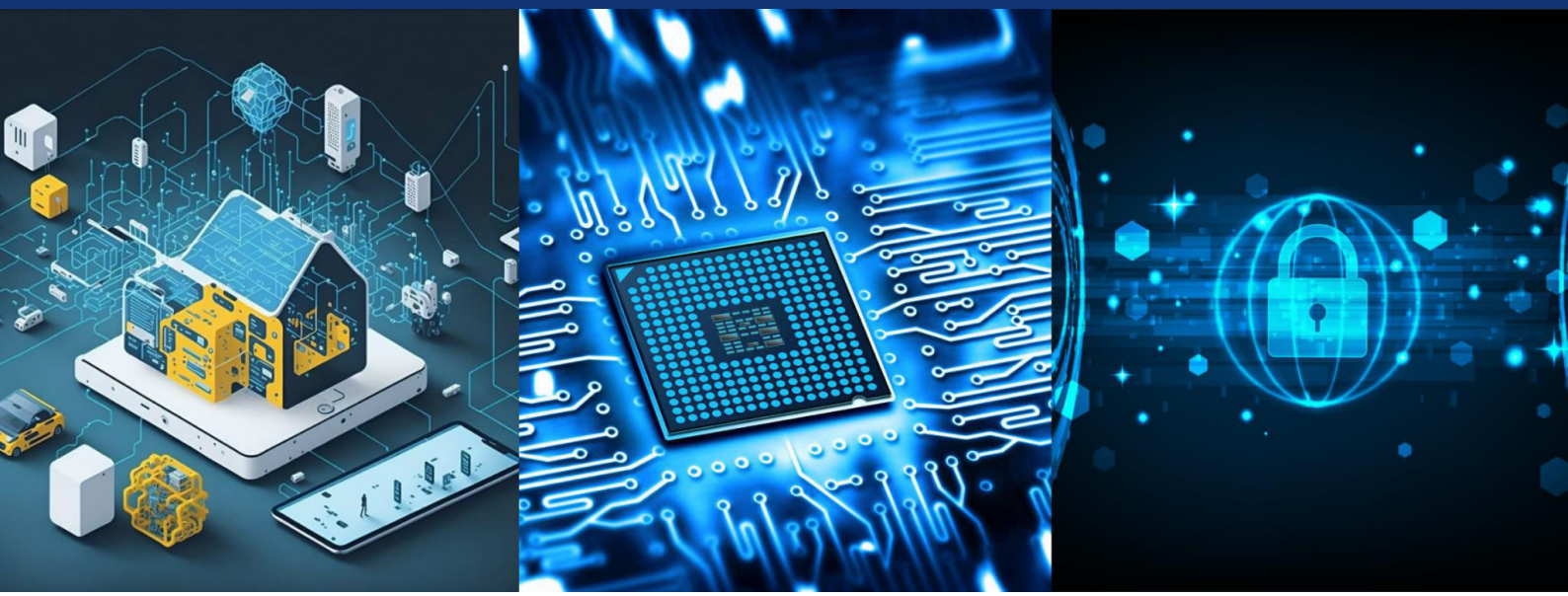
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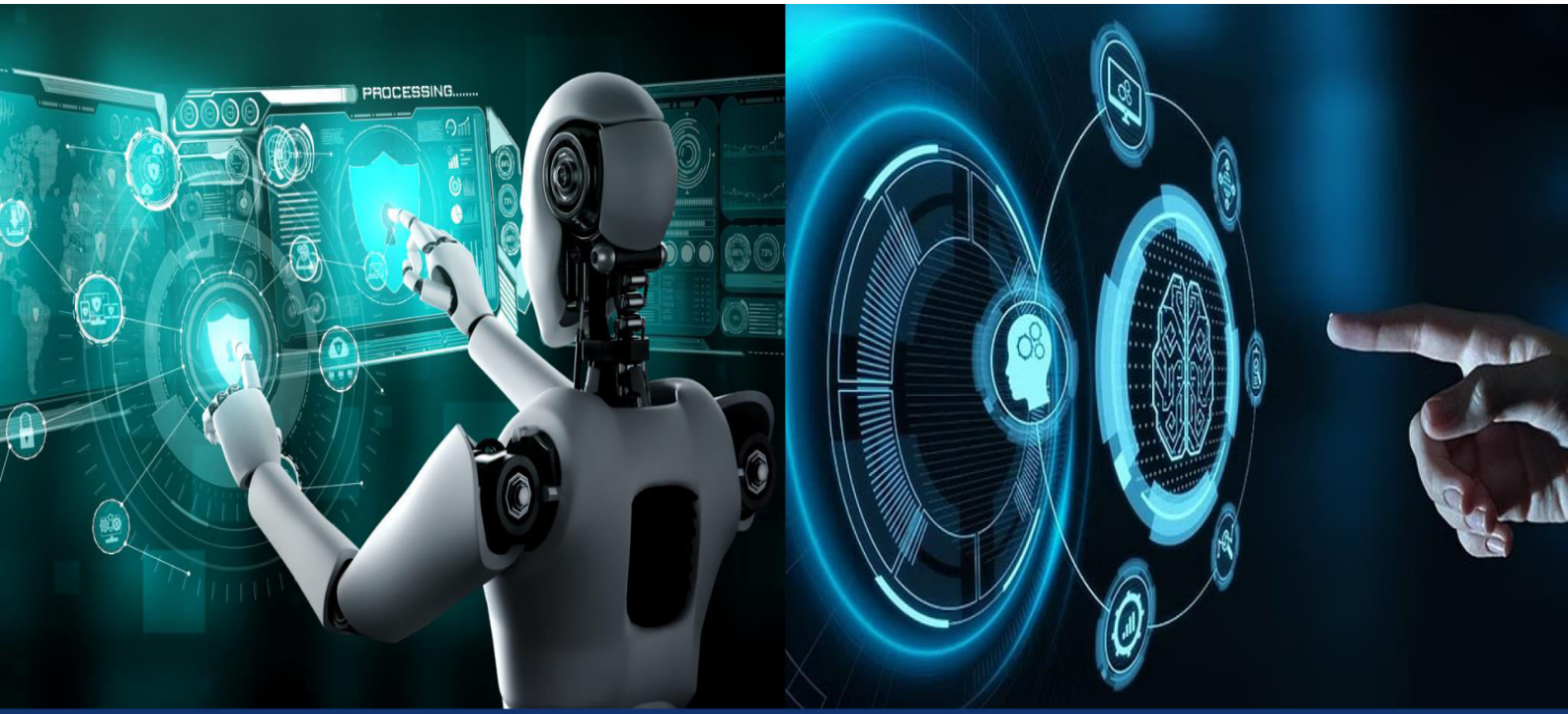
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Raspberry Pi Based Navigator and Reader for the Visually Impaired

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ABSTRACT: Visually impaired people face challenges in independent mobility, recognizing nearby people and currency, and accessing printed information. This paper presents a Raspberry Pi-based navigator and reader that combines camera-based perception, machine-learning-based recognition, optical character recognition (OCR), text-to-speech (TTS), and wireless emergency communication in a portable assistive system. A camera captures images of the surroundings; the reported object-detection pipeline uses the You Only Look Once (YOLO) algorithm to identify objects and obstacles and provide spoken alerts. Face-recognition and currency-recognition modules provide additional contextual assistance. For reading support, image preprocessing and Tesseract OCR extract printed text, which is converted into audio through a TTS engine. An emergency button initiates communication through wireless modules and the ESP32 so that a caretaker can be notified with location information. The project report documents successful demonstrations of object detection, face detection, currency detection, and reading assistance. In one reported OCR test, the system extracted "BAPUJI INSTITUTE OF ENGINEERING AND TECHNOLOGY" from a live camera image. The integrated design aims to improve accessibility, confidence, and safety while reducing dependence on other people. Further work is needed to quantify recognition accuracy and response time across varied environmental conditions.

KEYWORDS: Visually Impaired, Assistive Technology, Raspberry Pi Pico 2W, YOLO, Optical Character Recognition Text-to-Speech Face Recognition, Currency Recognition, ESP32, Emergency Alert.

I. INTRODUCTION

Vision impairment can make independent travel, recognition of familiar people, handling currency, and reading signs or documents difficult. Traditional aids such as white canes provide important mobility support but do not independently identify all objects, read printed information, or notify caregivers during emergencies. Separate assistive devices can also increase cost and complexity.

Recent advances in embedded processing, computer vision, deep learning, and wireless communication enable compact systems to interpret camera images and communicate information through audio. This project proposes a Raspberry Pi-based navigator and reader that combines obstacle and object detection, face recognition, currency recognition, OCR, speech output, and an emergency alert function within one assistive platform.

The main contribution is the integration of several everyday assistance functions into a single prototype. Instead of presenting visual results alone, the system is designed to provide spoken descriptions and readings so that the user can respond without needing to see a screen.

II. RELATED WORK

Prior work on Raspberry Pi-based readers has used camera capture, Tesseract OCR, and text-to-speech to make printed text accessible to blind users [1], [2], [5], [9]. Wearable-reader approaches emphasize portability but may not include obstacle detection or emergency alerts. Object-detection systems using YOLO and computer vision provide spoken information about nearby objects, although some focus primarily on navigation and do not provide reading or currency recognition [3], [6], [8], [10].

GPS- and voice-guidance-based navigation approaches support location-aware mobility [4], while CNN-based currency recognition assists with identifying banknote denominations [7]. IoT emergency-alert approaches add location sharing

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and caregiver notification [11]. Multi-functional systems combine some of these capabilities, but integrating recognition, reading, navigation support, and emergency communication in one compact device remains a practical design challenge [12].

The proposed project addresses this integration gap by combining camera-based perception, OCR-to-speech, face and currency recognition, and a wireless emergency-alert path.

III. PROBLEM IDENTIFICATION AND OBJECTIVES

The project report identifies six key challenges: obstacles that may not be detected by a conventional cane; difficulty identifying currency denominations; difficulty recognizing familiar people in social settings; limited access to signs, labels, and documents; lack of a simple emergency alert with location information; and limited real-time reassurance for caregivers.

The objectives are to develop a camera-based assistive system, provide real-time audio feedback, detect objects and obstacles, recognize currency and familiar faces, read printed text using OCR and TTS, and enable an emergency button to send location-related information to a designated caretaker.

IV. PROPOSED METHODOLOGY

A. System Architecture: The reported prototype includes a Raspberry Pi Pico 2W, web camera, Bluetooth transceiver, ESP32, emergency push-button, battery/power subsystem, and audio output. The camera supplies visual input, the processing pipeline performs detection or text extraction, and the speaker provides spoken feedback. Wireless communication is used for device communication.

B. Object and Obstacle Detection: Camera frames are captured and preprocessed using image-processing operations. The report describes YOLO as the object-detection method. YOLO evaluates an image in a single forward pass and predicts object classes, bounding boxes, and confidence scores. Detected objects are converted into short audio warnings, such as an obstacle or person being present, to improve environmental awareness.

C. Face and Currency Recognition: The face-recognition module detects faces and compares extracted facial features with previously registered identities. When a known face is recognized, the system announces the identity through audio. For currency recognition, an image of a banknote is analyzed by a trained recognition model to determine its denomination, which is then announced to the user. The report does not provide numerical accuracy measurements for these modules.

D. Reading Assistance: The camera captures text-bearing images. Preprocessing, including grayscale conversion and noise reduction, is applied before the image is passed to Tesseract OCR. The recognized text is cleaned and sent to a text-to-speech engine, and the generated audio is played through the speaker. If text is not detected, the process returns to image capture and continues scanning.

E. Emergency Alert: The emergency button is monitored by the communication subsystem. When pressed, the system initiates wireless communication involving the Raspberry Pi Pico 2W and ESP32 and is intended to transmit an alert with the user's current location to a registered caretaker. The report describes this as a safety feature; it does not provide measured delivery latency or network-reliability statistics.

V. HARDWARE AND SOFTWARE DESCRIPTION

Key hardware elements are the Raspberry Pi Pico 2W for embedded control and communication, a web camera for image acquisition, a Bluetooth transceiver for short-range wireless data exchange, an ESP32 for emergency communication, a push-button for manual emergency activation, a battery/power supply, and a speaker for audio output.

The report identifies Python as the main programming language. OpenCV is used for camera handling and image preprocessing; YOLO is used for object detection; CNN-based methods support visual recognition tasks; Tesseract

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provides OCR; and a TTS engine converts recognized text and alerts into speech. The system is organized into modules so that object detection, face recognition, currency recognition, reading assistance, and emergency communication can be tested and integrated.

VI. BLOCK DIAGRAM

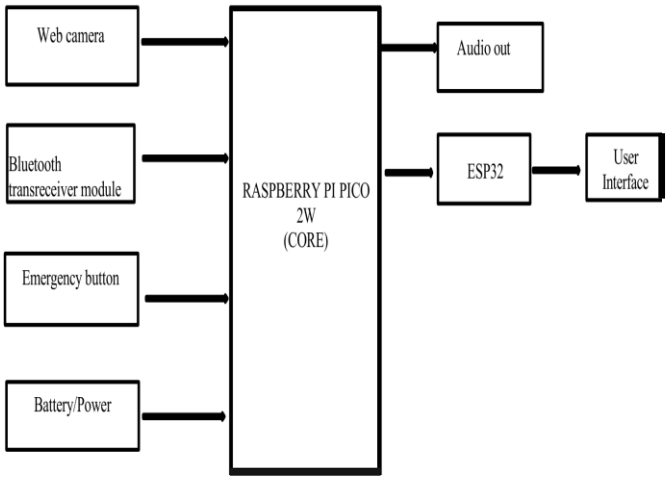


Fig 1. Block diagram

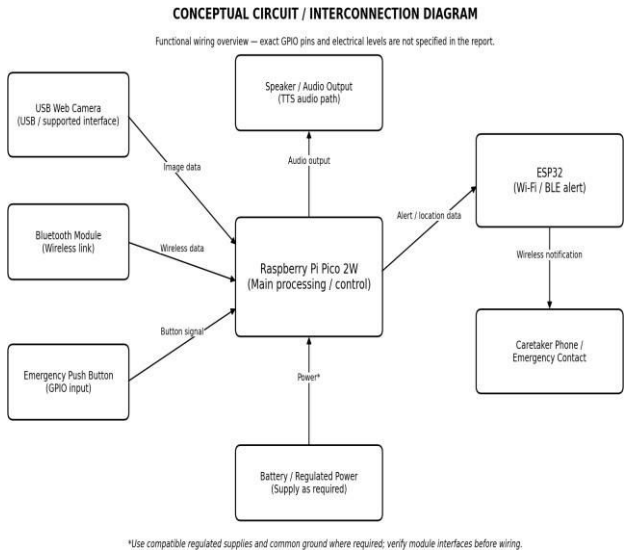


Fig. 2. Conceptual circuit/interconnection diagram.

VII. RESULTS AND DISCUSSION

The project report presents prototype demonstrations for object detection, face detection, currency detection, and reading assistance. The reading-assistance test successfully extracted the English text “BAPUJI INSTITUTE OF ENGINEERING AND TECHNOLOGY” from a live camera input, and the report states that the recognized text can be delivered through audio output. This demonstrates the integration of camera capture, text recognition, and audio feedback for the tested example.

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The reported object-detection demonstration indicates that the system can identify objects in the camera view and provide audio warnings. Face and currency detection are also presented as implemented functions. The report, however, does not provide a standardized test dataset, per-class accuracy, precision/recall, frame rate, or numerical end-to-end response-time measurements. Therefore, quantitative performance comparisons cannot be made from the available results.

The report identifies limitations that include reduced detection performance in low light or cluttered scenes, OCR difficulty with stylized or curved text, reduced face-recognition performance when faces are occluded or viewed at extreme angles, possible misclassification of worn currency, and dependence of emergency notifications on reliable wireless connectivity. Simultaneous execution of multiple modules may also increase processing load.

VIII. CONCLUSION AND FUTURE SCOPE

This paper presented a Raspberry Pi-based navigator and reader intended to improve independence and safety for visually impaired users. The prototype combines object and obstacle detection, face recognition, currency recognition, OCR-based reading, speech output, and wireless emergency notification. The reported OCR demonstration successfully extracted a sample institutional sign from a live camera image, while the project report also documents demonstrations of the other recognition modules. The integrated approach illustrates how embedded systems, computer vision, and wireless communication can support multiple daily tasks through audio feedback.

Reporting accuracy, latency and power consumption; improving recognition under low-light and cluttered conditions; adding GPS-based route guidance and indoor localization; enabling voice commands and OCR/TTS; and developing a caretaker mobile application with reliable location updates. These improvements should be validated through structured trials with users and representative environments.

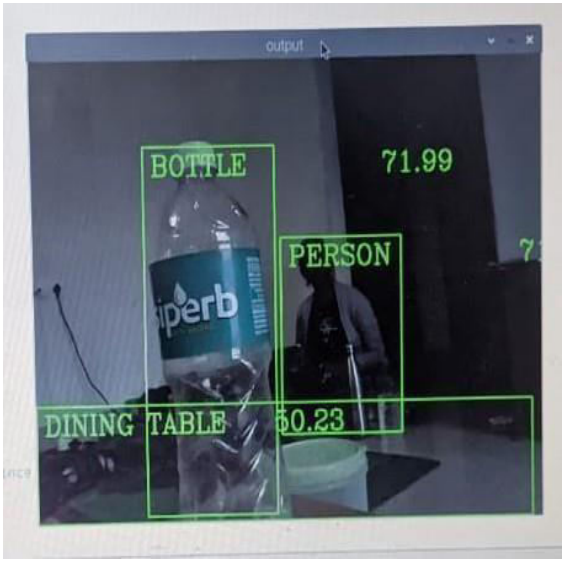


Fig 3. Person and object detection

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Fig 4. Person detection

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