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AI-Powered Visual Navigation System

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Abstract: The Augmented Reality (AR) Navigation System for Visually Impaired Individuals aims to enhance their ability to move independently in unfamiliar environments. Using a mobile device's camera, the system captures real-time images, processes them to identify objects. Users interact with the system through voice commands, enabling hands-free operation, while synthesized speech delivers navigation instructions and object descriptions. This approach helps visually impaired individuals by offering real-time, on-demand access to visual information, improving their mobility and independence. The system leverages AI, image processing, and voice interaction for an efficient and accessible navigation solution.

I. INTRODUCTION

Nowadays, the determination of the position of a person or an object in space is fundamental for many applications and services. Knowing the position of a person or object is important for many services, and GPS is the most common system used today. It's widely used in areas like aviation, shipping, and everyday navigation through smartphones. However, GPS doesn't work well indoors due to weak signals, which affects its accuracy or causes it to fail completely. This is a problem, especially for visually impaired individuals who face challenges navigating unfamiliar spaces. To help with this, new technologies have been developed. One such solution is the AI-Powered Visual Navigation Aid. It uses a device's camera to capture real-time images and applies AI and image processing to detect objects and obstacles. Users can control the system with voice commands and receive spoken instructions to guide them. This technology gives visually impaired users access to important visual information, helping them move safely and independently. The main goal of this system is to improve their mobility, confidence, and safety especially in indoor spaces by providing clear and accurate navigation support.

II. LITERATURE SURVEY

Danah Omary, Gayatri Mehta, "Multi-Modal Interactions of Mixed Reality Framework", 2024 IEEE 17th Dallas Circuits and Systems Conference (DCAS)

The proposed system is a glove-based Mixed Reality (MR) solution designed to help blind and visually impaired (BVI) individuals interact with virtual objects using touch, sound, and sight. It tracks hand and finger movements using sensors like flex sensors or accelerometers and provides tactile feedback through vibration motors, allowing users to "feel" virtual objects. A voice assistant, audio cues, and visual interfaces support different levels of vision. Combined with a Mixed Reality headset like the HoloLens, the system offers an immersive and accessible way for BVI users to explore and understand 3D virtual environments.

Daniele Croce Laura Giarre "An Indoor and Outdoor Navigation System for Visually Impaired People". Jan 2019 (IEEE)

Over the years, technology has helped visually impaired people by replacing some functions of vision. Early tools like Braille displays and speech systems handled specific tasks, but full vision replacement is still a challenge. This paper introduces an improved system that uses a phone camera and multiple sensors to guide users by detecting floor patterns like colored tapes. It measures direction and speed using computer vision and gives feedback through phone vibrations. The system combines camera data with motion sensors for more accurate indoor tracking and was tested with real users.

III. EXISTING SYSTEM

The navigation system developed for the Microsoft HoloLens 2 is designed to assist visually impaired users by providing real-time environmental awareness and guidance. Utilizing the HoloLens 2's advanced sensors and spatial mapping capabilities, the system continuously tracks the user's position and constructs a 3D map of the surrounding environment. It intelligently analyzes this data to identify the optimal path to a desired destination, avoiding obstacles and dynamically adapting to changes in the space. To guide users effectively, the system employs 3D auditory feedback (A3DF), allowing users to hear spatialized sounds that indicate direction, distance, and movement cues. The entire application is built using the Unity game engine, which enables seamless integration of real-time spatial mapping, audio rendering, and user interaction wi thin a robust mixed reality environment.

IV. PROPOSED SYSTEM

The AI-powered visual navigation system is designed to empower visually impaired individuals by enabling safe and independent movement through real-time auditory assistance. Utilizing the device's camera in combination with the YOLOv5 object detection algorithm, the system accurately identifies and classifies objects in the user's surroundings, such as pedestrians, vehicles, furniture, or obstacles. This visual information is then converted into meaningful audio cues using speech synthesis powered by the pyttsx3 text-to-speech engine. By translating visual data into descriptive voice feedback, the system allows users to perceive their environment without relying on sight. The continuous, hands-free audio guidance ensures that users can confidently navigate through both indoor and outdoor environments, including busy streets, unfamiliar buildings, or open spaces. This integration of computer vision and natural language audio output transforms how visually impaired individuals interact with the world, offering a greater sense of awareness, autonomy, and safety.

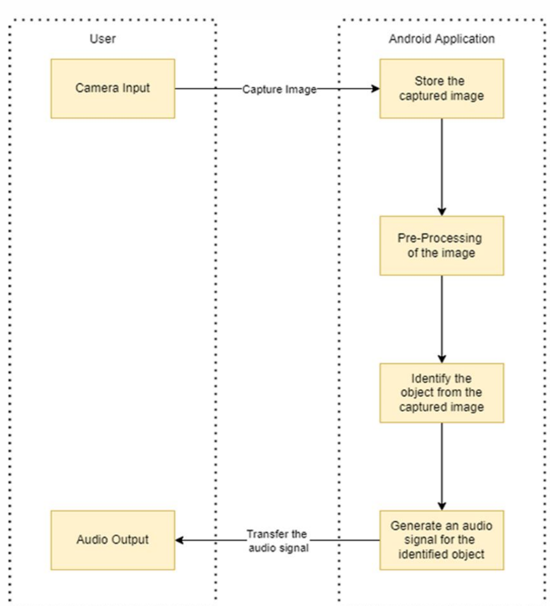
V. IMPLIMENTATION

The AI-powered visual navigation system is a smart, assistive solution designed to enhance mobility and independence for visually impaired individuals. It leverages the device's built-in camera to continuously capture the surrounding environment, using the YOLOv5 deep learning model for real-time object detection. This allows the system to accurately recognize and classify various objects such as people, vehicles, doors, obstacles, and more. Once detected, relevant information is conveyed to the user through clear, spoken guidance using pyttsx3, a text-to-speech engine that delivers auditory feedback in real time. To further improve usability, the system integrates speech recognition capabilities, enabling users to interact with it through voice commands, making the experience completely hands-free. Whether in indoor environments like homes or offices, or outdoor areas such as streets and parks, the system adapts seamlessly to changing surroundings, offering timely audio cues that assist users in making safe and informed navigation decisions. By combining object detection, speech output, and voice control, this system significantly improves situational awareness and supports greater independence for visually impaired users.

VI. MODULES

1) Object detection **-** The system uses YOLOv5 with a 0.4 confidence threshold to detect objects and draw labeled bounding boxes around them in video frames.
2) Speech recognition **-** The system uses the speech_recognition library with Google's API to convert microphone input into text, allowing voice commands to trigger actions like scanning or pausing.
3) Text to speech **-** The system uses pyttsx3 to convert text into speech, providing feedback and navigation instructions like "Move right to avoid the obstacle," with distances estimated from bounding box sizes.

VII. SYSTEM ARCHITECTURE



VIII. RESULT AND ANALYSIS

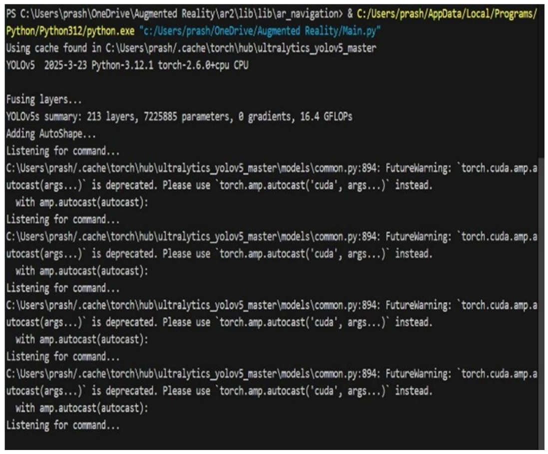


Fig 1: Listening for command

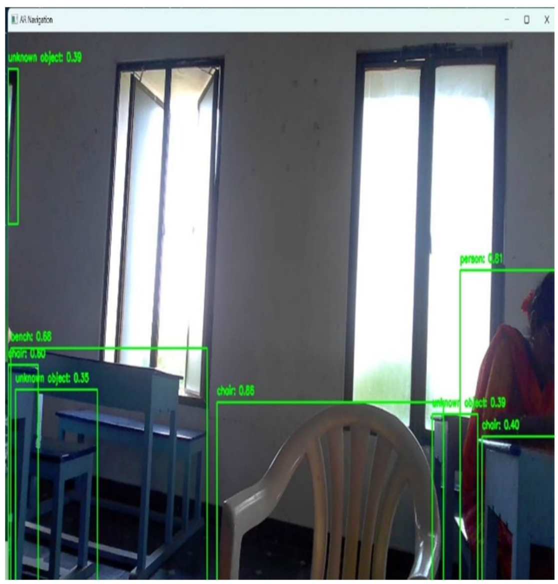


Fig 2: Open camera and detect objects

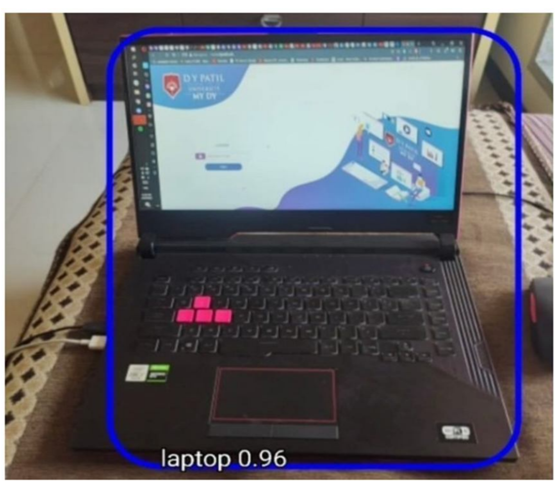


Fig 3: Detecting Objects

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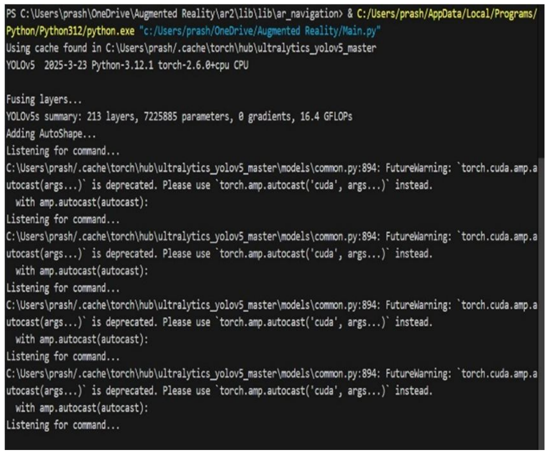

Fig 4:Output in the form of voice

IX. CONCLUSION

The AI-Powered Visual Navigation System is an innovative and supportive technology developed to aid visually impaired individuals in navigating their surroundings safely and independently. At the heart of this system is a camera that continuously captures real-time images of the environment. These visuals are processed using advanced artificial intelligence algorithms capable of recognizing and analyzing objects, obstacles, pathways, and other critical spatial details. The AI interprets this information instantly and translates it into clear, spoken instructions that guide the user step by step.

X. FUTURE SCOPE

The future of the AI-powered Visual Navigation System holds immense promise, with several avenues for expansion and enhancement. One key area for growth is the development of mobile and tablet applications, which would make the system more accessible and convenient for users who need guidance while on the move. By offering a mobile-friendly platform, users can seamlessly access navigation tools in real-time, whether they are commuting, traveling, or navigating unfamiliar environments. Furthermore, integrating multilingual support is another vital step toward inclusivity and user-friendliness.This not only improves the overall accessibility of the system but also enhances its performance by offering a more personalized and user-centric experience. The future of the AI-powered Visual Navigation System holds immense promise, with several avenues for expansion and enhancement. One key area for growth is the development of mobile and tablet applications, which would make the system more accessible and convenient for users who need guidance while on the move. By offering a mobile-friendly platform, users can seamlessly access navigation tools in real-time, whether they are commuting, traveling, or navigating unfamiliar environments.This not only improves the overall accessibility of the system but also enhances its performance by offering a more personalized and user-centric experience.

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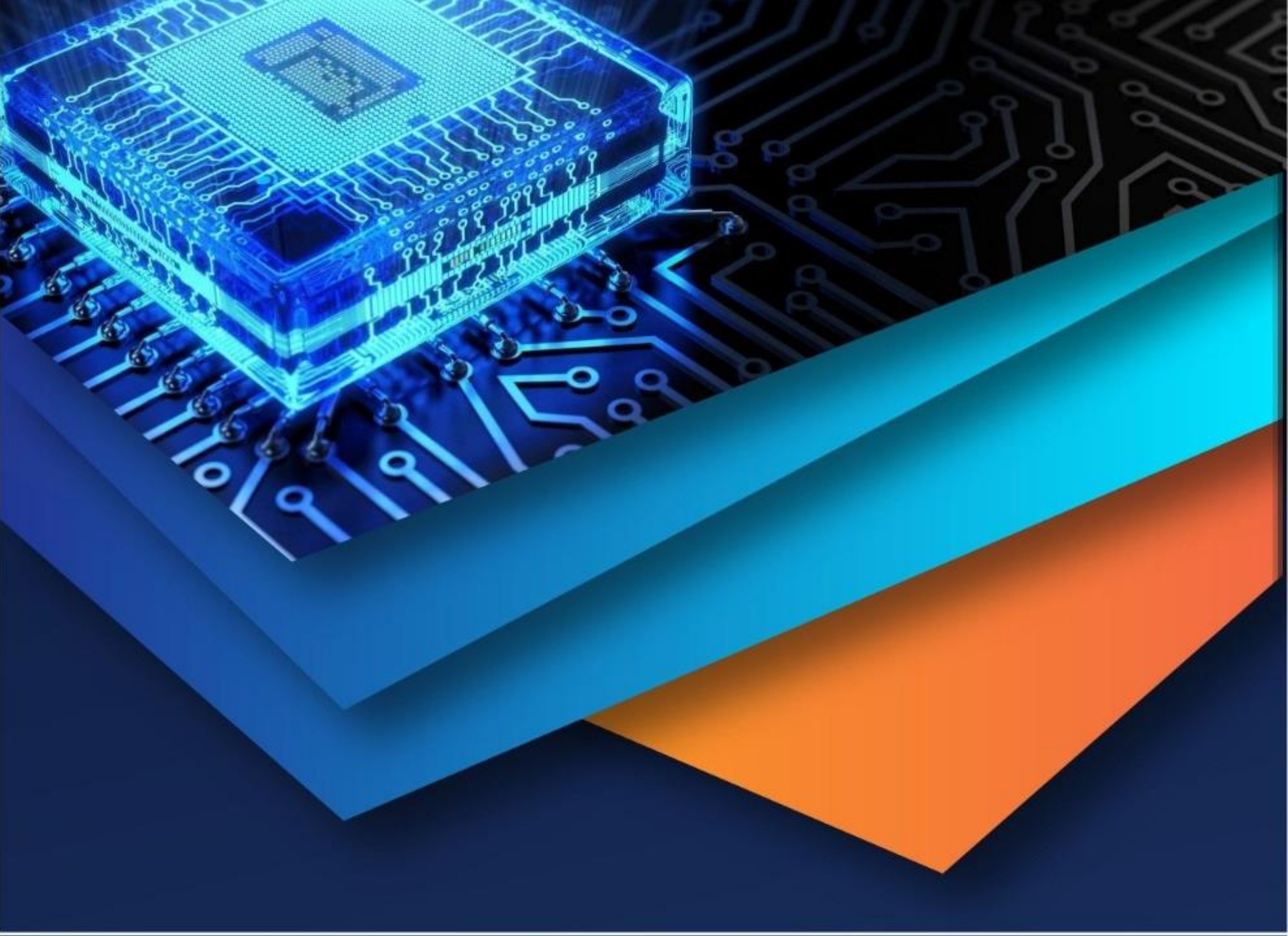

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