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AI Based Object Detection for Blind Assistance

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Abstract
Visually impaired individuals face significant challenges in identifying obstacles, navigating unfamiliar places, recognizing nearby objects, and accessing real-time information. Current assistance systems usually depend on costly sensors or lack smart automation. To fill this gap, we propose an Enhanced Real-Time Blind Assistance System. This system integrates live object detection, voice-command interaction, multilingual support, text-reading capability, and emergency alert handling. The system uses TensorFlow.js with the COCO-SSD model to detect objects through a live camera feed. It provides spoken feedback about object proximity and direction. Additionally, it monitors critical conditions and sends emergency notifications when necessary. This system operates entirely through a browser, so it requires no special hardware. This makes it easy to access and deploy. The findings indicate that the system detects objects accurately, delivers timely alerts, and responds effectively to voice commands. Ultimately, it improves mobility, safety, and helping visually impaired individuals move around on their own whether the user is indoor or outside.

Keywords: *Assistance System; COCO-SSD Model; Emergency Alert System; Object Detection; Speech Interaction.*

1. Introduction
Visual impairment significantly restricts an individual's ability to perceive obstacles, recognize objects, and navigate unfamiliar environments safely. According to global health studies, millions of people worldwide suffer from partial or complete vision loss, making independent mobility a major challenge. Conventional mobility aids such as white canes and guide dogs provide basic assistance but offer limited information about the surrounding environment. As a result, visually impaired individuals often depend on external support for safe navigation. With the advancement of computer vision and artificial intelligence, several assistive technologies have been developed to enhance environmental awareness for visually impaired users (Birari et al., 2023; Rajan et al., 2023). Early vision-based systems focused on obstacle detection using ultrasonic sensors and wearable devices. However, these systems were often expensive, hardware dependent, and limited in functionality. Recent research has shifted towards camera-based object detection systems using deep learning techniques, enabling real-time recognition of multiple objects with improved accuracy. The objective of this research is to develop a lightweight, real-time object detection system that assists visually impaired users in navigating their surroundings independently. The proposed system emphasizes accessibility, minimal hardware dependency, and effective feedback mechanisms. By integrating object detection with distance estimation and multimodal alerts, the system aims to improve safety, confidence, and mobility for blind and visually impaired individuals.

1.1. Literature Survey
People who are blind or visually impaired encounter challenges that many people do not notice. These include crossing streets, identifying obstacles, reading labels, and recognizing surrounding objects. Everyday movement becomes uncertain in an environment that is not visible. Over the years,

traditional assistive tools like white canes, sensor-based sticks, and basic voice navigation systems have tried to address these issues. However, they only tackle small parts of a much larger problem. Technology has advanced toward real-time perception with machine learning and computer vision, particularly through on-device object detection. Models like YOLO, MobileNet-SSD, and COCO-SSD now make instant classification possible, transforming cameras into perception tools. Despite these advancements, these solutions seldom achieve real-world usability. Many systems rely on bulky equipment, slow processing, outdated offline models, or limited user interaction. Some assistive devices can detect obstacles but cannot identify them; knowing an object exists is not the same as knowing if it is a bike, a dog, or a moving vehicle. Others provide alerts only after the likelihood of a collision increases, often resulting in delayed reactions. Multiple applications are limited to desktops, lack vibration feedback, or do not support continuous speech output. This study directly targets these gaps. The aim is to create an AI-based visual assistance system that detects real-world objects through a camera, classifies them instantly, warns users with voice instructions, and triggers vibration feedback when objects come close. Instead of static detection, this system seeks dynamic, user-aware, smart guidance, which is lacking in current tools.

1.2. Related Works

Heba Najm et al. (2020) developed an assistive system that uses real-time object detection and provides voice-based guidance to visually impaired users [1]. Their work showed that turning detected object labels into speech improves awareness of the environment. However, their system lacked feedback based on proximity and did not classify alerts by urgency, which meant all detected objects were treated the same. Manduchi et al. (2012) explored the possibility of helping blind individuals understand visual content without sight, using camera-based sensing and automatic scene understanding [2]. Their research laid the groundwork for future assistive vision systems, but it did not include real-time interaction with objects. Tapu et al. (2015) introduced a smartphone-based assistant called ALICE that detects objects and guides blind users through structured voice feedback [3]. While it was portable and practical, their system focused mainly on indoor navigation and did not offer real-time awareness of the surroundings outdoors. Wang et al. (2013) proposed a method for navigation support that centered on recognizing signs and doors to improve access in public spaces [4]. Their method improved access indoors but did not address general objects during daily movement. Bai et al. (2019) created a wearable travel aid device aimed at helping with environmental perception and navigation [5]. Although it was highly effective for mobility assistance, its complex hardware and wearable features limited its practicality in real-world situations. Potdar et al. (2018) developed a CNN-based live object recognition system designed to help blind users identify nearby objects [6]. However, the system only provided object names and did not convey their distance or urgency. Kotyan et al. (2019) designed Drishtikon, a smart navigation aid aimed at improving decision help for visually impaired users [7]. While it was promising, it relied on specialized hardware and did not provide dual-mode alerts. Jafri and Du (2014) gave an overview of computer vision-based recognition tools for assisting visually impaired individuals [8]. Their survey pointed out the shift from basic detection to real-time recognition using deep learning, but practical applications were still limited at that time. Redmon et al. (2016) introduced YOLO, which ranks as one of the most widely used detection frameworks [9]. YOLO enabled real-time detection and later became the main algorithmic foundation for modern assistance tools. Ren et al. (2015) proposed Faster R-CNN, which ensures precise outcomes in object detection and region-based analysis [10]. Majority of the existing systems can detect objects however; they do not help users gauge their distance. This lack of distance awareness reduces real-time safety. Many tools rely only on voice output. This leads to repeated announcements that can mislead users while they are moving. Some solutions need expensive hardware or extra sensors, making them tough to use outside. Cloud-based systems can improve accuracy but often face delays when the internet connection is weak.

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Overall, previous systems lack distance awareness, priority alerts, and dual-mode feedback, which limits safe navigation. The proposed system tackles these problems with real-time detection, selective speech output, and vibration alerts based on how close objects are. Table 1 shows the comparison

Table 1 Comparison Table

Paper	Proposed Methodology	Key Features	Limitations	Advantages of Our System
Assisting blind people using object detection with vocal feedback (2020)	YOLO-based detection with speech output	Real-time classification	No distance alerts, no vibration	Distance-based vibration+priority alerts
Computer vision without sight(2012)	Conceptual vision-based assistance	Introduced visual interpretation for blind mobility	Not real-time	Real-time detection,acinable guidance
"ALICE: A Smartphone assistant (2015)	Smartphone-based navigation support	Voice-based path insights	Works mainly for indoor scenes	Outdoor support+ continuous live alerts
Detecting signage and doors(2015)	Scene-based recognition of signs/doors	Useful for building navigation	Limited object coverage	Detects multiple everyday objects
Object recognition Survey (2014)	Survey study of assistive CV models	Identifies research gaps	No working system provided	Fully implemented working solution
Wearable travel aid (2019)	Wearable perception device	Continuous assistance through wearable unit	Expensive dedicated hardware	Runs on normal mobile devices
CNN-based live object recognition(2018)	CNN-based recognition	Identifies object types	No risk/urgency decision	Alerts+vibration feedback
Faster -RCNN object detection (2015)	High-accuracy object detection	Precise detection and bounding boxes	Slow on mobiles, not practical for real-time	Lightweight live detection instead
Object detection with voice guidance using YOLO7 (2023)	YOLOv7 detection	Good accuracy &speech alerts	Speech only notifications	Dual-mode alerts for clarity
AI-based wearable vision system(2024)	Multimodal LLM-based detection	Contextual interpretation	High compute demand	Lightweight deployable design
Object recognition using MobileNet-SSD(2023)	MobileNet-SSD	Works on mobile devices	Repetitive alerts without priority	Priority filtered announcements

2. Method

The proposed blind assistance system is designed to operate in real time using a camera-enabled device. The methodology focuses on simplicity, efficiency, and user-friendly interaction while ensuring accurate object detection and timely feedback. Live video is continuously captured using the device camera. The video frames are processed using the COCO-SSD object detection model implemented with TensorFlow.js [11]. Each frame is analyzed to identify objects, generate bounding boxes, and assign confidence scores. Detected objects are filtered using a predefined confidence threshold to ensure reliability. Distance estimation is performed based on the relative size of the bounding boxes. Larger bounding boxes indicate closer objects, while smaller boxes represent distant objects. Based on this estimation, the system prioritizes alerts and generates appropriate audio and vibration feedback. This approach reduces unnecessary alerts and improves user focus during navigation.

2.1. System Architecture

The architecture of a system keeps a continuous cycle: frame acquisition, object recognition, interpretation, and alert execution. Once a decision is made, it resets for the next frame, helping the system stay aware in real time. This real-time loop offers guidance while moving instead of only after encountering an obstacle [12]. Unlike older assistive systems that relied on sensors or simple speech, this architecture combines recognition, distance reasoning, and multi-mode alerts in a single, coordinated flow, making it more reliable for navigation assistance. The overall system architecture of the proposed blind assistance system is illustrated in Figure The architecture consists of a live video acquisition module, object detection module, distance interpretation unit, alert decision logic, and multimodal output generation module. These components operate sequentially in a continuous loop to provide real-time navigation assistance

3. Results and Discussion

3.1. Results

The system was tested in various indoor and outdoor environments, including corridors, open spaces, and streets. The object detection model identified common objects such as people, doors, vehicles, and furniture in real time. The distance-based alert mechanism differentiated between near and far obstacles and generated timely warnings for the user. nThe system demonstrated stable performance under normal lighting conditions and achieved satisfactory detection accuracy for most object categories supported by the COCO dataset. The response time was suitable for real-time navigation, with minimal latency observed during continuous operation.

3.2. Discussion

The experimental results indicate that integrating object detection with distance-aware feedback significantly enhances the usability of assistive navigation systems. Unlike traditional systems that rely solely on audio alerts, the proposed approach combines speech and vibration feedback, reducing cognitive overload. The browser-based implementation further improves accessibility by allowing deployment on commonly available devices. However, performance may vary under low-light conditions or highly cluttered environments. Future improvements could include adaptive lighting compensation, GPS integration, and directional audio cues to enhance navigation accuracy and user experience.

Conclusion

This research presents an AI based object detection system designed to assist visually impaired individuals in independent navigation [13]. By leveraging real-time computer vision [14], distance estimation, and multimodal feedback, the system improves environmental awareness and user safety. The lightweight and accessible design makes it suitable for practical deployment without the need for specialized hardware. Future work will focus on expanding object categories, improving robustness, and integrating additional navigation features to further enhance mobility support [15].

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