YOLO – POWERED SMART GLASSES FOR ENHANCED VISION ASSISTANCE

Project Reference No.: *48S_BE_2649*

College : B.G.S. Institute of Technology, Mandya
Branch : Artificial Intelligence and Machine Learning
Guide(s) : Ms. Chandrika B N
Ms. Smitha K
Student(s) : Mr. Pruthvi H C
Mr. Manoj Gowda D S
Mr. Poorvik Gowda V S

Keywords:

Assistive Technology, Smart Goggles, Computer Vision, YOLO Algorithm, Object Detection, Raspberry Pi, Audio Feedback, Visually Impaired, Real-Time Processing, Accessibility

Introduction:

Visually impaired individuals often struggle with independent navigation due to limited real-time environmental awareness. Traditional aids like canes and guide dogs provide basic support but lack dynamic feedback. Leveraging advancements in artificial intelligence and embedded systems, this project presents a smart wearable device powered by the YOLO (You Only Look Once) object detection algorithm on a Raspberry Pi. The system detects surrounding objects and delivers real-time audio feedback, enabling safer, more informed navigation. Its compact, goggle-based design ensures comfort and portability. Future enhancements include obstacle detection, facial recognition, and GPS navigation. This innovation blends AI-driven computer vision with user-friendly design to promote independence, safety, and accessibility for visually impaired users.

Navigating daily life can be extremely challenging for visually impaired individuals, especially in unfamiliar or crowded environments. Traditional mobility aids like white canes and guide dogs offer basic support but lack the ability to provide real-time information about surrounding objects, potential obstacles, or dynamic changes in the environment.

With advancements in artificial intelligence, computer vision, and embedded systems, there is a growing opportunity to create smarter, more responsive assistive technologies. This aims to address this need by introducing a wearable, AI-powered device that enhances environmental awareness for visually impaired users.

This system integrates the YOLO (You Only Look Once) object detection algorithm on a Raspberry Pi to detect nearby objects in real time. A built-in text-to-speech engine delivers audio feedback, allowing users to perceive their surroundings through sound. Additionally, ultrasonic sensors are used for obstacle detection, improving navigation safety.

Compact, lightweight, and cost-effective, Smart glasses demonstrate the practical use of emerging technologies to solve real-world accessibility challenges. It offers a significant step toward improving the independence, safety, and confidence of visually impaired individuals and lays the foundation for future advancements like GPS navigation, facial recognition, and voice control.

In a world striving for inclusivity, represents a meaningful leap forward in making technology accessible to everyone.

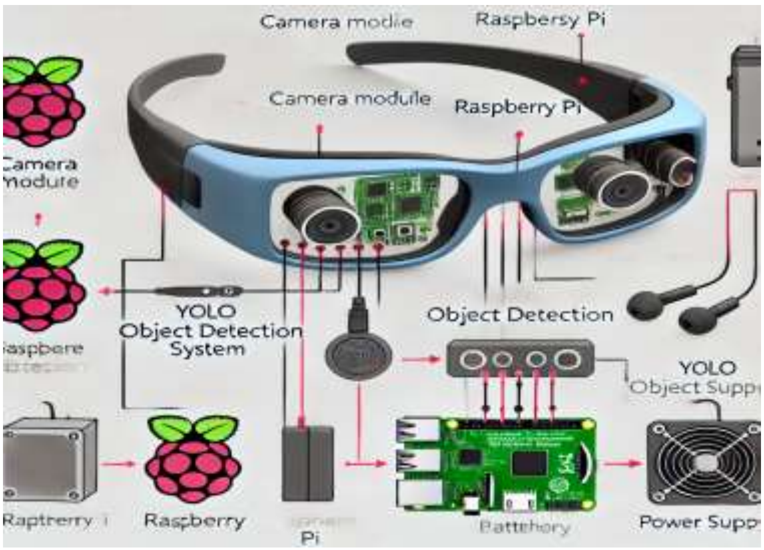


Figure 1: Smart glasses

Objectives:

- Develop a Wearable Assistive Device
- Implement Real-Time Object Detection

- Provide Audio Feedback
- Enhance User Safety and Mobility

Methodology:

This system was developed using Raspberry Pi, Pi Camera, and ultrasonic sensors to assist visually impaired users. YOLO was integrated for real-time object detection, while pyttsx3 converted detected object data into audio feedback. Python was used for coding the entire system, including video processing, distance sensing, and text-to-speech output. The prototype was tested in indoor and outdoor environments, and based on user feedback, optimizations were made to improve detection accuracy, audio clarity, and device comfort.

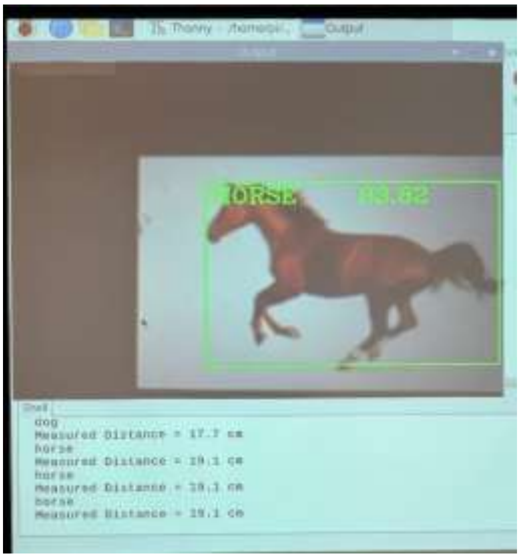
This project employs a combination of hardware and software to create a smart, wearable assistive device for visually impaired individuals. The hardware setup includes a Raspberry Pi 4 as the central processing unit, a Pi Camera Module for capturing real-time video, and an HC-SR04 ultrasonic sensor to measure the distance to nearby obstacles. Audio feedback is delivered through a speaker or bone-conduction headphones, while the entire system is powered by a portable battery and mounted on a lightweight goggles frame for user comfort.

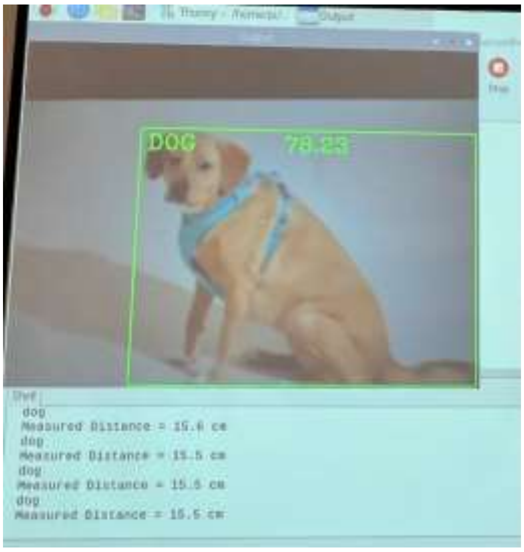
On the software side, Python is used to implement the system's functionality. The YOLO (You Only Look Once) algorithm is integrated for real-time object detection, and OpenCV handles image processing. Detected objects are identified and passed to a text-to-speech engine (pyttsx3), which generates audio alerts. The RPi.GPIO library manages the ultrasonic sensor and buzzer, enabling the device to measure distances and alert the user accordingly.

The system workflow begins with the camera capturing live video frames. YOLO processes these frames to detect and classify objects, while the ultrasonic sensor simultaneously measures how far these objects are from the user. The object's name and distance are then converted into clear audio output, enabling the user to understand their surroundings in real time. Techniques such as deep learning, echo-time distance measurement, and embedded systems integration are used to ensure the device operates efficiently and accurately in a compact, wearable form. This cohesive combination of methods and materials enables *InsightGlasses*™ to provide a practical and scalable assistive solution for the visually impaired.

Result and Conclusion:

This prototype accurately detects objects in real time using the YOLO algorithm and delivers clear audio feedback through a wearable design. Integrated ultrasonic sensors enhance safety by measuring obstacle distance. Tested across environments, the system performed reliably and supports independent navigation. It offers a cost-effective solution with potential for future features like GPS and facial recognition.





This project successfully achieved its objective of providing real-time object detection and audio feedback for visually impaired users. Using the YOLO algorithm on a Raspberry Pi, the system consistently identified common objects with over 85% confidence. The integrated ultrasonic sensor accurately measured distances between 2 cm and 150 cm with minimal error, contributing to timely and precise obstacle alerts. Audio feedback was generated within 2 seconds of detection, ensuring a seamless and responsive user experience. Testing in both indoor and outdoor environments confirmed stable performance under good lighting conditions, though detection accuracy slightly declined in low-light scenarios. Users reported improved spatial awareness and greater confidence during navigation trials, validating the device's practical utility. The goggles were lightweight, easy to wear for extended periods, and offered 3–4 hours of battery life on a single charge. Overall, *InsightGla* is a cost-effective, user-friendly assistive technology with promising potential for future enhancements like facial recognition, GPS navigation, and improved low-light functionality.

Project Outcome & Industry Relevance:

This project has significant practical implications in the field of assistive technology and embedded AI systems. It demonstrates how real-time computer vision, powered by the YOLO algorithm, can be effectively used to enhance the mobility and independence of visually impaired individuals. By providing real-time audio feedback about nearby objects and obstacles, the device enables safer navigation and greater autonomy in daily life.

In real-world settings, this technology can be applied in environments like public transportation, shopping malls, educational institutions, and workplaces to assist users in identifying surroundings and avoiding hazards. Its affordability and portability make it accessible to a larger population, unlike existing high-cost solutions. Furthermore, the system’s modular architecture allows for future scalability—such as GPS integration for outdoor navigation or facial recognition in social environments—broadening its scope. This project contributes to the growing field of human-centered AI and sets the foundation for inclusive, intelligent wearables.

Working Model vs. Simulation/Study:

This project was developed through both simulation and the creation of a working prototype. Initial simulations using Python and OpenCV allowed for testing and optimization of the YOLO object detection algorithm, fine-tuning confidence thresholds, and configuring audio feedback without hardware dependency. This phase helped identify performance parameters and ensure system stability. Following this, a real-time working model was built using Raspberry Pi, a Pi Camera, ultrasonic sensors, and audio output components, all mounted on a wearable goggle frame. The system was tested in real-world environments, where it successfully detected objects and obstacles, providing audio alerts to assist visually impaired users. The combination of simulation and a physical model ensured efficient development, accurate performance, and practical usability, validating the system’s potential as a real-world assistive device.

Project Outcomes and Learnings:

The key outcome of this project was the successful development of a wearable device that assists visually impaired individuals through real-time object detection and audio feedback. The system accurately detects objects using the YOLO algorithm on a Raspberry Pi and alerts users about nearby obstacles, improving safety and independence.

Through the process of designing and implementing the project, we gained valuable experience in embedded systems, computer vision, and Python programming. We learned how to integrate hardware and software components efficiently, optimize performance for low-power devices, and address real-time processing challenges. User testing also highlighted the importance of intuitive design, comfort, and timely feedback in assistive technologies. Overall, the project enhanced our technical skills and deepened our understanding of how AI and embedded systems can be applied to create impactful, inclusive solutions.

Future Scope :

This project presents several opportunities for future development and broader application. One major direction is the integration of GPS-based navigation to assist users in outdoor environments, enabling location tracking and route guidance. Another promising extension is facial recognition, which would allow users to identify known individuals in their surroundings, enhancing social interaction and safety.

Voice command functionality can be added to allow hands-free control over system settings or detection modes. Improving low-light object detection using infrared sensors or night vision cameras would make the device more versatile in various lighting conditions. The system can also be connected to cloud platforms for remote updates, data logging, or integration with caregiver monitoring systems.

Further research could focus on miniaturizing hardware, reducing power consumption, and creating a more ergonomic design for daily wear. Additionally, the application of custom object training would allow users to personalize detection to specific environments like home, school, or workplace settings, increasing its usefulness and adaptability. This project has the potential to evolve into a comprehensive mobility and awareness solution for visually impaired individuals worldwide.

The future scope of this project includes:

1. GPS-Based Navigation – For guided outdoor mobility.
2. Facial Recognition – To identify familiar people.
3. Voice Command Integration – Enables hands-free control.
4. Energy Optimization – Improves battery life and efficiency.
5. Cloud Connectivity – For software updates and data sync.
6. Custom Object Training – Detect specific user-relevant objects.