AI Cane: A Cost-Effective Edge AI Assistive Device for Real-Time Object Detection and Spatial Awareness for the Visually Impaired

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Visual impairment significantly limits an individual's ability to live independently and navigate their surroundings safely, often requiring external assistance. Current solutions, such as traditional white canes and advanced smart glasses, have limitations including high cost, limited functionality, and lack of accessibility. To address these challenges, the AI Cane was developed as an affordable assistive device that uses an Edge AI model and real-time feedback to enhance user independence and environmental awareness. The AI Cane utilizes a deep neural network (DNN) model trained for object detection to identify objects in the surroundings. A custom-labeled image dataset was created using polygon segmentation, with 80% allocated for training and 20% for testing. The model achieved over 90% accuracy on training and testing, and 89% on real-time indoor testing, demonstrating reliable performance. The device is built on a compact embedded platform that integrates a Raspberry Pi, a camera, a LiDAR sensor, audio output, and a 3D-printed casing, enabling near-real-time text-to-speech feedback for effective obstacle and object recognition, with an average response time of 1.96 seconds. A web app was created to make the AI Cane more customizable and user-friendly. Through the web app, caregivers and users can upload their own images to label objects or people, creating a personalized dataset. This can also help people with Alzheimer's or memory loss to recognize their family members. The system operates completely offline during daily use, ensuring reliability even without internet access. The AI Cane is a low-cost (under $100), customizable assistive device that helps people with visual or cognitive impairments live more independently and improve their quality of life.

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