ABSTRACT

Visually impaired individuals require navigation aids that not only detect obstacles but also provide real-time position information to enhance mobility safety. This research aims to design and implement a smart navigation system based on Raspberry Pi 5 that can recognize obstacles and send the user's location in an emergency to assist user independence and safety.

The system is designed using a camera as the main sensor for obstacle detection with the Faster R-CNN method based on MobileNet V3 Large FPN, and is equipped with a Neo-6M GPS module for position tracking and SIM800L for sending coordinates via SMS and a vibration motor as feedback. The implementation of testing was carried out directly in a real environment using Raspberry Pi 5 as the main computing unit.

The training results showed an mAP@0.5e of 81.1%, while field testing yielded an average system accuracy of ≈ 79%, with an average confidence of 0.82 (human), 0.78 (tree), and 0.67 (dangerous road). The average inference time was recorded at 7–8 seconds, meaning that the system did not meet the real-time criteria (0.03–0.07 s per frame) and required optimization to ensure safety response. The GPS module showed a deviation of 6, 52 – 9,09 m, while SIM800L successfully sent emergency coordinates in 90% of trials within 6-8 seconds. The system was able to operate for ±2.6 hours with a power consumption of 6.48 Wh. Overall, the developed system has functioned according to the research objectives in supporting navigation for the visually impaired, although model optimization, GPS accuracy in certain areas, and lighting condition improvements are still needed to make the system's performance more stable in various environments.

***Keywords**: Faster R-CNN, Raspberry Pi 5, GPS, SIM800L, Visually Impaired, Smart Cane, Navigation, Panic Button*