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Portable Sensing-Driven Smart Helper Device: Personalized, Rehabilitation-Oriented Assistive Technology

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Abstract

The independent mobility of people with disabilities still relies on canes and Braille blocks, which do not provide proactive and continuous guidance [1]. There is a need for low-cost, infrastructure-free solutions that operate indoors and outdoors and provide predictable guidance in real time. Traditional GPS/AI navigation depends on expensive sensors and computation and performs poorly indoors, whereas classical line tracing is not well adapted to human walking and variable environments [2]. This study presents a Raspberry Pi 5 visual to haptic aid that converts a colored guidance lane into vibration feedback in real time. The camera analyzes a vertically elongated central region of interest (ROI) using hue–saturation–value (HSV) segmentation and compares the red coverage with a threshold ($\theta \approx 0.7$). When the coverage remains above the threshold for approximately 1 second, the device emits 0.12 s vibration pulses at 0.2 s intervals and pauses when alignment is restored. The entire pipeline runs on device in Python; V4L2 camera access, udev (without root privileges), and systemd (auto start) simplify deployment. On highly textured floors, in mixed or ambiguously colored scenes, and under very low illumination, performance may degrade. Mitigation strategies include adaptive threshold and color models, lighting calibration, and selective sensor fusion.

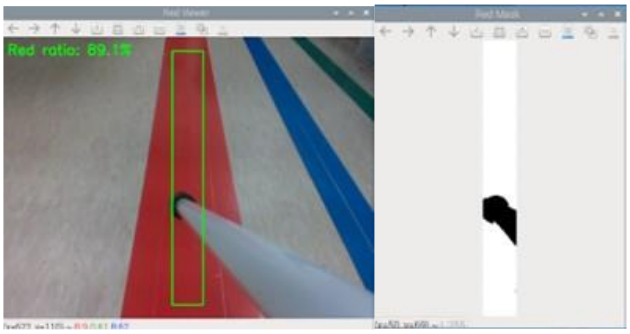


Figure 1. Composite system view of ROI-based red-lane detection and implementation

References

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