Eye-Gaze-Based Navigation for Accessible Wheelchair Control in Domestic Environments

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Disabilities affect approximately 650 million individuals in the Asia-Pacific region, with elderly populations particularly impacted by sensory impairments, mobility restrictions, and paralysis. While motorized mobility devices offer increased independence, traditional control systems often rely on intrusive wearable sensors that can be uncomfortable and prone to performance degradation. This research presents a novel head vertical orientation independent control system for motorized wheelchairs using eye gesture recognition through a binocular camera arrangement. The system employed a dual-camera setup and computer vision algorithms to track facial landmarks and eye movements, maintaining accuracy regardless of vertical head position changes. The proposed methodology incorporated Eye Aspect Ratio (EAR) and Average Black Pixel Ratio (ABPR) analysis across five predefined zones, with signal optimization through moving average filtering. Experimental results demonstrated robust performance with varying head orientations, achieving 95 % accuracy for horizontal gaze detection, 90 % for upward gaze, 85 % for downward gaze detection and the system's overall accuracy of 91.5 %. The system successfully executed complex navigation tasks, validating its effectiveness for real-world applications.

Keywords: *assistive controlling, assistive wheelchair, eye detection, gaze-based navigation, vision command.*