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Rehabilitation Reimagined: Integrating AI and Smart Wearable Innovations in Clinical Gait Biomechanics to Optimize Musculoskeletal Recovery

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Abstract: Traditional motion capture systems in clinical rehabilitation rely on cumbersome marker-based technologies that are costly, slow to set up, and often uncomfortable for patients. Current musculoskeletal rehabilitation methods lack real-time, objective data analysis capabilities, which limits the accuracy of treatment plans and personalized care in clinical settings. This study aims to improve clinical analysis and rehabilitation methods by combining AI-powered real-time markerless motion capture technology with affordable smart wearables and force platforms. The project focuses on forming collaborations with the Physical Medicine and Rehabilitation Departments of major hospitals around Mindanao, with the goal of enhancing musculoskeletal rehabilitation results. Our method leverages OpenCap technology with iOS devices for real-time markerless motion capture, capturing inverse kinematics and kinetics. Custom Python scripts will analyze gait cycles, identify normal trends, and detect abnormalities. Innovative smart wearables, insole sensors, non–invasive glucose monitors, and low-cost, eco-friendly 3D force platforms will be built, calibrated, and optimized to be synchronized with the OpenCap data. This integrated approach offers a more accessible, affordable, and precise method for clinical gait analysis compared to traditional systems. The multi-modal data integration, which combines motion capture, force platforms, and wearable sensors, allows for accurate, personalized rehabilitation plans. The project lays a foundation for better diagnoses, treatments, and management of gait disorders, ultimately improving musculoskeletal recovery outcomes through advanced technology integration in clinical practice.

Key Words: Markerless Motion Capture; Clinical Gait Analysis; Smart Wearables; Force plates; Musculoskeletal Rehabilitation

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