A Smart Bionic Leg Brace: An Electromechanically Actuated Active-Assist Wearable Orthotic Device for Comprehensive Restoration of Gait Characteristics across Everyday Mobility Scenarios

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Illnesses and injuries like multiple sclerosis, stroke, and poliomyelitis can cause a loss of leg strength, necessitating the use of a Knee-Ankle-Foot Orthosis (KAFO, or leg brace) that locks the knee joint to prevent leg collapse. However, an immobilized knee causes abnormal walking gait, which leads to hip/back pain, chronic fatigue, and joint/muscle damage. It is estimated that over 100 million patients around the world could benefit from a bionic leg brace that substitutes for lost muscle functionality and assists the user by actively bending the leg during walking. In this project, a versatile smart bionic leg brace was developed that can restore natural walking gait across the entire body in different everyday mobility scenarios. By redesigning hardware and optimizing retrofit mechanics, maximum force, speed, and range of motion were achieved. Voice-control functionality was integrated into a smartwatch/smartphone app to facilitate ease of use. Advanced algorithms were developed for the brace to assist in sitting/standing, ascending/descending stairs/ramps, entering/exiting vehicles, and to intelligently adapt to the user's walking speed and gait over any terrain. To evaluate the bionic brace and assess algorithm robustness, extensive data-mining methodology was formulated and executed. Walking gait data was collected from 8 sensors across the body, analyzed, and statistically modeled. This smart bionic brace provides unparalleled performance – all 8 walking gait characteristics evaluated had been normalized across the tested mobility scenarios, including significant reductions in gait pathologies – at only 2.6% of the cost of the most expensive, yet less functional KAFOs available today.

Awards Won:

Second Award of $2,000

International Council on Systems Engineering - INCOSE: Second award of $500