Brace Yourself: A Novel Electronically Aided Leg Orthosis

Payra, Syamantak

Over 6 million individuals in the US alone who lack leg muscle function due to illnesses like multiple sclerosis, spinal injury or poliomyelitis require Knee-Ankle-Foot-Orthoses (KAFOs), devices that lock the knee joint to allow standing/walking without leg collapse. However, since normal walking requires knee-bending, conventional fixed-knee KAFOs cause health problems: gait deviations, hip/back pain, joint/muscle damage and excess energy expenditure. There is no commercially available KAFO that assists in walking by actively bending the knee. The purpose of this project was to develop an Electronically-Aided, Active-Assist Knee-Ankle-Foot-Orthosis (EA-KAFO) that restores natural walking gait by actively rotating the knee joint. An Arduino microcontroller was programmed to detect walking gait using a gyroscope/orientation-sensor on the opposing leg. A linear actuator extends/retracts the EA-KAFO during the appropriate phase of the walking cycle. Brackets were designed and 3D-printed to retrofit the linear actuator to the conventional KAFO. Walking gait data was collected using MATLAB for a polio patient's functional right leg, left leg with fixed KAFO and EA-KAFO, and a healthy left leg. Datasets were compared, then statistically analyzed in Minitab. While the fixed KAFO caused significant gait deviations, the EA-KAFO normalizes walking gait, increasing the patient's foot-force by 200% and decreasing excess energy expenditure by up to 50%. Additionally, the cost of the EA-KAFO is only 2.5% that of more expensive, yet less functional KAFOs. This inexpensive, Electronically-Aided, Active-Assist KAFO alleviates problems faced by KAFO wearers, restoring a natural, comfortable, safe walking gait – increasing mobility, decreasing pain, and greatly improving quality of life.

Awards Won:

Intel ISEF Best of Category Award of $5,000

First Award of $5,000

International Council on Systems Engineering - INCOSE: First Award of $1,000

International Council on Systems Engineering - INCOSE: First Award of $3,000