An Artificial Neural Network for Controlled Force Augmentation in an Electromyographic Exoskeleton Arm

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An exoskeleton is a machine comprised of an outer framework, which is worn by a person for the purpose of applying energy to aid limb movement. The uses of such a device include helping patients rehabilitate their limb, helping first responders navigate dangerous environments, and helping soldiers carry heavy loads in and out of combat. The purpose of this engineering experiment is to design, construct, and analyze an exoskeleton arm which utilizes an artificial neural network and electromyography to help regulate force augmentation. The exoskeleton constructed maximizes portability, range of motion, and responsiveness, and minimizes cost and weight. The exoskeleton utilizes a cable drive system. The prototype was constructed by using aircraft grade aluminum, a shoulder mounted ball joint, high capacity lightweight batteries (Li-po), a small onboard microcontroller (arduino) which processes EMG signals with the artificial neural network, non-localized actuation with a back mounted motor, and a PID feedback loop. The researcher trained the artificial neural network with six weight values (2.27, 3.63, 5.90, 7.26, 9.53, 11.79 kg). The EMG circuit removed frequencies not in the range 20Hz to 500Hz. A 2200 mAh 12v Li-po battery with 45C rating was used to minimize weight and maintain a high charge density. In one forearm segment analysis, 222N was applied to a point and less than 400N/mm^2 stress was created. In another forearm analysis, 400N was applied and less than 700N/mm^2 stress was created. The EMG signal from the bicep was successfully detected, digitalized, and analyzed with the artificial neural network. A device was created which successfully achieved force augmentation, and metered output forces within the goal parameters.

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