An Ultra-Low Cost, Brain-Controlled Transhumeral Prosthesis Operated via a Novel EEG/Gesture-Based Approach

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Current upper limb prostheses lack effective and intuitive control systems and are often exorbitantly expensive. As a result, while prosthesis use can significantly increase quality of life, disuse rates among upper limb amputees remain high. To address these challenges, I developed an ultra-low-cost brain-controlled transhumeral prosthesis harnessing the neural interface capabilities of electroencephalography (EEG), the cost-reduction capabilities of 3D printing, and the sensitive gesture-detection enabled by an inertial measurement unit (IMU). My novel control system employs a hybridized system of single-channel prefrontal cortex EEG signals transmitted via Bluetooth enhanced by an algorithmic aggregate of gyroscopic-detected head gestures. The prosthesis itself boasts a high degree of durability, using an original 3D design, gyrating lattice structures, and an engineering-grade cyclic olefin polymer-based filament to achieve a tensile strength of up to 8,000 psi. During system testing, the utilization of subtle user gestures in tandem with EEG brainwave signals has enabled a naturally intuitive and dynamic method of control capable of easily manipulating a transhumeral prosthesis with four DoF. In a series of rigorous trials, the prosthesis was able to perform a complex object manipulation routine with 86.7% accuracy and an average completion time of 11.1 ± 1.4 seconds. Mean recorded latency from user thought to actuation was 1.43 ± 0.26 seconds, and the IMU-based head gesture detection system achieved a maximum articulation sensitivity of 5.85 Hz with 0.098 seconds of delay. The data and low manufacturing cost suggest that this prosthesis offers wide potential application as a compelling alternative to current upper limb prosthetics.

Awards Won:

Third Award of $1,000

International Council on Systems Engineering - INCOSE: Certificate of Honorable Mention