ProsthetiSense: Detecting Finger Movements for Prosthetics by Employing Deep Learning Algorithms via Non-Invasive Electromyogram Signals

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As the annual number of amputations continues to rise, limb loss continues to impede the daily lives of over 50 million people worldwide. Though several prosthetic options are available, most cosmetic, non-functional limbs cost around $5,000. However, while electromyograms (EMG), which record electrical signals in muscles, are relatively inexpensive, generally costing $200 to $400, myoelectric limbs cost around $20,000 to $80,000 due to the experimental control systems that many companies rely on, making them inaccessible to the general public. With deep learning algorithms, we can train models to detect a few broadly applicable gestures, effectively simplifying the process of designing and training myoelectric limbs. To train our model, we obtained a dataset recording various wrist movements stored as EMG data from 8 separate channels. After preprocessing our data by categorizing the hand motions as grabbing and at rest, we constructed a base neural network consisting of 3 dense layers. We systematically adjusted hyperparameters to recognize more patterns within our data and produce the optimal model. Our final model yielded a test accuracy of 94%, highlighting the promising potential for a machine-learning approach to controlled prosthetic movement. By pairing this model with simple robotic motors replicating our hand anatomy, we can calibrate patients' EMG data to program reliable and responsive prosthetics at a relatively low cost. Our study demonstrates a highly cost-effective alternative control system and accessible solution for amputees worldwide.

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