Advancing Multimodal Muscle Signal Processing: Pruning-Enhanced Machine Learning for sEMG and Mechanomyogram Integration in Task-Specific Hand Rehabilitation and Assistance

Wang, Minran (William) (School: Culver Academies)

Surface electromyography (sEMG) and mechanomyogram (MMG) signals are two prominent modalities in gesture recognition, increasingly employed in medical applications. These signals can be captured as images generated from instantaneous values, obtained using sEMG and acceleration sensors placed on the hand. Despite their potential, the integration of sEMG and MMG has been hindered by challenges in developing a unified system, particularly in the context of stroke rehabilitation. In this study, we present a novel method that employs sEMG and MMG signals as inputs for a deep learning model enhanced by pruning techniques in the design of a soft robotics-based facilitation device for stroke rehabilitation. Pruning, a key aspect of our proposed method, enables the optimization of the convolutional neural network (CNN) by reducing redundant connections, improving computational efficiency while maintaining gesture recognition accuracy. Utilizing the pruning-enhanced CNN for processing sEMG and MMG signals allows for rapid data acquisition response times and enhanced accuracy in recognizing task-specific postures. This integrated approach provides a more comprehensive understanding of patients' movements during rehabilitation training, offering valuable insights for personalized therapy. Our contribution lies in the development of an innovative signal processing technique that combines sEMG and MMG data with pruning-enhanced deep learning, improving gesture recognition performance in the context of stroke rehabilitation. This method has the potential to significantly advance soft robotics-based facilitation devices, ultimately benefiting patients and clinicians in the rehabilitation process.

Awards Won: