

Thesis Defense

Computer Science Master's Program

“Practical Multimodal Wearable Sensing for Functional Upper Extremity Primitive Classification in Stroke Rehabilitation”

By Nick Weiss

Abstract:

Stroke often causes long-term weakness and impaired motor control in the upper extremity (UE), making everyday tasks such as reaching, grasping, and moving objects more difficult. Restoring functional arm use is a central goal of post-stroke rehabilitation, but isolated clinical assessments may not fully capture how the affected arm is used during therapy or daily life. Wearable sensors offer a promising approach for continuous monitoring, and functional movement primitives can make sensor-based monitoring more interpretable by representing UE behavior as smaller, task-agnostic movement units.

This thesis evaluates whether five functional UE primitives can be classified using a reduced wearable sensing setup that combines motion and muscle activation data. Fourteen unimpaired participants performed structured functional tasks while wearing two sensing units on the dominant limb. Video-based labels were generated for Reach, Reposition, Transport, Stabilize, and Idle. Four model architectures were evaluated, and a temporal decoding pipeline was applied to convert raw predictions into continuous primitive timelines.

The Convolutional Neural Network-Bidirectional Long Short-Term Memory (CNN-BiLSTM) model achieved the strongest performance, with a macro-F1 score of 0.877 and decoded mean intersection-over-union of 0.786. A motion-only version of the CNN-BiLSTM slightly outperformed the combined motion and muscle activation version, suggesting that muscle activation did not provide an aggregate performance benefit in this dataset. These results indicate that reduced-sensor primitive classification is feasible for prescribed functional tasks and may support clinician-facing summaries of functional arm use.

Date: Monday, June 1st, 2026

Time: 9:00 – 11:00 AM

Location: 14-238b

Zoom Link:

<https://calpoly.zoom.us/j/88572914544?invitationssignature=8GrprHpNlw8yio-CCzyc5snNI0Dqm790fWjU-0fdPPE>

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