# Toward Drift-Resistant Assistive Device Control via sEMG–SMG Fusion

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***Abstract*—Effective assistive robotic technology requires an effective control interface. Optical-flow-based sonomyography (SMG) can provide continuous control signals for such devices, but may drift over time. This work investigates whether surface electromyography (sEMG) can reduce drift by restricting SMG tracking to periods of muscle activation. Although the combined sEMG–SMG signal reduces noise, our naive threshold-based approach does not improve control performance because tissue deformation can occur without measured sEMG activation. These results motivate improved sensor placement and more advanced fusion methods for hybrid biosensing control.**

## I. Introduction

Assistive technology can allow spinal cord injury survivors to recoup individual autonomy and significantly improve their quality of life. Biosensing (e.g., surface electromyography, or sEMG) is a promising technology with which to control such devices. Existing biosensing interfaces, however, are limited in two key ways. First, sEMG and similar signals are intrinsically discrete and require substantial post-processing to achieve continuous control signals. Second, these interfaces generally require frequent calibration, limiting all-day usage.

To address the first limitation, we have developed an optical-flow-based algorithm capable of generating continuous signals from tissue deformation with minimal calibration and processing using sonomyography (SMG), an emerging biosensing modality [1]. However, while these signals are robust over several minutes, they remain susceptible to the second limitation above, drifting over prolonged use [1] and often requiring recalibration. We hypothesize that by integrating discrete sEMG-derived activation information with these continuous SMG signals, we can produce a more robust and drift-resistant continuous control signal than either modality alone, which we investigate in this work.

## II. Materials & Methods

Because we expect the primary source of error to be passive drift in the sparse optical flow algorithm (i.e., tracked points deviating in the absence of motion), we use sEMG as a proxy for intended muscle activity to restrict the SMG signal, as illustrated in Fig. 1. SMG data from a Telemed ArtUS EXT-2H B-mode ultrasound system are collected from the biceps and converted into a continuous control signal using our optical flow algorithm [1], driving an on-screen cursor. Surface EMG signals from the biceps and triceps are recorded using a Delsys Trigno Quattro sensor.

The sEMG signals are rectified, smoothed, and thresholded above the noise floor using standard methods [2]. When both channels fall below the threshold, optical flow points are held fixed, keeping the SMG signal and cursor stationary. When

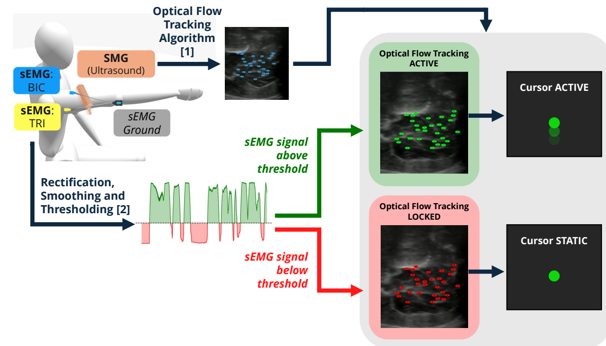


Fig. 1. Surface-EMG-augmented SMG control algorithm. When sEMG data collected from the biceps (BIC) or triceps (TRI) are above a threshold [2], SMG signals are used to control a cursor via sparse optical flow [1]; when both sEMG signals remain below the threshold, SMG signals are locked to prevent signal drift.

at least one channel exceeds the threshold, tracking proceeds normally, allowing cursor movement.

We evaluated tracking performance, signal drift, responsiveness, and user acceptability of this system as compared with unmodified SMG control [1] in a pilot cohort of 3 users.

## III. Results

Although our sEMG–SMG control signal exhibited less noise than our SMG signal alone, our naive sEMG filter was insufficient to improve signal quality. Our implementation assumes that SMG-measured tissue deformation will only occur when sEMG activation is observed. This is only approximately true, as non-measured muscles and external forces also contribute to deformation, such that our SMG signal was erroneously halted when features were moving.

## IV. Discussion & Conclusion

While our implementation did not increase SMG control performance, this work provides key insights into the time series behavior of sEMG and SMG signals, motivating continued development of hybrid sEMG–SMG control interfaces for assistive devices. Specifically, we are examining whether adding additional sEMG channels on other contributing muscles and placing sensors more precisely will improve controller performance. We are also exploring other sensor fusion paradigms, including state-based estimators (e.g., Kalman filtering) and using sEMG as a velocity scaling factor rather than a hard threshold.

## References

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