

ACTIVITY DETECTION FROM WEARABLE ELECTROMYOGRAM SENSORS USING HIDDEN MARKOV MODEL

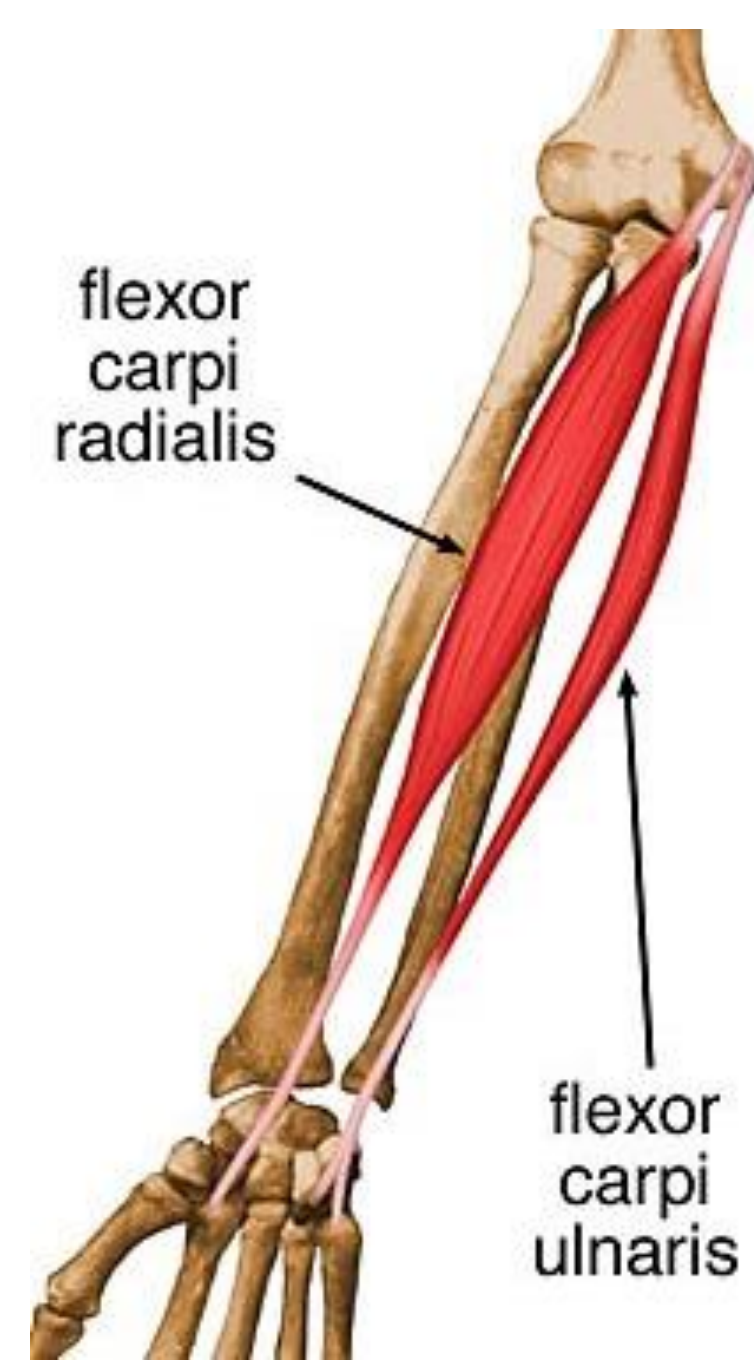
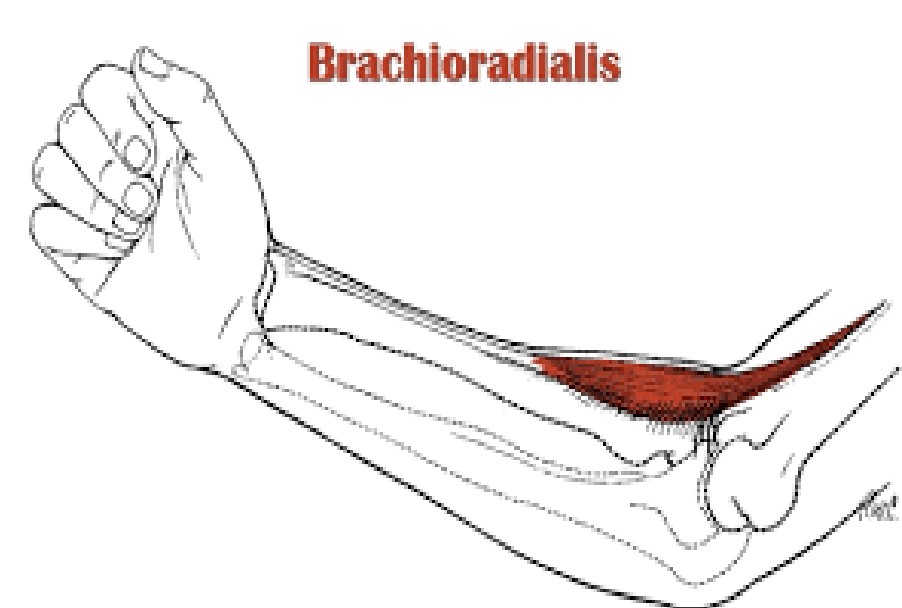
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INTRODUCTION

Electromyogram (EMG) is a measure of the electric potential generated in the muscles during muscle contraction and relaxation. Surface EMG is measured using sensors placed on the surface of the skin on top of the muscle being monitored.

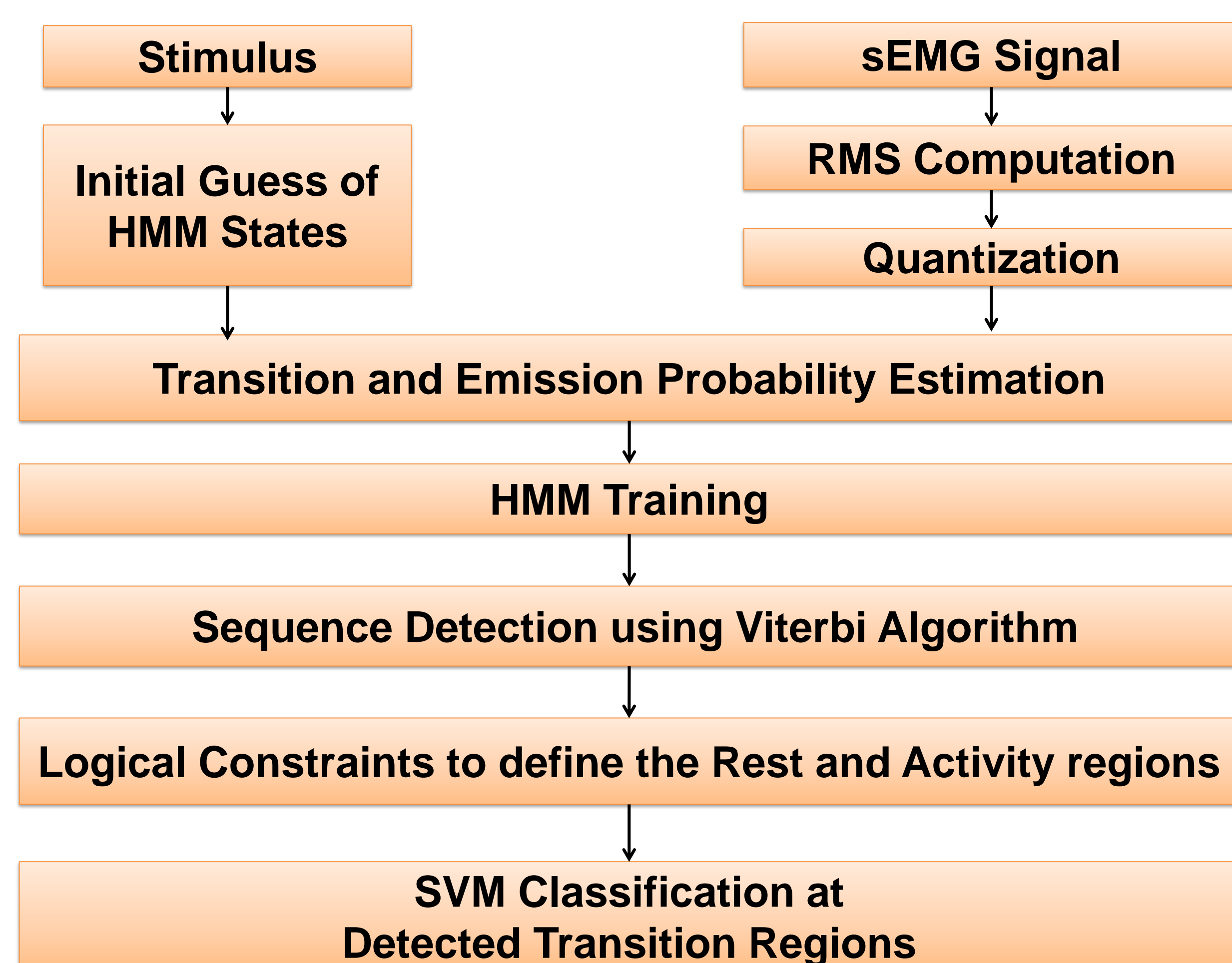
Muscles being monitored



Surface EMG is useful for Hand Motion Analysis for Applications such as:

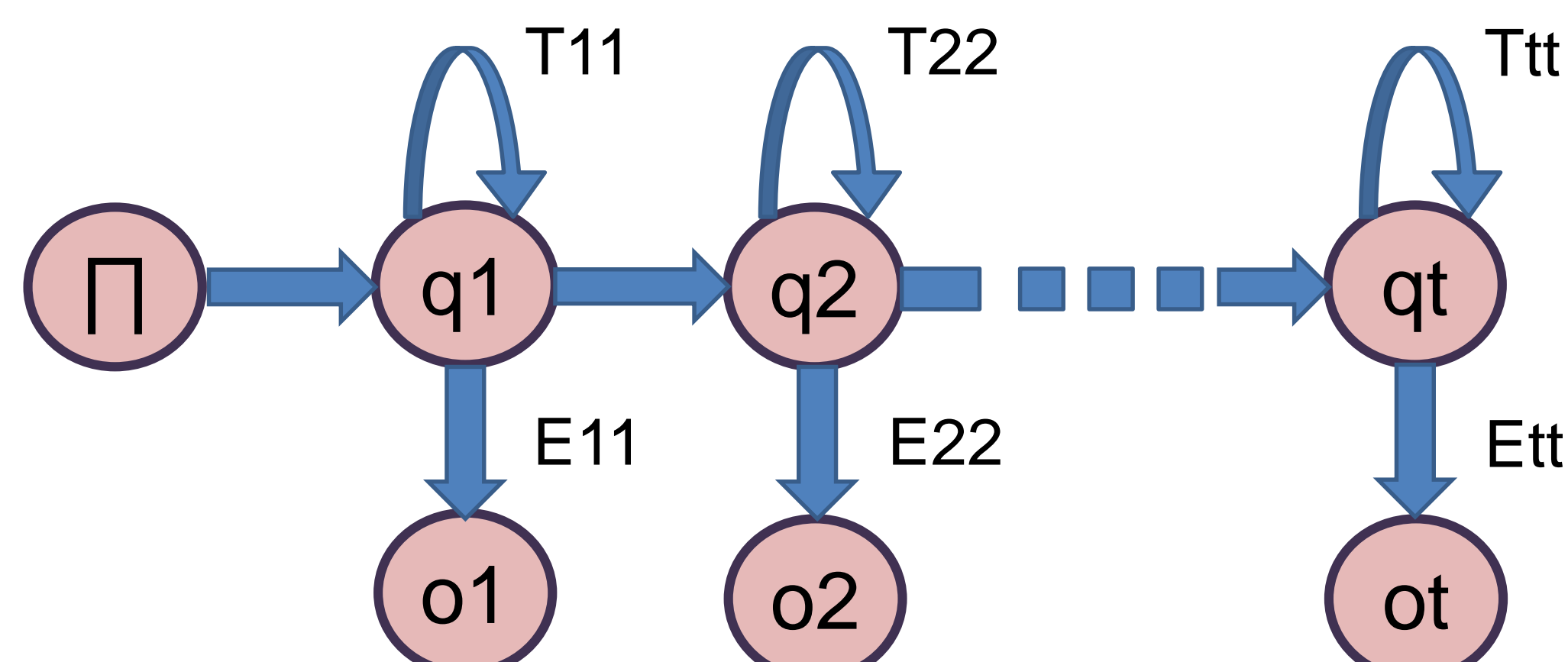
- ❖ Human Machine Interfaces
- ❖ Assistive technology, sign language recognition
- ❖ Prosthetic Control, Rehabilitation Sciences

PROPOSED TECHNIQUE FOR MUSCLE ACTIVITY DETECTION



HMM TOPOLOGY

In an HMM, the states are unknown or *hidden*. These states are predicted on the basis of initial state, transition probabilities and observations obtained from the signal.



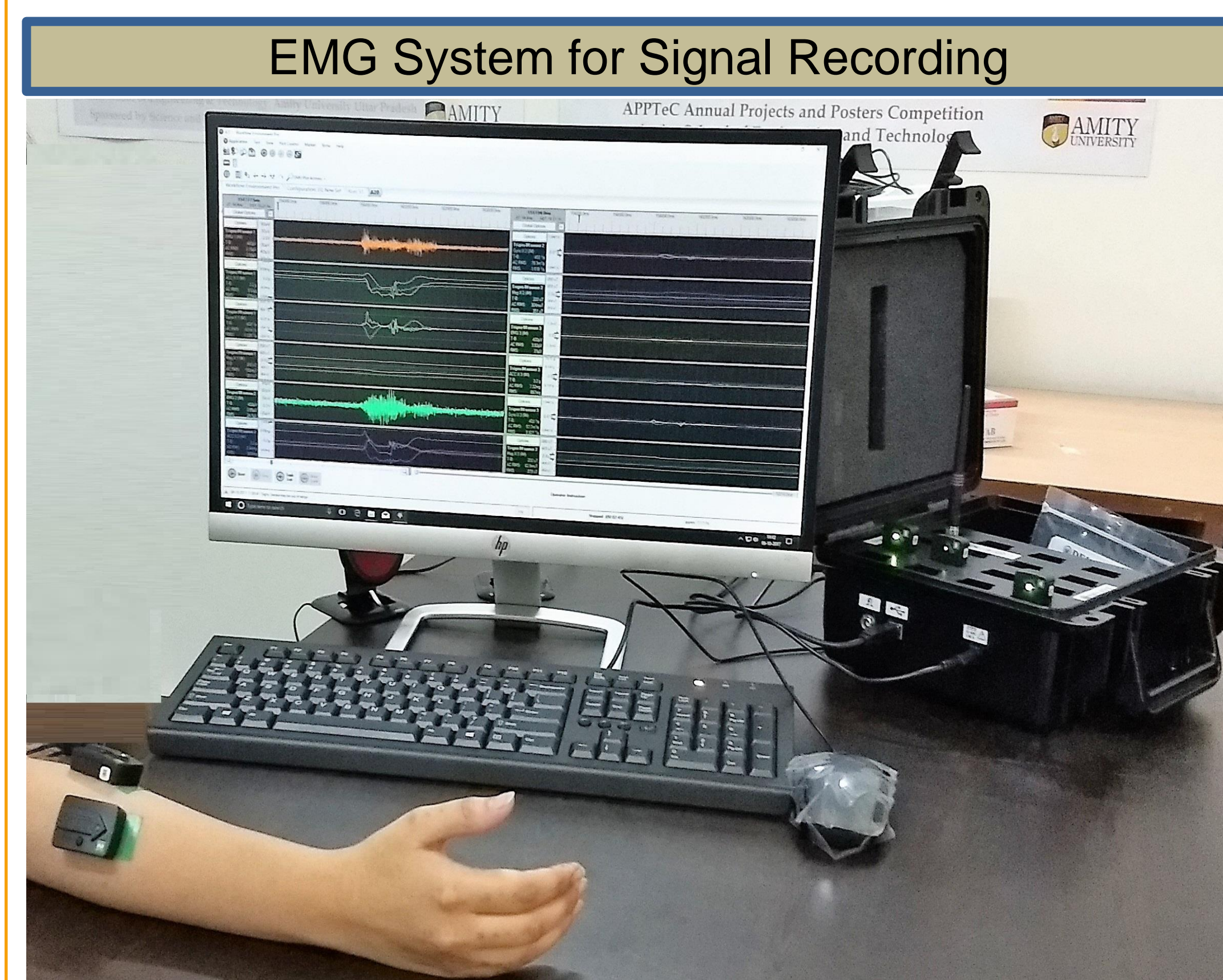
Hidden States, $Q = \{q_i\}$, $i = 1, 2, \dots, N$

Transition Probabilities, $T_{ij} = P(q_j \text{ at } t+1 | q_i \text{ at } t)$

Symbols, $O = \{o_k\}$, $k = 1, 2, \dots, M$

Emission Probabilities, $E_{ik} = P(o_k | q_i)$

EXPERIMENTAL SETUP



System Hardware consisting of Wireless Sensors

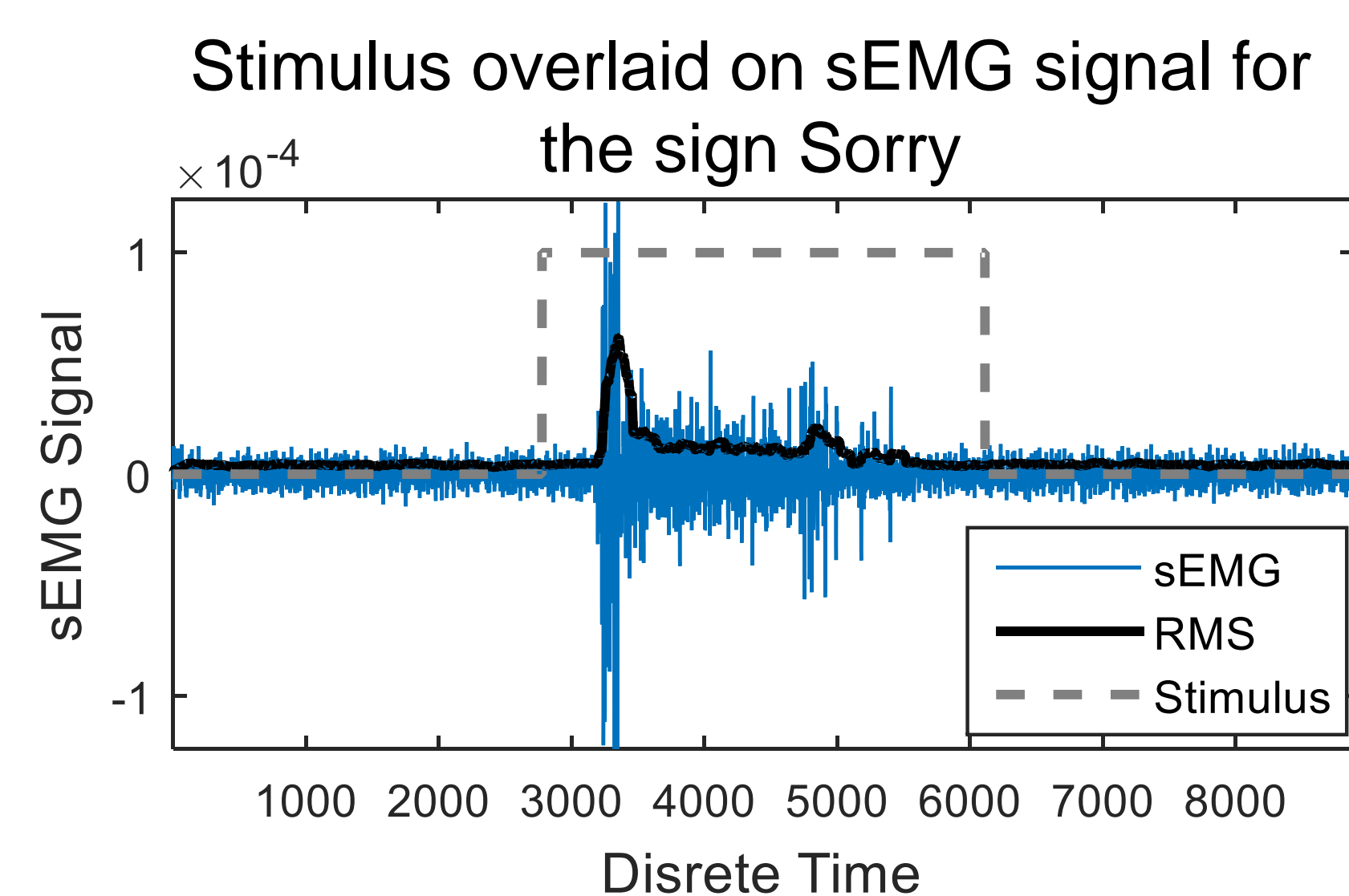


sEMG Sensors

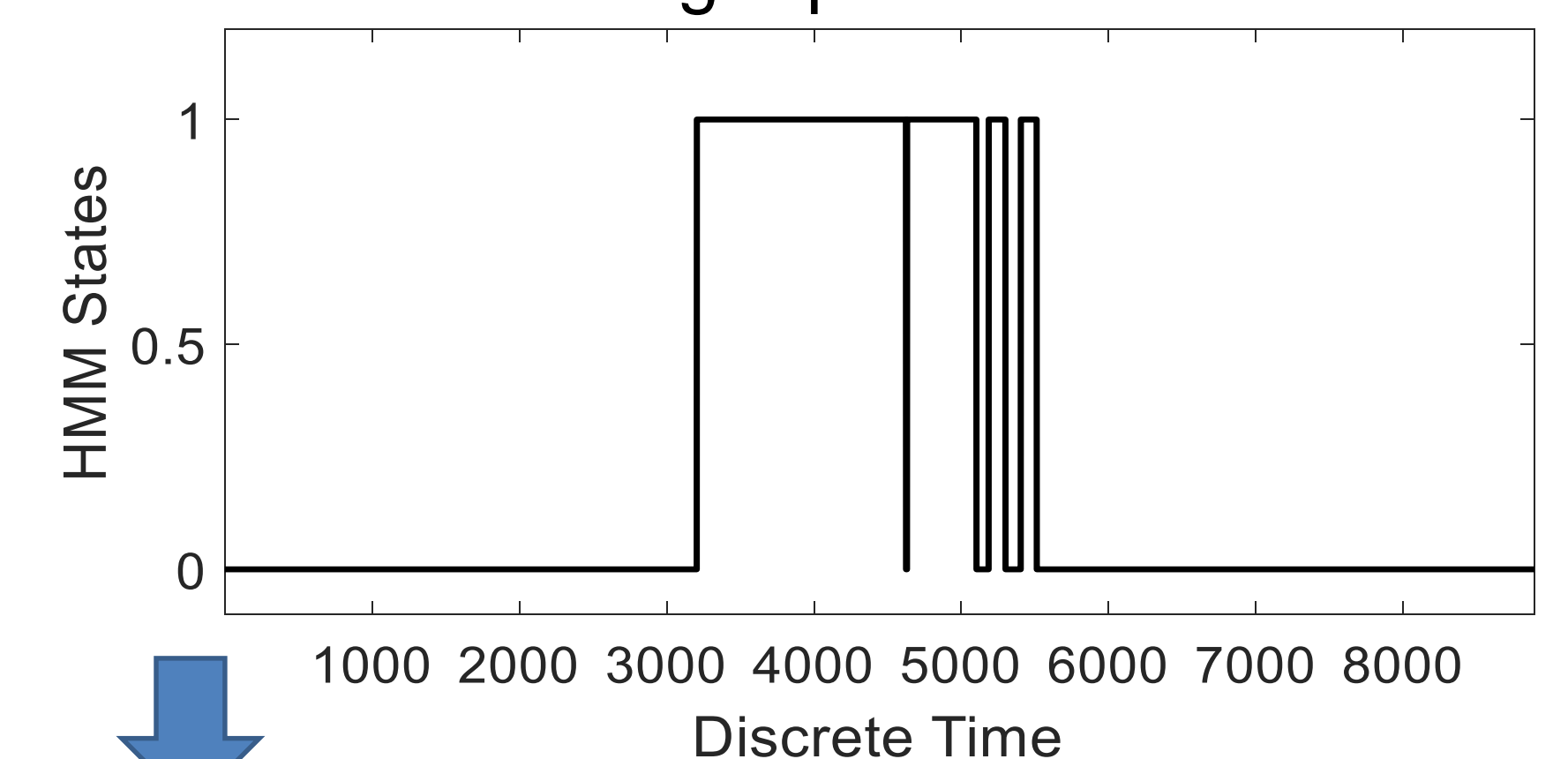
Sampling Period: 900 usec
Resolution Depth: 16 bits
Bandwidth: 450 ± 50 Hz,
>80 dB/dec



RESULTS AND DISCUSSIONS

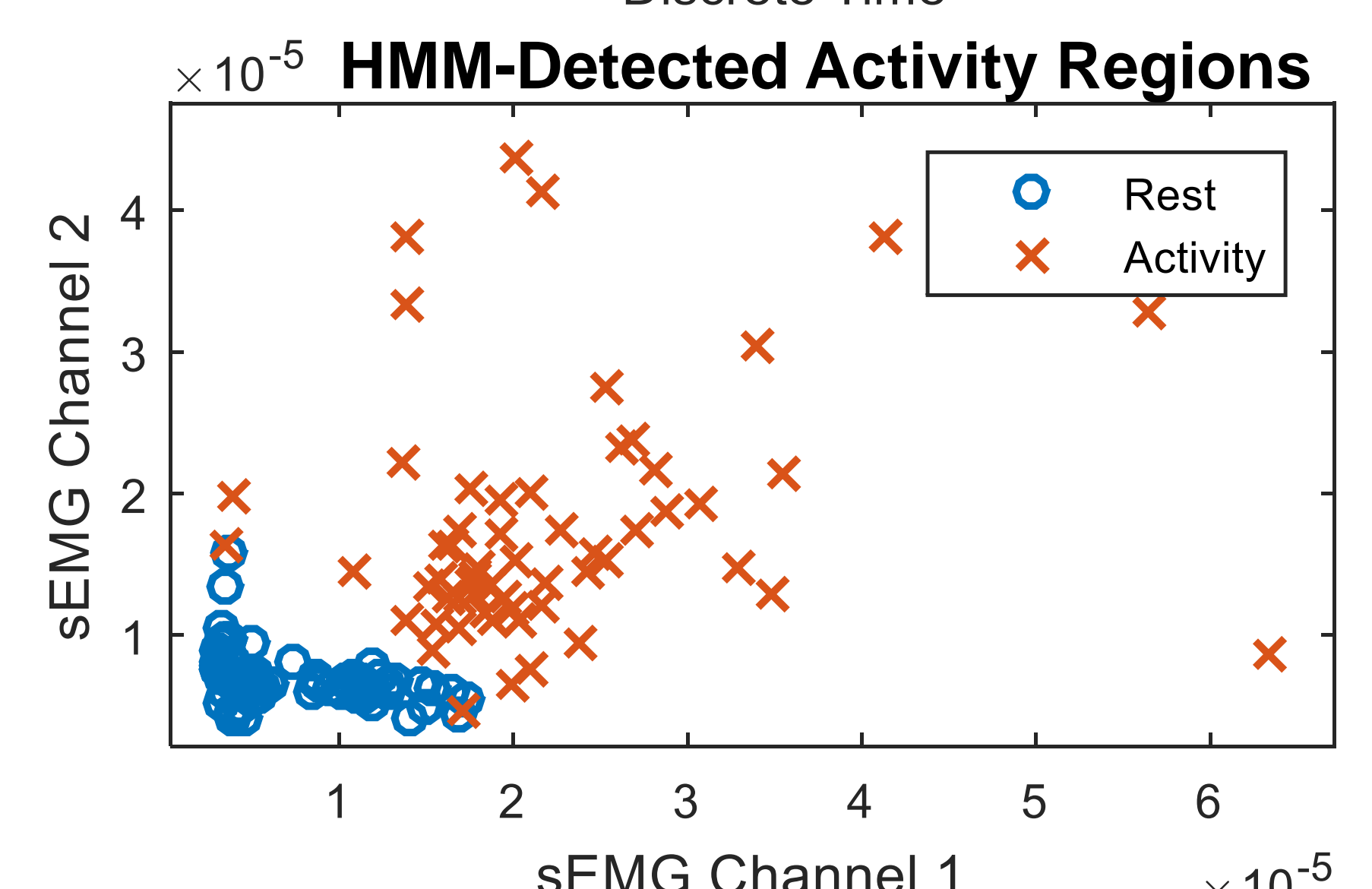
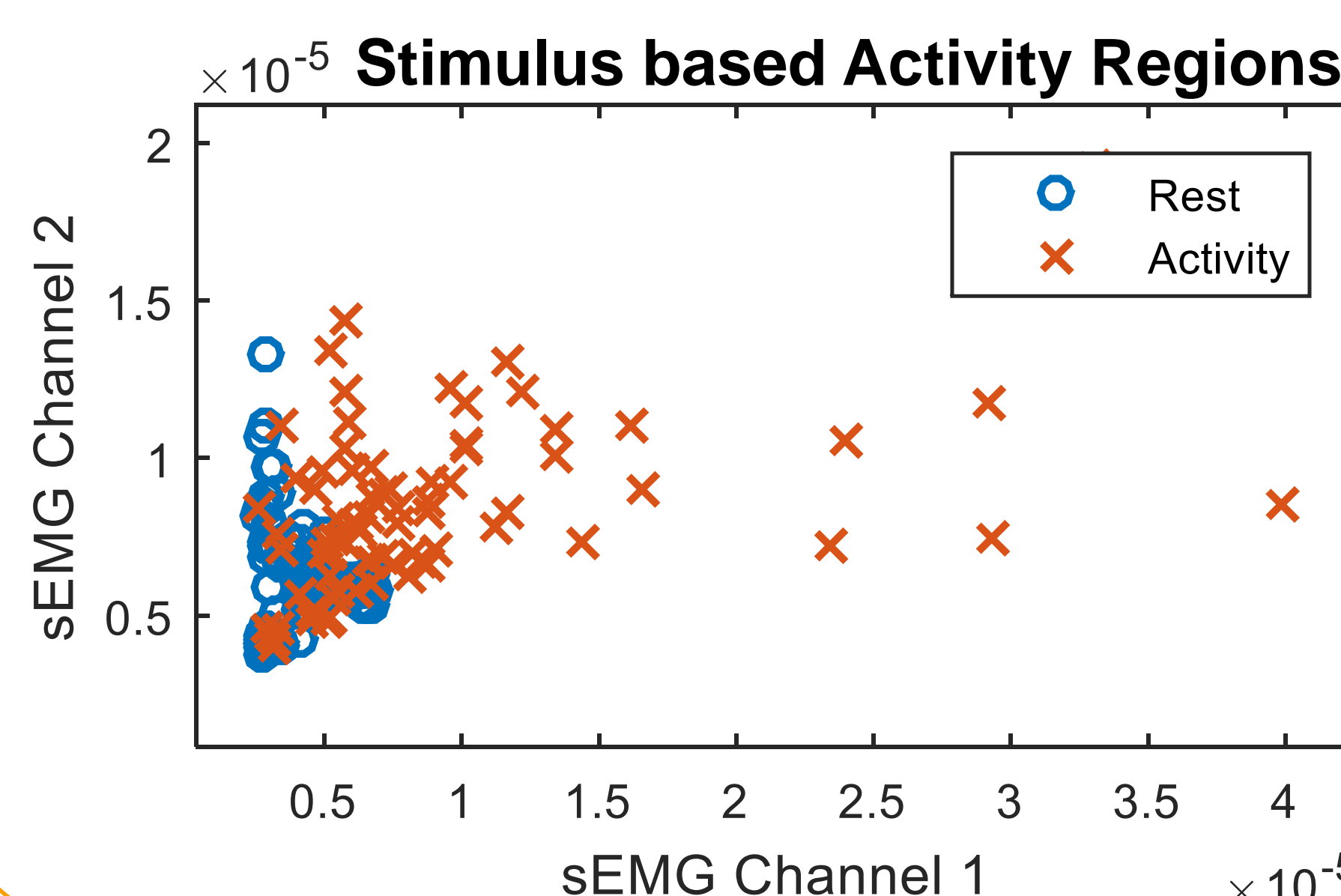
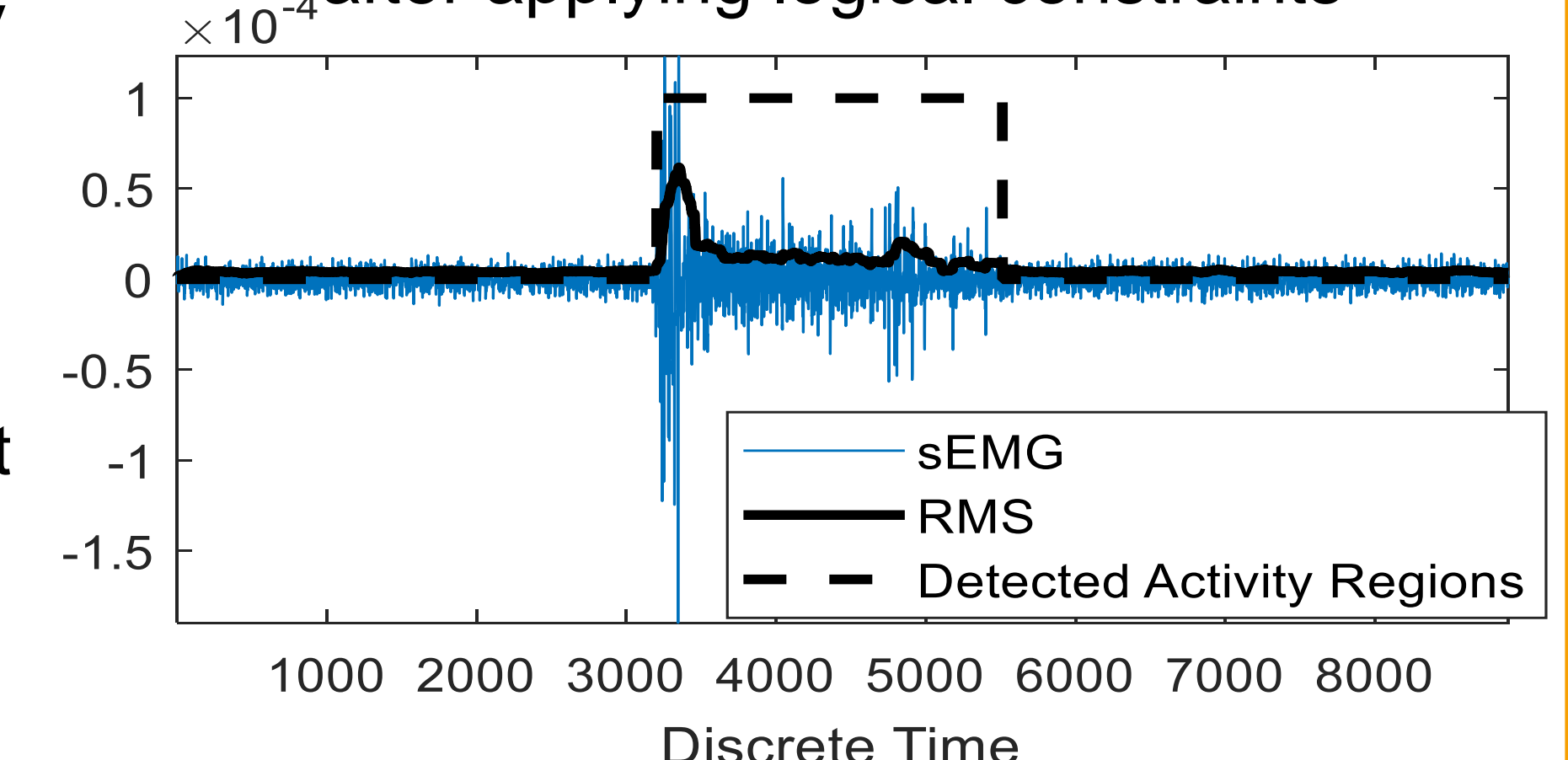


HMM Detected Activity Region showing rapid transition



- RMS extracted from 0.25 s segments around the start and termination instants indicated by Stimulus and Detected Activity Regions
- Reduced cluster confusion for RMS values around edges of activity onset detected from proposed algorithm
- SVM Classification Accuracy for activity onset improves to 96.25% from 87.50% for activity onset detection

Detected activity region from HMM states after applying logical constraints



REFERENCES

1. X. Zhang, X. Chen, Y. Li, V. Lantz, K. Wang, J. Yang, "A framework for hand gesture recognition based on accelerometer and EMG sensors," *IEEE Trans Systems, Man, and Cybernetics-Part A: Systems and Humans*, vol. 41, no. 6, pp. 1064-1076, 2011.
2. H. Veisi, H. Sameti, "Hidden-Markov-model-based voice activity detector with high speech detection rate for speech enhancement," *IET Signal Processing*, 17th April 2011.

Our Research paper: Rinki Gupta, Karush Suri, "Activity Detection from Wearable Electromyogram Sensors using Hidden Markov Model," *IEEE 2nd International Conference on Computing Methodologies and Communication (ICCMC)*, 15-16 Feb 2018, pp.1-6, 2018

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