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Prediction of finger movement using electromyography

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***Abstract*— With the aim of constructing a myoelectric control system that can handle the movements of daily tasks to improve the controllability of prosthetic devices, electromyography (EMG) signals of the forearms of four subjects with normal limbs during typing movement were acquired, and the best combinations of feature and classifier configurations were investigated. When Smoothing EMG signals were selected as features, and support vector machines (SVM) were used as discriminators, the best key identification accuracy (66% for one subject and 48% for the mean) was obtained.**

I. INTRODUCTION

The loss of fingertip movement due to upper limb amputation often causes disability in daily life and the impact on an individual's ability is particularly severe in work environments where typing is used. Upper limb amputees can participate in many work opportunities by using a well-functioning prosthetic hand. In recent years, there has been a lot of research on prosthetic hands using electromyography (EMG) control systems, and many studies have been conducted on hand movement tasks such as elbow and wrist abduction and adduction, or hand palm grip movements, in healthy subjects or amputees. However, no similar studies have been conducted on typing movement, which are an everyday task. In this study, we investigated feature and classifier selection among EMG control systems in order to find the combination with the best classification accuracy.

II. METHOD

Four healthy males participated in the experiment. A total of 8 sensors, 4 for each arm, were attached at equal intervals to the forearm at a 2:1 medial position relative to the hand. The subjects performed the task of typing on a keyboard in sequence while EMG and the time of key typing were recorded. There were 30 different keys to be typed, and each session consisted of 10 typing trials of these 30 keys, obtained data for 1200 trials per subject over 4 sessions. The preprocessing included baseline correction, bandwidth limitation, and decimation. After all the preprocessing was done, the muscle activity for 0.2 seconds (200 samples) around the typed time was cut out and four types of features were extracted. Smoothing EMG signal (sEMG) is a feature obtained by fullwave rectification of the preprocessed waveform and smoothing it using a Butterworth Filter (2nd order, cutoff frequency 5 Hz). Hudgin's Time-Domain feature (TD) is a set of features introduced in 1993[1]. It is a concatenation of five time-domain features extracted from each segment by segmenting the EMG sinal. The time domain features and auto regression (TDAR) feature combines TD features with the coefficients of the autoregressive model. Time Dependent - Power Spectrum Description (TD-PSD) feature was proposed by Timemy in 2016[2] and is a feature that extracts six frequency features from muscle activity and concatenates them. We compared the three classifiers: Support Vector Machine (SVM), Linear Discriminant Analysis (LDA), and Artificial Neural Network (ANN).

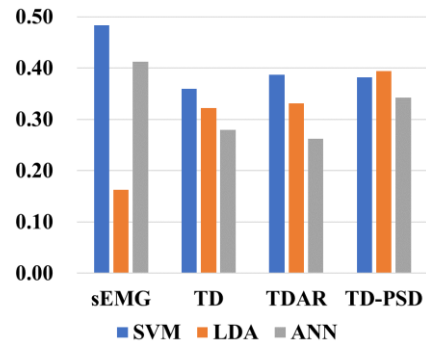

Fig.1 Identification accuracy comparison by Classifier.

III. RESULTS

Fig. 1 shows the classification accuracy for the test data for each classifier. The accuracies in the figure are the average values for all subjects, and no clear difference was observed between the classification accuracies of the right arm and the left arm. The combination of sEMG and SVM shows the best classification accuracy, which is significantly higher than the chance level (6.7%).

IV. DISCUSSION & CONCLUSION

We compared classification accuracy to find the best combination of features and classifiers to classify keys in a typing task. For all subjects, the best classification accuracy was obtained when the combination of feature: sEMG and classifier: SVM was used. This result suggests that the amplitude information of time series is important to classify fingertip movements with short motion time. In the future, improvement of the classification accuracy, investigation of the optimal number of sensors, and investigation of motion detection methods for real-time control systems are necessary.

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