


# Chapter 6

## Threshold–Based Machine Learning Model for Hand State Classification Using EMG Sensors and Support Vector Machines

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### **ABSTRACT**

*Electromyography sensors (EMG) are techniques used to get the electrical signals generated by muscle activation, providing valuable insights into muscle activity and its relation to the nervous system. This chapter addresses the challenge of achieving accurate, real-time classification of hand states using a hybrid system combining threshold-based detection and machine learning algorithms. The proposed method focuses on the development of an accurate and efficient muscle activation detection*

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*system that utilizes the EMG sensors along with Support Vector Machines (SVM) for real-time classification of two hand states. The key contribution of this research is to incorporate a robust architecture that is adaptable to diverse muscle activity patterns and has the potential for deployment in real-time applications such as rehabilitation centers and prosthetics. In this chapter, the model is trained on two users, with varying muscle strength, and evaluations are done using accuracy, precision, and confusion matrix. Testing showcased high accuracy and precision.*

## **1 INTRODUCTION**

This research aims to implement of a reliable and efficient Machine learning algorithm to get precise detection of hand state using EMG sensor. The objectives include training an SVM model capable of accurately distinguishing between open and closed hand states, Create an optimized framework where the threshold efficiently handles simple classifications (e.g., open hand state), and machine learning models focus on complex decisions (e.g., closed hand state) to maximize computational efficiency, and also achieve real-time adaptability with a focus on designing a system with low computational requirements, making it feasible for deployment on portable or battery-powered devices

In biomedical engineering, EMG is an essential tool used to measure and record electrical activity in muscles. It is an essential part of biomedical research by offering insights into muscle functionality through detection of electrical signals generated through muscle activation (Pérez-Reynoso et al., 2022). Whenever a muscle movement happens, it generates a tiny electrical potential, which the EMG sensors can detect. By analyzing these signals, we get insights of muscle activity, health and functionality. Over the years, EMG has found applications in the field of prosthetics, rehabilitation, robotics and sports science. The possibility of analyzing muscle activation patterns in real-time enables us to develop advanced systems such as machine learning techniques that bridge the gap between human intention and machine response (Xiong et al., 2021).

The key challenge in this scenario is interpreting EMG signals accurately, whilst getting influenced by factors such as noise, skin resistance, muscle fatigue and electrode placement. To address these, techniques such as wavelet denoising and adaptive filtering have been employed to preserve critical signal components while reducing artifacts (Kotov-Smolenskiy et al., 2021). Traditional methods include thresholds and fixed rules which are not sufficient for variability in population. For this purpose, we utilize machine learning technique such as SVMs. The integration of SVM has shown significant potential in improving the accuracy of muscle activation detection system (Wang et al., 2024). SVMs are powerful supervised learning models designed

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