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Descriptive Statistical Features-Based Improvement of Hand Gesture Identification

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ABSTRACT

One of the most significant tools for Human–Computer Interaction (HCI) is body language, namely gestures. Therefore, Gesture recognition using Mechanomyography (MMG) for controlling prostheses and rehabilitation devices has been researched for years. The MMG is gauged as the mechanical vibrations engendered by the muscle in its activation. Hence, MMG data provides information regarding the mechanical activity of muscles. It is obtained from the limb and facilitates the comprehension of hand gestures. A MMG dataset named "MMG DATA" that has already been produced is utilized in this paper. To improve the accuracy of classification and the speed of processing, we have extracted the twelve descriptive statistical features of the eight game motions and their iterations contained in the "MMG DATA" for each subject. Five distinct machine learning algorithms—including Decision Tree (DT), Linear Discriminant Analysis (LDA), Naive Bayes (NB), Support Vector Machine (SVM), and k-Nearest Neighbor (k-NN)—were used to categorize the hand gestures, with the results compared using several performance metrics. Several experiments have been carried out in order to validate the presented models. Additionally, two scenarios have been achieved by splitting the dataset into two different and far apart ratios: the first by randomly partitioning the dataset into 80% for training the models and 20% for testing them, while the second by evenly dividing the dataset into 50% for both training and testing phases. Drawing on the results of the performance metrics, it can be argued that this study effectively distinguishes and classifies the eight hand motions. Furthermore, it is worth noting that the results exhibit significant strength and stability, particularly when transitioning from the initial scenario to the subsequent scenario across all proposed models. Out of the classifiers that were chosen, the SVM emerged as the most successful, achieving a classification accuracy of 97.1%.

1. Introduction

Millions of individuals all around the world are missing arms or hands due to injury or illness [1–4]. In order to aid amputees in doing complex tasks, prosthetic hands are increasingly being adopted, with the expectation that they will have a high Degree of movement Freedom (DOFs) [1]. The purpose of the prosthetic hand is to replace the lost limb's manipulative and prehensile abilities to some degree. The capacity for the prosthesis to change finger configurations and execute a wide range of motions is essential for satisfying these requirements. This calls for a wide variety of control decisions to be sent to the prosthesis [5,6].

In the subject of Human–Computer Interaction (HCI), the study of gesture recognition technology focuses on the hands and fingers because they are one of the primary mechanisms by which humans communicate with the outside world, furthermore, people can control a remote system without really touching it [7].

There is a wide range of information obtainable from the human body's physiological signals. Acquiring physiological signals accurately enables diagnosis, monitoring, and therapy of disorders [8]. In the field of HCI, there has been a growing interest in utilizing biological signals as a means of extracting valuable information regarding the intended motion of the human body. These signals have demonstrated significant potential for advancing the field. [9–11].

Electromyography (EMG), which is based on the electrical activity of the muscle, is one multi-modal sensing approach that can be used to control prosthetic hands. This approach is well-known for recognizing hand gestures and operating the prosthetic hand. Other approaches,

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