Chapter 2
Bio-Inspired Techniques in Human-Computer Interface for Control of Assistive Devices: Bio-Inspired Techniques in Assistive Devices

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ABSTRACT

Most of the assistive devices are of user contact based control like body-powered prosthetic hand, joystick control of wheelchair, sip-and-puff, etc. and have a limited number of control movements. The performance of these assistive devices improves using bio-signals/gesture based control embedded in the processor. Gesture based control is widely used in wheelchair navigation control, communication with external world for neuromuscular impaired subjects. On the other hand, bio-signals are used widely in prosthetic devices, wheelchair control, orthotic devices, etc. with pattern recognition based control strategy. The choice and number of features used in pattern recognition for accurate control of assistive device is crucial. Further, these features performance also varies with the classifier. The appropriate selection of combination of pattern recognition will enhance the accuracy. This chapter focuses on bio-inspired techniques in selection of features and classification for the pattern recognition based assistive device control.

DOI: 10.4018/978-1-5225-2863-0.ch002

INTRODUCTION

Pattern recognition is a method of identifying the input information into particular category/class from various classes. Various researches have been carried out in improving control of intelligent assistive devices in the various stages of pattern recognition techniques, namely data preprocessing, feature extraction, feature selection/reduction, classification along with the development of control strategy of electric motor. In pattern recognition, the data usually considered as the raw measurements or raw values taken from the subjects to be classified. A simple block diagram of pattern recognition based control of assistive devices is shown in Figure 1.

The term feature in pattern recognition, refer to the result of the transformations applied to the raw data in order to transform them into another domain or space using time domain/ frequency domain/ time-frequency domain technique. Although, many features can be extracted from raw data for decoding intention and not all of them possesses discriminant capabilities. Some of the extracted features could cause confusion and degrade the classifier. Further, smaller the dimension of the feature vector, lesser the computation time and memory requirements. Therefore, choice of features or reduction of features is essential. Feature dimension reduction provides a method to decide whether it is necessary to include more features that would significantly contribute to the performance of the classifier. It is not a trivial to select the best set of features or the best transformation. The features must be selected or transformed based on the given problem. For the feature selection, some neural networks, population based bio-inspired techniques can be used. The features selection process involves choice of subset of extracted features in feature space by starting with all/without features or subset consisting of random features from the feature space. Feature selection process in the context of assistive devices will be reviewed later in this chapter. The Fourier transform and time-frequency transom yield coefficients of larger dimension and few of its coefficients carry the useful information to obtain the good classification performance. In literature, researchers applied feature reduction using linear or nonlinear projection of features to transform high dimensional feature space to lower dimensional feature space. A very popular method of feature reduction is principal component analysis (PCA) in which the features are projected to lower dimensional space to visualize the underlying class

Figure 1. Block diagram of pattern recognition based control of assistive device