Chapter 90
Bio-Inspired Techniques in Rehabilitation Engineering for Control of Assistive Devices

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ABSTRACT

The intelligent control of assistive devices is possible from bio-signals or gestures to find the user's intention. The goal of the user intention recognition system is to develop computational methods for decoding the acquired bio-signal data. One of the methods of accomplishing the objective will be using the pattern recognition system. The study of higher level control of assistive device using various data processing techniques with bio-inspired techniques is in progress. The knowledge of bio-inspired computation is essential for the neophytes to develop algorithms for identification of intention from bioelectric signals. Most literatures, demonstrates the application using signals and not much definite study describes the various bio-inspiring computation involved to develop the control of assistive devices in real-time. Therefore, this chapter presents a brief survey of the various bio-inspiring techniques used in interfacing devices for identification of information from the user intends.

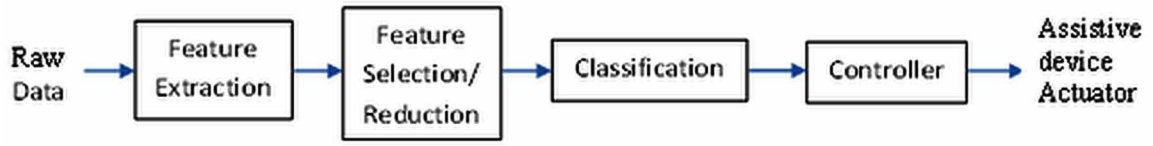
1. INTRODUCTION

Pattern recognition is a method of identifying the input information into particular category or 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/

DOI: 10.4018/978-1-5225-5204-8.ch090

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



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 by linear projection. There are other many feature reduction approaches like linear discriminant analysis (LDA), fuzzy discriminant analysis (FDA), self-organizing feature map (SOFM), kernel-based FDA, etc. are discussed in literatures.

The feature selection aims to cut the dimensionality by eliminating irrelevant and redundant features, thus considering a subset of features that characterize the best discrimination of patterns. Since, it is difficult to find the discriminant features and selection algorithm using population based technique, use evaluation function to find the features of good discriminating capability. Feature selection would ease the problem of over fitting and reduces the classifier computation time. The existing feature selection techniques in the literature are divided as filters and wrappers according to their dependency on the classification algorithms. Typically, feature selection techniques could be useful in supervised or unsupervised learning algorithms. The filter approach is independent of classification algorithm and uses statistical properties to identify the relevant features. Due to this capability, filter approach is computationally preferred than the wrapper approach. However, it has disadvantage of local optimal solution due to its single iteration. The wrapper approach is based on a classification algorithm need more computation time, but more accurate than the filter approach. The hybrid approach combines the advantages of the filter and wrapper.

Feature selection based on a search strategy is necessary to explore the feature space. However, an exhaustive search from the feature space is computationally difficult, starting from an empty/full feature set for the entire/no feature set with all possible combinations to decide the relevance features. This ex-