A Novel Technique of Black Tea Quality Prediction Using Electronic Tongue Signals

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***Abstract*—Electronic tongue (ET) system is under extensive development for automatic analysis and prediction of quality of different industrial end products. Each sensor in an ET system generates a specific electronic response in presence of different organic or inorganic compounds in the sample. The vital part of the ET system is the discrimination of the complex pattern generated by the sensor array. In this paper, a novel technique of black tea quality estimation is using the ET signals. A moving window is used to extract discrete wavelet transform coefficients from the transient response of ET. The energy in different frequency bands are used as the features of the ET signal for different positions of the window. The prediction of a new sample is performed by the highest score obtained by a particular class by testing all the patterns generated by windowing ET signal. The performance of the proposed technique is verified to estimate black tea quality using two kernel classifiers, namely support vector machine and recently proposed vector valued regularized kernel function approximation method. High prediction accuracy of both the classifiers confirms the effectiveness of the proposed technique of tea quality estimation using ET signals.**

***Index Terms*—Electronic tongue (ET), feature extraction, kernel classifiers, support vector machine (SVM), vector valued regularized kernel function approximation (VVRKFA), wavelet features.**

I. Introduction

THE electronic tongue (ET), also known as artificial tongue, is proficient in discriminating between substances with different taste modalities as well as distinguishing different substances eliciting same taste [1]–[3]. There are several sensors forming arrays in an ET system alike the human receptors those are responsible for sensing taste. The information given by each sensor is complementary and the amalgamations of different sensors consequences generate a unique pattern. The multisensor array system of ET shows clear correlation of its response with human perception for various substances.

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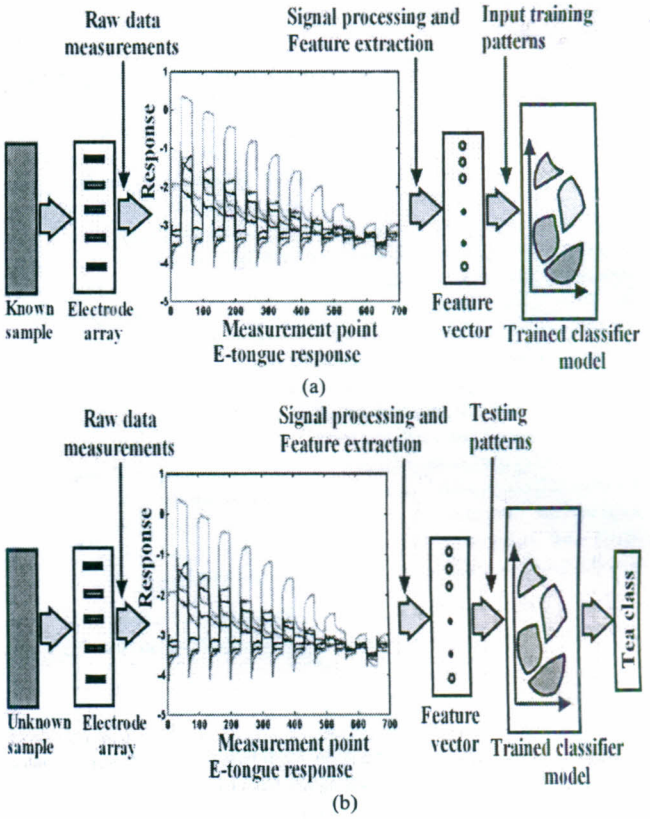

Fig. 1. Typical ET-based analysis system. (a) Training and (b) testing phase.

This correlation can be established by appropriate pattern recognition techniques for both qualitative and quantitative analysis of the test samples. The sensor array of ET works on liquid samples where the sensors respond on the whole for the different ingredients of the solution but not to a specific constituent of the solution, i.e., the responses of the sensors are nonspecific [1]. Therefore, depending on the presence of different ions and compounds, the collective response of the ET sensors varies from solution to solution.

The use of ET to analyze any substance has two phases: 1) training phase and 2) testing phase, as revealed in Fig. 1. In the training phase, as shown in Fig. 1(a), a classifier is trained to develop a model that establishes the correlation between the patterns extracted from the training samples and the corresponding targets (taste or quality) provided by the human test panels. In the testing phase, as shown in Fig. 1(b), an unknown sample is examined by the trained classifier model