Chapter 7

The Analysis of Plant’s Organic Volatiles Compounds with Electronic Nose and Pattern Recognition Techniques

Reza Ghaffari
School of Engineering, University of Warwick, UK

Fu Zhang
School of Engineering, University of Warwick, UK

Daciana Iliescu
School of Engineering, University of Warwick, UK

Evor Hines
School of Engineering, University of Warwick, UK

Mark Leeson
School of Engineering, University of Warwick, UK

Richard Napier
Warwick HRI, University of Warwick, UK

ABSTRACT

In this chapter, the authors introduce the principles of some of the most widely used supervised and unsupervised Pattern Recognition (PR) techniques and assess behaviour and performances. A dataset acquired from a set of experiments conducted at University of Warwick is employed to construct a case study in which the techniques will be applied. The chapter will also evaluate the integration of PR methods with an Electronic Nose (EN) device to develop and implement a plant diagnosis tool based on discriminating the Organic Volatile Compounds (VOC) released by plants when attacked by pest. The chapter concludes with a performance comparison and a brief discussion of how an appropriate PR technique can be coupled with an EN to produce a greenhouse plant pest and disease diagnosis system for day-to-day utilisation. Some consideration of further work is also presented.

DOI: 10.4018/978-1-60960-477-6.ch007
INTRODUCTION

Engineering systems often comprise a sensory subsystem of one or multiple sensors which collect or detect sensory data and produces measurement signals. These signals contain a raw data therefore in most cases the direct usage of these sensory signals is impossible, inefficient or even pointless. According to Heijden (2004), this can have several causes:

a. The information in the signals is represented in an inexplicit or ambiguous way making it harder to be recognizable without further processing.

b. The information is often hidden and only available in an encoded form prior to processing.

c. Sensors always produce measurement signals which come with a substantial noise and other complex disturbances therefore needs noise reduction techniques.

This indicates that a sensory signal which has been processed is more precise and more complete than information brought forth by empirical knowledge alone (Heijden et al., 2004). For the system to be able to make sensible and accurate decisions, the measurement signals should be used in combination with previous knowledge or pattern. Several techniques and methods have been used to process the measurement signals in order to suppress the noise and disclose the advantageous information required for the task at hand. Pattern Recognition (PR) is one of the most widely used techniques which have been implemented within various engineering systems.

In principal, PR is the scientific discipline whose goal is the classification of objects into categories or classes. These objects can be anything from a simple image, signal or any other type of sensory data, depending on the application (Theodoridis & Koutroumbas, 2006). PR techniques have gained their popularity by being the brain behind the recent Handwritten Character Recognition and Speech Recognition tools built in various machines and software such as Navigation and Call Center Systems. They are designed to mainly do complex feature selection, classification or data clustering.

There have been several sub-categories for PR techniques based on their characteristics, learning method and mathematical algorithms. However, PR techniques are normally based on three basic and well-known approaches: (a) Statistical (b) Structural and (c) Neural. Moreover, PR learning methods are often grouped into two more general categories although a combination of both can be used: (1) Supervised learning and (2) Unsupervised learning. Supervised learning is one of the most commonly undertaken analyses of the PR problems in which the learning phase will be adjusted according to a target dataset. In unsupervised learning, however, the classifier will not have any information regarding the subsets (classes or categories) of the sample data.

In PR approach, supervised learning is often associated to classification whereas unsupervised learning is mostly used for data clustering purposes. Several mathematical algorithms and optimisation techniques were used previously to enhance the performance of the classic PR methods and customise it for a specific application. The performance of the PR techniques is often rated by their ability in correct classification/clustering of provided training data samples. High processing power and memory capabilities of the recent computers allow PR algorithms to analyse the samples in fraction of a second and provide reliable solution depending on the application.

In this chapter few statistical and Artificial Neural Network (ANN) based PR techniques will be discussed and applied on the Electronic Nose (EN) generated dataset. In the next section, we will explain the case study, data collection and experimental setup.