

Chapter 9

Tomato Plant Health Monitoring: An Electronic Nose Approach

Fu Zhang

University of Warwick, UK

D. Daciana Iliescu

University of Warwick, UK

Evor L. Hines

University of Warwick, UK

Mark S. Leeson

University of Warwick, UK

ABSTRACT

Electric noses (e-noses), taking their inspiration from the human olfactory system, have been extensively used in food quality control and human disease monitoring. This chapter presents the e-nose as a potential candidate for health monitoring and disease and pest detection on tomato plants. Two common problems in greenhouse tomatoes, namely powdery mildew and spider mites, are considered. An experimental arrangement is described based on a commercial 13-sensor e-nose where tomato plants are grown in an isolated, controlled environment inside a greenhouse. Attention is paid to the preliminary results of data post-processing using two different techniques. First, Principal Component Analysis is employed and demonstrates clear evolution of the components as the plants develop disease or infestation. Subsequently, Grey System Theory enables the identification of clear groupings in the sensor responses and thus the reduction of the model, producing stronger trend

DOI: 10.4018/978-1-61520-915-6.ch009

differences in the Principal Component between healthy and unhealthy plants. The results, although preliminary, show that the e-nose with appropriate data post-processing is a promising approach to monitoring the development of tomato plant diseases and infestations.

INTRODUCTION

Researchers have been developing Artificial Sensing (AS) systems for decades to enhance or digitize the five human senses of sight, hearing, smell, taste and touch. Amongst these, machine olfaction is one of the most well developed aspects in AS.

Machine olfaction systems, commonly known as e-noses or chemical sensor arrays, were inspired by the human olfactory system and generally consist of two key components, namely the detection unit and processing unit. There is an increasing interest in research, development and application in various fields, including the food industry, medical diagnosis and environmental monitoring. Here we concentrate on the first of these using tomatoes as a specific example since reliable supplies of high quality fruit in agreed quantities are needed by both supermarkets and tomato growers. The resilience of the food supply chain is a critical aspect of food security (Adger, 2006) and thus detailed insights are timely and necessary. Greenhouses are used to increase fruit quality and yields in many parts of the world as they facilitate control of the growing and environmental conditions. Nevertheless, in addition to weekly yield can fluctuations (Zhang et al., 2010) the plants are still prey to diseases and pests that must be rapidly detected and eliminated to prevent catastrophic losses.

This chapter reveals the potential applications of e-noses in monitoring and detecting tomato plant diseases. A continuous experiment was performed within a greenhouse, during which daily measurements were collected on three tomato plants using a commercial e-nose system. One of the tomato plants was used as the health control and the others were infected with powdery mildew (*Oidium neolycopersici*) and two spotted spider mites manually at the early stage of the experiment respectively. The post-processing on the collected data sets indicates that e-nose can be used as a tool to monitoring tomato plant disease.

BACKGROUND

The prediction of crop yields and the detection of plant damage or infestation need methods to collect data regarding plant health in addition to diagnosis and analysis tools. The detection and recognition of chemical substances produced by plants thus form suitable approaches for greenhouse use. Volatile organic compounds (VOCs)

16 more pages are available in the full version of this document, which may be purchased using the "Add to Cart" button on the publisher's webpage: www.igi-global.com/chapter/tomato-plant-health-monitoring/52455

Related Content

Multi-Cellular Techniques

C. Anderson (2007). *Handbook of Research on Nature-Inspired Computing for Economics and Management* (pp. 16-27).

www.irma-international.org/chapter/multi-cellular-techniques/21117

From Optimization to Clustering: A Swarm Intelligence Approach

Megha Vora and T. T. Mirnalinee (2017). *Nature-Inspired Computing: Concepts, Methodologies, Tools, and Applications* (pp. 1519-1544).

www.irma-international.org/chapter/from-optimization-to-clustering/161081

Intuitionistic Fuzzy 2-Metric Space and Some Topological Properties

Q.M. Danish Lohani (2011). *International Journal of Artificial Life Research* (pp. 59-73).

www.irma-international.org/article/intuitionistic-fuzzy-metric-space-some/56323

Estimation of Dynamic Noise in Mandelbrot Map

Ketan Jha and Mamta Rani (2017). *International Journal of Artificial Life Research* (pp. 1-20).

www.irma-international.org/article/estimation-of-dynamic-noise-in-mandelbrot-map/192174

Innovative Genetic Algorithmic Approach to Select Potential Patches Enclosing Real and Complex Zeros of Nonlinear Equation

Vijaya Lakshmi V. Nadimpalli, Rajeev Wankar and Raghavendra Rao Chillarige (2017). *International Journal of Natural Computing Research* (pp. 18-37).

www.irma-international.org/article/innovative-genetic-algorithmic-approach-to-select-potential-patches-enclosing-real-and-complex-zeros-of-nonlinear-equation/198499