Chapter 63
Particle Swarm Optimization of BP-ANN Based Soft Sensor for Greenhouse Climate

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ABSTRACT

In this article, the authors develop the Particle Swarm Optimization algorithm (PSO) in order to optimise the BP network in order to elaborate an accurate dynamic model that can describe the behavior of the temperature and the relative humidity under an experimental greenhouse system. The PSO algorithm is applied to the Back-Propagation Neural Network (BP-NN) in the training phase to search optimal weights baded on neural networks. This approach consists of minimising the reel function which is the mean squared difference between the real measured values of the outputs of the model and the values estimated by the elaborated neural network model. In order to select the model which possess higher generalization ability, various models of different complexity are examined by the test-error procedure. The best performance is produced by the usage of one hidden layer with fourteen nodes. A comparison of measured and simulated data regarding the generalization ability of the trained BP-NN model for both temperature and relative humidity under greenhouse have been performed and showed that the elaborated model was able to identify the inside greenhouse temperature and humidity with a good accurately.

1. INTRODUCTION

A greenhouse system is a closed environment where some climate variables can be manipulated in order to obtain adequate climatic conditions, for the development and growth of the cultures, using automatic control strategies (Shamshiri & Ismail 2013). The greenhouse environmental control involves the field of control technology, as the way to optimize inside greenhouse climate based on measured variables and acting on greenhouse equipment (Lu et al., 2015). The dynamics of the climatic variables in a greenhouse are very complex. That is due to the presence of nonlinearities, subjected to strong disturbances (measurable and non-measurable ones) and a high degree of correlation among variables (Frausto & Pieters, 2004; Bennis et al., 2008).

Due to the complexity of the real engineering systems, like the greenhouse system, some importance has been put into implementing Artificial Intelligence (AI) techniques including neural networks, fuzzy logic, neuro-fuzzy, evolutionary algorithms, or some combination among them. Although artificial intelligent methods offer the advantage of the capability of capturing essential functional relationships among the data when such relationships are not a priori known or are very difficult to describe mathematically in situations of the collected data are corrupted by noise. Therefore, they had gained importance and successfully applied in large areas, such as modelling, prediction, control, optimization, business, and financial engineering (He & Ma, 2010).

For plants of high complexity, like greenhouse process, it is of main importance to develop accurate models of the plant which will be used to describe the system behaviour. Furthermore, a perfect model is significant for the parmaters tuning of the controller based on the system's dynamic model, to design a performance control law (Kiranyaz et al., 2009). In this way, neural networks algorithms are a very sophisticated nonlinear modelling techniques used to perform an accurate modelling of the greenhouse system dynamics for temperature or both air temperature and relative humidity, due to its capability of learning and generalization from examples using the data-driven self-adaptive approach, as long as enough data are presented in the training process (Lai & Zhang, 2009).