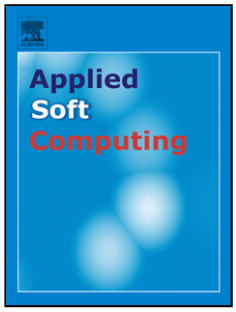

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PII: S1568-4946(17)30628-2
DOI: https://doi.org/doi:10.1016/j.asoc.2017.10.023
Reference: ASOC 4518

To appear in: *Applied Soft Computing*

Received date: 7-11-2015
Revised date: 30-6-2017
Accepted date: 13-10-2017

Please cite this article as: Alfonso Pérez-González, Ofelia Begovich-Mendoza, Javier Ruiz-León, Modeling of a Greenhouse Prototype Using PSO and Differential Evolution Algorithms Based on a Real-Time LabView^{TM} Application, *<![CDATA[Applied Soft Computing Journal]]>* (2017), https://doi.org/10.1016/j.asoc.2017.10.023

Modeling of a Greenhouse Prototype Using PSO and Differential Evolution Algorithms Based on a Real-Time LabView^{TM} Application

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Abstract

In general, to obtain an adequate mathematical model of a greenhouse is a difficult task due to the complexity of the involved equations that describe the dynamics of the system, and the required high number of physical parameters, which are complicated or even impossible to measure. In these situations, estimation methods are commonly used to obtain a suitable approximation for those parameters. This paper presents the application and comparison of a collection of methods based on Particle Swarm Optimization (PSO) and Differential Evolution (DE), using them as the tools to identify the parameters that complete a proposed mathematical model for a greenhouse. These parameters are sought aiming to approximate the dynamic behavior of a greenhouse physical prototype building in CINVESTAV Campus Guadalajara, by using the heuristic algorithms in order to minimize a proposed error function, which considers as arguments estimations and measurements of the two more representative dynamics of the climate conditions inside a greenhouse: namely, the air temperature and relative humidity. Different forms of PSO and DE algorithms are considered and applied in order to select the one that achieves the set of parameters with the lowest evaluation error. The comparison of the selected algorithms is carried out in an offline optimization schedule using real data recorded through the LabView^{TM} SignalExpress application, and a real-time implementation in a LabView^{TM} code, implemented to optimize the model in a sample to sample execution. The proposed model, with its corresponding computed parameters, is validated comparing its results against the real dynamic behavior of the temperature and relative humidity, that are measured directly from the greenhouse prototype, showing a good agreement between real and estimated values. Several tests were executed in order to find PSO and DE best calibration conditions. Experimental results allow us to propose an efficient way to deal with numerical optimization problems of high complexity, applying a two stages scheme based on a first offline pre-identification, where the obtained results are used as initial condition for an online, real-time refinement process.

Keywords: Particle Swarm Optimization, Differential Evolution, Greenhouse model, LabView^{TM} application, Real-time application.

1. Introduction

A greenhouse usually consists of a structure, build in metal in most cases, coated with a transparent material which provides the property to convert the building into a closed room, for the containment of a growing area for plants. The main purpose of a greenhouse is the climate adaptation at the interior of the closed structure, aiming to produce the ideal conditions for the growth and development of specific crops, providing independence of the external environment while a level of isolation and protection against natural

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