Available online at www.sciencedirect.com

ScienceDirect

Procedia Computer Science 121 (2017) 306–313

Procedia Computer Science

www.elsevier.com/locate/procedia

CENTERIS - International Conference on ENTERprise Information Systems / ProjMAN - International Conference on Project MANagement / HCist - International Conference on Health and Social Care Information Systems and Technologies, CENTERIS / ProjMAN / HCist 2017, 8-10 November 2017, Barcelona, Spain

A System for the Monitoring and Predicting of Data in Precision Agriculture in a Rose Greenhouse Based on Wireless Sensor Networks

Schubert Rodríguez[a], Tatiana Gualotuña[b*], Carlos Grilo[a]

[a]*School of Technology and Management, CIIC, Polytechnic Institute of Leiria, R. Gen. Norton de Matos, 2411-901 Leiria, Portugal*
[b]*Departamento de Ciencias de la Computación, Universidad de las Fuerzas Armadas ESPE, Av. General Rumiñahui, 382 Sangolquí – Ecuador*

Abstract

In order to provide the best growing conditions for roses in a greenhouse, a Wireless Sensor Network has been designed and implemented that allows for agricultural environment data collection such as temperature, humidity and light. Each sensor node can transmit monitoring data to the cloud. Data mining techniques were used with the purpose of identifying behavioral patterns given the environment conditions captured by the sensor network. The operationalization of this research was taken as a case study within the rose greenhouses available to Universidad de las Fuerzas Armadas – ESPE, Ecuador.

Peer-review under responsibility of the scientific committee of the CENTERIS - International Conference on ENTERprise Information Systems / ProjMAN - International Conference on Project MANagement / HCist - International Conference on Health and Social Care Information Systems and Technologies.

Keywords: Wireless Sensor Networks, Data Mining, IOT, Precision Agriculture, Greenhouses.

1. Introduction

Technological development has influenced the dynamics of necessities of people by providing technological

* Corresponding author. Tel.: +593-9-8209-2865.
E-mail address: 2152221@ipleiria.pt

1877-0509
Peer-review under responsibility of the scientific committee of the CENTERIS - International Conference on ENTERprise Information Systems / ProjMAN - International Conference on Project MANagement / HCist - International Conference on Health and Social Care Information Systems and Technologies.
10.1016/j.procs.2017.11.042

solutions aimed at improving the productivity of crops[1]. However, in many countries, like Ecuador, access to technology resources is a restriction to small and medium producers, given high costs of the technologies or unawareness of the use of market solutions[2]. This restricts the competitiveness of those farmers when it comes to the quality of production. It is therefore required to provide new, low-cost alternatives that allow for the collection and processing of data in order to obtain information with added value that can improve agricultural productivity.

Problems related to climate change, water scarcity and environmental inattention, demand automated methodologies and tools that allow adequate decision making with the goal of reducing negative impact caused by those factors in agricultural production. Information systems melded with information management techniques are gaining popularity in the global setting[3]. Studies have indicated that adequate control over environmental conditions such as temperature, relative humidity, ventilation, among others; prevent the rise of plagues and in case of infection, help adequate treatment[4]. In order to control environmental conditions, crops are farmed in greenhouses equipped with the adequate infrastructure that includes: heaters, ventilators, watering systems, among others, which are operated manually or automatically, achieving care and preventive actions that improve both quality and production [5].

Greenhouses in Ecuador, where this work took place, are installed in sites that lack reliable Internet access, which complicates the tasks of monitoring and crop control[6]. Information management is manual and there is no crop-specific empirical data, affecting decision making. Therefore, it is needed to strengthen the use of information and communication technologies as Wireless Sensor Networks (WSN), together with the use of data management techniques, to provide predictive solutions that support adequate decision making and opportune management of crop production. WSNs, used in the Internet of Things projects as information collection agents, allow capturing great data flows that support determining behaviors and predicting environmental variables that influence the growing of crops[7].

A WSN is a network formed by a series of small low-cost, low-energy, easily-deployable sensors[8]. Providing scalability, flexibility and cost reduction, it is a viable solution for precision agriculture applications[9, 10]. In this context, precision agriculture refers to data detection, collection, and transfer to a control station for decision making, in order to improve the performance of crops and assure sustainable growing. WSN technologies are used in agriculture to provide remote monitoring of parameters such as temperature, relative humidity, luminosity, among others, in order to create a simple and effective interaction environment to monitor the growing of crops[11, 12].

There are several technological solutions in order to motorize climatic conditions in the yard or greenhouse, however, most of those implementations provide individual monitoring and represents a strong investment, many of husbandmen cannot effort this amount of money to put on this solution in their greenhouse. Therefore, it is imperative to provide a solution which can be implemented by small agriculturalists.

This work's goal was the development of an environmental conditions monitoring system applied to high precision agriculture, within a controlled environment. For this, a WSN was developed within a greenhouse of roses. The sensor network allows environmental conditions data collection, visualization in a web or mobile application and subsequently, using data mining techniques, obtaining a prediction model with good accuracy.

Nomenclature

WSN	Wireless Sensor Networks

What remains of this article is structured as follows: Section 2 presents the state of the art. Section 3 describes the developed system, its architecture, design and tests. Section 4 describes the web/mobile application, its architecture and features. Section 5 describes the prediction model, the tests, results and discussion. Finally, in Section 6 some conclusions are derived and future work is advanced.

2. State of the Art

In this section, we compile some works with similar experimentation alignments to that of ours; we highlight their progress and differences when compared with this work's goal.

Work done by Bhargava K et al.[13] proposes a WSN design, that constructs a decision-making support system for the prediction of apple plagues, helping to identify periods that are prone to infection using registered temperature and