

**FACULTAD DE INGENIERÍA**

Escuela Académico Profesional de Ingeniería de Sistemas e Informática

Tesis

**Implementation of and Agriculture 4.0 Oriented  
System for Monitoring Environmental Variables:  
Alstroemeria Hybrida, Astromelia Case**

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Para optar el Título Profesional de  
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# Implementation of and agriculture 4.0 oriented system for monitoring environmental variables: *Alstroemeria hybrida* – *Astromelia* case

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**Abstract**—In recent times, agriculture faces new challenges due to climate change, water scarcity and the need to increase crop productivity, agriculture 4.0, through the application of technology allows real-time monitoring of environmental variables in crops such as *astromelia*, becoming a valuable tool for decision making of small farmers. This study implements a proposal oriented to agriculture 4.0 with the deployment of Wireless Sensor Network (WSN) by making use of the ESP32 module, accompanied by soil moisture sensors YL-69, temperature and relative humidity DHT11 and rain sensor HL-83, for data acquisition, which will then be transmitted via a Wi-Fi connection to a MySQL database on a web server implemented for this purpose, allowing real-time monitoring through a web application developed using PHP, Javascript, HTML5, CSS, JQuery and Google Charts. The implementation of our proposal in a Phytotoldo dedicated to the cultivation of *Astromelias*, which allows to confirm the suitability of ESP32 modules and their associated sensors for real-time monitoring of environmental variables in the cultivation of *Astromelias*, and the correct recording of historical data for later evaluation to remain easily adaptable for other crop varieties.

**Keywords**—WSN, ESP32, DHT11, YL-69, HL-83, Agriculture 4.0.

## I. INTRODUCTION

Today, agriculture is faced with the need to increase its productivity and reduce the low quality of crops, which are affected by climate change, the increasing scarcity of water worldwide, coupled with the traditional farming habits of small and micro plots, which have been relegated in the use of technology due to their size and the need to reduce costs. Although in advanced economies, especially in Western Europe and North America, there are many studies and applications of data collection, automation and Internet of Things technologies, in underdeveloped countries such as ours, the study and implementation of these technologies is very recent and not very widespread, generating a great disadvantage in terms of competitiveness due to low productivity in terms of both quantity and quality. The technology applied to agriculture 4.0, allows us to propose monitoring and data analysis systems through a wireless sensor network (WSN), low cost, lower energy consumption, scalable and easy to implement, allowing continuous data collection efficiently in open field or greenhouse environments, facilitating decision making in real time, as

well as for analysis over long periods using statistical methods.

Making a literature review we found the present study that shows us the advantages of using the microcontroller platform such as Arduino and the software tool for data acquisition Parallax PLX-DAQ (free Excel add-in), together with the LM35 temperature sensor, storing the data in a spreadsheet for further study and evaluation by using statistical methods, managing to improve the sensitivity of the temperature sensor by manipulating the working voltage of the same [1]. We also found a study that proposes the use of the Arduino microcontroller platform with MQ-135 sensors (gas detection probe), to build a gas detection system such as carbon dioxide that thanks to its low price is accessible to the general public, it is oriented to use in enclosed spaces such as offices, demonstrating the correct detection and alert to dangerous levels of carbon dioxide in parts per million, using LEDs as a witness of the levels of carbon dioxide concentration [2].

Regarding the application of sensors and actuators we found a work in which it is proposed to use an Arduino platform, to design an automatic irrigation system, oriented to home gardens or orchards, trying to minimize the work of humans, for this the Arduino platform was used, along with humidity sensors FC-28 and as a means of communication the Bluetooth module HC05 to emit and receive data, which will be displayed through a mobile application developed in Android Studio, concluding that the system works in real time, and the sensitivity of the sensors is acceptable compared to high sensitivity sensors and high cost, allowing automated irrigation or manually by using the web application [3]. We also find the present article that offers us a solution to make agriculture smarter by using automation technologies and Internet of Things, by using a remotely controlled intelligent robot to perform weeding, surveillance, spraying, etc. works based on GPS, secondly it uses intelligent irrigation with decision making and intelligent control in addition to intelligent warehouse management with temperature and humidity maintenance, using AVR Atmega 16/32 microcontrollers, Zigbee modules, humidity and temperature sensors, in addition to Raspberry Pi [4].

During our research about the communication protocols used in this type of projects, we found an article that shows us a wireless networked sensor system (WDS), using open