Automated Greenhouse

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Abstract – *Protected agriculture is one of the modern techniques used to control environmental and phytosanitary conditions in order to increase agricultural production. Among the different types of greenhouses, the more relevant are the use of a precision agriculture-based sensors network applied to greenhouse vegetable crops; greenhouse irrigation and temperature remotely-controlled have been identified such as temperature, relative humidity, light intensity and water activity.*

The tunnel type greenhouse was chosen for implementation in this project because its advantages incluiding the low cost materials and lesser space needed, therefore becoming a good option for people who want to produce their own vegetables on a smaller scale.

DHT11 sensor is used to measure temperature and humidity variables. In order to reach a better control, the prototype structure is divided in four quadrants and components are programmed through an Arduino Uno microcontroller. In case of a temperature or humidity increase, the irrigation system or the fan will be activated, respectively.

Key Words: Arduino, Carrot, Greenhouse, Sensor

1. INTRODUCTION

Maintaining optimal environmental conditions within current greenhouse systems requires a skilled workforce, investment in equipment, and constant monitoring. The purpose of the project is to develop a scale prototype of an automated greenhouse for growing vegetables integrating sensors, actuators, ¨Arduino Uno¨ technology with control algorithm and two devices for displaying variables, in order to support the economy family from low-income areas.

Currently, the interest in the nutritional quality of what is consumed daily has increased, thanks to this, many individuals seek to grow their own food. However, quality can be interpred in many ways; consumers distrust conventional foods because of the lack of information they have about them. Studies by reveal a gradual preference by people for healthy and organic foods, likewise, similar works indicate that people prefer foods that have additional characteristics, for example, their relationship with the environment.

On the other hand, factors such as the time dedicated to the cultivation of plants, and adequate space within the dwellings prevent them from carrying out their own cultivation. This degree work was carried out in order to present a solution to the lack of time and space for cultivation. This degree work was carried out in order to present a solution to the lack of time and space for the cultivation of edible plants in an indoor environment at a low cost.

2. MATERIALS AND METHODS

2.1 Prototype design

2.1.1 Design of the measurement and control system

In a greenhouse, it is important to monitor and control the variables that influence the development of the crop, such as: temperature and relative humidity.

1. Selection of sensors and irrigation system.

To obtain the value of these variables, it was decided to use the DHT11 sensor and apply a drip irrigation system, to efficiently use the water.

2. Design of the main control system.

An analysis of information was carried out on the topics related to Automated Greenhouses such as:

- *Study on the cultivation of Carrot.*
- *Irrigation systems.*
- *Greenhouse automation.*

All this to design the routine on the "arduino uno" board and have a proper main control system.

2.1.2 Design and implementation of the physical and electronic structure

Design of the physical structure (scale size).

The greenhouse selected is to grow carrots, due to the distance requirements between each plant, a tunnel-type greenhouse was selected, for which, the design of the prototype structure was drawn, using SolidWorks software, in order to dimension and distribute the components, the measurements of the physical structure are as follows: length: 1m, width: 6m and height: 55 cm, as shown in Figure 1.

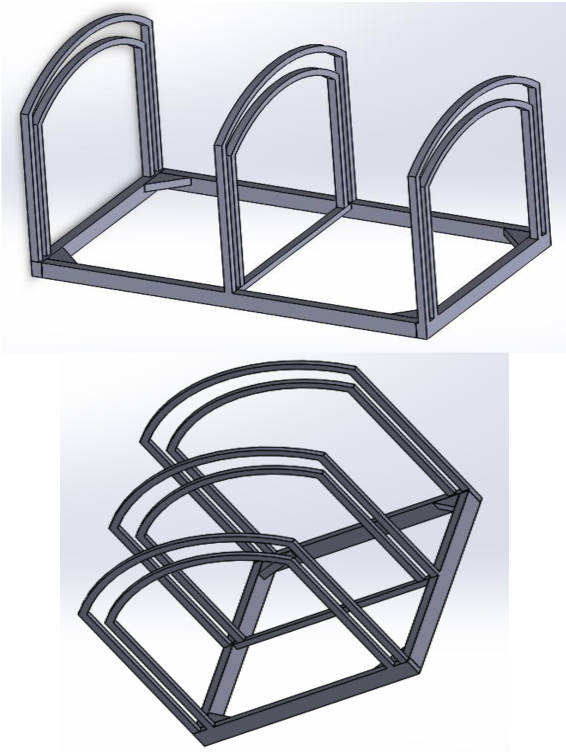

Figure 1. Greenhouse's structure. Own source (2021).

Selection of materials for the construction of the prototype.

For the control, the materials for the electronic circuit are: arduino board, LCD screen, as inputs: DHT11 sensors, as outputs; actuators (water pump), fan, breadboard, and components such as: resistors, diodes, relays. Assembly of the control system elements.

To locate the sensors, the greenhouse was divided into four quadrants;

A DHT11 sensor was placed in each quadrant to control the variables (temperature and humidity) as well as an irrigation system for efficient use of water in the carrot crop.

The LCD screen was installed to display the measurement results obtained by the sensors. Therefore, they were programmed to send the data and be updated every certain time.

Programming in Arduino.

We proceeded to perform the programming in the Arduino software for the management of each component in this way: fan and water pump were controlled to adapt the climate inside the greenhouse.

sistema_de_riego_jesus

```
#include <LiquidCrystal.h>

#include <DHT.h>
#include <DHT_U.h>


int sensor = 9;
LiquidCrystal lcd(8,7,6,5,4,3,2);
int temperatura;
int humedad;
DHT dht(sensor, DHT11);
int ventilador = 10;
int bomba = 11;
bool ventilador_activado = false;
bool bomba_activada = false;
int temperatura_limite = 22;
int humedad_limite = 80;

 void setup(){
  Serial.begin(9600);
  Serial.print("Iniciando sistema de riego automatico perros");
  dht.begin();
  lcd.begin(16,2);
  lcd.print("Sistema de riego");
  delay(3000);
  pinMode(ventilador,OUTPUT);
  pinMode(bomba, OUTPUT);


 }
void loop(){
  humedad = dht.readHumidity();
  temperatura = dht.readTemperature();
  lcd.clear();
  lcd.setCursor(0,0);
  lcd.print("temperatura: ");
  Serial.println("temperatura: ");
  lcd.print(temperatura);
  Serial.println(temperatura);
  lcd.print("C");
  lcd.setCursor(0,1);
  lcd.print("humedad: ");
  lcd.print(humedad);
  lcd.print("%");
   delay(500);

  if(temperatura > temperatura_limite){
    digitalWrite(ventilador,HIGH);
    ventilador_activado = true;



}

else{
  digitalWrite(ventilador,LOW);
  ventilador_activado = false;
}

if(humedad > humedad_limite){
  digitalWrite(bomba, HIGH);
  bomba_activada = true;

}
else{
  digitalWrite(bomba,LOW);
  bomba_activada = false;
}
}
```

Figure 2. Programming the DHT11 sensors. Own source (2021).

2.1.3 Measurements and testing

1. The tests were carried out by sensor, as well as all of them, in order to guarantee optimal operation, that is to say that each sensor: measures the environmental variables adequately, these readings are shown on the screen. The routine actuates the electronic components. In these tests some details were found which were identified and corrected at the programming level.

Figure 3. Greenhouse's Display. Own source (2021).

3. RESULTS

Greenhouse performance evaluation was carried out in the "ALAN" Laboratory of the Technological University of Tlaxcala. The greenhouse was initially operated under vacuum, this in order to ensure the correct operation of the mechanical components and to verify that the temperature and relative humidity parameters were correct,

Figure 4 shows the behavior of the temperature and the relationship between the environment and the temperature inside the greenhouse.

Figure 5 shows the behavior of relative humidity and the relationship between ambient relative humidity and humidity inside the greenhouse.

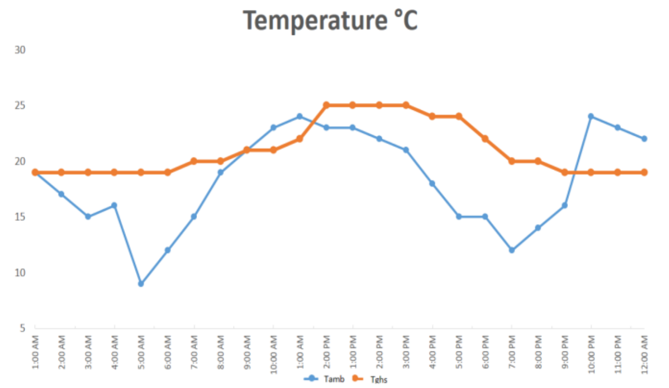

Figure 4. Greenhouse's Temperature. Own source (2021).

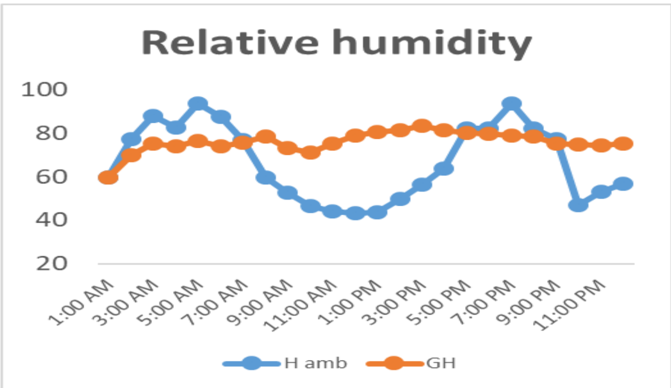

Figure 5. Greenhouse's Relative Humidity. Own source (2021).

3.1 Irrigation

Before the test period, carrot was selected as the crop, sowing 50 carrot plants. Once sown the crop cycle began, checking conditions daily. Water requirements was lower at the beginning of the growing season, but amount of water and irrigation intervals increased after, due the climatic conditions and plant development stage, see Figure 6.

Figure 6. Greenhouse's Temperature and Relative Humidity. Own source (2021).

4. DISCUSSION

According to the bibliography, greenhouse yields vary widely depending on climatic conditions, crop variety, growing season, and related agricultural practices. In the present study, irrigation treatments did not significantly affect yield. The number of irrigations and, therefore, the irrigation frequencies were different.

In order to validate the use of the prototype, carrots were cooked in a period of 61 days. With satisfactory results.

5. CONCLUSIONS

The overall evaluation of the results showed that close follow-up and rapid response appear to be the key factor for success. The most important step in the transition to organically grown greenhouse vegetables lies in the willingness of the farmer to accept and receive technology and training to operate it.

So the greenhouse prototype is validated.

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BIOGRAPHIES

Moises Sanchez Moredia earned a Bachelor of Arts in Applied Modern Languages, specialized in English as a second language teaching by University Autonoma Tlaxcala. He holds a Master´s Degree in School Administration and Management by Universidad Interncional de la Rioja (UNIR). From 2016 to 2018, He was the coordinator of the English area in Universidad Tecnologica de Tlaxcala where he currently teaches English in Industrial Maintenance Engineering.

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