Monitoring System with Humidity and Growth Level Detection for Horticulture

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Abstract

Smart Farming System with humidity and growth level detection presented in this paper is designed to monitor and control the production of the fresh produce. This smart farming system is designed to monitor the changes due to environment parameters which includes temperature, soil moisture level of the crops, and growth level of the crops. A sensor is placed at certain distance from the plant and the growth rate of the plant is monitored from time to time. Any plant which did not show positive or consistent growth rate will be eliminated and replace with new seeds. Therefore, the farmer can produce more productive plan in the estimated time. The system allows the user to choose the type of soils used for the plantation. The specific temperature and humidity level have been stored in the system and will be automatically set based on the soil selected. The humidity sensor included in this system can benefit the farmer by constantly monitor the humidity level of the soils from time to time before he can continue with the watering the crops. When the soil moisture humidity sensor detects the percentage of the soil is lower than the value that was pre-set in the system, the water pump will be trigger and start to pump water to the crop. While the water pump started to supply the water, the humidity sensor will continue to measure the sold humidity. The water pump will stop after the soil moisture humidity level reached the healthy level for the crop to growth. An automatic cooling System is a system that used to maintain and monitor the temperature in the greenhouse or plantation area. For sensitive crops such the temperature monitoring is very important to ensure the growth and production of the produce. The Smart Farming System proposed in this paper is built with a combination management system including environment parameters monitoring system and automatic technology control system. Arduino UNO is the central unit that plays an important role to receive and control all the function of the project. This combined system is design for modern smart horticultural or large-scale horticultural in order to produce more sustainable production.

Keywords: Smart Laundry, RFID system, Visual Basic, Automatic Control

1. Introduction

Horticultural is referring to the evolution of sustainable of high-value and intensively cultivated food and plants. In Malaysia the government has established the statutory body such as Federal Land Development Authority, FELDA and Federal Land Consolidation and Rehabilitation Authority, FELCA which is in charge of developing the rural areas by allowing rural communities to participate in economic activities to create income.[1]

Looking at the potentials of farming and plantation in Malaysia, many companies have invested in agricultural technology. Large scale plantations such as fruits[3-4], vegetables[5-6], and trees[7] contribute to the raise of company revenue. Cooperating the use of technologies has brought up the agricultural system into a whole new level. The use of Internet of Things, IOT integrated system in agriculture[8-9] have given good impact on the production of agricultural system as well as promoting appropriate agricultural management system. Thus, agricultural is no longer viewed as low-income employment but requires a professional management system that corporate with high-end technology especially for large scale production. There are several challenges of applying the IOT based system as presented in Ref. 10 which includes the high-power consumptions, high cost for the networking and maintenance, complicated infrastructure and the lack of IOT knowledge among the farmers in rural areas.

In this paper, a simple monitoring system for humidity and growth level detection is presented. The focus in the paper is to develop a system which can measure the suitable crops for different plants and to ensure the humidity of the soils is well maintained to ensure effective growth of the crops. Environment parameters including air temperature, soil moisture humidity, and growth level detection can affect the growth condition of the crops. The scope of this project is to develop the smart farming system including the sensor to detect the humidity of the soil and measure the growth level of the crops based on the different type of soil. Apart from that, this project able to detect the temperature of the horticulture to make sure the temperature of the horticulture always stays in the stable range. The sensors used in the project are exploited to detect the temperature of the environment, growth level, and soil moisture humidity level of the crop. Fig. 1 shows the connection of the sensors, Arduino and other relevant components included in this project.

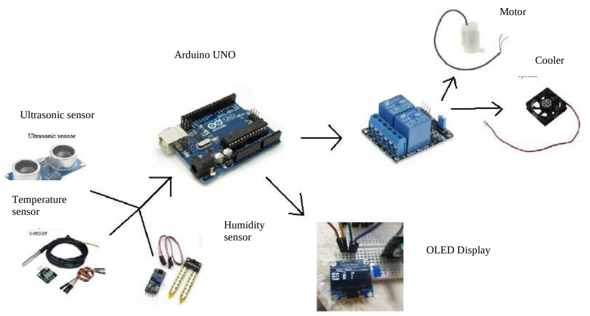

Fig. 1: Connection of sensors and components to the Arduino

2. Methodology

The Monitoring System with Humidity and Growth Level Detection for Horticulture presented in this paper is designed to help the framers to ensure healthier growth and to increase the produce of the crops. The system started by asking the user to identify the types of soils to be used in the plantation. There are three types of soils identified[11] and the example of suitable crops for each soil is presented in Table 1.

Table 1: Suitable crops based on different types of soils[11]

Types of Soil	Type1: Clay Soil	Type2: Sandy Soil	Type3: Silt Soil
Example of crops	Lettuce Onions	Cabbages Radishes	Turnips Spring Onions

2.1. *Soil Moisture Calculation*

There are six steps to calculate the moisture humidity for different type of soils as presented by Ref. 11. Below are the 6 steps to calculate the soil moisture (%).

1. Identify the length of the root depth for a mature crop
   This parameter is important to ensure sufficient area for the root to expend and grow and to ensure the root able to absorb the water and nutrient from soils.
2. Design and calculate the volume for plant the crops. It is very important to have a sufficient room and area for the crops to expand. Too small area may lead to shortage or immature plant growth.
3. Identify the soil core dry and wet weight
   This factor is to measure the soil core dry and wet weigh to calculate the water mass base on different types of soil.
4. Calculate the water mass using Eq. (1)
5. Calculate the Volumetric Water Content, VWC using Eq. (2)
6. Calculate the soil moisture using Eq. (3)

$$Water\ Mass = Soil\ Core\ Wet\ Weight - Soil\ Core\ Dry\ Weight \quad (1)$$

$$Volumetric\ Water\ Content, VWC = \frac{Core\ DryWeight}{Core\ Volume} \quad (2)$$

$$Soil\ Moisture(\%) = VWC\ \times 100\% \quad (3)$$

In this project, the prototype was tested using the acrylic box which was built to represent the underground soils with a size of $200\ mm\ \times 200\ mm$ base. Fig. 2 shows the acrylic box to mimic the height of the soils with height of $500\ mm$ and filled with the sandy soils.

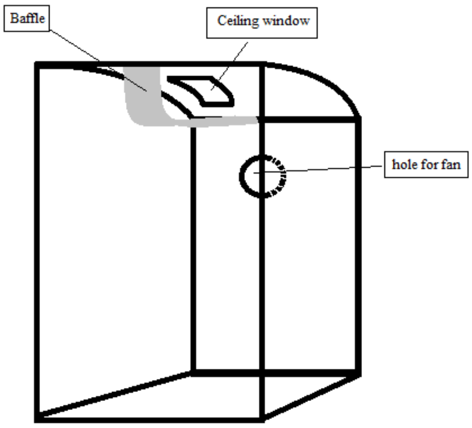

Fig. 2: The Acrylic Box with height 500 mm

The weight of an empty acrylic box is measured at 1.5kg. Next, the weight of the box with three different soils for two different types (wet and dry) is measure and presented in Table 2.

Table 2: Weight of wet and dry soils.

	Sand	**Slits**	**Clay**
Wet	35	20	26
Dry	30	15.5	25

Then, by using the Eq. (1) – (3), the humidity percentage is calculated and presented in Table 3.

Table 3: Humidity percentage of three different soils.

Sand	**Slits**	**Clay**
27%	24%	5.4%

2.2. *Hardware Integration*

Fig. 3 shows the schematic diagram of the project which includes three different sensors connected to the Arduino UNO; temperature sensor, ultrasonic sensor, and soil moisture humidity sensor. Each of the sensor have specific function. For ultrasonic sensor which represented growth level detection to detect and show the high of the crops in OLED. Soil moisture humidity sensor is to detect the soil moisture and have the function of smart watering system. The smart watering system will be break by using case coding which allow the user to select the type of soil that had set the specific value. Temperature sensor is to detect the room temperature which have the function of smart cooling system. When the data that the temperature send to Arduino UNO reach the minimum temperature the smart cooling system will started to trigger. If the room temperature keep increasing and over maximum temperature the alarm system will trigger and alert the user.

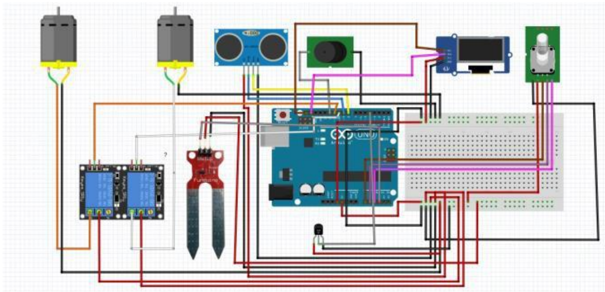

Fig. 3: Schematic Connection

Smart Farming System with Humidity and Growth Level Detection presented in this paper is a system that is designed to increase the work efficiency of the farmers. The prototype of the project have total three sections. The first section is allow the user to select which type of soil are used to plant the crops. There will be total three different type of soil allow the user to select which is sandy soil, silts soil, and clay soils. After selecting the soil, the OLED will show the environment parameters of the horticultural. growth level detection, soil moisture level, and room temperature are the three environment parameters of the project. Each of the environment parameters have play an important role to make sure the horticultural stay in the best performance. Ultrasonic sensor represented the growth level detection function to show the high of the crops. Automatic technology system of smart watering system and smart cooling system is installed in this prototype. Temperature sensor represented the room temperature have the function of smart cooling system when the temperature inside the horticultural is un-normal, the smart cooling system will trigger. Furthermore, if the temperature is keep increasing when the smart cooling system is triggered, there will be an alarm system to alert the farmers. Fig. 4 show the flow chart of the Smart Farming System with Humidity and Growth Level Detection system.

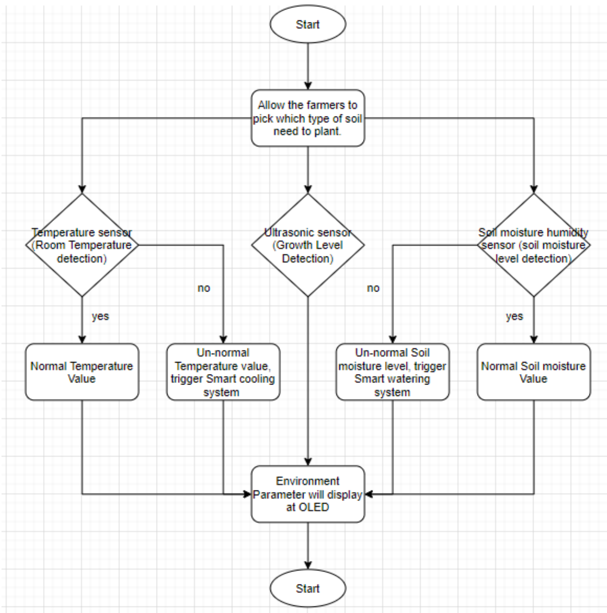

Fig. 4: Flow chart of the Smart Farming System with Humidity and Growth Level Detection system.

3. Result and Discussion

The system will display the LOGO and the Tittle of the project delay for 2 second(s). After the LOGO and Tittle display, the coming OLED will display is the main menu. Which show in Fig. 5.

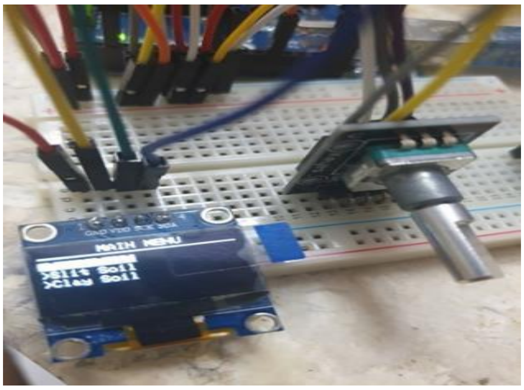

Fig. 5: Menu selection for soils

Sandy soil, slits soil, and clay soil will be display and allow the farmers to do selection. Rotary encoder is the switch that allow the farmers to turn clockwise and anti-clockwise. Middle button of the rotary encoder is enter and exit button. Each of the selection will show three environment parameters which is high, soil, and temp which label with the type of soil that the farmers had selected. Three of the soil will show three of the environment parameters. The only different is the soil moisture value. Each of the soil have the specific value which set in the coding by using break case.

3.1. *Measurement of Growth Level Detection*

Growth level detection is one of the rare facilities to design a horticultural. The system of growth level detection is rare in research paper. This part will discuss the important of the growth level detection for the horticultural design. Figure 14 is the experiment to prove the important and the purpose of the growth level detection. The experiment is two crops is plant at the same time and both crops have the ultrasonic sensor to observe the high of both plant. Crops A have the function of smart watering system which will trigger when the soil moisture humidity sensor detect the soil moisture level for the crops is too low. Crops B will be watering every morning 10am and 10pm. The results will be record every morning.

Table 4: Growth Record Of The Crop A and Crop B

Week	Crop A (automatic watering system)	Crop B (10am and 10pm)
1	0cm	0cm
2	0.8cm	0cm
3	1.5cm	0.8cm
4	2cm	1cm
5	4.3cm	1.8cm
6	5cm	2.3cm
7	5.2cm	3.0cm
8	5.5cm	3.3cm
9	5.8cm	3.5cm
10	6cm	3.5cm
11	6.2cm	3.5cm
12	6.4cm	0cm

The Experiment stop at day 12 because Crops B withered because the lack of water. Furthermore, the growth of the Crop B is slower compare with Crop A base on the Table 4. Experiment above clearly show that the important and the purpose of the growth level detection. When the farmers find out that the growth level of the crops is abnormal, the farmers able to fertilize the crops or replant immediately to increase the work efficiency.

4. Conclusion and recommendations

This research paper presented a Smart Farming System with Humidity and Growth Level Detection which including the smart cooling and smart watering system. Environment parameters including air temperature, soil moisture, and room temperature were showed in the OLED. The soil moisture for different type of soil able be calculated based on the root depth of the crops. The Internet of Things (IoT) system able to add in this project which allow the farmers to view the parameters by using the IoT system. Furthermore, pH level detection able to add in this project by using the pH level sensor. The demonstration of this project is available in the link: https://www.youtube.com/watch?v=GSFXapTjee0

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12. Authors Introduction

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