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Monitoring System Platform for Agricultural Research and Analysis

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ABSTRACT – This research article contents the study and development in the topic of monitoring system platform for agricultural research and analysis. This platform is developed to manage and analyze the data of the initial environment. The Chinese kale is used as an example plant in this research. The IoT devices and sensors are used to monitoring and collecting the data. The IoT controllers are raspberry Pi and Arduino Uno. The sensors are temperature sensors, relative humidity sensors, light intensity sensors, soil humidity sensors, and Raspberry Pi camera. The data of the environment are such as temperature, relative humidity, light intensity, soil humidity, and Chinese kale leaf color. The data will be collected and displayed on the thingspeak platform. This platform is still running and on the way to be improved and developed.

KEYWORDS: Monitoring System, Monitoring Platform, Internet of Thing, Smart farm, Agricultural

1. Introduction

The office of Agricultural Economics (Thailand) has revealed the number of farmers in 2017, there are more than 980,000 farmers throughout Thailand and the future population of the agricultural sector may be tended to increase. Although the population of the agricultural sector increases every year. However, agricultural production tends to decrease. Agricultural Economic Report: 2nd Quarter 2019 and Outlook for 2019 shows that the crop production index is at 100.1, down 3.3 percent from the same period in 2018, Since the weather is hot and dry, including the amount of water that is less than last year.

According to Thai farmers, the main problems are Thai farmers still lack the knowledge of technology and analysis of factors affecting the growth of vegetables and also still have to deal with unfavorable weather conditions. These problems are the main causes of unexpected productivity of the agriculture of both farmers and consumers. Some researcher developed the machine and system which can help the farmer [1-3].

Therefore, a lot of Thai farmers need a platform that helps in monitoring the environment to make better agricultural results. Thus, this platform is designed and developed to serve this demand. The internet of things (IoT) devices such as raspberry Pi and Arduino Uno. Also, the sensors are applied for monitoring and collecting temperature values, humidity values, and soil moisture values. These data are useful for farmers to follow up with the environment of plants and can use for data analysis in the future.

2. Materials and Devices

2.1 Sample plant

Chinese kale (Brassica alboglabra L.H. Bailey) is a vegetable that has different characteristics of each species. Three species are popular in Thailand, including broadleaf, pointed leaf and the last one is long petiole (Chiang Mai Royal Agricultural Research Center, 2014) [4]. All three kale species can be grown

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throughout the year, but all three kale species will grow well from October until April. Although kale is a vegetable that has a growth period until the harvest period is 45 to 55 days. Chinese kale is also weather-resistant as well. The optimum temperature for growing kale yields that the temperature range is 18 to 32 °C (The World Vegetable Center, 2012). Therefore, Chinese kale is a suitable option for this research [5].

2.2 DHT11 and DHT22

DHT11 is the sensor module that measures the temperature and humidity. This sensor includes a resistive-type of humidity measurement and NCT temperature measurement with a small size component. There are 4-pins that are the low voltage at 3 to 5.5 voltage used. The measurement range of DHT11 is 0 to 50-degree Celsius, humidity is in the range 20 to 80 %RH and The measurement range of DHT22 are -40 to 80-degree Celsius, humidity is in range 0 to 100 %RH. DHT22 can also display the value in the form of a decimal point, which has more accuracy than DHT11 [6].

2.3 LDR (Light Dependent Resistor)

LDR or light dependent resistor the module to detect the environmental light and measuring the light intensity. The module is 3-pins connecting that are a low voltage that at 3.3 to 5 voltages used.

2.4 Soil moisture sensor

The soil moisture sensor is used to detect the moisture of the soil. The component has two probes to pass current in the soil that is a low voltage that at 3.3 to 5 voltages used. The depth detection in the soil is about 37 mm.

2.5 Webcam

The OKER webcam model 088 is used in this research. This webcam is high quality at 2 megapixels up to 10 megapixels depended on support software. The frame rate of this webcam is 30fps. Moreover, a high-quality glass lens focus range at 30mm up to-infinitive is included.

2.6 Raspberry Pi 3 Model B+

Raspberry Pi 3 Model B+ is the new version of Raspberry Pi that boasting core processor at a 64-bit system and the processor is running at 1.4GHz. The built in dual-band Wi-Fi content in 2.4GHz and 5GHz. The built in Bluetooth is 4.2/BLE [9].

2.7 Arduino UNO R3

The microcontroller board with ATmega328 that have digital I/O for 14 pins, analog input for 6 pins and PWM Digital I/O for 6 pins. The operating voltage for this board is 5V with the recommended input voltage at 7 – 12V.

3. SYSTEM DIAGRAM

This system diagram is designed based on automated farming by using raspberry pi3 model B+ and Arduino UNO is used as IoT devices and sends the data of sensors to the database via Wi-Fi. The sensors that are used in this research are DHT11, DHT22, LDR sensor module, soil moisture sensor. For DHT11 and DHT22, two of the sensors use to compare the same values to get more detailed and the accuracy of real data. Also, the camera that is an OKER Webcam model 088 is used to capture the Chinese kale leaf.

The data will be stored in the database at thingspeak.com which is an IoT platform. The thinkspeak can use to analyze and perform all data of this platform. The data is set into three parts [7-8]. First is the air part. This part uses DHT11 module, DHT22 module to collect air temperature and air humidity. The LDR sensor module is used to collect light intensity. Second, the OKER Webcam model 088 is used to capture pictures of plant growth and the color of plant leaves. The third is the ground part. The soil moisture sensor is used to collect the value of ground humidity. The overview of the system diagram is shown in fig. 1.

For the analysis of the color value of Chinese kale leaf from the picture, the diagram is shown in fig. 2. The system is set up to perform color analysis every day, the system cropping the image size 54 * 54 pixels in the green area, which is the area of a Chinese kale leaf. After getting the image, the system will start to analyze the color value by converting the RGB color model to the HSV color model and display the H or Hue value which is the degree of color value and take the result to be displayed on the thingspeak platform [10].

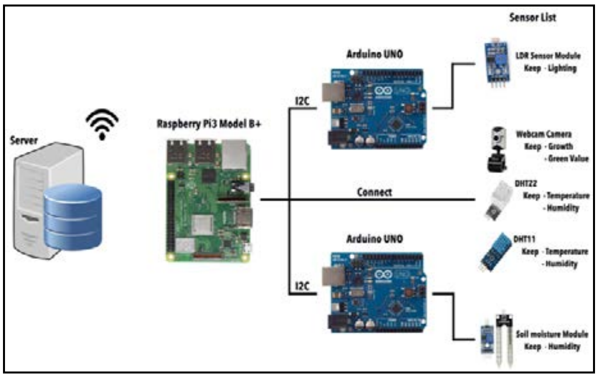


Figure 1. The overview of system diagram.

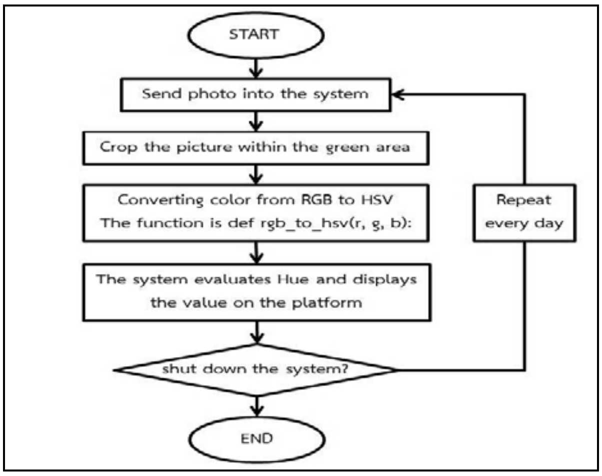


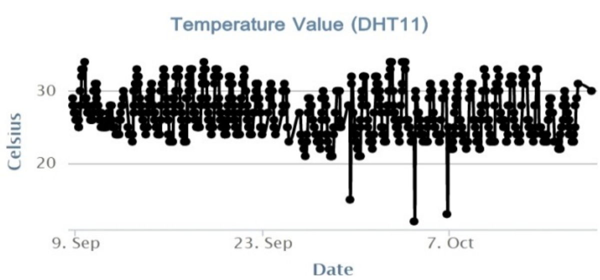
Figure 2. The overview of converting color diagram.

4. RESULTS AND DISCUSSION

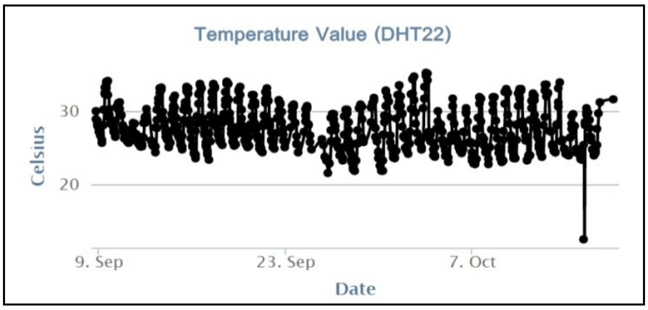
For data collection from the sensors mentioned in Section II, the system is set to collect ambient weather data on the experiment plots every 1 hour and take the values displayed on the Thingspeak.com platform. By setting the system to store the first value as of 8 September 2019 at 8:00 pm until October 17, 2019, at 3.00 pm, which is an example of the data set presented in this research. The system recorded values are as follows.

4.1 Temperature

For the values shown in the graph below, both graphs are the air temperature values in the experimental area. The first graph (a) shows the temperature values from DHT11 and the second graph (b) shows the temperature values from DHT22. From both graphs, there are some very low points on the graphs. The cause is a failure from the equipment and electrical system from the experimental area causing an error.



(a)

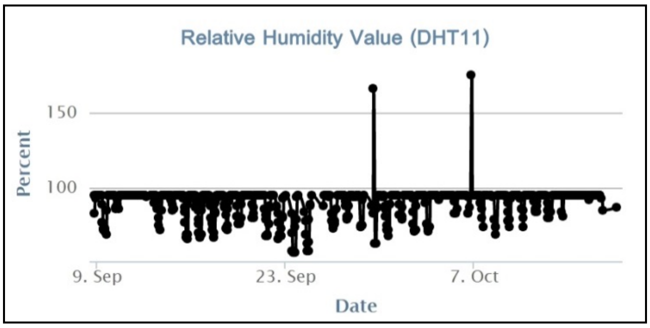


(b)

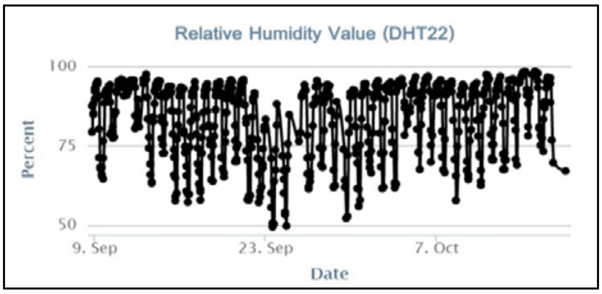
Figure 3. (a) The temperature value from DHT11 and (b) The temperature value from DHT22.

4.2 Relative humidity

For the values shown in the graph below, the two graphs are the relative humidity of the air in the experimental area. The first graph (a) shows the relative humidity from the DHT11 and the second graph (b) shows the relative humidity from the DHT22. The error values that appear on the graph are caused by the same reasons mentioned above.



(a)



(b)

Figure 4. (a) The relative humidity value from DHT11 and (b) The relative humidity value from DHT22.

4.3 Light intensity

For the values shown in the graph below is the light intensity in the experimental area by the graph showing values from the light dependent resistor (LDR). In the case of the graph showing the light intensity, the highest light intensity is about 254 and the lowest is 2. Due to the location of this system, the experimental area is located in the uncontrolled environment that is in the shade but the sunlight can illuminate that area and from collecting every 1 hour, causing the high-low values throughout the period shown in the graph.

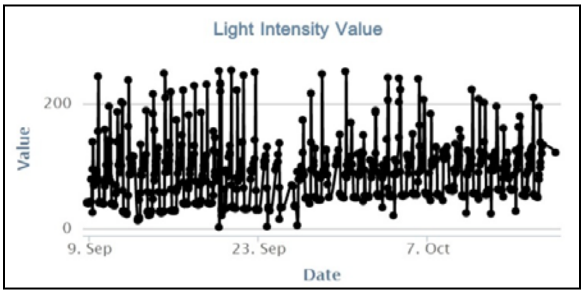


Figure 5. The light intensity value graph.

4.4 Soil humidity

The values shown in the graph below are the soil humidity values in the experimental area. The graph shows the relative humidity from the Soil Moisture Sensor. After the system starts working with an error occur, the sensor cannot be operated. After the initial solution, the error values shown in the graph are a group of data that is collected at the lowest value of the graph and the system resumes normal operation within a few hours afterward.

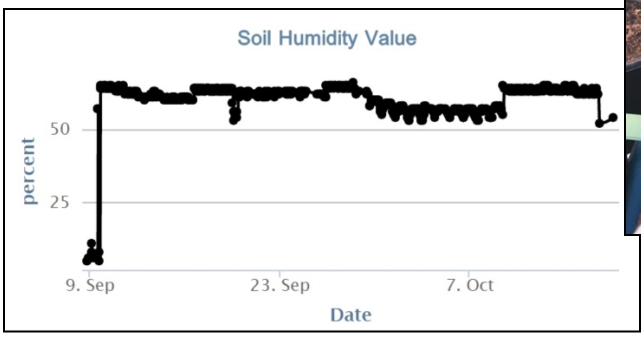


Figure 6. The humidity value graph.

4.5 Chinese kale leaf color

The values shown in the graph below are the color values of Chinese kale leaf to assess whether the Chinese kale is still growing well. The graph below shows the Hue value in the HSV color model. The HSV is highly accurate color theories and the color that is closely related to human eyes. The HSV color model that are 1) H: Hue is the primary color that varies according to the frequency of light, with values ranging from 0 to 360 degrees, such as green at 120 degrees, yellow at 60 degrees, etc. 2) S: Saturation is the saturation of that color with values ranging from 0 to 100 percent. 3) V: Value is the brightness of color which will have values from 0 to 100 percent as well.

According to the HSV color model, the system has been set up to analyze the color of the Chinese kale leaf using the values of Hue as a reference to the HSV color model. The degrees of green are in the range of 70 degrees to 160 degrees. The system will analyze the color from the image in the area of Chinese kale leaf (Sample area) from the RGB color model to the HSV color model and take the color values shown in the graph. However, the value may be higher than the human eye can analyze because the initial analysis from that system will have other factors involved such as the light and the atmosphere around vegetable plots, etc. The preliminary testing of the webcam, referring to the image from below (b) of the Chinese kale leaf is not clear as there is a lot of light reflected in the image resulting in unable to analyze the color precisely. To initially solve this problem, there are temporarily used images from iPhone S6 as the image below (a). The system will analyze the color value from the image and show the received value on the thingspeak.

(a) (b)

Figure 7. The image of Chinese kale leaf from from iPhone S6 and (b) The image of Chinese kale leaf from Oker webcam.

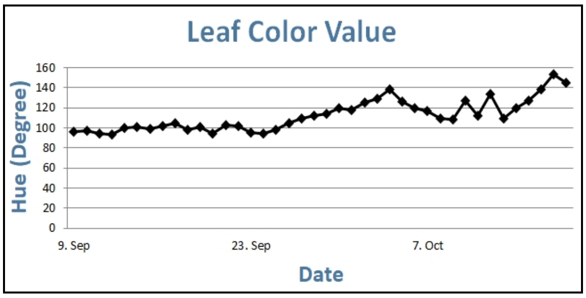


Figure 8. The Chinese kale leaf color value which is Hue in HSV color model.

5. Conclusion

For this research article, a set of devices for vegetable plot installation has been developed to facilitate the collection of the environmental values in vegetable plot areas. All values shown on the platform can be checked at any time. Even if the equipment is working at a satisfactory level but there are still device limitations mentioned in Section 3 that need to be improved. Also, this kit is the prototype of the development of basic equipment set for the research team to be able to further study and develop at the machine learning and data analysis. In terms of color value analysis from Chinese kale leaves. Although the value obtained from the analysis has factors of light impact which cause color analysis to be inaccurate, the values that the system has collected and shown in Figure 9. The graph shows that the leaves of Chinese kale are green, which increases with the growth of Chinese kale. (At the red straight line), which is an acceptable color value that the Chinese kale is growing all the time.

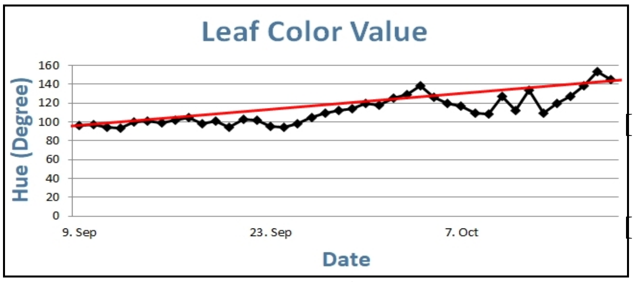


Figure 9. The Chinese kale leaf color value which is Hue in HSV color model with the red straight line that show the growth of Chinese kale.

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