Development of Smart Agriculture (Smart Hydroponic) to Monitor Soil Humidity Level

Ahamad Zaki Mohamed Noor, Muhammad Shahimi Dzulkafle, Najib Mohamad Bohri, Muhamad Haikal Mohd Khaireez, Siti Sarah Jupri, and Muhammad Hafidz Fazli Md Fauadi

Abstract Recently, the world is evolving along the 4.0 industrial revolution. One of the major developments which come along through this development is a smart cultivation. This kind of industry will help thousands of farmers and agricultural industries that are immersed and utilizing the use of technology like the Arduino. A real-time environment monitoring can provide a visualization of the data and condition of the agriculture. An integration of software and a hardware system which is equipped with a humidity sensor, temperature sensor and water level sensor will lead to the advancement of agriculture among us. We decided to do smart hydroponics as our project. Smart hydroponic system helps to maintain the quality of the crops from far. This system could help our farmers to maintain their crops with less effort because this system requires ThingSpeak and Blynk applications. We could get a notification on the Blynk apps about the information of our crops which is received from ThingSpeak where the data can be monitored by us. This system can help us monitor our crops and can help us prevent something that can cause a major loss towards our crops. The agricultural industry has been pushed by crucial factors such

A. Z. M. Noor (✉) · M. S. Dzulkafle · N. M. Bohri · M. H. M. Khaireez · S. S. Jupri
Universiti Kuala Lumpur Malaysian Spanish Institute, Kulim Hi-Tech Park, 09000 Kulim, Kedah, Malaysia
e-mail: ahamadzaki@unikl.edu.my

M. S. Dzulkafle
e-mail: shahimi.dzulkafle@unikl.edu.my

N. M. Bohri
e-mail: najib.bohri@unikl.edu.my

M. H. M. Khaireez
e-mail: haikal.khaireez@unikl.edu.my

S. S. Jupri
e-mail: ssarah.jupri@s.unikl.edu.my

M. H. F. M. Fauadi
Centre of Smart System and Innovative Design, Faculty of Manufacturing Engineering, Universiti Teknikal Malaysia Melaka, Hang Tuah Jaya, 76100 Durian Tunggal, Melaka, Malaysia
e-mail: hafidz@utem.edu.my

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as rapid population growth, food security and climate change to explore more creative measures to improve productivity and crop yield. As a result, by offering end-to-end visibility in the agricultural processes, the Internet of things has emerged as a saviour for the farming industry.

Keywords Sensor technology · Smart agriculture · Hydroponics · Internet of things

1 Introduction

As the agriculture is one of the basics of life which provides the most crucial sources, the food industry is started by cultivating and providing jobs for humans. The food industry is also one of the pillars and strengths of the financial condition in country's economy (Da Silva et al. 2009).

Unfortunately, we still could find that many farmers are not exposed to utilizing the technology towards the agriculture activities. Thus, a modern method must replace the traditional method to fill the gap and activates towards the fast phase of farming industry. We decided to extend the framework in this mini-project by adding the water sensor and the DHT sensor (Lakhiar et al. 2018).

The visualized notification can be easily identified in our system by the present LED. LEDs are mounted here and light up as the sensor senses low soil humidity. By using a NodeMCU, we decided to collect the reading of data. Data is sent to the Blynk application in the form of a notification (Verma et al. 2016).

Our strategies can be quickly and effectively implemented in current facilities in a cost-effective way. In comparison with the traditional technique used, farmers must monitor the plant manually to provide sufficient humidity for soil. Instead of manual control, a smart farm system must be designed to help the farmer keep growing.

2 Literature

The Arduino used in the smart hydroponic system is one of the innovative technologies that is gaining more and more interest nowadays. Automated hydroponic systems have been investigated in the literature for the long run. This is because the automated systems have the advantage of providing huge throughput, high efficiency and need no specialized manpower. To integrate the hydroponic system, a communication protocol namely the Internet of things (IoT) needs to be embedded since it is suitable for many applications (Hafidz et al. 2020). Furthermore, the automation of hydroponics is not beyond reach since the tasks administered during a hydroponic system can easily be automated. Also, computers have the capacity to try to do it better, due to their high availability compared to humans (Lakhiar et al. 2018).

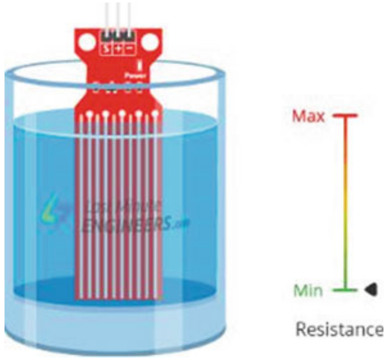

Fig. 1 Water level sensor

2.1 Arduino Uno

The Arduino is a single-board microcontroller intended to allow the programmed more access to interactive objects and their world. The hardware is based on an 8-bit Atmel AVR microcontroller or an open-source hardware board with a 32-bit Atmel ARM. The current models consist of a USB interface, 6 analogue input pins and 14 digital I/O pins that allow multiple extension boards to be connected to the user.

They are simply linked to a device with a USB cable or with an AC-to-DC adapter or battery to get started. Android mobile phone sends instruction to the Arduino board via Wi-Fi module and Arduino will process them in order to control all the inputs and outputs (Mahindar et al. 2018).

2.2 Type of Sensors

2.2.1 Water Level Sensor

Water level sensors are basically used to track and determine the water level in a container. This sensor also can be used to determine the level of solids too for example powder. The set of parallel conductors were exposed whose resistance adjustment corresponds to the distance from the top of the sensor to the water's surface as shown in Fig. 1. According to the resistance, the sensor generates an output voltage that we can be used as water level measurement (Kilmer 2010).

2.2.2 Humidity and Temperature Sensor (DHT11)

Since the beginning of taking care of the crops is highly needed to take care of the humidity, DHT 11 which is shown in Fig. 2 will monitor the humidity of the surrounding air. The normal temperature and humidity of the normally grown crops

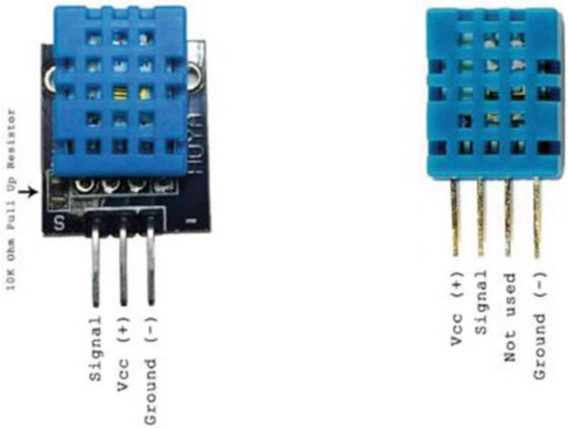

Fig. 2 DHT11

are different. This system is set to take care of the first two months of the normal crops. Spray mist will be triggered based on the reading from the DHT 11. This component will read the level of water to be used for spraying the surroundings (Lakhiar et al. 2018).

2.2.3 Soil Moisture Sensor

A soil hygrometer or soil moisture sensor as shown in Fig. 3 is the best choice of sensor which is able read the soil moisture. Soil moisture is needed to be read for maintaining the water needed for the crops. In the early stages of the seeds, this is everything needed to be taken care of. Since the type of soil is hard to absorb the water, we delayed the detection reading to be read. The system also reduces the amount of moisture reading (Ding and Chandra 2019).

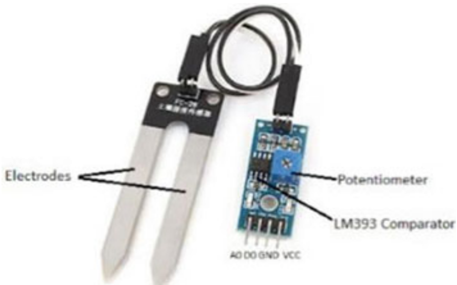

Fig. 3 Soil moisture sensor

2.3 Cloud Platform

ThingSpeak and Blynk apps will be used as monitor and data storage. These platforms help in accomplishing the smart hydroponic system. These are the platforms that are widely used for small project to be expanded to industrial usage (Waworundeng et al. 2019).

ThingSpeak is the platform where all the data will be stored in the cloud. This kind of platform is mainly used as a data cloud storage. The system will collect data from each component that will be sent from the NodeMCU (Ray 2016).

As for the Blynk app, user can monitor the live data directly from their phones. Blynk app is the platform that is widely used as the software that will help the user communicate directly to the system (Aafreen et al. 2019).

This will help on improving the way of taking care of the crops. This platform is the base of the system that helps on improving the way of growing crops. It is also easy to do a maintenance for maintaining the component lifetime.

3 Methodology

The system works at several levels. In the system, there will be three LEDs which indicate the available water level in the tank system, soil and air humidity. The main objectives of the system are to monitor the water and humidity level which is suitable for plant cultivation.

The first LED is to detect the water level at certain height in the water tank. In this program, the LED is switched on as the water level is at the optimum water level. This LED is connected to the water level sensor. This sensor will provide the signal to the system. The LED will be switched on or blinking. The LED will start blinking as soon as the water level reaches the minimum water level. However, the LED is always switched on to indicate the water level is an optimum height. This will help the farmer to obtain information on the water level inside the water tank.

Further to the working system, the system is divided into two sections. The first layout is to control the humidity of soil. Then, the second layout is to monitor the humidity and the temperature of the air surrounding for cultivation activities.

The first layout of the system will monitor the humidity of soil using the soil hygrometer sensor. The measurement is taken using the soil hygrometer sensor to check the suitable level of humidity of soil. Farmers will receive the notification through the Blynk application as the LED two is switched on. This indicated that the level of humidity of soil is low. Therefore, precise information can be analysed using ThingSpeak. Furthermore, the LED two is switched on, and the water sprinkle will be activated as soon as it receives a signal indicating that the soil is insufficient of humidity. This device will provide enough water until reaching the optimum percentages of soil humidity.

The second layout is the system that helps to detect the level of humidity and temperature of the air. The measurement is taken using the DHT sensor to check the suitable level of humidity and temperature of air. This measurement is taken into percentage form to indicate the suitable percentage for plant growth. The indicator for this sensor can be visualized by the farmers using the LED indicator which is LED three. This result of percentage can be monitored from the ThingSpeak. Here, we decided to code the program by making the LEDs switched on when the humidity of air is at low percentage. Therefore, farmers are well informed that the air humidity is low; thus, the system will send data to the mist spray. The mist spray will turn on as they receive the signal. This device will provide enough water until reaching the optimum percentages of air humidity and temperature. Farmers can receive the notification through the Blynk application. The water level inside the tank is referring to the first LED as mentioned before.

Lastly, to ensure that there is no water wastage during the farming process, the soil hygrometer and DHT sensor will provide the data. If both soil and air are at right percentages of humidity, the LED will be turned off. Therefore, the water sprinkler and mist spray will be turned off as no water is required during the condition.

From the flow chart in Fig. 4, the presence of water is important to start the system. This shows that the presence of water will activate other components. As the objectives of this system are to control the humidity of air and soil, all the data will be kept in ThingSpeak and can be monitored through the Blynk application.

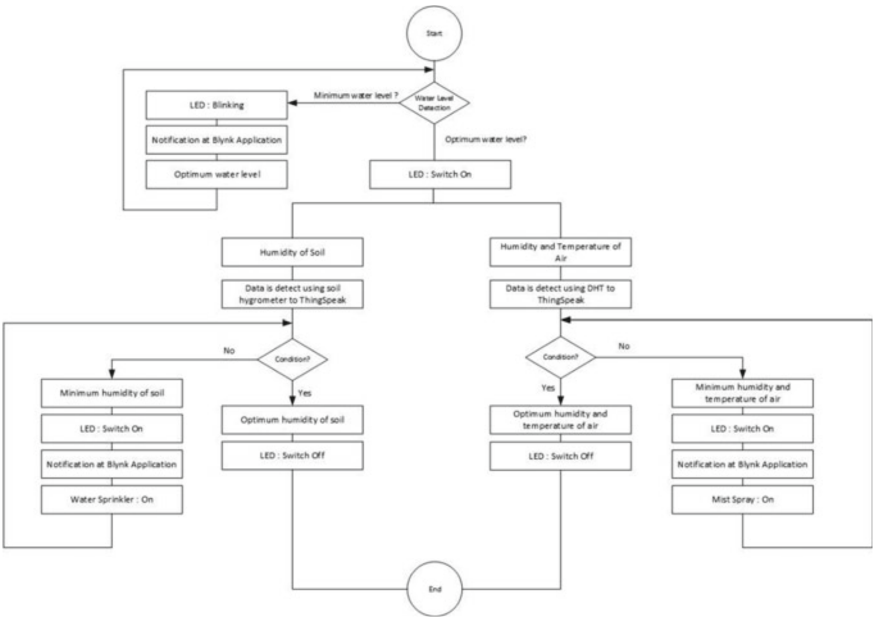

Fig. 4 System flow chart

The component of the soil hygrometer is used to read the humidity of the soil and also to trigger the sprinkler to water the plants or crops. Without the presence of water, the sprinkler will not be activated for watering. The information of humidity of the crops can be monitored through the Blynk app. Blynk is used to monitor live information about the humidity of the soil.

While the DHT11 component is used to detect the humidity and temperature in the surroundings. Surrounding humidity is important at the early stage of growing crops to maintain their quality from the beginning of the plantation. ThingSpeak is used to capture and store data for history usage. From the ThingSpeak, there are two types of data presence which are in gauge and timeline graph.

An Arduino R3 is used to collect data from the components, and NodeMCU will act as a platform to send data to ThingSpeak and Blynk. Arduino and NodeMCU will be generally known as a receiver and transmitter. So, the LED lights up as a command from the NodeMCU is received. The flow chart is shown in Fig. 4.

4 Result and Discussion

Before obtaining the results, all the components were assembled in order to detect the soil humidity level. The components that were assembled are the Arduino Uno, ESP8266, water level sensor, DHT11 and soil moisture sensor. The result obtained is from the ThingSpeak and Blynk applications. Each result is displayed in this section to analyse the functionality. Figure 5 shows the complete circuit assembly.

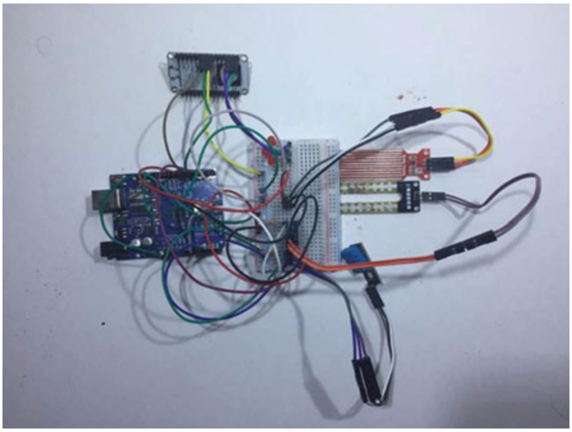

Fig. 5 Complete circuit assembly

Fig. 6 Result from ThingSpeak

4.1 Result from ThingSpeak

From the ThingSpeak application, four channels were created. Channels 1 and 2 display the temperature and humidity, respectively, from the data input through the DHT11. Channel 3 measures the water level from the embedded water level sensor. For channel 4, soil moisture sensor was used to determine the soil humidity. Figure 6 shows the result obtained from ThingSpeak.

4.2 Result from Blynk

This section discusses the result obtained from the Blynk application. This display shares information on the temperature, humidity level, water level and soil hygrometer. Figure 7 shows the display from the Blynk application.

5 Conclusions

In conclusion, the application of the IoT is applied in our daily life to improve the development of technology in our country. This smart hydroponic system is one of the innovation technologies that will be widely used in future. This project also will improve our structure and mentality of agriculture industries, especially in Malaysia. We learn to integrate the key components of the prior project during the project to

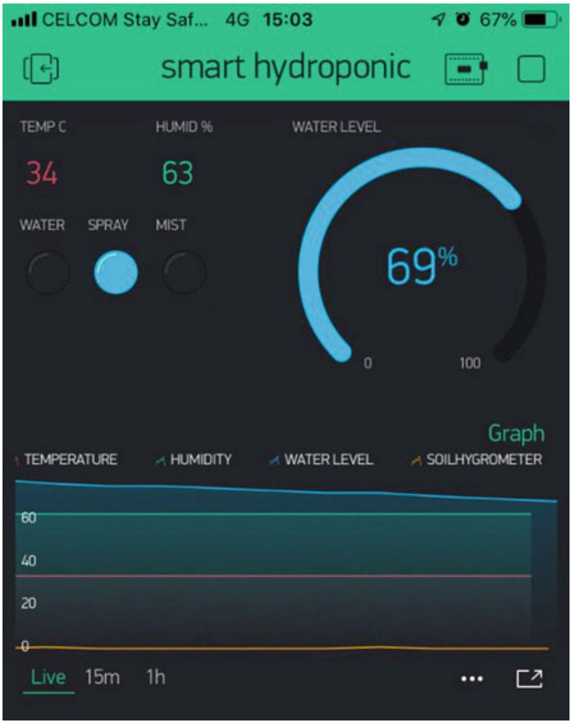

Fig. 7 Display from the Blynk app

create a device that is specific to our case study. In comparison, we demonstrate that the types of precision farming systems implemented rely on the use of software for business management. Control systems manage sensor data and provide remote input for supply and decision support, as well as computer and equipment automation to respond to emerging challenges and performance support.

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