Evolution in Electrical and Electronic Engineering Vol. 4 No. 2 (2023) 317-323
© Universiti Tun Hussein Onn Malaysia Publisher's Office

EEEE

Homepage: http://publisher.uthm.edu.my/periodicals/index.php/eeee
e-ISSN : 2756-8458

IoT Based Soil Nutrient Development Monitoring for Smart Pineapple Farming Using Firebase

Adaikan Kannappan[1], **Elmy Johana Mohamad**[1]*

[1]Faculty of Electrical and Electronic Engineering,
Universiti Tun Hussein Onn Malaysia, Batu Pahat, Johor, 86400, MALAYSIA

*Corresponding Author Designation

DOI: https://doi.org/10.30880/eeee.2023.04.02.040
Received 15 January 2023; Accepted 07 April 2023; Available online 30 October 2023

Abstract: This system is optimized to monitor seven soil properties in real-time with an implementation of single soil sensor powered by renewable energy. A dashboard system is designed for accessing information regarding crops anywhere. End users will be able to observe the current condition of crops from any desired location and time. Implementation of a seven in one soil sensor to a Wi-Fi compatible microcontroller module which is configured to a database can be accessed through a designed application. Data collection in this research is carried out manually with a time interval of five seconds. A master unit is feeds real time updates database while the client is placed in the desired observing area. Both units communicate through a long-range wide area network technology. The designed dashboard system retrieves real time data from the connected database. Real-time data feeds will be interrupted if Wi-Fi connection is disrupted under any circumstance. Farmers or any end users will be highly benefitted by this system for agricultural purpose as real-time crop conditions observation ensures that the growth of crops are not affected if maintained accordingly. The dashboard system can be improvised by integrating a data analyzation technique for detailed crop reviews.

Keywords: Soil Properties, Real Time Monitoring, Seven in One Soil Sensor

1. Introduction

The art and science of nurturing the land, raising crops, and providing people with wholesome food is known as agriculture. Promoting sustainable development was a key strategy to counter the deterioration of the environment through time. Most likely, the area utilised for cultivating crops won't change. Crop production must be steadily raised along with population growth.

The best natural environment for a plant's growth and development is soil. There has been a lot of study done to identify the reasons why farmers' crops fail to produce as expected. The primary cause of unstable plant development in infertile soil is the imbalance of nature. As a result, soil sensors are often put in greenhouses to track the soil's many properties, including its temperature, moisture content, pH

**Corresponding author: elmy@uthm.edu.my*

level, soil conductivity, and other nutrients like potassium, phosphorus, and nitrogen. These soil constituents have a significant impact on plant output [1]. Great crop yields, water conservation, labour and fertiliser cost savings, increased farm profitability, and inexhaustible information on the ever-changing climate are just a few of the many benefits of soil sensors [2]. Through implementing the Internet of Things (IoT) system by connecting the high precision agriculture sensor to microcontroller, the obtained data can be transmitted to a cloud platform in real time.

Maintaining the optimum level for any plantation is significant. As for pineapple farming, the optimal time to plant is during the rainy season. The preferable range of pH level of soil is 5.5. to 6.0. For effective a growth rate, moisture level should be from 100 to 120 mm per month. Suitable temperature for efficient pineapple development ranges from 20 to 30°C. The ideal nutrient content in soil should be maintained at a ratio of 3/1 for phosphorus, 150 mm/kg and 175 mg/ha of Nitrogen.

2. Materials and Methods

2.1 Block Diagram

The input seven in one soil sensor is implemented on the client unit. It is capable of measuring seven parameters found in soil which is temperature, humidity, pH level, conductivity, nitrogen, phosphorus, and potassium. Whereas the output will be displayed in designed application CropBuddy through fetching data from Firebase Database which is configured with the master unit. Each unit contains a E90-DTU Data Transceiver with an antenna to enable long range communication between them. A NodeMCU ESP32 microcontroller is programmed to be a medium the components in each unit present.

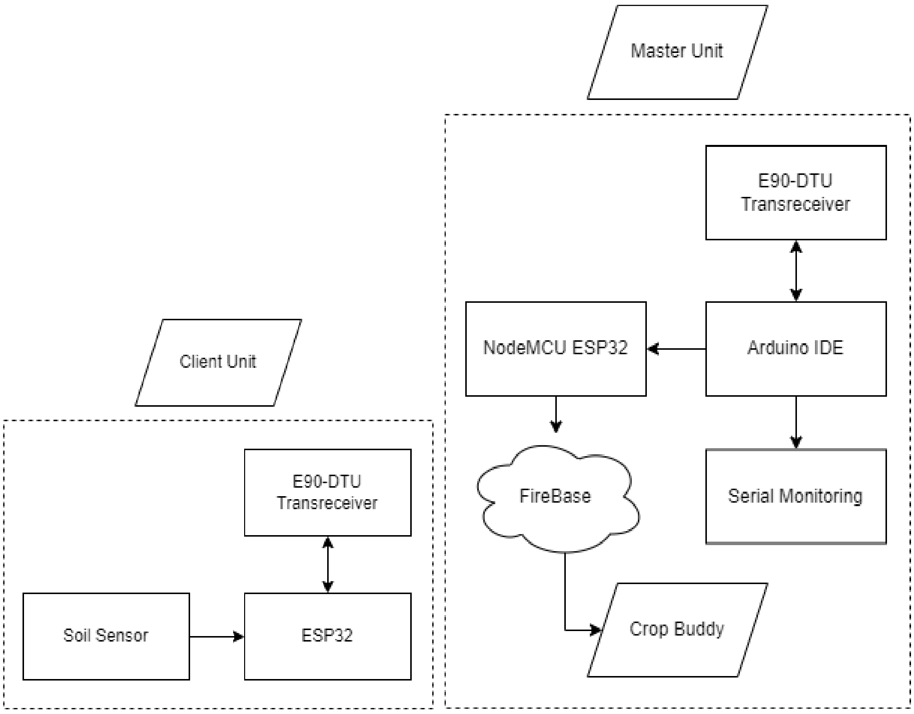

Figure 1: Block diagram of the system

2.2 Methods

The client unit and the sensor implemented in it is placed in the desired area. As in Figure 2, 12V DC power is plugged in to the master unit while the client unit's charge controller will be turned on to initiate both units. Real-time data is collected in the client unit transmitted to the master unit through the data transceiver. Then, Firebase Database receives the updates through the NodeMCU ESP32 and transmits to the CropBuddy Application.

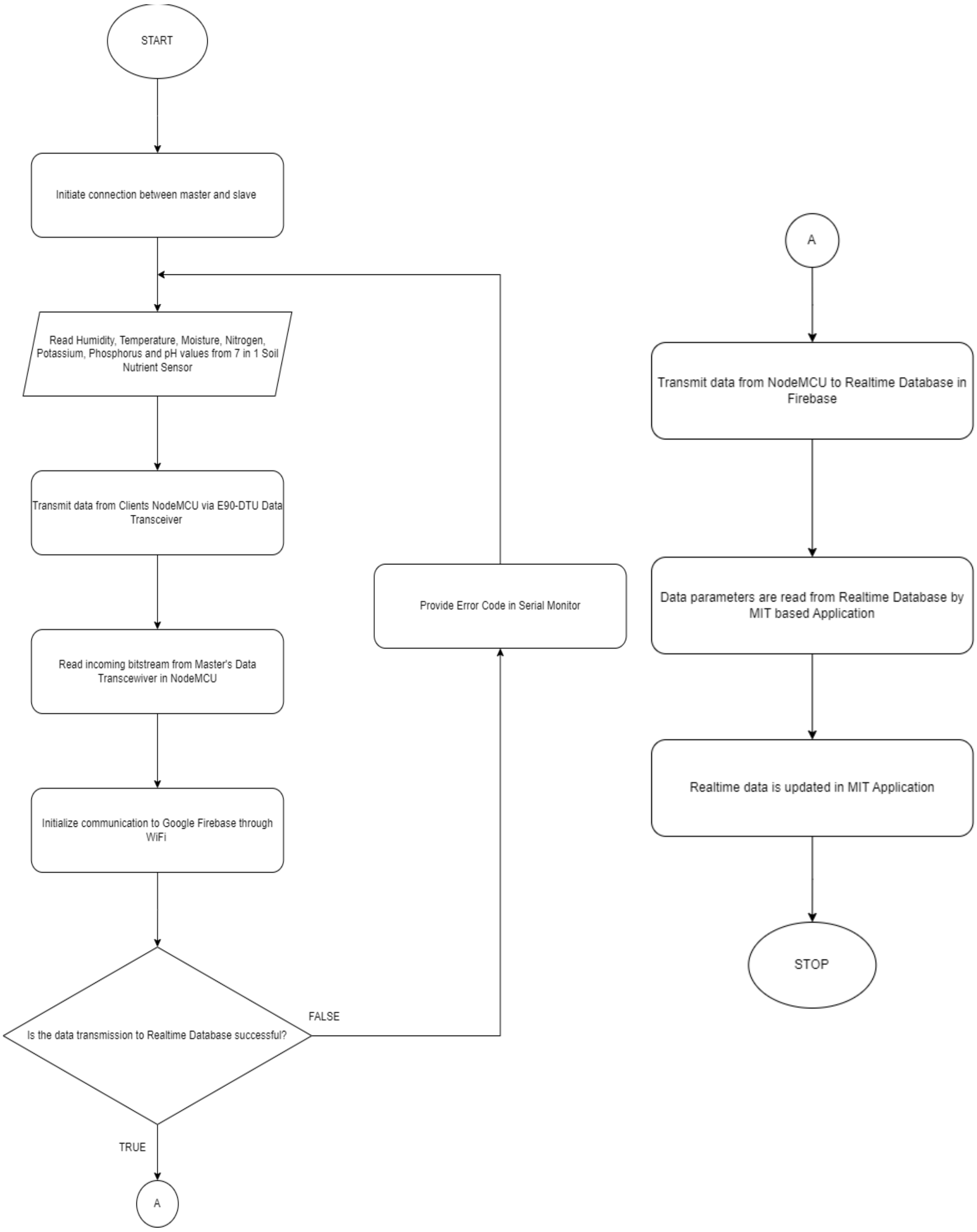

Figure 2: Flowchart of integration of hardware and software

The master unit as shown in Figure 3 is established by implementing a NodeMCU ESP32, RS485-to-TTL Converter and E90-DTU Data Transceiver. The NodeMCU is programmed to read data from the data transceiver present and transmit them to Firebase Database. Meanwhile, the RS485-to-TTL is used as medium between Data Transceiver and ESP32 to fetch data.

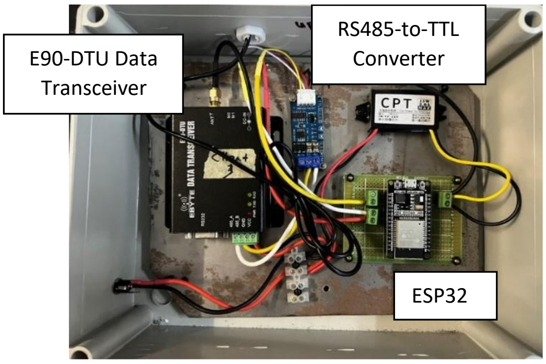

Figure 3: Master unit

The client unit as in Figure 4 has the same components as master unit with an additional instrument Solar Charge Controller and Solar Panel as shown in Figure 5. The solar panel converts sunlight into accessible electricity to power the client unit. The solar charge controller was used to allow the flow of electricity from solar panel to the powering device. It avoids any internal damage to the battery by providing a safe and efficient battery charging.

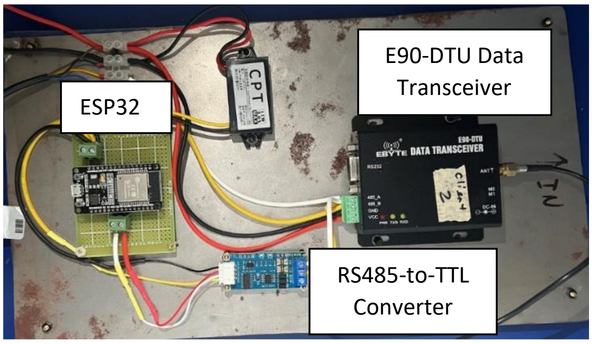

Figure 4: Client unit

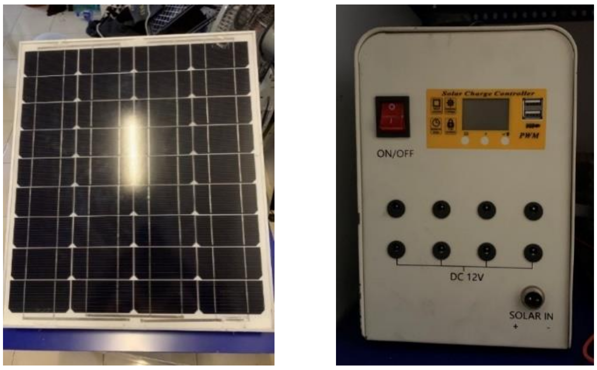

Figure 5: Solar panel and solar charge controller

3. Results and Discussion

A soil was prepped without adding any fertilizers or water. The unfertilized or watered soil monitor purpose was to test the functionality of the system. Soil sensor was placed in the prepared soil. Then, both units are turned on. The outputs are monitored through three output, Serial Monitor from Arduino IDE, Firebase Database from Google Firebase and lastly CropBuddy application designed in MIT App Inventor 2. Before readings are gathered, the pot was left with the sensor placed for five minutes to ensure stable data feeding to database. Examples of output was provided in Figure 6.

Figure 6 represents the output of initial state soil properties. The soil contents were observed for 50 seconds with a time interval of 5 seconds. A total of ten data were collected and presented in Table 1 to Table 3.

Monitor

Monitoring System

pH: 5.75

Moisture: 0.5 %RH

Temperature: 29.2°C

Conductivity: 625 µs/cm

Nitrogen: 32mg/kg

Phosphorus: 44mg/kg

Potassium: 104mg/kg

Figure 6: Output from CropBuddy application

Table 1: Monitored Soil Content on pH and Moisture

Data	pH	Moisture (%RH)
1	5.75	0.5
2	5.75	0.5
3	5.78	0.2
4	5.78	0.2
5	5.78	0.2
6	5.78	0.9
7	5.75	0.9
8	5.75	0.2
9	5.75	0.2
10	5.75	0.2

Table 2: Monitored Soil Content on Temperature and Conductivity

Data	Temperature (°C)	Conductivity (µs/cm)
1	29.2	625
2	29.2	625
3	29.2	625
4	29.2	625
5	29.2	625
6	29.2	625
7	29.2	625
8	29.2	625
9	29.2	625
10	29.2	625

Table 3: Monitored Soil Content on Nitrogen, Phosphorus, Potassium

Data	Nitrogen (mm/kg)	Phosphorus (mm/kg)	Potassium (mm/kg)
1	32	44	104
2	32	44	104
3	32	44	104
4	32	44	104
5	32	44	104
6	32	44	104
7	32	44	104
8	32	44	104
9	32	44	104
10	32	44	104

Throughout the time that data were collected, the soil's nitrogen, phosphorus, potassium, conductivity, and temperature remained unchanged. The pH and moisture levels in the soil did, however, vary a little. The pH ranged from 5.75 (lowest) to 5.78 (highest). The lowest recorded moisture level was 0.2%RH, while the highest was 0.9%RH. For comparison, Figure 7 displayed the gathered data as a bar chart.

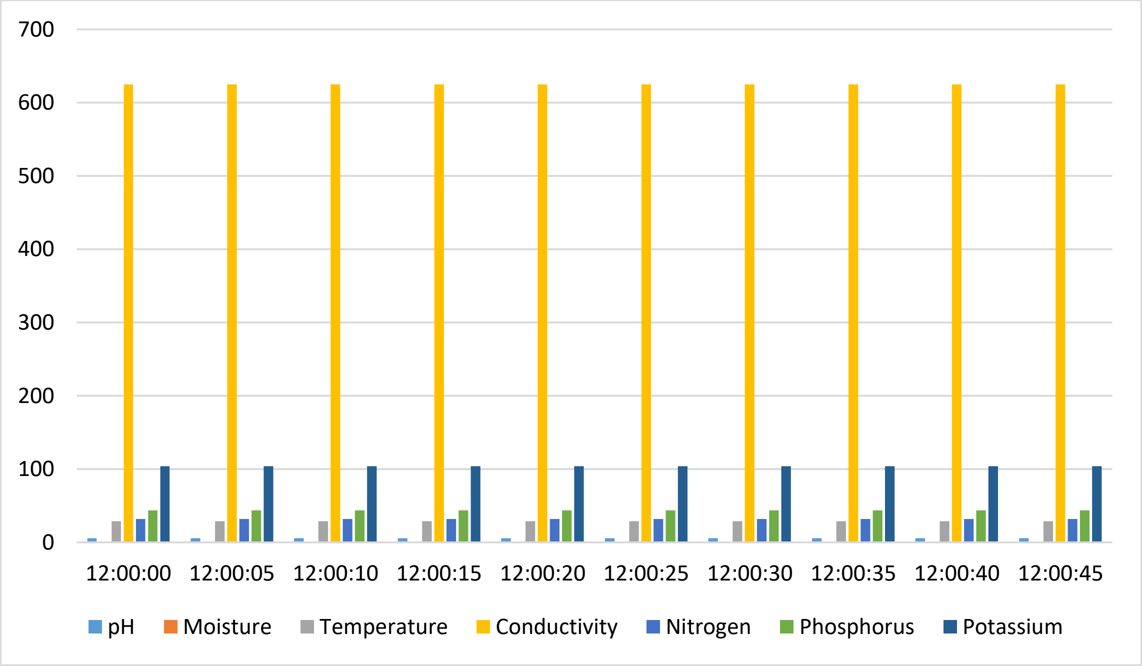

Figure 7: Comparison between soil properties vs. time

4. Conclusion

Compared to the design of mobile applications, the hardware configuration was more difficult. A client unit in the hardware is continually in communication with the master unit. To achieve the intended result, a variety of components, including soil sensors that can sense numerous parameters and microcontrollers, have been used. To establish consistent and reliable long-range communication between the master and client unit, LoRaWan was deployed. The master unit interacts with the Firebase Database via the mobile application, allowing farmers or end users to check crop status in real-time whenever and wherever they want. The free version of the Firebase real-time database is presently setup since it has sufficient capacity to complete this work. Three applications**,** Serial Monitor of the Arduino

IDE, Firebase Database, and CropBuddy allow users to examine the parameters' results. Only Android users may access the mobile application.

Acknowledgement

The authors would like to thank the Faculty of Electrical and Electronic Engineering, Universiti Tun Hussein Onn Malaysia for its support.

References

[1] "Importance of soil moisture and temperature sensor/PH sensor/EC sensor for Plant Growth," Importance of Soil Moisture and Temperature Sensor/PH Sensor/EC Sensor for Plant Growth. [Online]. Available: https://www.rikasensor.com/what-is-the-importance-of-soil-sensor-for-plant- growth.html. [Accessed: 10-Apr-2022].

[2] "Soil moisture applications and practices using the hydra probe soil moisture sensor," Stevens Water, 28-Mar-2016. [Online]. Available: https://stevenswater.com/news-and-articles/soil-moisture-applications-and-practices-using-the-hydraprobe-soil-moisture sensor/#:~:text=The%20benefits%20of%20optimizing%20irrigation,and%20in creasing%20the%20farmer%20profitability. [Accessed: 10-Apr-2022].