The Development of Smart Farm with Environmental Analysis

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Abstract. This work is an on-going research to develop a smart farm system with environmental analysis for terrace vegetable farming with web application. The terrace farm is separated into 3 levels of moisture settings according to the type of vegetables that require low, medium or high moisture content. The environmental sensors monitor the moisture in the soil and send the information to the database of the farm server. The processed information from the sensors will be analyzed and then provide the appropriate environmental factors in plant growth. The smart farm can be monitored and controlled by web application. This smart farm is considered low carbon agriculture due to the power usage from the community microgrid of 25 kW PV system.

Keywords: Database · Farming sensor · Smart farm · Terrace farming

1 Introduction

At present, agricultural farmers faced numerous obstacles such as shortage of labor, shortage of water and low quality agricultural products. In addition, the modern farming in Thailand emits large amount of carbon dioxide which is due to the usage of large farming machineries. The carbon dioxide emission affected the environment. The farmers also have to be responsible for the ever-increasing investment for farming and resulted in reduce income. Therefore, to solve the farmer's issues, there is a need to develop an effective farming practices to achieve high yield and increase the value of agriculture from the limited resources. Technologies can be the solution to the current issues in farming [1]. There are several researches on sensor technologies [2], temperature and irradiation control in green house [3], development of environmental sensors and data transfer through wireless protocol [4, 5]. These technologies could be applied to the smart farm system to control the farming condition to provide high yield plant production.

This research main objective is to develop the smart farm system in the small community level. The analysis of farm environmental conditions will determine the factors affecting plant grown. Database of farm environment factors can be used to analyze and control the farm through the web application. The goal is to increase the

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quality and quantity of products and reduce the farm production cost. In this work, the smart farm is integrated with the power generation system from 25 kW PV microgrid system.

2 Smart Farm Design

The smart farm prototype was set up at the Smart Community Farm of the Asian Development College for Community Economy and Technology (adiCET), Chiang Mai Rajabhat University. The terrace farming area was 200 m^3.

2.1 Terrace Farming Area

In this work, terrace farming was set up with the moisture monitoring system to control 3 level of terrace. The moisture levels of the soil were set as 3 levels: low, medium and high.

2.2 Smart Farm System

The Smart Farm System comprised of 4 parts which are Vegetable Garden, Weather Station, Server & Database, and Monitoring & Control through Web Application. Figure 1 showed the Block diagram of the 4 parts.

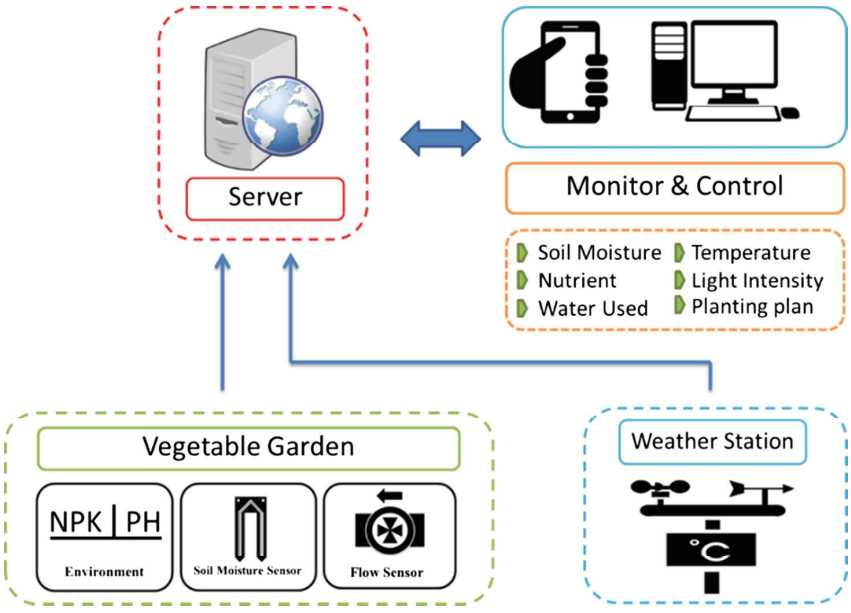

Fig. 1. Block diagram overview of Smart Farm

Vegetable Garden
Vegetable garden will install the soil moisture sensors, water flow sensors, NPK sensors and pH sensors. The data from these sensors will provide the real-time

environment information of smart farm. The data will be then transfer to database in the farm's server.

Weather Station
Weather station comprise of light intensity sensor, relative humidity sensor, temperature sensor and wind speed sensor. The information will provide the trend of environmental changes at the smart farm and also the calculation of the reference crop evapotranspiration from the environmental data [6].

Server
Server stores the database of the farm data from the vegetable garden and weather station for analysis.

Monitoring and Control
Monitoring and control focuses on the status display and control of the smart farm through web application. This function can control water distribution in the farm.

2.3 Data Transfer

The MQTT protocol is a way to send data to the MQTT Server, which is the intermediary for receiving the information from the sensors in the farm. As shown in Fig. 2, the moisture, environmental and flow sensors will measure and send data to the server. The server is responsible for processing the data received from sensors on the farm and working with the MySQL database. The processed data will be displayed and the farm conditions will be controlled through web application.

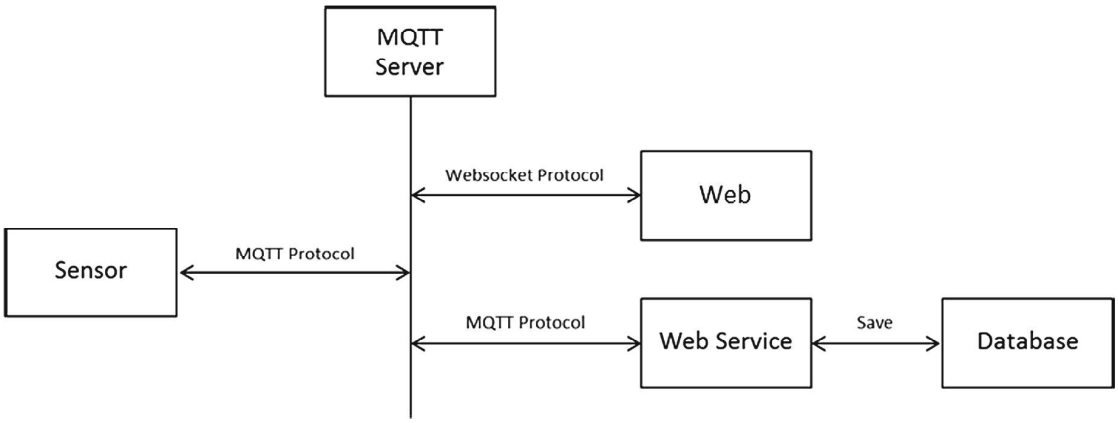

Fig. 2. Transmission of sensor data within the farm

3 System Database

The smart farm system database is categorized into 3 parts which are (1) Suitable factors for plants database which is the reference database for Soil moisture, Nutrient, pH, Light intensity and Temperature that are suitable for each plant; (2) Environmental in agricultural database which will stored the real data from the terrace smart farm with the data of Soil moisture, Nutrient, pH, Water usage; and (3) Weather data from the

weather station which includes data, Light intensity, Relative humidity, Temperature and Wind Speed.

For the analysis of the environment for plants, the real data from the sensors is compared to the suitable factor for the plant database. The farm environmental data will be compared with the weather database. The comparison will be processed and the results can be the recommendation to control the farm conditions to achieve suitable condition for each type of plant (Fig. 3).

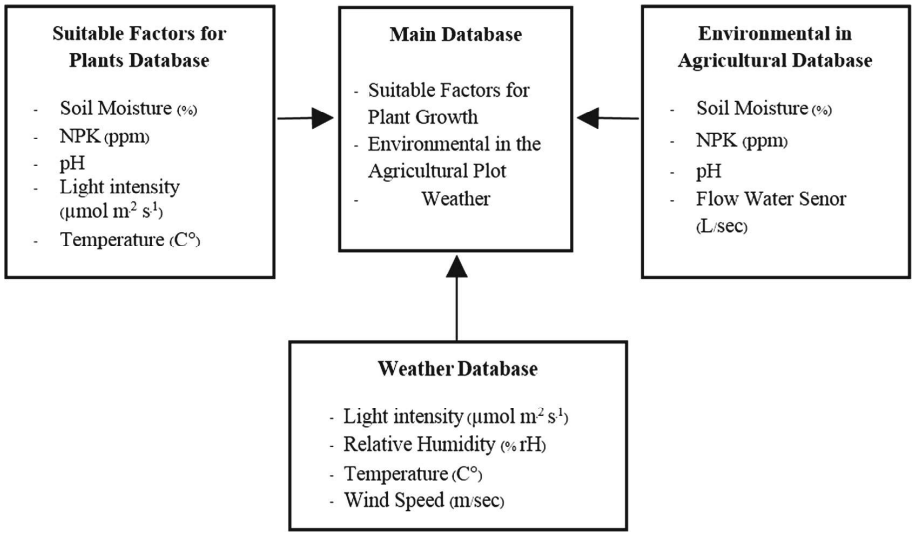

Fig. 3. Database format

4 Results

This is an on-going research. At present, the farm moisture sensors and water distribution system were installed. The power is from the 25 kW PV system near the smart farm. The farm was arranged into 3 terrace levels for low, medium and high moisture setting. The Moisture Control System Performance was tested by measuring the moisture of 10 points in the farm with 10 repetitions for each point. The average moisture measurement results from 3 plots according to the 60%, 75% and 90% moisture settings were found at 62.26%, 76.84% and 92.19%, respectively. The error of the soil moisture measurement system was at ±2.19%. These data will be transferred to the agricultural database via MQTT protocol and will be used for the smart farm processing to develop the suitable conditions for each type of plants.

5 Conclusion

The smart farm with environmental analysis focused on the development of measurement system and the suitability of the environment analysis in farm. Measurements of the farming condition will be collected to establish a database of environmental factors that affect the growth of plants. This data will be the basis for comparative analysis of environmental factors suitable for plant growth.

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