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The Implementation of Smart Environment Monitoring System for Strawberry Farm

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***Abstract*— This project is developing a smart system for strawberry farm by deploying IoT technology. The Arduino Mega and Node MCU are used as the main processor to control and capture environmental factors such as: temperature, humidity, soil moisture, light, and water HP value, then send those significant parameters to store in the NETPIE could service, over the Internet. The farmers will, then, able to access that real-time environment information via mobile/web application. Based on statically information displayed, farmer can manually or automatically control the watering pump, water cooling spray pump and/or airflow fan to create suitable environment for growing the strawberries in the greenhouse. In the experiment, the developed system and all its functionalities can work well as desired. User is able to maintain the strawberry farm by our smart-phone/web application over the Internet. The real-time environmental parameters are able to display, and also able to control environment of the farm off-line or on-line. The developed smart system is an agriculture solution and demonstrated as strawberry greenhouse at Department of Computer Engineering and Information Technology, Faculty of Engineering, National University of Laos, as a study field to improve accuracy and stability of the system.**

Keywords—Smart Farm, Smart Agriculture, Strawberry Farm, IoT

I. INTRODUCTION

The Lao PDR is primarily an agricultural economy country, almost 80 percent of the total population is engaged in farming. In recent years, a short cycle crop, such as watermelon, strawberry, and organic vegetables have become a popular agricultural commodity for farmers rather than rice for export and local market [1]. The cultivation of strawberry is gaining popularity across the country. However, the cultivation of strawberries in Laos is particularly favorable in the highlands, in winter season, because of strawberry cultivations are very sensitive to environmental conditions such as temperature, lighting, humidity, moisture, etc. these major parameters could seriously impact the quality and yield of the strawberry farm.

In order to maximize the potential of growing strawberries in varied areas, modernization of the agricultural system is required. Growing strawberries in an environmentally greenhouse could be an interesting solution. However, controlling temperature, lighting, humidity, moisture in the of greenhouse in the way of manually is a labor-intensive work process. Therefore, a smart system is needed to help labor monitor and control the parameters in real time to suitable environment to the farm.

As we know that, IoT (Internet of Things) [2] is one of the most important technology that is implemented in many smart applications and it becomes essential for building block of smart community which plays significant role for improving the performance of monitoring the activities for farming agriculture [3, 4]. This project is an implementation and research of using IoT for environment monitoring and controlling of the strawberry greenhouse as a demonstration model of a smart farm.

II. OBJECTIVES

- To create a controllable environment agriculture system for planting strawberry by using IoT technology
- To develop an alternative demonstration of smart strawberry farm.

III. SYSTEM ARCHITECTURE

In this project, the strawberries were grown are growing inside a greenhouse that able to monitor and control the environment factors at any time, from anywhere, through the Internet. The IoT devices are used to measure temperature, humidity, soil moisture, light content and water PH (Potential of Hydrogen) values in the greenhouse. The captured those environmental factors are able to display on mobile/web application through some an internet cloud service. Farmers, then, are able to monitor and control the real-time environment of the farm, remotely or can be locally either, to ensure an environment conducive to the growth of strawberries. “Fig. 1”, illustrates the system overview of the proposed smart strawberry farm.

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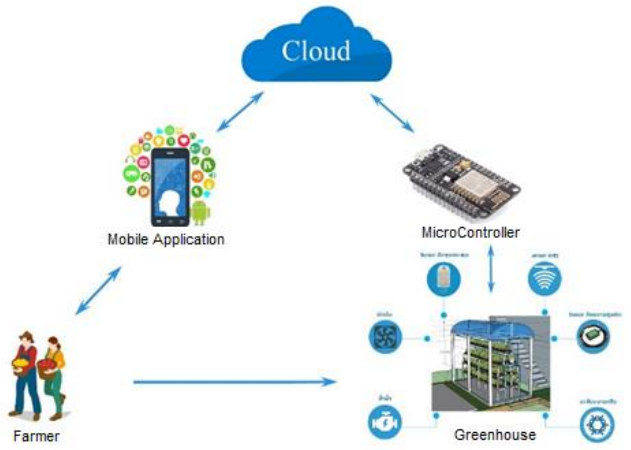

Fig. 1. The Proposed Smart Strawberry Farm

The developed system consists of two main sub-system, IoT and Automation Greenhouse systems as indicated in "Fig. 2" and "Fig. 3", respectively.

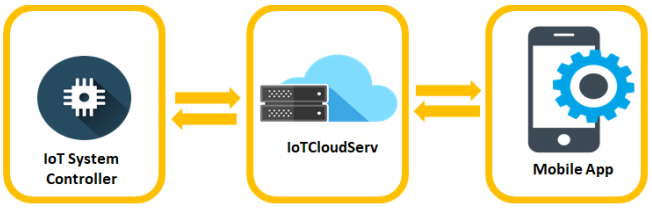

Fig. 2. The IoT System Components

The IoT system components are about implementing controller, IoT cloud service, and application. The controller is assembly from an Arduino Mega and a Node MCU. This process block is to capture the environment factors of the greenhouse then, send them to NETPIE IoT cloud service [5] over the Internet, which can be displayed on the mobile application of user. MQTT protocol [5] is used as communication protocol between our controller/application and NETPIE IoT cloud service.

The "Fig. 3" shown the diagram of hardware components of the greenhouse, called Automation Greenhouse system. The Automation Greenhouse system consists of automatic water irrigation, air cooling, and smart monitoring. The automatic water irrigation system is controlled by switch ON/OFF solenoid valve based on the given threshold value. The threshold value will compare to an average value of soil moisture data that can be get from multiple of soil moisture sensors. Since, the mist cooling system and fans are used to control air temperature and humidity inside the greenhouse. Cold water will spray out around as misting, inside the greenhouse, to decrease air temperature. However, the mist can increase humidity to inside the greenhouse. To decrease the humidity, fan is used to create air-flow in and out of the greenhouse. While, the real-time temperature, humidity, soil moisture and other sufficient environment data are uploaded on to an IoT cloud service by our smart monitoring system.

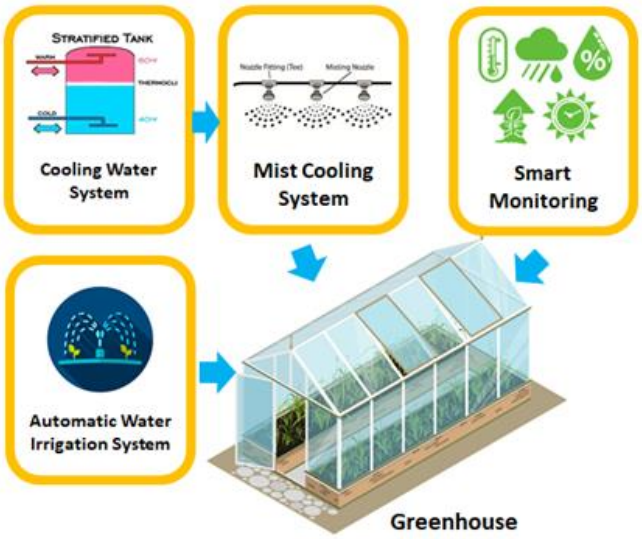

Fig. 3. The Automation Greenhouse System

"Fig. 4", shown a diagram of the system connecting detail. Arduino Maga 2560 [7] is used as main processor in order to collect and process data from soil moisture sensor, DHT22 (air temperature and humidity) sensor, light sensor, water PH sensor, water flow meter. It also uses to control solenoid valve (water pump), fans and mist sprayer. While, ESP8266 NodeMCU [8] is used as a WiFi module to share (subscribe/public) information between Arduino Maga 2560, application and NETPIE Cloud service throughout the Internet Connection.

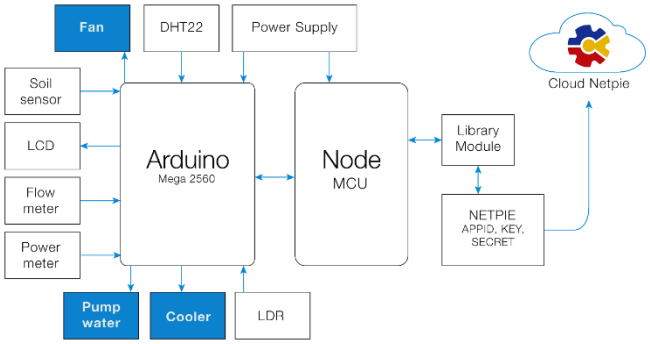

Fig. 4. The System Connecting Detail Diagram

IV. Implementation

This project is implemented by planting strawberry trees in a greenhouse, sized 2x4x3m, shown in "Fig. 5". The developed system can work well during operation period in 3 months. We are able to monitor the air temperature, humidity, soil moisture, light content and water PH values, remotely through our self-developed smart phone and web application. The system was automatically turn ON/OFF solenoid valve for water irrigation, fans and mist sprayer based on detected related data from the greenhouse, for better environment to grow the strawberries. The system also allowed user to manually turn ON/OFF through smartphone/web application or direct to mini-keyboard on the control box.

Fig. 5. A Strawberry Greenhouse for Demostration

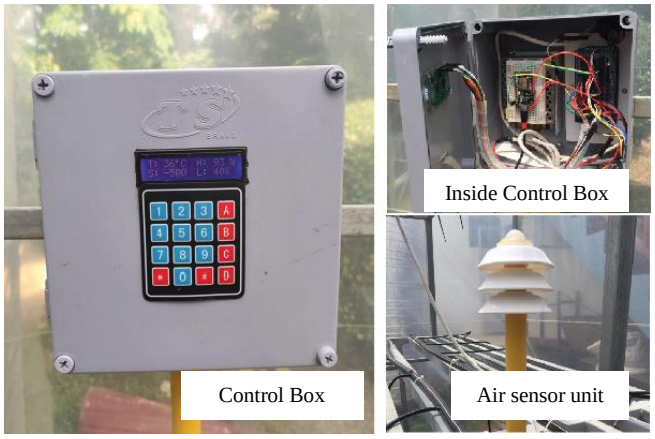

Fig. 6. The Installation of Developed Hardwares

The “Fig. 6” shown the installation of our developed control box and sensors unit. The control box consists of AC/DC inverter power supply, ESP8266 NodeMCU module, Arduino Maga 2560 board, 16x2 LCD mono display and 4x4 keypad. Air sensors unit was design to minims some effect from direct sunlight and provides sufficient ventilation to the sensors [9]. A photoresistor (light senor) and DHT22 (temperature and humidity sensors) were properly putting inside a pipe cover by upside-down layered melamine plastic dishes.

Fig. 7. Sample of the Smart Phone Application

The “Fig. 7” shown the user interface of our developed smart-phone and web applications. Node.js is used as a main framework to build up web application. Since, smart-phone application is coded by Java Android. The applications are inter-connect with NETPIE Cloud service by microgear library (NETPIE client).

V. CONCLUSIONS & FUTURE WORK

This project is a demonstration of smart agriculture solution for a strawberry farm by using IoT technology. A greenhouse, IoT controller and application are newly built up to demonstrate a smart farm system. Our smart system is implemented and tested with the real environment. The experiment result shown that use is able to monitor and control environment of the greenhouse efficiently as our expectation. The environmental parameters such as: air temperature, humidity, light and soil moisture can be displayed on the smart-phone/web application. water irrigation, fans and mist sprayer of the farm will automatically perform based on detected data, or can be manually switch OFF/ON through the smart-phone/web application. Since this system is newly implement, more stable sensing, more significant environmental parameters, better cooling system, and efficient power supply source need to be study and improve.

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