Development of Next-Generation Horticulture Plant based on Wireless-Sensor-Network

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Abstract: This study, and at the same time it promotes the growth of strawberry in CO2 topical application technology, and collects in the sensing technology the optimal environment measurements. Then, operate the data stored in the server, to improve productivity

Keywords—**Strawberry-Cultivation, Photosynthesis, Wireless-Sensor-Network, Internet-of-Things, Optimal-growth-promotion, crop-environment, Environmental-Measurement,)**

1. Introduction

In this paper, we developed wireless sensor network and CO2 controller for strawberry farming. Our application to promote growing and increase quality of strawberry in Okinawa prefecture. There is few subtropical regions in Japan. Farmers are often faced with some problems such as environmental measurements, At that time, they solve that problem themself using their experience and expertise. Therefore, we think environmental sensing data represent that and it is an especially important in subtropical regions. We develop an efficient strawberry growing environment monitoring system with automatic measurement technology (wireless engine sensor network).

2. CO2 application technology

Horticulture cultivation is capable of harvesting that does not depend on the season when performing the environmental control, furthermore, quality is substantially stable. In general, strawberry seedlings with is carried out in September, the harvest period is until late November to late March, it has also been verified in the long-term of if the harvest time by performing CO2 application cultivation. Spraying of CO2 is taking into account the regional characteristics, carried out in a CO2 topical application technology. This method can be applied for pinpoint is without raising the temperature and humidity in the house, there is a merit that can provide efficient CO2 in small amounts. If the effectiveness of this study have been shown, it can be also enables to apply other green house plants, and leading to the prefecture crop production stability. The landscape of research and development for the purpose of strawberry growth promotion is shown in Fig. 1

Figure 1. Appearance of Strawberry house

2.1 CO2 application system for growth promotion

Fig.2 is indicated our CO2 control system. Our system consists of CO2 controller, CO2 indicating tube, environmental measurement sensor module group (temperature, humidity, soil temperature, illumination, CO2 concentration), and the repeater (raspberry pi). All the data are collected to server by wireless communication. This system is enable to reduce the running costs than conventional house filling method.

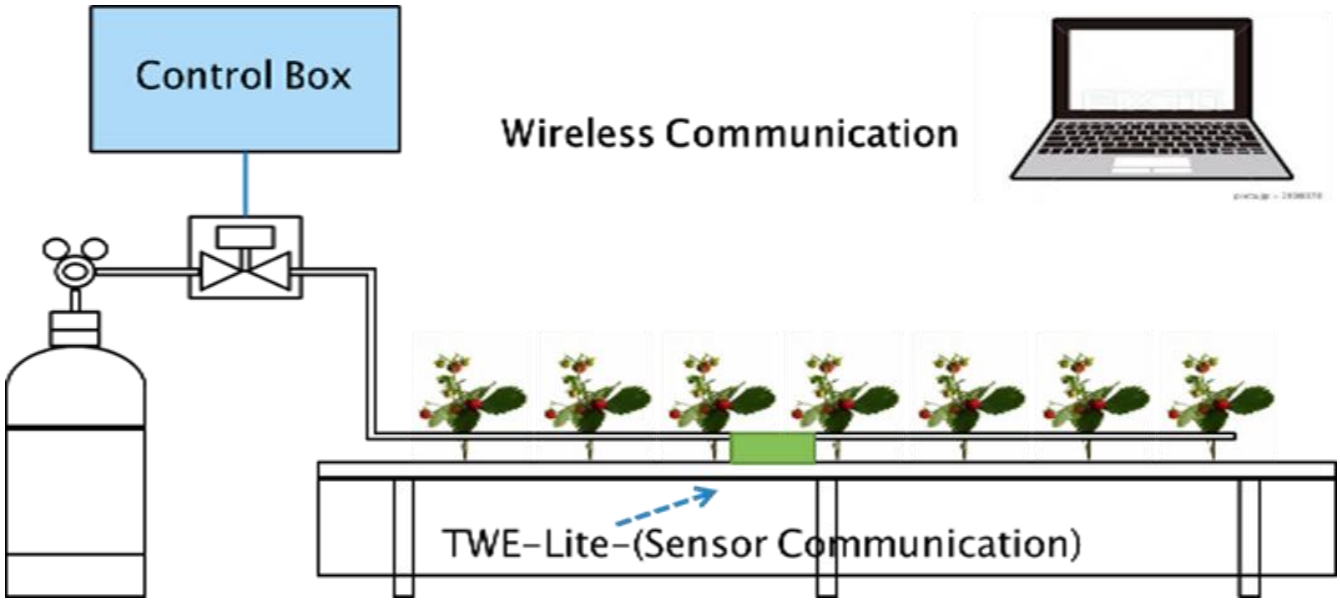


Figure 2. Schematic Diagram of CO2 Application System

3. Sensor-network over the Zigbee

We considered the device requirements and specifications as follows.

Low consumption: Sensor device measures some environmental parameters for a long time. It must keep the own energy for running oneself.

Multiple communication on same network: It will be occurred that data can't be sent or received some reason (too weak field intensity, too long conveying distance...). In this case, other device that is be closer than this device to server should relay that data.

Especial license free: Our motivation is that famers use our application. Therefore, our application must be used without some especial license.

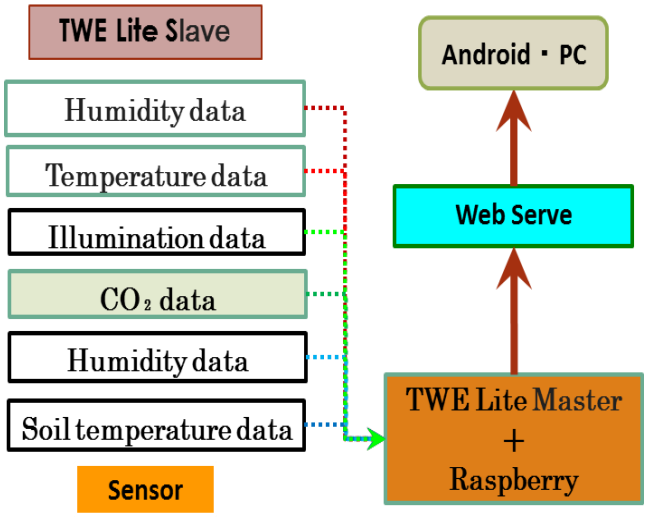


Figure 3. Schematic Diagram of Sensor Network

For the above specification, we choose the "TWE-Lite". This is a 2.4GHz band wireless module for multi-channel simultaneous connection standard and that drive the low voltage (from 2.3 [V] to at 3.6 [V]). The wireless standard, the simultaneous connection terminal between the network can be available, namely Broad Cast. This TWE-Lite slave unit, measured data by each sensor modules are collected and transferred to the TWI-Lite master unit. Thereafter, the data is stored in the local server (Raspberry Pi), and stored data is sent to our computer system in the University of the Ryukyus through the WAN. Researchers and farmers can check the data in the terminal, such as a PC or tablet. The schematic diagram of network is shown in Fig. 3. The Raspberry Pi that was installed in the house shown in Figure Fig. 4.

Figure 4. Raspberry Pi was installed in a house

3-1. Sensor Network by using TWE-Lite

Our sensor device conducted in the following manner. At first, each sensors are mounted on a breadboard based on the circuit diagram of Fig. 5, and housed in the exterior of the plastic. Each of the sensors are analog and Inter-Integrated Circuit (I2C) communications, These protocols are perseverated according with the characteristics. Furthermore, in order to reduce power consumption, the timing of data collection from the sensor modules are carried out by using a switching DC-DC converter and the signal of TWE-Lite. In this experiment, to get the data from the sensors, the sampling time is a one-minute intervals. After that the sensor device sent to the server continuously, the server (Raspberry Pi) collects all the data from sensor devices, and push the data to the server in Our University through WAN.

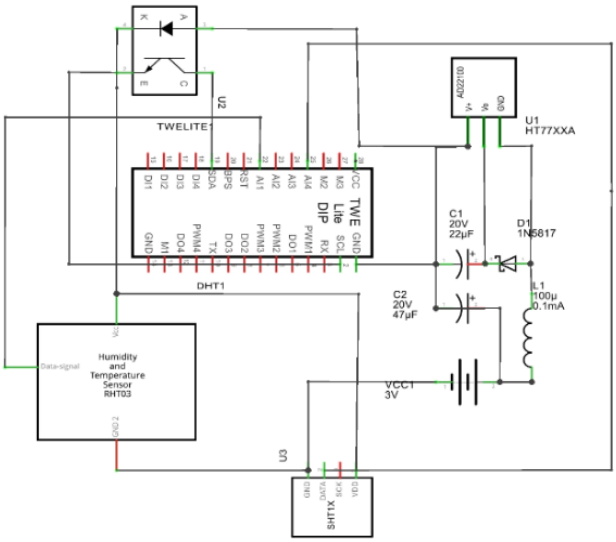


Fig. 5. Sensor network circuit system

3-2. Developed type of sensor.

In this paper, we implemented a weather station and soil measurement sensor. A state where the weather station is to measure the temperature and humidity is shown in Fig.6.

The case in order to keep the breathability has been designed in a semi-open type, the measured value in condensation and dew is prevented from changing.

Carry out the measurement by the sensor group that is attached to the tip of the instrument of soil measurement sensor as shown in Fig. 7.

The soil moisture is measured by the dielectric constant between the copper terminals, as well as to measure the soil temperature in the resistivity of the thermistor. Also, has been created inside the circuit is sealed so as not to fail in moisture.Environmental measurement device for the data to be collected by the application and the situation is different, it must be a sensor design according to the specifications. In the future, in addition to improve so as to follow the needs of the site, it continues to create a high equipment a more complete.

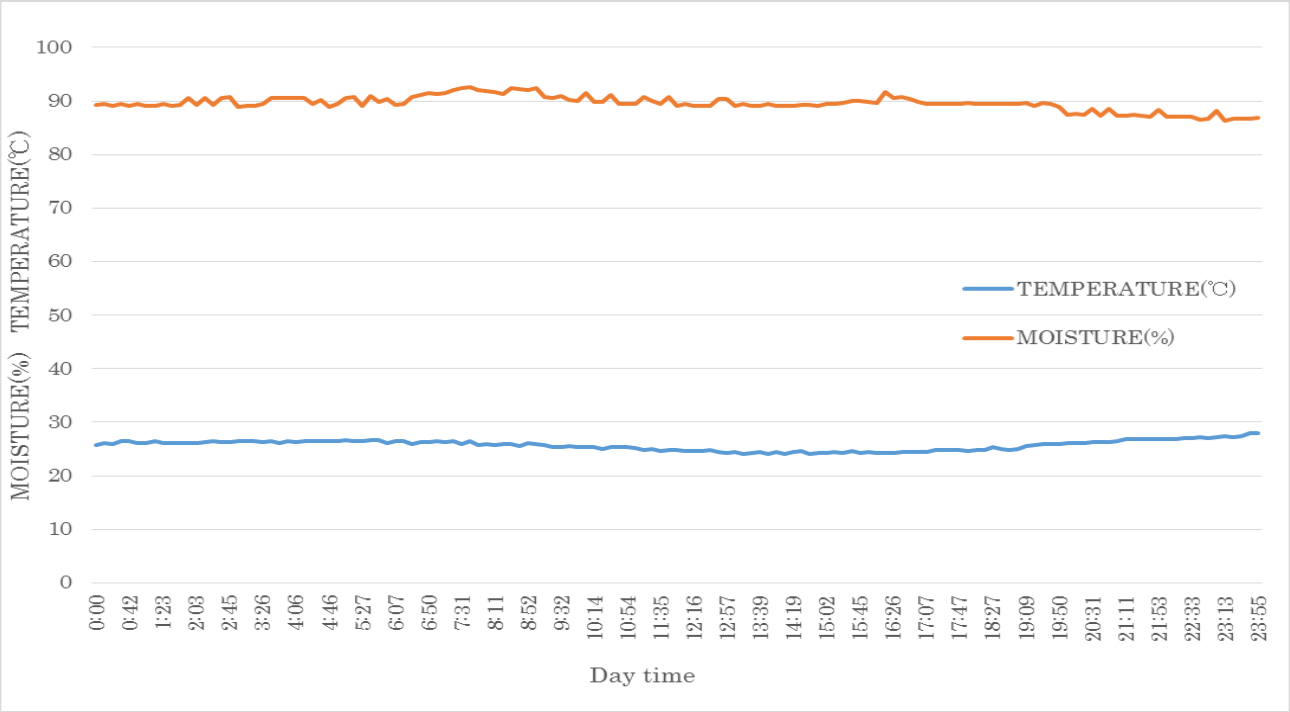
Figure 6. Weather station

Figure 7. Soil measurement sensor

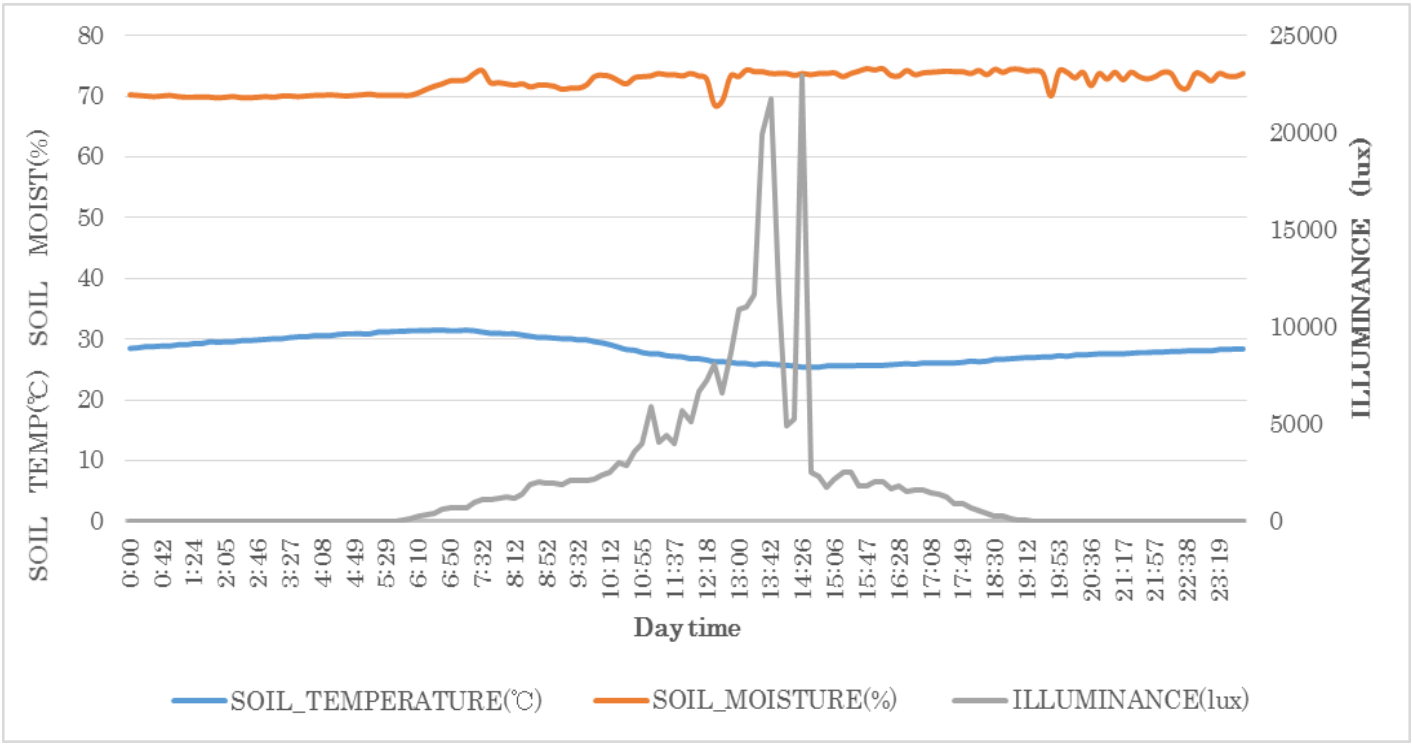
4. Data acquisition experiments with TWE-Lite

Measuring the one day's worth of environmental data in this experiment May 4 days (sunny) temperature 25.5 ℃ (14:00), were analyzed. Temperature, humidity, soil moisture, soil temperature, the sensor group of illumination is operated at one-minute intervals, an aggregation of data to the Raspberry Pi. Respectively, Graphs.1 is weather station, Graph.2 is the value measured by the soil measurement sensor. Each of, temperature and soil temperature [℃], the humidity of the humidity and soil [%], illuminance is expressed in [LUX]. During the day looking at the Graphs.1 of data has a high temperature, it can be seen that the humidity is down.

In addition, farms for irrigation farming, Graphs.2 are not major changes seen in the data of soil temperature and soil moisture. Since steel prop house illuminance in the time period there is a portion to be shaded, it can be confirmed that some values are falling.



Graph 1. Weather station data May 4



Graph 2. Soil measurement sensor May 4

1. Conclusion

We sure that our application not only for strawberry but can also be used for leafy vegetable, mango that is principal products in Okinawa prefecture. We will improve the sensor device. Such as, implementing the energy harvest, long term operation, increase sensing targets etc. In the future, we analyze the parameters and apply for CO2 control.

References

The Internet of Things. IBM Japan.2016/04/08.<http://www-01.ibm.com/software/jp/info/internet-of-things/>
Parrot FLOWER POWER. Parrot .2016/04/08 < http://www.parrot.com/jp/products/flower-power/ >