Investigation of communication networking protocol for UECS using IM920 and its validity

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Abstract

In recent years, Low Power Wide Area Network (LPWAN) has attracted attention as an application in open field and greenhouse cultivation because it has the several benefits and possibilities in order not only to construct the network for distributed fields or greenhouses but also to reduce the management cost of them. In this study, we focus on the application of LPWAN to development of practical devices based on Ubiquitous Environment Control System (UECS) proposed by Hoshi et al. (2004). As the first application, we are developing a transmission module to relay setting parameters for a node in certain UECS network to a node in the other network. The transmission module was developed by using Arduino Mega 2560, Arduino Ethernet Shield 2 and IM920 Sub-GHz wireless network module. The program was developed based on the UECS library for Arduino called "UARDECS" proposed by Low-cost UECS group (2013). The performance of developed node for transmission distance and loss (quality) was verified by the feasibility tests.

Keywords

Ubiquitous Environment Control System (UECS), Low Power Wide Area Network (LPWAN), Sub-GHz wireless network, Field environmental monitoring and control

Introduction

In Japan, typical greenhouses are small and the owner owns several greenhouses, which are distributed at a prescribed distance, in general. Thus, each greenhouse is managed individually and then the management becomes complicated and costly. To avoid this problem, a network infrastructure for such distributed greenhouses is required. For instance, a wireless network connecting between several greenhouses has benefits and advantages for simple installation and rearrangement of nodes, and a reduction of instillation time and cost.

On the other hand, Hoshi et al. (2004) developed Ubiquitous Environment Control System (UECS) in order to establish environmental monitoring and control system for small and medium scale growers. The UECS has fully supported Internet Protocol (IP) through the Ethernet and Wi-Fi network without any modification. However, the actual application of WiFi network in agriculture has the following problems as (1) the transmission quality suddenly drops due to radio band conflicts, and (2) the accuracy defined by throughput and packet loss depends on the environmental condition in the greenhouse. Thus, a usage of Wi-Fi network in agriculture is limited. In order to overcome this problem, we are investigating utilization of Low Power Wide Area Network (LPWAN) as the network infrastructure connecting each distributed greenhouse as shown in Fig. 1.

In this study, the transmission module was developed by using Arduino and IM920 Sub-GHz wireless network module. The module has a function to relay setting parameters for a node in certain UECS network to a node in the other UECS network using LPWAN. Performance for the transmission distance and transmission loss was verified by the feasibility tests.

Materials and Method

Development of transmission node based on LPWAN

Figure 2 shows a prototyping setup of the transmission node, which is consisted of Arduino Mega 2560 as the main computer board for UECS node, Arduino Ethernet Shield 2 to communicate UECS-CCM between each UECS node in a certain greenhouse, and IM920c Sub-GHz wireless network module to connect each distributed greenhouse network. The

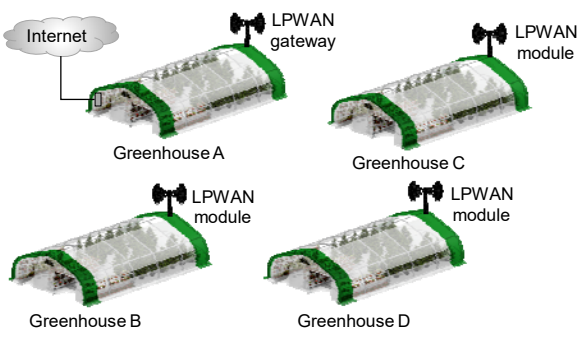

Figure 1. Utilization of LPWAN as the network infrastructure connecting each distributed greenhouse.

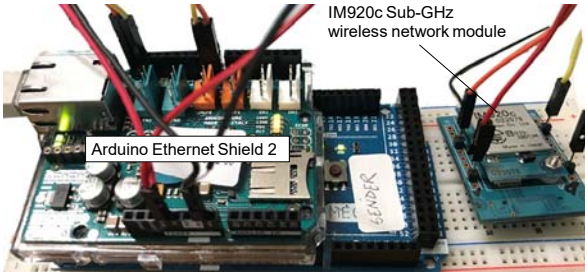

Figure 2. A prototyping setup of the transmission node using IM920c Sub-GHz wireless network module.

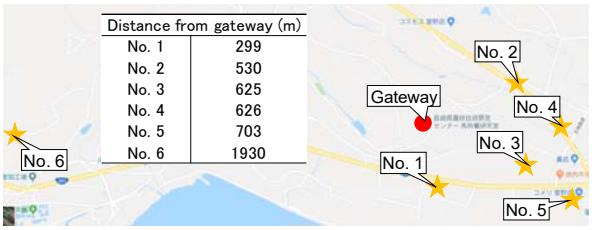

Figure 3. Transmission test condition using IM920c module.

program was developed by the UECS library for Arduino called "UARDECS" proposed by Low-cost UECS group (2013). The transmission function is to encode from the UECS-CCM to short CCM while the receiving function is to decode from the short CCM to the UECS-CCM. These functions are important for LPWAN because the transmission speed is very low comparing with WiFi network and the amount of transmitted data per an hour has the restrictions.

Evaluation test of developed node

Figure 3 shows the transmission test condition using the IM920c module. The test was carried out in real farming area with a small valley and mountain. In this test, we confirmed whether the signal transmitted from the gateway node was received by the receiver node or not. Further, the RSSI (Received Signal Strength Indication) value in each observation point was also evaluated when the signal was received.

Next, we investigated transmission test of UECS-CCM using the developed node. Encoding and decoding speed and accuracy of UECS-CCM were evaluated by a simple test condition using two UECS nodes with the IM920 module. In this test, variation of the RSSI value and number of packet loss were also evaluated to confirm the transmission quality using the IM920 module.

Result and Discussion

Table 1 shows the transmission test result using the IM920 module for the several observation points. As you can see from the table, the RSSI value for each observation point does not depend on distance from the gateway. It means that the transmission quality is remarkably influenced not only by the surrounding environmental condition such as structures and topography but also by node location and arrangement.

Table 1. Transmission test result using IM920 module for the several observation points.

	Input power (dBm)	RSSI value	Distance (m)
No. 1	-115	120	531
No. 2	-117	118	627
No. 3	-111	124	626
No. 4	-116	119	704
No. 5	-96	139	300
No. 6	-113	122	1930

Further, the developed module could relay the UECS-CCM to the other node in the different UECS network. We are now extending the program so as to relay arbitrary UECS-CCMs defined as reference table.

Concluding Remarks

In this study, the transmission module was developed using the IM920 module and has the function to relay the setting parameters for an arbitrary node in certain UECS network to an arbitrary node in the other UECS network. Performance for the transmission distance and transmission loss was verified by the feasibility tests.

Acknowledgement

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Reference

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