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Research Paper

Development of mobile control system for lighting tower in golf courses

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Abstract

Background/Objectives: It is a common for existing golf courses to manage all lighting facilities in batches because it is hard to control-lighting individually. That is very much part of the golf courses and forces the whole golf course to light on even though play was finished due to the difficulty of real time checking situation
Methods/Statistical analysis: Lighting control device and method in this study are provided not only to control remotely individual lighting installed each hole in golf course but to inspect failure of lighting. There is no longer to stay golf course in person to control lighting system.
Findings: Lighting control device and method to be able to control individual lighting installed each hole in golf course is provided to response for the problem in a waste of electricity after playing. User device makes it possible to remotely control lighting and inspect failure of it
Improvements/Applications: It can expect to reduce golf course operation management cost by building a smart tower remote control system

Keywords: *Country Club; Lighting Tower; Monitoring; Embedded; Middle Ware*

1. Introduction

There are many lamp equipment used in golf courses for the night time play to provide same daytime surroundings. It is a common for game control room to control lighting towers in batches at night game because it is hard to check the situation in real time after the game. That is very much part of the golf courses and causes a waste of electricity due to the operation of whole lighting tower even though the game was finished. The amount of electric light rates used a day based on an eighteen hole golf course is about 840,000 Korean Won and paid more than 300 million Won in a year[1,2]. Building smart remote control system can dramatically reduce the management expense of golf club so as to be easily controlled the lighting tower by caddies through the development of application that is possible to control the lighting tower by smartphone as well as the development of embedded device for communication. An existing lighting towers in golf clubs are installed the types of multiple-stage and fixed stage and are used several kinds of remote control system [3],[4]. Data T/RX between central control room and lighting tower is used wire or wireless communication and it may cost a lot due to purchase radios during initial setup. In terms of management, access to operating equipment and efficiency are not good enough due to not only the form of centrally managing programs in batches for On/Off lighting tower remotely but scheduling management in advance. This is a current picture of it [5], [6]. A survey found that lighting tower based on the form of centrally managed program is still in a usage because there are currently no development cases. Differentiating technology factors are applied in this study to achieve high efficiency with low power applied LoRa technology based on IoT for communication to the lighting tower and can make management efficiency maximize through the way of controlling lighting tower easily by caddies with mobile device instead of centrally managing method 7, 8.

2. Mobile control system development of lighting tower in golf course

2.1. Smartphone application development of controlling lighting tower

Its system for lighting tower is composed of information screen, status screen, control screen, statistics screen. Middleware program of lighting tower control device is shown in Figure 1.

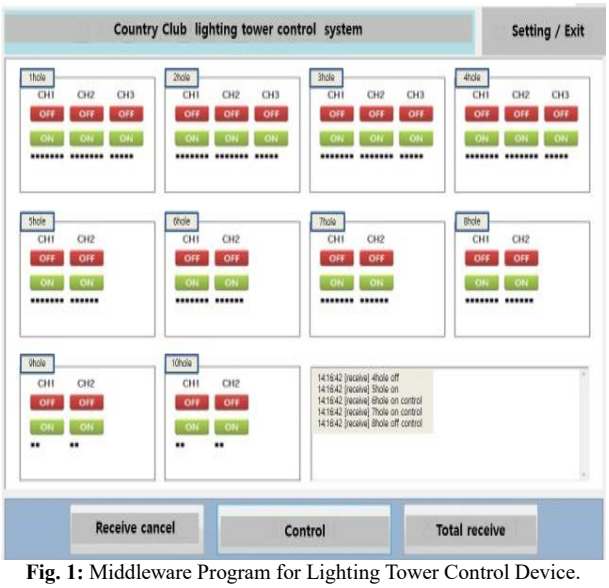

Fig. 1: Middleware Program for Lighting Tower Control Device.

2.2. Development of central control device for lighting tower

Middleware for implementation of control system based on NET Framework 3.5 in Visual Studio 2008 is designed. A core function is to receive data in TCP for storage in database that is coming from each controller of lighting tower. Threads is implemented as Listen, Connect, and Receive operation so as to operate function as TCP server. Connection library of database is used the version 5.1.7 ADO.Net driver for MySQL. APM for control system based on web is composed of Apache + PHP + MYSQL and is easily built web development environment in Window environment. Block diagram of control board for lighting tower is shown in Figure 29, 10.

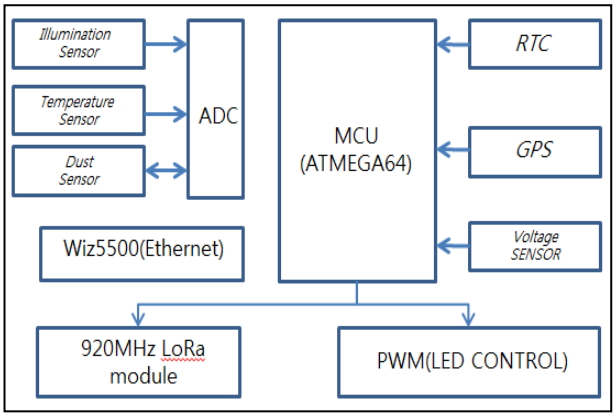

Fig. 2: Block Diagram of Control Board for Lighting Tower.

MCU module as a main device has a LCD and Key pad to control each module. It can be not only downloaded firmware through ISP but remotely transmitted in real time through PLC and Sub-Ghz LoRa RF communication to control each situation after collecting operation data of on and off condition in lighting tower from MCU control module.

Power module provides internal power supply to control and applies power design algorithm which possesses participating company to minimize power consumption as well as to secure stability. SPD module performs a role to protect a stroke of lightning, including prevention of equipment damage such as electrical and communication device caused by serge. RF power module based on LoRa application is used as RF auxiliary module and relay output module is to control magnetic switch inside main controller. Output current check module is to inspect current such as lighting tower output, output current at each channel respectively, and short circuit. Analog physical quantity in sample holding through ADC is converted digital signal to able to deal with processor as shown in figure 3.

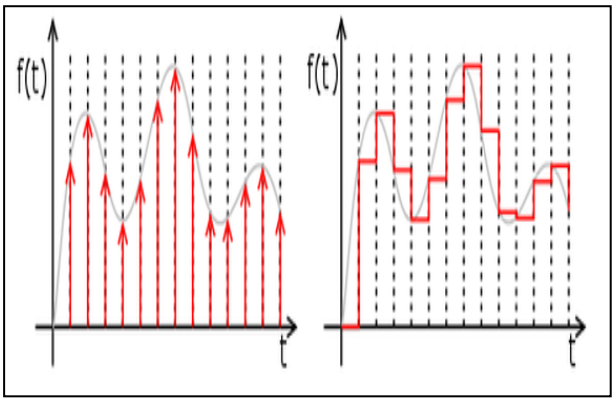

Fig. 3: Method of Sample Hold in Analog Data.

LoRa module forms a central control system with mesh network and performs a role to deliver control commands or to collect lighting tower information. Communication between internal parts of integrated controller in lighting tower is adopted 12C Bus communication method for the purpose of simplification of wiring as well as controllingmulti device using only two pins of input and output and software. 12C-BUS data is composed of eight bit data with repeated structure combined Acknowledge to confirm data and START and STOP exists for informing them.

2.3. Middle program for controlling lighting tower in golf course

Middleware based on NET Framework 3.5 is designed in Visual Studio 2008. Receiving data from each hole periodically in turn on and turn off light after parsing is stored on database to figure out remote control state in real time using data log screen. If the program is started, the current value of latitude and longitude is checked through GPS initialization and is calculated the time of sunrise and sunset. Network hop is formed with LoRa module through initialization of LoRa module and then is connected Ethernet mode after initializing PWM to control LED lighting tower while attempts to connect TCP from lighting tower controller. Sensing data correspond to controller and on-off condition is receiving when connecting is complete. Flow chart of middleware program in lighting control toweris shown in figure 4.

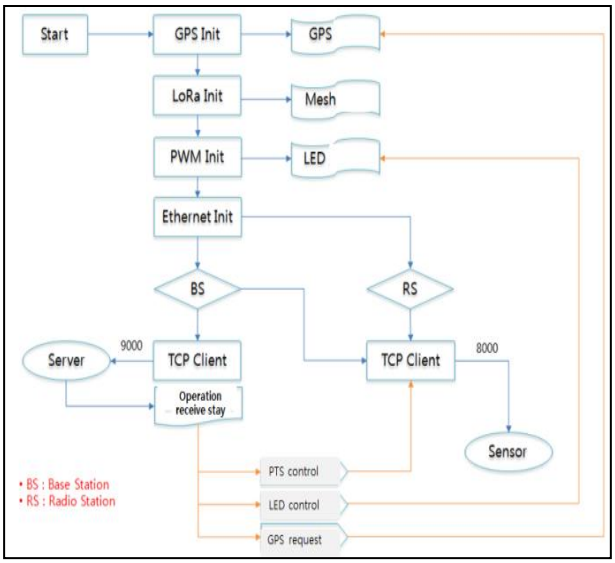

Fig. 4:.Flow Chart of Middleware Program in Lighting Tower Control.

Hardware resulting product is shown in figure 5 and picture of interlocking device is shown in figure 6.

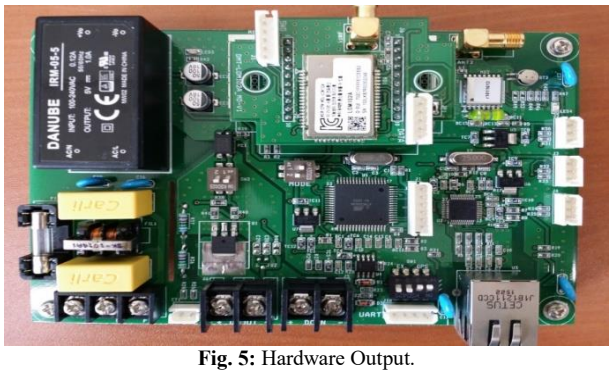

Fig. 5: Hardware Output.

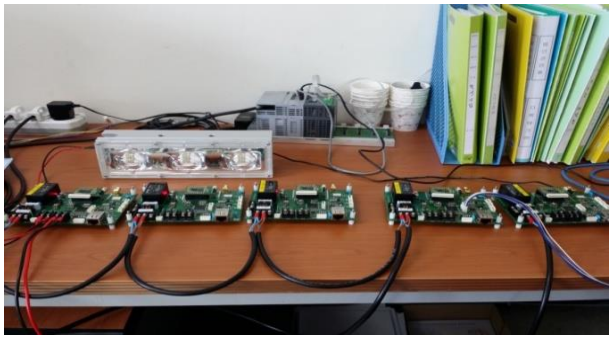

Fig. 6: Device Linkage.

2.4 Development of transmit receive module based lora

Radio communication module circuit of LoRa between control server and lighting tower controlled is designed and communication protocol composed of mesh network topology is also designed. The subject of data transmit receive between LoRa node is composed of Base Node, Mesh Node, and End Node. Base node is relevant to node of connecting middleware in server and Mesh node is to deliver data request packet in order to request GPS data which is located a hall further away from electrical room. LoRa node is composed of Mesh network.

Composition of LoRa interface has RF communication module which is consisted of SX1276 LoRa transceiver and STM32F031 MPU. SMD type of 210LS031 module is installed and makes use of UART2 port connector which is separated twenty pin connector and UART1 port is assigned modification of parameter and target board. Host interface which is compatible with RS232C of 3.3V TTL level is doing UART. Composition of LoRa network is shown in figure 7.

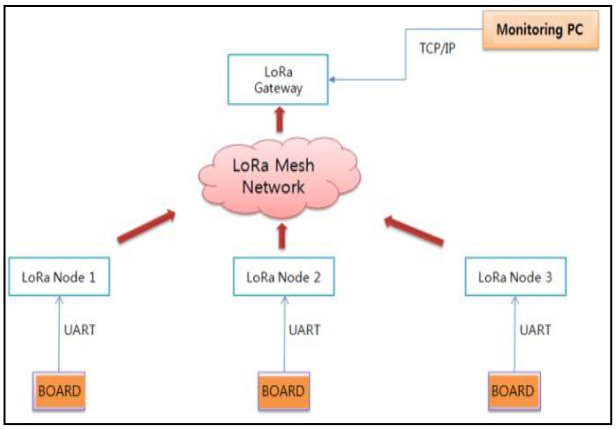

Fig. 7:.Lora Network Configuration.

Mesh network is configured to test five set which go through test production. There was no significant for test results of wireless on-off control through smartphone application. Test device configuration is shown in figure 8(a) and (b).

Fig. 8: Test Equipment Configuration (A).

Fig. 8: Test Equipment Configuration (B).

According to test result, data receiving is possible at request packet transmission after composing mesh network between Base node and End node. Test has performed data receiving more than 100 times without any failure. Data is confirmed to receive normally in case of changing factors such as band width, spreading factor, RF power, and RF frequency. The picture of test result is shown in figure 9.

3. Conclusion

It is natural to need lots of lighting in golf course which has extensive eighteen holes. Existing golf courses to manage all lighting facilities are very much part of the golf courses and forces the whole golf course to light on even though play was finished due to the difficulty of real time checking situation. The operation of whole lighting tower in golf course causes the problem in a waste of electricity. Even though technology is developed to individually control each lighting located in each hole, there is problem to waste of time and human resources due to directly conduct lighting on and off by people. Therefore lighting control device and method are being demanded to produce an appropriate background depending on players' situation and location.

Lighting control device and method in this study are provided not only to control remotely individual lighting installed each hole in golf course but to inspect failure of lighting. There is no longer to stay golf course in person to control lighting system.

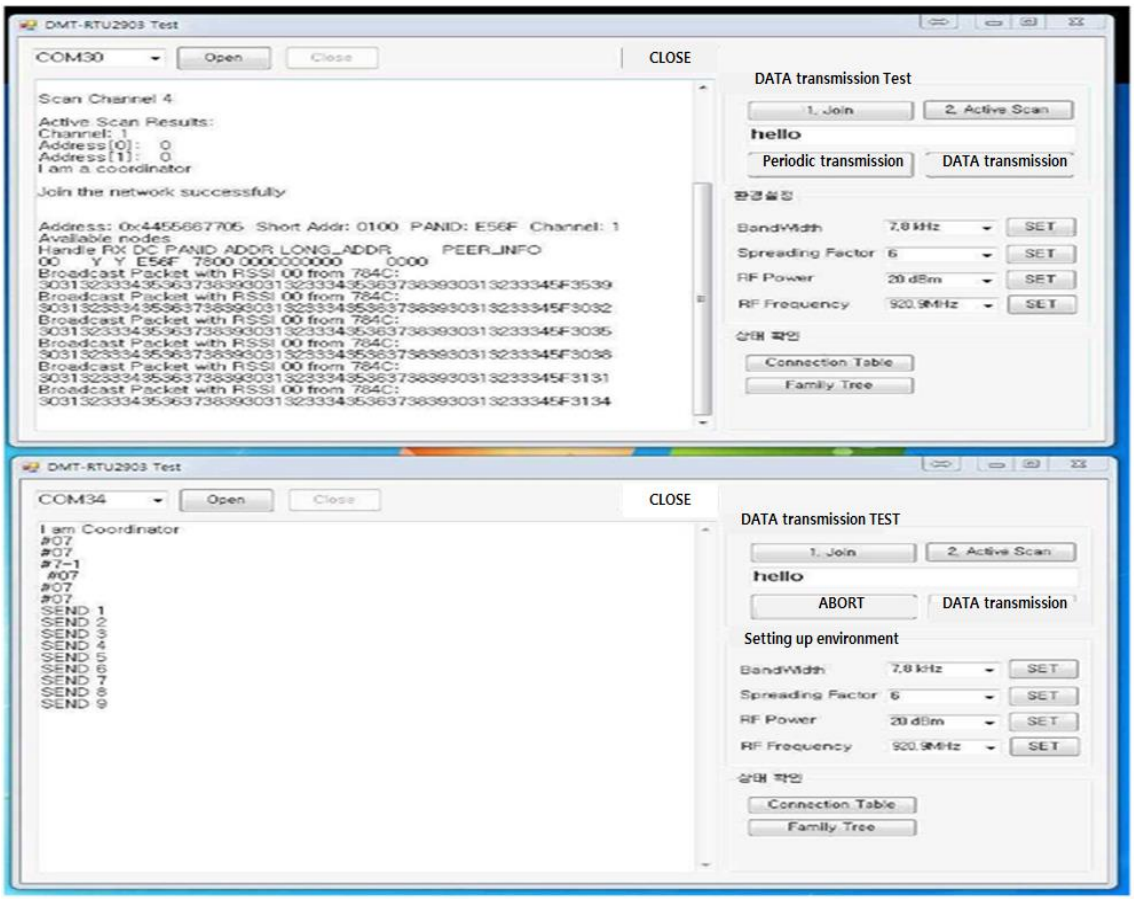

Fig. 9: Picture of Test Result.

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