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Design and Development of Sprinkler Control System Utilizing Mobile with IoT

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Abstract

We studied on the design of a sprinkler control system that communicates with the administrator's mobile through a wireless communication network and a sprinkler unit that sprays water on the vegetation area. This sprinkler control system consists of a communication module that receives an operation signal for the operation of the sprinkler unit from the administrator's mobile, and a control module that controls the sprinkler unit according to the operation signal received through the communication module. It is also designed to control sprinkler units by measuring temperature, humidity, light intensities, vibration and field images in the vegetation area in real time through sensors and camera for each of them and comparing them with established limit criteria.

The sprinkler allows the administrator to control the sprinkler more easily because the administrator operates the sprinkler through the mobile from a distance, and emergency situations occur and can respond quickly.

Keywords: *Sprinkler Control System, IoT, Communication Module, Control Module, Sensor Module*

1. Introduction

Sprinklers are used to irrigate crop cultivation area, lawns on golf courses, vegetation areas etc. Sprinkler is an irrigation facility that opens and closes water under proper pressure, and it can easily and simply solve the problem of uniform irrigation in wide areas that humans could not afford in a day, so it can expect to increase crop production by facilitating the growth of wide-scale crops smoothly. Additionally, a properly designed sprinkler system addresses uniform irrigation in a timely manner while minimizing loss and damage to natural ecosystems such as soil, water, air, plants, and animals [1]. Therefore, the development of sprinkler systems can be seen as a revolution in irrigation agricultural development [2]. Nevertheless, sprinkler system management relies mostly on manpower, which not only takes labor and time, but also creates errors such as over-irrigation [3, 4].

Recently, a smart sprinkler control systems have been developed to minimize these errors based on the Fourth Industrial Revolution technology, after it began to evolve into a digital system based on wired and wireless networks [5, 6]. Internet of Things (IoT) is a technology characterized by inexpensive devices, low-power wireless technology, and availability of cloud data for storage and processing, leading to natural selection for smart water management applications [4].

Sprinkler control systems based on IoT are very economical because the basic components are much cheaper and easier to use. Using smartphone applications can also add features such as monitoring and security [3].

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Recently, research on the development of IoT-based irrigation system has been increasing. Among them, there are many sensor-based cases in soil humidity and weather (temperature and humidity) [7].

This study proposes a sprinkler control system using temperature and humidity information in the vegetation area, as in recent research trends. And it is designed to enable automatic management based on real-time data on more various environmental information in the vegetation area. The proposed sprinkler control system may also manage energy waste reduction, economic effect, stable and healthy vegetation by automatically controlling irrigation water by receiving temperature and humidity data from the Meteorological Administration in real time.

2. Methods

Recently, as interest in returning farming has increased, there are many sprinklers to manage crops in plastic houses or to water crops, landscaping trees, and crops. As such, sprinklers play an important role in farm income.

Before the use of sprinkler, humans had to do the work of spraying pesticides or watering themselves, but now IoT has developed, and the sprinkler can be controlled just by using sensors to communicate with the machine. You can turn on/off the sprinkler at the right time by sending a signal from a PC or mobile at a remote location without directly turning on/off the switch of the sprinkler, so it is convenient to go directly to the plastic house when the time comes and water the crops from a remote location.

2.1 Hardware Design

The sprinkler proposed in this paper is intended to increase user convenience by enabling remote On/Off of the sprinkler system using IoT.

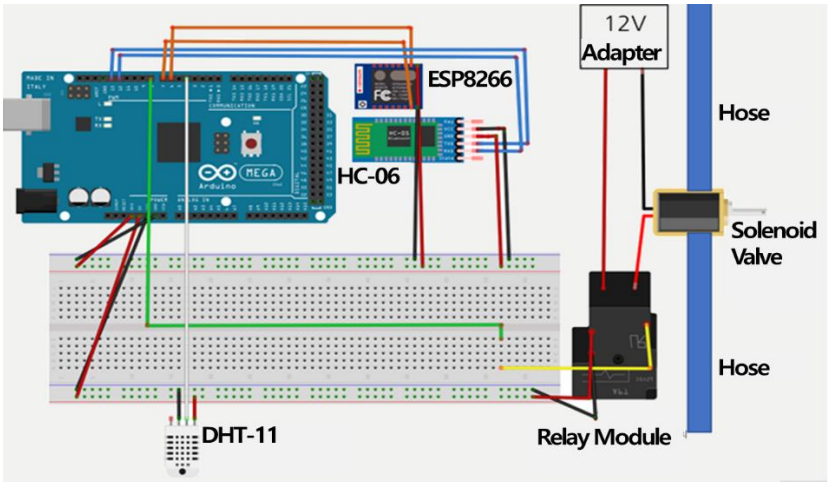


Figure 1. Design of system configuration and schematic

This sprinkler control system consists of a communication module that receives an operation signal for the operation of the sprinkler unit from the administrator's mobile, and a control module that controls the sprinkler unit according to the operation signal received through the communication module.

The system configuration of this paper is shown in Figure 1. Microcontroller (Arduino Mega 2560), Bluetooth module (HC-06), Wi-Fi module (ESP-8266), solenoid valve, relay module, temperature and humidity sensor (DHT-11), hose, etc. The hose is connected to the water tank and connected to the solenoid valve. The hose is connected to the water source and connected to the solenoid valve.

In this paper, as shown in Figure 2, the sprinkler system consists of a sprinkler unit, a communication module, a sensor module, and a control module.

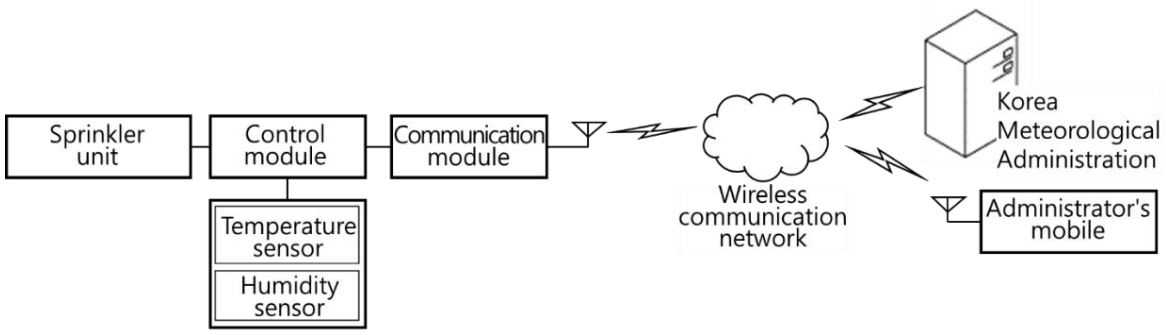


Figure 2. Block diagram of the basic sprinkler system

The composition of the sprinkler system developed in this paper is as follows. First, the sprinkler unit supplies the spray head installed on the upper part of the pipe to spray water supplied through the support and pipe installed on the vegetation support surface to the vegetation.

The communication module communicates with the administrator's terminal for automatic on/off of the sprinkler. It transmits the received control signal through data communication with the administrator's terminal through the wireless network.

The sensor module has a temperature sensor that measures the temperature of the vegetation area and a humidity sensor that measures the humidity installed in the pipeline at the top of the fixed body to transmit the measured temperature and humidity information to the control module.

The control module operates the sprinkler unit according to the control signal transmitted through communication. That is, when the administrator transmits a control signal for operation through the communication control through the terminal, the communication module receives the control signal and transmits it to the control to be controlled, and the control operates the supply pump that supplies water to the vegetation area. .

Meanwhile, when the manager transmits a stop signal to the communication module through the terminal, the communication module receives the corresponding control signal and transmits it to the control, and the control stops the supply of water to the vegetation area and stops the supply pump.

In the sprinkler system of this study, the communication module can communicate with the management server of the weather observation institution. Here, the meteorological observation agency is an agency that observes and forecasts the weather, and the meteorological agency is applied. The communication module communicates data with the main server of the weather observation organization and receives weather information about the weather in the vegetation area where the sprinkler unit is installed from the main server. Here, the meteorological information includes information on the temperature and humidity of the vegetation area.

2.2 Software Design

The control module may control the operation of the sprinkler unit based on measurement data transmitted from the sensor module while the sprinkler unit is operating. That is, if the temperature of the vegetation area is less than the preset dormancy temperature based on the measured data provided by the temperature sensor, the control module determines that the plants in the vegetation area are dormant. If the plant is determined to be dormant, the sprinkler unit is controlled so that water supply to the vegetation is blocked. As shown in Fig. 3, the dormant temperature is applied at 15℃. If the temperature in the vegetation area is lower than 15℃, because the turf is dormant, even if water is supplied to the vegetation area, the vegetation of plants will not be affected. Accordingly, the control module is set to automatically stop the operation of the supply pump of the water supply unit when the temperature of the vegetation area is below the dormant temperature. This paper

was developed by Arduino using an open source based single board microcontroller [8, 9].

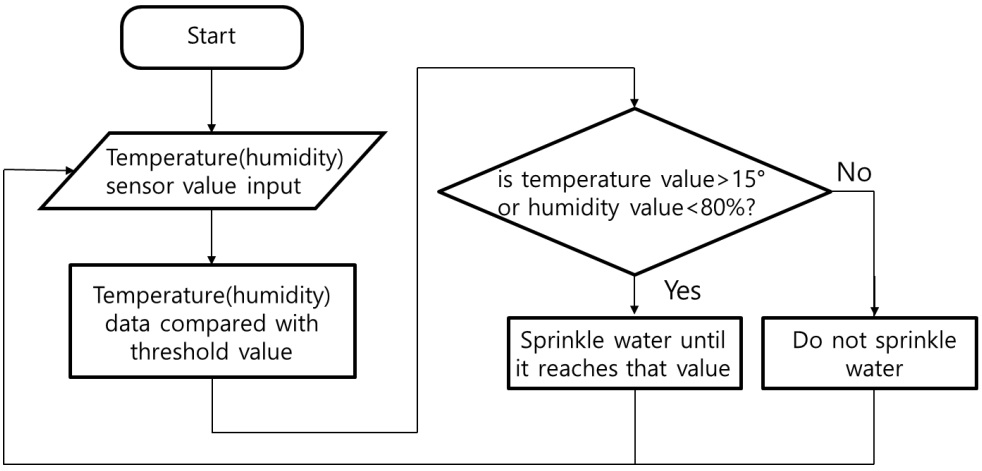


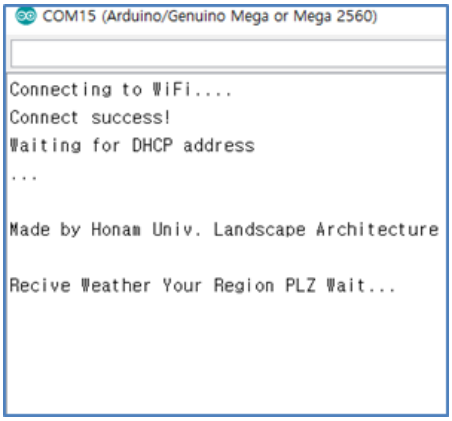
Figure 3. Operation flow chart of the developed system

```
int templl= line.indexOf("</hour>");
if(templl>0) {
  String tmp_str="<hour>";
  String wt_hour = line.substring(line.indexOf(tmp_str)+tmp_str.length(),templl);
  Serial.print("hour is ");
  Serial.println(wt_hour);
}

// temperature ①
int temp= line.indexOf("</temp>");
if(temp>0) {
  String tmp_str="<temp>";
  String wt_temp = line.substring(line.indexOf(tmp_str)+tmp_str.length(),temp);
  Serial.print("temperature is ");
  Serial.println(wt_temp);
}

// weather information ②
int wfEn= line.indexOf("</wfEn>");
if(wfEn>0) {
  String tmp_str="<wfEn>";
  String wt_twfEn = line.substring(line.indexOf(tmp_str)+tmp_str.length(),wfEn);
  Serial.print("weather is ");
  Serial.println(wt_twfEn);
}

//humidity ③
int reh= line.indexOf("</reh>");
if(reh>0) {
  String tmp_str="<reh>";
  String wt_reh = line.substring(line.indexOf(tmp_str)+tmp_str.length(),reh);
  Serial.print("Humidity is ");
```



Connected to module

Figure 4. System control source

Figure 4 is a system control source, where ① is a section for controlling temperature, ② is a section for checking water information, and ③ is a section for controlling humidity. In this way, the control module has the advantage of being able to conveniently manage the vegetation area because the control module can control the sprinkler unit according to the environment of the vegetation area based on the measured data of the sensor

module.

3. Testing of the proposed system

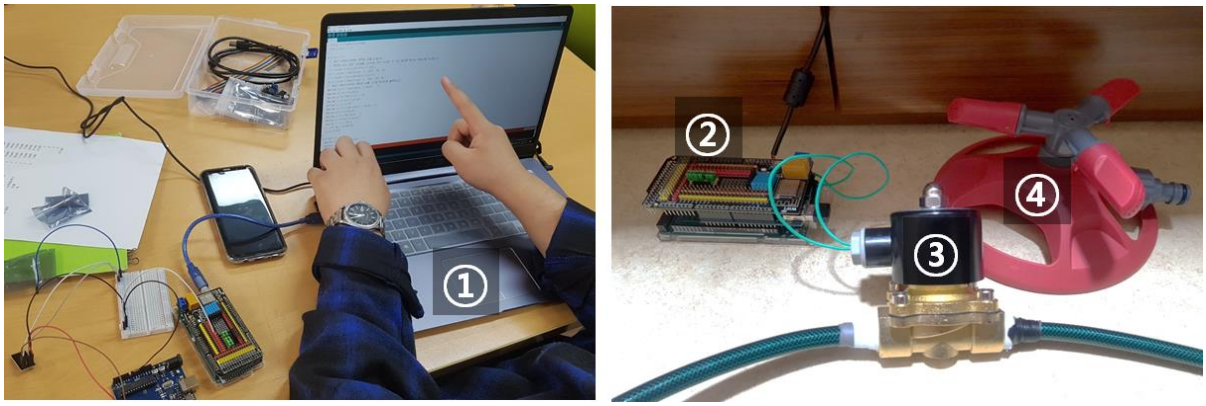


Figure 5. System control developed using Arduino

Figure 5 shows the control of the IoT-based sprinkler system proposed in this paper, 1 shows the control of the system using Arduino, and 2 is connected to the system with a control module. 3 supplies water to the pipe with a water pump. In 4, water is sprayed to the sprinkler head.

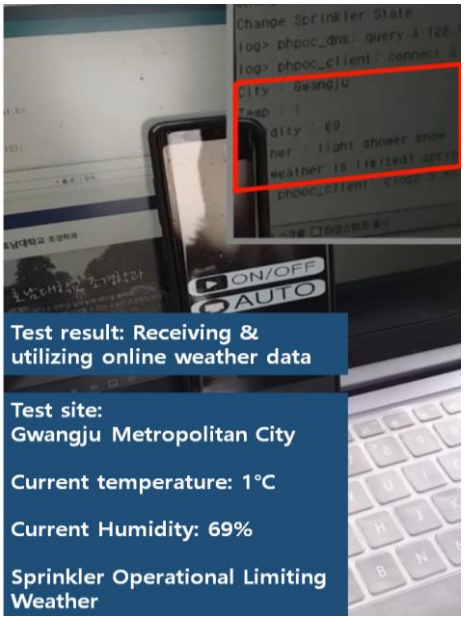


Figure 6. System control developed using Arduino

Figure 6 shows the final test of the developed IoT-based sprinkler system. This sprinkler system basically communicates with the Korea Meteorological Administration and receives weather (temperature, humidity) information in the vegetation area.

It is also designed to control sprinkler units by measuring light intensities, vibration and field images in the vegetation area in real time through sensors and camera for each of them and comparing them with established limit criteria. In the case of light intensities, if the amount of light measured by the sensor exceeds the reference amount of light, the sprinkler unit can be controlled to increase by an increment (10-15%) from the set amount of water set by the administrator, allowing sufficient water to be supplied to the vegetation even if some water

is evaporated by sunlight.

4. Conclusion

With increasing interest in returning farms, sprinklers play an important role in farm household income to manage crops in greenhouses or to water crops, landscape trees, and crops.

With the development of IoT, such a sprinkler can control the sprinkler just by communicating with the unit using sensors. When a signal is sent from a PC or mobile from a remote location, the sprinkler can be turned on/off according to the time, so when the time comes, it is possible to water crops from a remote location and manage them conveniently without going directly to the green house.

In this paper, we proposed a sprinkler control system that allows administrators to operate sprinklers over mobile from a long distance in the event of an emergency in the vegetation area. The sprinkler system we proposed in this study is more accurate, faster, and minimizes water management errors because it can be operated and stopped by itself by comparing the values measured by each sensors, camera and image analysis part with the established limits for various weather conditions (temperature, humidity, light intensity, vegetation image, vibration, etc.).

Although research on sprinkler system based on IoT is increasing, it is still in its early stages in the field of landscape architecture. Therefore, this study is valuable as a research that developed the sprinkler control system with IoT as a landscape architecture facility. In the future, research on the field of landscape architecture, which is integrated with IT technology, we will have to be carried out continuously.

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