Research on Intelligent Monitoring System for Automatic Sprinkling of Intelligent Power Control Park

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Abstract. Based on the analysis of the traditional automatic sprinkler maintenance methods in parks, the paper proposes the use of photovoltaic power supply and remote controllable automatic sprinkler methods. On the basis of using solar power as the power source, batteries are used to store electrical energy. The paper also adopted distributed unit design in the design, which solved the layout problems of various parks with complex terrain. In the design, environmental and engineering factors are fully considered to make the design simple, reliable, and easy to construct. At the same time, the unit monomer was tested and verified, and the results showed that the process is simple, the data is reliable, and the production efficiency is high.

Keywords. Smart power, photovoltaic power supply, automatic sprinkler, park sprinkler, intelligent monitoring system.

1. Introduction
With the continuous development of urban public facilities and residential environment construction, urban populations continue to concentrate, industrial and domestic water use is increasing rapidly, and various green areas such as tourism, leisure, sports fields and residential communities are also increasing. Urban water supplies the tense situation is becoming increasingly prominent. Traditional ground flood irrigation can no longer meet the requirements of modern park sprinklers, and it is imperative to adopt efficient park sprinkler monitoring methods. The author of this article puts forward a targeted smart watering strategy by studying the water demand, heat resistance and disease laws of park greening [1]. According to the characteristics of less infrastructure and sufficient solar energy in the planting environment, the system is powered by a combination of solar energy and lithium batteries. At the same time, CAN technology is used to realize the communication between the control terminal and each node, allowing users to remotely monitor and centrally manage the greening. The results show that the intelligent sprinkler system implemented in this study can save about 46.9% of water compared with general sprinkler methods. While achieving intelligent management, it reduces design costs.
2. **Overall system design**

2.1. **Demand analysis**

In order to meet the requirements of energy saving and emission reduction, intelligent control, information management, easy maintenance, low price, etc., this system adopts 4 key technologies that are not available in the current general watering method.

2.1.1 *Watering strategy.* By investigating the law of greening growth, the paper formulates an intelligent watering strategy, which saves precious water resources while ensuring good greening growth.

2.1.2 *Power supply mode.* Relying on low power consumption design, the paper uses solar energy combined with lithium battery to supply power, so that the system can operate independently, which saves energy and reduces emissions, and is easy to maintain [2].

2.1.3 *System power consumption.* The thesis adopts bistable pulse solenoid valve, which can be controlled without energizing the solenoid valve for a long time, which makes the low power consumption operation of the system possible.

2.1.4 *Remote control.* The paper uses CAN technology to realize remote control, so that each single sprinkler node can easily form a large sprinkler system.

2.2. **Overall system structure**

The overall structure of the system is shown in Figure 1, consisting of a number of sprinkler nodes and a controller. The sprinkler node is composed of solar power supply module, nRF905 wireless transceiver module, soil moisture sensor, alarm module and sprinkler equipment. The controller is mainly composed of nRF905 wireless transceiver module, liquid crystal display module, and key control module.

**Figure 1.** The overall structure of the system
2.3. Principles of Solar Power Control
The system monitors the soil moisture in real time through the soil moisture sensor of the sprinkler node, and sends it to the node controller, and the controller judges whether it needs sprinkling according to the received soil moisture. Each sprinkler node is equipped with a pyroelectric alarm, which can monitor the conditions in the sprinkler area. When someone enters the monitoring area, the node automatically alarmed and transmits the alarm information to the control device through the wireless network for display [3]. The administrator can realize close monitoring and control of the sprinkling status of farmland through the easy-to-operate manual control equipment, and realize intelligent sprinkling. As shown in the system block diagram in Figure 2, this system includes solar cell components, control and management systems, water pumps, pipes, sprinklers, etc. The output end of the solar cell module is connected to the input end of the control management module, the output end of the control management module is connected to the input end of the water pump, the output end of the water pump is connected to the pipeline input end, and the pipeline output end is connected to the nozzle.

The water pump can be PS1200HR-20 photovoltaic water pump, and its power is 480-1200W. The solar cell module outputs power to supply power to the control management module and the water pump. The power parameters of the solar cell modules are input to the control management module as a basis for judging the weather conditions, and the control management module issues instructions to automatically switch the water pump to sprinkle according to the power parameters of the solar cell modules, and automatically adjust the irrigation volume of the spray pump. The control management module controls the work of the water pump according to the set workflow. The pipeline is the pipeline of the existing green sprinkler system. The control management system in this system uses the workflow shown in Figure 3 for control.
Figure 3. Flow chart of control management system

The basic working principle of this system is that when there is light irradiating the solar modules, the solar module power generation is supplied to the control management system. When the control management system detects that the solar module parameters meet the set parameters for turning on the water pump, the water pump is turned on, and the control management system takes a certain period of time. The solar module parameters are checked at intervals to determine the weather conditions, so as to adjust the power of the water pump to control the amount of water sprayed. When the control and management system detect the shutdown pump parameter set by the solar module parameter composite setting, the water pump is turned off and the watering is stopped. Component parameters and on-off pump parameters are set on the control management system on-site according to the specific solar greening sprinkler system configuration [4]. The solar green sprinkler system can be a 1kW solar cell module system composed of 6 pieces of 175Wp solar panels. The water pump uses a PS1200HR-20 photovoltaic pump with a power of 480-1200W; set it on the control management module when solar energy is detected. When the actual power of the component system (the product of the measured voltage and the measured current) rises to more than 800W, it can be judged that the weather is clear and the temperature is high, and the water pump needs to be turned on. When the actual power is less than 750W, it can be judged as cloudy or cloudy, do not need to turn on the water pump; when the actual power is greater than 800W and less than 900, the pump sprinkles at low speed, and when the actual power is greater than or equal to 900W, the pump sprinkles at high speed.

3. System hardware and software introduction

3.1. Hardware selection

3.1.1 Single chip microcomputer. The system uses the 12C5A60S2 single-chip microcomputer produced by Hongjing Technology as the system's microcontroller. It is a new generation 805 single-chip with high speed, low power consumption and super anti-interference. It has a dedicated reset circuit for MAX810, 2 PWMs, and 8 high-speed 10-bit A/D converters.

3.1.2 Wireless transceiver module. The system uses the nRF905 wireless transceiver module produced by Norway Nordic Company. The chip adopts GPSK modulation mode, which can automatically complete the processing of prefix and CRC (cyclic redundancy check). The on-chip hardware can automatically complete Manchester encoding/decoding, using SPI the interface communicates with the microcontroller, and the configuration is very convenient. Its power consumption is very low, the current is only 11mA when transmitting with -10dBm output power, and the current is 12.5Ma when in receiving.
mode. The chip consists of a fully integrated frequency modulator, a receiver with a demodulator, a power amplifier, a crystal oscillator and a regulator.

3.1.3 Humidity sensor. The system uses the SHT11 series humidity sensor, which is a highly integrated temperature and humidity sensor chip. It uses patented CMOSens technology to provide full-scale calibration digital output, and due to the optimized integrated circuit form, it has extremely high reliability and excellent long-term stability. The response is fast, less than 4s.

3.2. Software process

The program flow is shown in Figure 4. After the device is powered on, the system initializes the serial port, nRF905, and the timing clock of the TDMA communication protocol, sets nRF905 to wireless receiving mode, and the alarm detects whether someone breaks in. If someone breaks in, an alarm will be issued immediately. Whether the data received by the wireless receiver is a synchronous clock, if it is to start the normal working mode, if not, it is judged whether it is a control command. Determine whether it is a power consumption control command. If it is, start the low power consumption mode. If it is not, judge whether it is a sprinkling control command. If it is a sprinkling command, start or stop sprinkling [5]. If not, start the automatic detection sprinkler mode. If the low power consumption mode is activated, the system will turn off the soil moisture sensor and turn off the solenoid valve. Under the normal mode, the soil humidity is automatically detected, and the watering on demand is automatically realized according to the present value, and the soil humidity information and the watering information are transmitted to the controller.

\[
M_{\text{water}} = \left(80\% F_e - 60\% F_e \right) \rho_{\text{water}} V_{\text{soil}}
\]

In the formula: \(M_{\text{water}}\) is the quality of water; \(V_{\text{soil}}\) is the volume of soil; \(F_e\) is the field water holding capacity; \(\rho_{\text{water}}\) is the density of water. The corresponding soil moisture content is

![Figure 4. Program flow chart](image-url)
\[ S_{WC} = \frac{M_{\text{water}}}{M_{\text{soil}}} \times 100\% = \frac{M_{\text{water}}}{\rho_{\text{soil}} V_{\text{soil}}} \times 100\% \] (2)

In the formula, \( S_{WC} \) is the soil moisture content; \( \rho_{\text{soil}} \) is the density of the dried soil. Therefore, the sprinkling strategy on the software should detect whether the sampling value of the moisture sensor is between 14.3% and 10.7% as the benchmark for sprinkling. When the power of the lithium battery used in this system is 20%~100%, the corresponding output voltage is 3.6~4.2V. Since the range of the embedded AD channel of the microcontroller is 0~3.3V, the detection channel has undergone a voltage division process, and the voltage output to the AD channel is

\[ V_{\text{out}} = \frac{3.6 - 4.2}{2} = 1.8 - 2.1V \] (3)

The solar power management strategy on the software should be based on whether the sampled value after the partial pressure of the lithium battery is in the above interval, as the benchmark for charging.

4. System Test

4.1. System operating status

The sub-sprinkler nodes and control terminals of the system use CAN to realize communication to form a large-scale sprinkler system. The user can monitor the working status of each node at the control terminal, and control the sub-nodes through the terminal.

4.2. Water saving by sprinkling

This scheme adopts the sprinkling method, which can control the amount and uniformity of the sprayed water, avoid ground runoff and deep seepage loss, and greatly improve the water utilization rate. At the same time, the intelligent sprinkling strategy can further avoid the deep penetration loss caused by excessive sprinkling. The verification shows that the water consumption for sprinkling after using this system is only 46.9% of the original.

5. Conclusion

After the above experimental tests, it is verified that the green soil moisture monitoring system is operating normally. The humidity collected by the system nodes can be uploaded to the terminal using the ZigBee network and coordinator, which can accurately monitor the green soil entropy and provide more reliable information to the nursing campus greening staff. But also to ensure water-saving sprinkling. The biggest advantage of this system is the use of solar energy as a power source, and the step-up and step-down meet the design requirements. The design can provide ideas for modern agricultural system services, promote agricultural energy saving, water saving and sprinkling, and truly achieve green and environmental protection.

Acknowledgments

Supported by the Research and Development Fund of Shenyang Urban Construction University (Grant No. XKJ202101).

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