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The design of tea garden environmental monitoring system based on WSN

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Abstract. Through the application of wireless sensor network (WSN) in tea garden, it can realize the change of traditional tea garden to the modern ones, and effectively improves the comprehensive productive capacity of tea garden. According to the requirement of real-time remote in agricultural information collection and monitoring and the power supply affected by environmental limitations, based on WSN, this paper designs a set of tea garden environmental monitoring system, which achieves the monitoring nodes with ad-hoc network as well as automatic acquisition and transmission to the tea plantations of air temperature, light intensity, soil temperature and humidity.

1. Introduction

The application of Wireless sensor network (WSN) in agriculture is increasingly extensive, and many researchers have studied WSN applied in greenhouses, aquaculture and farmland over the years. Especially in recent years, the researchers have researched the aspects of tea garden information acquisition using nRF905 as a wireless transmission medium, while the network capacity is limited, and the effective transmission distance is short, which are not conducive to a wide range of tea garden information monitoring. Based on this, at the same time, considering Guizhou province is one of the four origin countries in Chinese tea, and is the tea producing area with the only domestic low latitude, high elevation, and weak daylight, while Tongren City is one of the major producing area of Guizhou tea, there has a long history of tea production, tea plantations are mainly distributed in the alpine foothills, all the year round cloud and mist with being pregnant good tea and other unique natural environment, and the natural quality of tea is excellent, which has become one of the leading industry that gives priority to develop the most widely distributed economic crops and agriculture. However, the tea garden is poorly managed, the power supply affected by environmental limitations, and brand awareness is strong, which causes the tea price is low, and benefit with less ideal. Therefore, this paper, based on WSN, designs a set of tea garden environmental monitoring system, which helps tea garden manager real-time control the growing environmental information of tea trees, and takes timely intervention measures, at the same time, is of great significance to strengthen the international competitiveness of Tongren City, to promote its economic, and to increase farmers' income.

In the tea garden, construct the monitoring of tea growing environment, including air temperature, air humidity, light, carbon dioxide concentration, soil moisture, soil temperature, and weather station with monitoring the wind speed, wind direction, rainfall, light, and air temperature and humidity, and buy a set of soil analyzer to analyze each element content of soil. The above data can provide basic data for tea cultivation management; the obtained data can display on a PC, and also see through the Android mobile terminal. Meanwhile, the changing curve of important data can be real-time display on the big screen.

2. System design

The structure design of monitoring systems is mainly composed of wireless sensing nodes, wireless gateway, and monitoring server. Because there are many commonalities between the wireless sensing nodes and wireless gateway, our design will integrate both, as shown in Fig. 1. Through regulating the GPRS module, altering Zigbee wireless ad-hoc network module, set to realize switching from the gateway and nodes. The design of wireless sensing nodes and gateway is made up of the following several modules: solar power system, power system, microcontroller, Zigbee wireless ad-hoc network module, GPRS module, air temperature and humidity sensors, light intensity sensors, soil temperature and humidity sensors, and JTAG debug interface. It will mainly interpret weather stations, three kinds of sensors, and soil analyzer as follows.

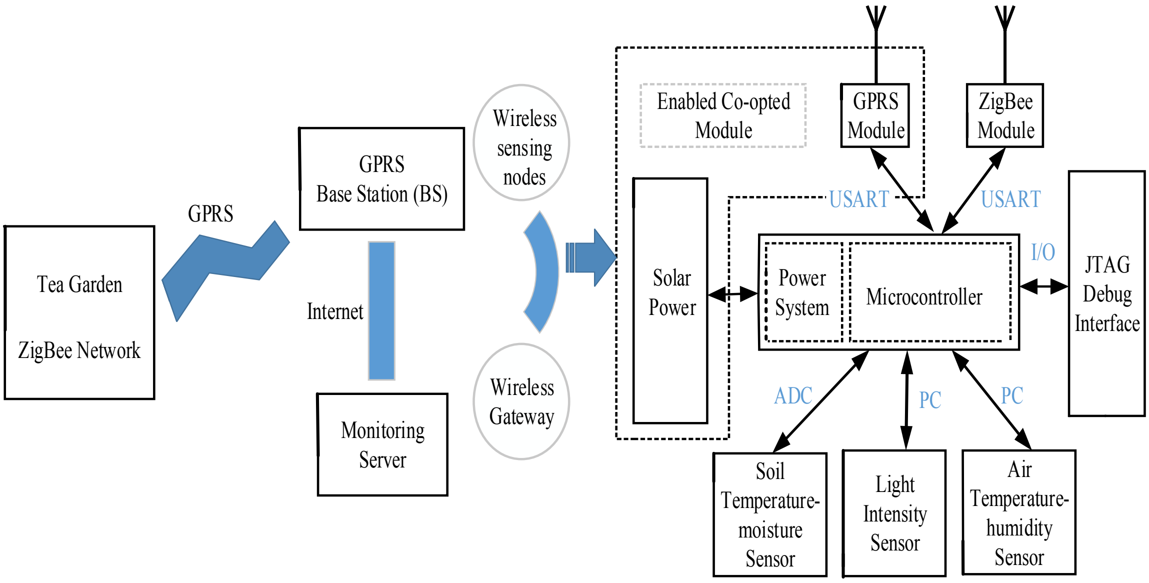

Figure 1. System framework.

2.1. Weather station

Weather station with DC12V power supply mainly has the following functions. Support solar power and 5-channel sensors, i.e., air temperature and humidity, light, rainfall, wind speed, and wind direction; Bear to collect up to 8-channel wireless sensor data; Wireless communication distance beyond-visual-range is 100 meters; Sustain cloud service technology, and query acquisition data at any time by various methods such as mobile phones, i-pad, and computers.

2.2. Sensors

This subsection mainly expounds three kinds of sensors. First, air temperature and humidity sensors: Radiation shield materials-Ultraviolet resistant PC; Measuring range of the relative humidity: 0 ~ 100%, and its accuracy: ± 2% (20℃); Measuring range: - 40 ~ + 60 ℃, and its accuracy: ± 0.2℃. Second, light intensity sensor: Measuring range: 0~200000 lx; Accuracy: ± 2%. Third, rainfall sensor: Distinguishability--0.2 mm; Aperture diameter: 200 mm; Measurement mode: Tipping bucket; Measuring range: 0~4 mm. Lastly, wind velocity and wind direction sensors: Measuring range of wind velocity: 0.3~30 m/s, its accuracy: ± 0.5 m/s, and the initial wind speed: 0.3 m/s; Measuring range of wind direction: 0~360°, its accuracy: ± 1%, and the initial wind speed: < 0.6m/s.

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2.3. Soil analyser
The subsection explains soil analyser from three aspects in the following way. First, the performance feature: Using microprocessor technology, digital circuit, programming design, single-chip microcomputer control, touch keys, and liquid crystal display; AC and DC [vehicle-mounted and lithium battery] (optional), built-in high capacity battery, and be able to work continuously for 4 hours in the absence of the power converter; Built-in thermal printer to store print and test results; Using optical filter as light source, and silicon semiconductor as a signal receipt-system, lifetime can lengthen out to 100000 hours; The dark box is designed by double-multi-channel mechanism to avoid the system error generated by different channels; The stability of work is better than 6 times of the national standard JJG179-90, and the repeatability achieves the index of grating spectrophotometer; The system software of expert fertilization. Second, test project: Soil nutrients: nitric nitrogen, ammonium nitrogen, instant phosphorus, instant potassium, organic matter, total nitrogen, total phosphorus, total potassium, pH value, conductivity salt, etc.; Trace elements: boron, manganese, iron, copper, calcium, magnesium, sulfur, chlorine, zinc, silicon, etc.; Fertilizer nutrient: nitrogen, phosphorus and potassium in elemental chemical fertilizer; Compound (mixed) fertilizer and ammonium nitrogen, nitrate nitrogen, phosphorus, potassium, biuret, and humic acid in urea; Available nitrogen, available phosphorus and available potassium, total nitrogen, total phosphorus, total potassium and organic matter in organic fertilizer; Plant nutrients: nitrogen, phosphorus and potassium in plant; Nitrite; Tobacco leaf nutrient: total nitrogen, total phosphorus, total potassium in tobacco leaves, reducing sugar, total sugar, boron, manganese, iron, copper, calcium, magnesium, etc. in tobacco leaf. Lastly, technical parameters: Measuring range and distinguishability 0.001-9999; Stability: drift is less than 0.003 within three minutes; Linear error is less than 0.003; Repeatability error is less than 0.005; Sensitivity: Red light≥4.5×10-5; Blue light≥3.17×10-3; Green glow≥2.35×10-3; Orange light≥2.13×10-3; Wavelength Range: Red light: 680±2nm; Blue light:: 420±2nm; Green glow: 510±2nm; Orange light: 590±2nm; The test range of moisture content: Humidity range: 0.01%~1.00%; Relative error: ±5%; Measurement technical parameters of PH value: The test range: 1~14; Error: ±0.1; Measurement technical parameters of salinity (conductance): The test range: 0.01%~1.00%; Relative error: ±5%; Power supply for this instrument: AC: 180V~240V, 50Hz; DC: 12V, 5W(vehicle-mounted); Lithium battery: 12V, 5000MA; The combination of NPK and potassium: Phosphorus and potassium can be completed to digest simultaneously in the soil within 3 minutes; Test Speed: Measure a soil sample (N, P, K)≤30 minutes, meanwhile measure five soil samples≤50 minutes (including former processing time); Vibration resistance: qualified.

2.4. User-friendly control
Complete supporting facilities: Measuring speed instrument combines medicine, apparatus, and instrument as a whole, and is easy to be carried, which is equal to a small laboratory that is convenient for field testing and mobile service. The finished product is out of the box, which guarantees the shortcut of test speed. Its cost is low, and the cost of measuring one nutrient (N, P, K) only needs 2 yuan.

3. GPRS module
This system adopts Client/Server (C/S) mode to transmit remote data, the real-time connectivity capacity of GPRS module with the server affects the durability of data transmission. This system uses the "handshake" way to realize the real-time connectivity between the client and the server as shown in Fig. 2. The “handshake” process: GPRS module transmits data packets to the server, through the server to return data packets to reach instructions. If “handshake” successes, to continue to transmit data, or retry to connect to the server.

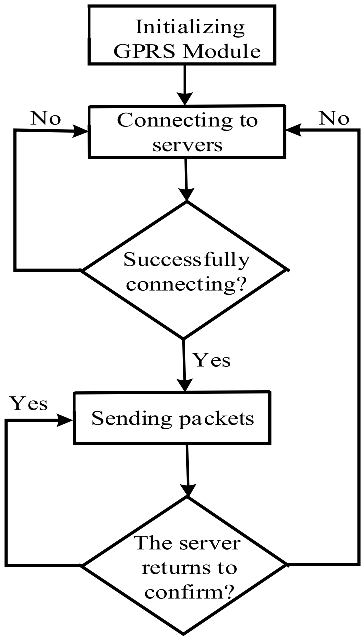

Figure 2. The "handshake" process of GPRS module.

4. Conclusion

The above design is about the overall architecture of monitoring system and the next step of our work is to find a place for research trial: Certain tea garden of Tongren city in Guizhou province. The purpose of our experiments is to prove our designed system can achieve stable data transmission, and is suitable for the real-time monitoring of soil information in the tea garden.

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