Crop Growth Environment Monitoring System Based on Wireless Sensor Network

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Abstract
Modern agricultural research is mainly divided into four important parts: the acquisition, transmission, processing and application of agricultural information. Wireless sensor network (WSN) technology is a research hot spot in the field of agricultural environmental monitoring. Wireless sensor crops make growth environment monitoring and intelligent data collection easier and more convenient. It changes the traditional crop data collection methods and monitoring system methods. WSN technology has become the main way to change the traditional farming methods in China. Based on the TRA algorithm and multi-sensor information fusion, this paper monitors the crop growth environment and can effectively improve the level of information and intelligence of crop management through the combination of software and hardware. Wireless sensor networks can quickly and timely collect, upload, and store and display various crop growth environment factors to obtain more accurate crop growth factor data. Regularity is obtained through data trend analysis, and then trend prediction is made to make crops more finely planted and promote high quality and high yield. It also helps growers monitor the crop growth environment and reduce people’s labor intensity.

Key words: Wireless Sensor Network, Crop Growth, Monitoring System

1. Introduction
Agriculture has entered the stage of modern agriculture. Modern agricultural technology combined with modern science and technology, using modern agricultural machinery, water conservancy facilities, soilless cultivation, greenhouses and other sowing methods, the ability to resist natural disasters has made a leap-forward development, and the quality and yield of crops are also very high [1, 2]. Crop growth is affected by the environment, which is a key factor affecting the yield and quality of crops. Whether crops grow well or not depends on the suitability of environmental conditions. Strengthening the monitoring and systematic research of environmental factors is a way to achieve crop yield and value protection, and is also a branch of modern fine agriculture development. In order to continuously meet people’s demand for food, agricultural planting needs to be more precise. Therefore, with the development of the times, the idea of refined agriculture has emerged. Modern precision agriculture is a concept of cutting-edge thinking and creation era, and its core lies in agricultural management [3]. The purpose of this paper is to promote crop production and conservation, planting and environmental optimization, ecological greening and environmental protection. Among them, the use of wireless sensor networks, remote sensing and other technologies to collect environmental parameters of crop growth, to maximize adaptation and adjustment of crop growth, and promote crop yield is one of the development directions in this field [4-6]. Agricultural production is the process of human society development, and all stages of human history development are closely related to agriculture. Agriculture is the guarantee for the survival and continuous development of mankind and the foundation for the development of human civilization. Compared with western developed countries, China’s agricultural production modernization is still not perfect, and it is in the process of transforming from traditional agricultural production to high modernization. New technologies can effectively enable operators to more intelligently capture real-time data, determine decision outcomes, optimize functional modules and evaluate. For environmental factors affecting the growth of agricultural greenhouse crops, such as temperature and humidity, temperature, light intensity and other factors, intelligent collection and judgment are realized to assist operators in making decisions [7]. In the process of realizing the development of agricultural production information, it is necessary to be able to intelligently and effectively control the data collection of the above factors. In order to predict the unfavorable factors affecting crop growth, effective protection measures are taken to overcome some of the drawbacks caused by human factors, reduce the losses caused by unfavorable factors, and maximize the economic benefits brought by intellectualization to agricultural production.

China has begun to change the mode of agricultural development, promote agricultural informationization and intelligent construction, and agricultural informationization realizes the collection, transmission, and
processing and agricultural management decision-making of agricultural informationization at a lower cost by using new technical means [8]. In this way, traditional agricultural production is transformed and upgraded to achieve scientific agricultural management and high yield and good harvest. This is of great significance to modern agricultural informationization and sustainable agricultural development. With the sensor technology in recent decades, the research of wireless communication technology has become more and more in-depth, and related technologies are also constantly improving and developing, and wireless sensor networks have been rapidly developed. The development and emergence of WSN provides solutions for monitoring crop growth environments. Wireless sensor networks are conceived under the development of microcomputer technology and wireless communication technology [9]. Sensor networks change the traditional way of life and change the way people communicate with the objective world. The signals of the objective world collected by the sensor nodes are transformed into human computer signals to study the laws of the objective world. A WSN is essentially a group of WSN nodes that are distributed throughout the surveillance area. A large number of low-cost sensor nodes form a wireless ad hoc network in a multi-hop manner. The nodes assist each other in sending the collected data to the monitoring center over the wireless network. Wireless sensor networks are data-centric, self-organizing wireless networks. The network has good dynamic topology organization function, strong self-management ability and self-healing ability. However, the Achilles heel of wireless sensor networks is limited power consumption. Since there are a large number of sensor nodes in the monitoring area, battery replacement is impractical, and continuous power is used in special areas, and the battery level of the sensor nodes is limited. It is also subject to a certain degree of limitation on the storage capacity of the node. At the same time, an important goal of WSN design is to meet the low power consumption, low cost and low transmission speed requirements of wireless transmission. The network extends the life of the node and minimizes the energy consumption of the node. The application of wireless sensor networks in crop growth environment monitoring should be further development and innovation of applications. Crop diseases seriously affect the development of greenhouse agriculture, reflecting the growth and development of greenhouse crops. WSN has a unique advantage in this application. First, wireless sensor networks can fully monitor monitored crops. Secondly, the parameters of the ecological factors can be directly obtained, and the parameters of the ecological factors can only be obtained after the traditional sampling and laboratory tests are required. Wireless sensor networks can directly obtain parameters of environmental factors and directly analyze and calculate the causes of crop diseases. In addition, you can save more human resources. Sampling tests require a lot of people to complete. Calculation and testing after sampling also requires a lot of manpower. Only one professional in the WSN can obtain the causes and preventive measures of crop diseases at the monitoring center at any time.

Today, the Netherlands and other countries that have conducted facility agriculture research have automated the monitoring and operation of the growing environment and have conducted extensive research on artificial intelligence. Established a greenhouse management, decision-making and consulting expert system, using telemetry and network technology for remote control, management diagnosis and real-time environmental monitoring. At the same time, it also provides users with various information services, such as information technology support and services as well as weather information, truly unattended, remote monitoring and fully automated. The application technology of crop growth monitoring system for foreign facilities and agricultural facilities is more mature than that of China. Due to the differences in soil and water, climate and region between foreign countries and China, the direct introduction of a complete monitoring system from abroad will result in the system not being able to play its full role, and it will be difficult to maintain in future use. Therefore, China cannot directly use foreign complete monitoring system. We can learn from their advanced technologies and methods, and develop crop environmental monitoring systems that are suitable for China’s national conditions and actual production.

This paper designs a crop growth environment monitoring system based on TRA and multi-sensor information fusion [10]. In the crop-growing environment, the sensor is attached to the environmental site as a monitoring point, integrated with the embedded control chip and peripheral circuits. Combined with the embedded operating system, various application interfaces are arranged through peripheral circuits to detect information such as ambient temperature, humidity and infrared information. Multi-sensor information fusion technology is used to fuse the collected data and transmit it to remote clients via wireless network to realize remote monitoring of crops.

2. Proposed Method

This paper proposes a WSN monitoring system based on TRA algorithm (TREE Routing Algorithm). In order to better use the wireless network sensor for crop growth environment monitoring, this paper first puts forward the problem hypothesis on the problem in the second part, and then proposes the tree topology algorithm based on the problem hypothesis, which lays a foundation for the experimental part.
2.1. Model Assumptions

The energy model used in the fixed family routing algorithm discussed in this paper uses the first order radio model, which is based on two assumptions:
(1) All nodes in the network are identical.
(2) Radio signals consume the same amount of energy in all directions.

In this model, the energy used for the Kbit data emitted by the sensor node is:

\[ E_{\text{send}} = kE_{\text{elec}} + kE_{\text{amp}}d^\beta \]  

The energy used by the sensor node to receive Kbit data is:

\[ E_{\text{receive}} = kE_{\text{elec}} \]  

In wireless transmission, the transmission power decreases exponentially as the transmission distance increases. In this paper, the energy used by the sensor node to emit Kbit data is:

\[ E_{\text{send}} = \begin{cases} kE_{\text{elec}} + kE_{\text{amp}}d^2, & d < d_0 \\ kE_{\text{elec}} + E_{\text{amp}}d^4, & d \geq d_0 \end{cases} \]  

In the equation, \( E_{\text{elec}} = 50nJ / \text{bit} \) is the energy used by the transmitting circuit and the receiving circuit, indicating that the energy used by the transmitting circuit and the receiving circuit to process 1 bit of data is 50 nJ. \( E_{\text{amp}} = 1050nJ / \text{bit} / m^2 \) is a multiple of the signal amplifier, meaning that the energy used by the signal amplifier to transmit 1-bit data per unit area is 10\( pJ \), and \( E_{\text{amp}} = 0.013nJ / \text{bit} / m^4 \).

The power used for transmission is unchanged as the node sends out data. According to Equation 1, the energy used to send the data is:

\[ E_{\text{send}} = kE_{\text{elec}} + kL \]  

Where \( E_{\text{elec}} \) is a fixed value, related to the transmit power, and the transmit power is constant, and has no relationship with the location of the receiving node. The energy used to receive the 1-bit data is:

\[ E_{\text{receive}} = kE_{\text{elec}} \]  

Let the network have a total of \( N \) nodes deployed, each node sends 1 bit of data, because each node sends its own data, and also forwards more data sent by the node than the number of nodes. Therefore, the data sent by the node numbered \( n \) is \( (N \leq n) \) mbit data and \( (N \leq n) \) mbit data is received. Since the energy used by the node mainly includes the sensor module, the processor module and the wireless communication module, most of the energy used by the wireless communication module. The energy consumption calculated here mainly considers the energy required by the communication module, and the energy used by the numbering node can be obtained as follows:

\[ E_n = E_{\text{send}} + E_{\text{receive}} = (N - n + 1)mE_{\text{elec}} + (N - n + 1)mL + (N - n)mE_{\text{elec}} = (2(N - n) + 1)mE_{\text{elec}} + (N - n + 1)mL \]  

It can be known from the formula that in a chain topology, the energy used by a node is linear with the number of nodes. It can be understood that the energy used by the node decreases as the number of nodes increases. Since the transmission amount of the node is only larger than the amount of data sent by the own node, the more the number of nodes, the smaller the amount of data required for the node to forward to other nodes, thereby reducing the energy consumption.

2.2. Tree Topology Algorithm

On this basis, this paper proposes a tree topology algorithm. The basic ideas are as follows:

The next hop transmission packet of each node is within its communication range, the node energy value is within a certain range, and the node with the smallest node number is the next hop destination node. Therefore
the data transfer mode of each node is rotated from each node to another point. The specific implementation of changing the topology to a tree is as follows:

1. Route establishment: Each node broadcasts its own node number and its own residual energy value to the node within its communication range. Each node saves the received other node information and sorts according to the number, from which the node having the smallest number and its own remaining energy node higher than a certain value ELOW is selected as the next hop target node.

2. Data forwarding: If the node needs to send data to the sink node, it only needs to send the data to the next hop target node of the current node, and then send it.

3. Route maintenance.

Proactively changing the route: If a node sends data unsuccessfully in Tmax, node \( N \) needs to select the next hop node. At this time, the node will request the message-forwarding broadcast to find the communication range of the target node, and the remaining energy is greater than ELOW when another node \( N \) receives the request message from the node. The number of nodes of node \( N \) and the remaining energy of the information sent to the node, and the nodes with the smallest number of \( N \) nodes select as the next hop node. Establish a topology from node \( N \). If the node does not receive feedback from other nodes, the next hop target node cannot be selected.

Passive change routing: When the residual energy value of node \( N \) is less than ELOW. Node \( N \) broadcasts a cancellation notification message of its own node number and its own residual energy value to nodes within its communication range. Therefore, other nodes can dynamically reselect their next hop node based on the undefined energy level of the node. According to their initial stage. The ELOW value varies with the type of node, based on the fact that when the remaining energy of the node reaches the ELOW value, there is enough energy to inform other nodes that they cannot act as the next hop target node. If the node \( N \) is selected as the next hop target node before the node, the active change routing mechanism is performed upon receiving the node \( N \) to cancel the route notification message.

3. Experiments

3.1. Experimental Technical Indicators

In order to enable agricultural experts to study the relationship between microenvironment factors and plant growth conditions in farmland environmental monitoring areas, nodes in the system need to be monitored. The main indicators of growth environmental factors include ambient humidity, temperature, \( \text{CO}_2 \) concentration, and light intensity. For different growth environment factors, you need to select the appropriate sensor to monitor it. Taking into account the factors such as energy consumption, measurement range, accuracy, cost and volume, the sensors and main technical indicators selected for this system design are shown in Table 1.

<table>
<thead>
<tr>
<th>Types</th>
<th>Technical Indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>GB2100A</td>
<td>Power supply voltage: 12<del>36V, water level measurement range: 0</del>0.5m, accuracy: ±0.5mm</td>
</tr>
<tr>
<td>DS18B20</td>
<td>Supply voltage: 3.0<del>5.5V, water temperature measurement range: 0</del>100°C, accuracy: ±0.5°C (25°C), response time &lt;8s, average power consumption: 150μW (25°C, 3.3V, 1 time/second)</td>
</tr>
<tr>
<td>SHT10P</td>
<td>Supply voltage: 2.4<del>5.5V, ambient temperature measurement range: -40</del>123.8°C, accuracy: ±0.5°C (25°C), ambient humidity measurement range: 0~100%, accuracy: ±3%RH(25°C)</td>
</tr>
<tr>
<td>S1087</td>
<td>No power supply required, light intensity measurement range: 0<del>20000Lux, spectral range: 320</del>730nm (visible light), infrared sensitivity ratio: 10%, warm-up time &lt;10s, average power consumption: 3.5mW (25°C, 3.3V, 1 time/second)</td>
</tr>
</tbody>
</table>
3.2. Experimental Reference Information

After completing the system hardware design and software design, the next step is to build, debug, test and analyze the system. This includes testing and analyzing wireless sensor nodes, as well as testing and analyzing the entire system. Node debugging and testing, including sensor interface analysis, sensor node uncertainty communication capabilities, and low power consumption, whether the system can complete the collection task normally determines the system uncertainty analysis and testing.

To assess the communication performance of wireless sensor nodes in a field application environment, we measured the communication range of nodes in open space and crop environments, respectively. This provides the necessary reference information for the deployment of our actual application system.

In the field environment, the communication range of the wireless sensor node was tested, the test temperature was 23 °C, and the wireless sensor node was powered by 3.0 dry batteries, as shown in Table 2.

<table>
<thead>
<tr>
<th>Test environment</th>
<th>Transmit power (dBm)</th>
<th>Communication distance (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature: 23 °C</td>
<td>-18</td>
<td>67</td>
</tr>
<tr>
<td>Height of the wireless sensor node: 0.5m</td>
<td>0</td>
<td>215</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>297</td>
</tr>
</tbody>
</table>

As can be seen from Table 2 and Figure 1, the communication range of the wireless sensor node depends on the transmit power. The communication range increases as the transmission power increases. However, if only the communication range is considered and the transmission power is increased, the power consumed by the wireless sensor node becomes very large, which is obviously not an economically reasonable setting. Therefore, we need to set the appropriate RF transmit power according to the actual application requirements of the site. In this paper, the power of the wireless transmit signal is set at 0 dBm, which already meets the application requirements of the site.

3.3. Communication Range

In order to be closer to the actual application environment of the site, the communication distance of the nodes is measured in an environment with crops. Since the crop environment will make the transmitted RF signal significantly weakened, this paper sets the wireless sensor nodes of different heights. Therefore,
relationship between the node setting height and the communication range is calculated. The communication range of the wireless sensor nodes at different altitudes is tested with the transmit power of 0 dBm as the node, as shown in Table 3.

<table>
<thead>
<tr>
<th>Test Environment</th>
<th>Different Heights (M)</th>
<th>Communication Distance (M)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature: 25 ° C</td>
<td>0</td>
<td>21</td>
</tr>
<tr>
<td>Working Voltage: 3.0V</td>
<td>0.5</td>
<td>30</td>
</tr>
<tr>
<td>Transmitting Power: 0dbm</td>
<td>1</td>
<td>51</td>
</tr>
<tr>
<td></td>
<td>1.5</td>
<td>53</td>
</tr>
</tbody>
</table>

**Table 3. Placement height and communication range of wireless sensor nodes**

![Figure 2. Relationship between communication range and placement height of line sensor nodes](image)

As can be seen from Table 3 and Figure 2, different placement heights have an important impact on the monitoring range of wireless sensor nodes. The higher the placement height, the larger the communication ranges of the wireless sensor node. However, as the height of the WSN node placement increases, the communication range corresponding to the WSN node also increases, but the increase is smaller. When the release height reaches about 1.5 meters, the increase in the communication range is no longer significant. Therefore, based on the comprehensive experimental results and the above analysis, the placement height of the wireless sensor node is temporarily 1 meter.

After the system construction is completed, test and analyze the monitoring functions of the entire system, including collecting and analyzing various parameters. The crop growth environment parameters in the environment are collected using six wireless sensor nodes in the system and transmitted wirelessly through the underlying WSN. The data is sent to the coordinator, then sent to the mobile communication network via GPRS, and finally to the data center. Monitoring data can be displayed on the monitoring system of the data center.

4. Discussion

We use the above temperature and humidity sensor SHT10 P to collect ambient temperature and humidity parameters. The actual test of temperature and humidity sensor data on the wireless sensor nodes in the system is performed through a curve. The test time is from 8:00 am to 8:00 pm. As shown in Fig. 3, the humidity in the day is basically in the range of 45% to 53%, and there is no significant change.

One of the more important parameters in crop planting is humidity, which is one of the most important factors affecting plant growth. Humidity directly or indirectly affects transpiration, photosynthesis and pests of crops. The life activities of crops mainly rely on transpiration to absorb water and transport mineral nutrients to various parts. The transpiration of crops decreases with the increase of humidity in the environment, and once the transpiration is weakened, the power of plants to transport mineral nutrients decreases. Environmental humidity indirect plant photosynthesis, if the humidity in the environment is high, it will inhibit the transpiration of plants. Although the water in the plant is sufficient, the water does not circulate, which is not conducive to transporting mineral nutrients in the plants, thereby enhancing photosynthesis and promoting the growth and development of crops. The relative humidity of crop growth varies with the season and crop type.
As shown in Fig. 4, the temperature in one day is in the range of 20 °C to 27 °C, the temperature is low in the morning and evening, and the temperature reaches the maximum value in one day at around 14 o’clock, which is in line with the actual situation.

All life activities of crops are closely related to temperature, and the life activities of crops can only be carried out within a certain temperature range. The “three base point temperatures” are the minimum temperature, optimum temperature and upper limit temperature for maintaining crop growth. These three temperatures are the most basic temperature indicators for keeping crops growing. Many plants have a lower temperature of 5 to 15 °C, an optimum temperature of 20 to 28 °C, and a maximum temperature of 30 to 35 °C. In general, crops can sustain life while crops stop growing at upper temperature and temperature. At the optimum temperature, the life of the crop is most active. When the temperature is lower than the lower limit temperature or higher than the upper limit temperature, the crop will suffer different degrees of damage or even death when it is in such an environment. The data collected by the systems in Figures 3 and 4 is shown in an intuitive data curve that approximates the temperature and humidity values measured by standard instruments and visually show the trend of temperature changes. By comparing the temperature and humidity data curves, it can be seen that the higher the temperature, the lower the corresponding humidity, and the two have obvious correlation characteristics. Therefore, the data obtained from the WSN-based crop environment monitoring system can provide crop growth information for the growing environment of agriculture and crops in China.

The carbon dioxide concentration data of the crop growth environment was collected using a carbon dioxide concentration sensor COZIR for 7 days and represented by a curve as shown in Figure 5.
As can be seen from Figure 5, the collected data are of the same size and the carbon dioxide concentration curves are essentially the same. The important material basis for plant photosynthesis is carbon dioxide. In addition, it can affect the length, density, thickness, and number, surface area, root-shoot ratio, root physiological characteristics, rhizosphere micro-ecology and root exudates of plant roots. This helps plants absorb more nutrients and moisture. After sunset, when the photosynthesis of the plants stops, the breathing continues, and the activities of the microorganisms in the soil can produce carbon dioxide. This makes the concentration of carbon dioxide in the night greenhouse much higher than during the day. During the day, as plant photosynthesis progresses, the concentration of carbon dioxide in the greenhouse gradually decreases. According to previous experimental studies, in the greenhouse without ventilation, the concentration of carbon dioxide in the greenhouse decreased to about 300 PPM after the sun comes out an hour, while the outdoor carbon dioxide concentration was about 360 PPM. After 2 to 3 hours of sunrise, the carbon dioxide concentration drops to between 80 PPM and 150 PPM, close to the carbon dioxide compensation point of the greenhouse crop. At this time, the crop basically stopped photosynthesis because the concentration of carbon dioxide in the air was too low.

A light intensity sensor S1087 assembled by wireless sensor nodes in the system is used to collect light intensity information for the crop-growing environment, and presented through the curve, as shown in Figure 6.

As a source of energy for photosynthesis, light is one of the important factors affecting plant growth. The net photosynthetic rate of plants increases with the increase of light intensity between the photosynthetic compensation point and the light saturation point. The optimal light intensity interval for plant growth is not fixed. It varies with plant species, variety and growth environment, but is generally distributed between 200-1500μmol/(m²s). To ensure crop growth under suitable light intensity, it can be adjusted by artificial
light. Light intensity. As can be seen from Figure 6, the collected data are the same size and the light intensity curves are basically the same. It can be used as a data reference for subsequent crop growth environment analysis based on agricultural expert knowledge systems. Compared with the light intensity curves of the crop growth environment in Figures 5 and 6, it can be found that when the light intensity value is large, the corresponding carbon dioxide concentration is the lowest, which is also in accordance with the laws of the natural environment.

By analyzing the mechanism of crop photosynthesis, the main factors affecting crop photosynthesis are temperature, light and carbon dioxide. When the environmental conditions of the crops are not the same, there is a certain difference in the carbon dioxide saturation point corresponding to the plants. The photosynthetic rate of the corresponding plants is a problem that needs to be solved in future research. In photosynthesis, the stronger the intensity of light, the higher the activity of enzymes in plants, and the higher the photosynthetic rate of plants. During the gradual change of carbon dioxide concentration from 500 to 2000 μmol−1, the photosynthetic rate undergoes a process of gradual rise to gradual change. Slow changes in photosynthetic rate have become an important factor limiting the increase in carbon dioxide concentration in the initial range of photosynthesis. It is no longer the only ingredient that limits photosynthesis, and temperature and light are important growth factors that limit photosynthetic efficiency. At the same light and carbon dioxide concentrations, the corresponding photosynthetic rates are different at different temperatures, since temperature directly affects the activity of mold during photosynthesis. As the temperature changes from low to high, the enzyme activity and photosynthetic rate also increase. The data collected by the system can be combined with temperature, light and carbon dioxide to analyze the relationship between photosynthetic rate and photosynthetic rate to determine the environment most suitable for crop growth. Through the relationship obtained, an artificial intelligence regulator can be constructed in the future, so that the crop can grow better and achieve a high-yield goal.

The occurrence of plant diseases is the result of a combination of pathogen species, host plant species and plant growth environment (temperature, humidity, air circulation and soil components), and only encounters suitable host plants for a long time. Suitable for environmental conditions, the disease can be quickly infected in the plant population. Through the data collected by the WSN, the influencing factors of plant disease infection are analyzed and discussed, and comprehensive information data is provided for the establishment of the disease early warning model to improve the accuracy of early warning of induced crop diseases.

The real-time monitoring function of crop environmental information can effectively guide the production of agricultural production, and can greatly improve production efficiency. The site can be manually collected and recorded in real time, but this type of operation is computationally intensive and the recorded data cannot be quickly provided to the operator in real time. The system is used for information transmission under wired communication conditions, but the disadvantage is that it is expensive and is often accompanied by environmental factors such as humidity, temperature and glare in an agricultural greenhouse. These factors often lead to problems such as cable aging and reduced detection accuracy. This will greatly reduce the accuracy of the system, while at the same time increasing maintenance costs. Based on the above two shortcomings, the system uses real-time communication network for data transmission. Combined with effective and reliable information fusion algorithm, it can meet the requirements of accuracy and real-time in the agricultural production process. The data collected by the WSN-based crop growth environment information collection system designed in this paper is very consistent with the actual environmental parameters. It can be used as an important data reference for subsequent crop growth information analysis systems, providing an important reference for scientific management and behavioral decision-making of farmland. Thereby promoting the scientific management of farmland and achieving the goal of high yield and good harvest. The monitoring system and information collection of the WSN will significantly improve the quality and quantity of China’s agriculture, and will also bring a new course for the development of agriculture in the future. With the advancement of science and technology, the way of the labor about farmers will change, and the advancement of technology will bring convenience to humans.

5. Conclusions

China is a big agricultural country. China’s agriculture is undergoing transformation, from traditional farming to intelligent information digital farming. Developing agriculture with the scientific concept of development, leading the development and production of agriculture, sustainable development is the goal of our agriculture, and also the requirements for the development of agricultural science and technology at this stage. The four main components of modern digital agriculture alone are the acquisition, transmission, processing and application of agricultural information. The arrival of wireless sensor networks is a fast, convenient and real-time effective function for environmental monitoring, data collection and processing in the agricultural field. The WSN makes up for the lack of time, effort, consumables and real-time in the traditional agricultural data collection and monitoring system. The monitoring system of wireless sensor networks has become the research
focus and research hot spot of agricultural science and technology workers. Based on the actual needs of crop planting environment and crop information collection, the paper designs and designs a cash crop growth data collection and monitoring system based on wireless sensor networks. At the same time, it realizes the application of intelligence, networking and actualization, which can be used to guide the methods of crop planting, and also provide a diagnosis of pests and diseases. Thereby increasing crop yield and quality, reducing time, labor, consumables and agricultural pollution in the production process. The research work of this paper is summarized as follows:

1) This paper briefly introduces the research status of wireless sensor networks at home and abroad and the application background in modern agriculture. By analyzing and comparing the agricultural environment monitoring system designed by the predecessors, the shortcomings of the wireless sensor networks studied by the predecessors in terms of network lifetime, node energy consumption and data acquisition algorithms are proposed. Based on the predecessors, the design scheme of the agricultural environment monitoring system based on TRA algorithm for WSN is proposed.

2) The core of the monitoring system designed in this paper is a low-power processor. The sensor module of the wireless sensor node and the wireless sensor hardware and the circuit scheme of the communication module are designed. At the same time, the solar power supply unit is designed for the node using solar panels and super capacitors, and the workflow of the sensor node software is given. The main control system of the mobile node is designed by using the processor, and the circuit design scheme of the power drive module, the wireless communication module and various peripheral interfaces is given. Based on the embedded operating system, the hardware drivers and applications of the node are designed.

3) In this paper, the soft design and software design of wireless sensor nodes are designed hard. At the same time, in the hardware design process of the node, low-power consumables are used in the nodes, hardware low-power design is carried out, and low-power implementation is realized in software.

4) A crop growth environment collection and monitoring system was set up. The development of the human-machine interface and the main control program is the final processing and reality of the monitoring and control of the entire measurement process and the growth environment data.

References


