Research on Key Technologies of Intelligent Seeding Robot Based on Zigbee Network

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Abstract: Aimed at the problems of slow seeding speed, inaccurate path tracking and low efficiency of domestic intelligent seeding robot. An intelligent seeding robot based on Zigbee network is proposed. Wireless sensor and Zigbee network technology are combined to obtain real-time environmental data in the working area and transmit it to the robot for seeding operation. The incremental PID control method corrected by digital compass is adopted to control the robot to walk in a straight line and the ant colony algorithm is adopted to realize the path planning of the intelligent seeding robot. It solves the problem of seeding robot effectively and makes intelligent seeding robot widely used.

1.Introduction
China is a large agricultural production country, and the population base has a great demand for agricultural products. Therefore, the country should increase investment in agriculture, improve the level of agricultural mechanization, improve wireless sensor and Zigbee network technology, and make agriculture develop toward the direction of intelligence. Intelligent robot farming can greatly reduce labor intensity and production costs, improve the industrial cycle rate and solve the basic problems of agricultural production labor resources shortage [1].

With the rapid development of social production technology, more and more attention has been paid to the development of robot technology at home and abroad. America's Prospero agricultural robot optimises the spacing and depth of the seeds, Germany has developed an air-sucking precision wheat planter and Japan has developed various agricultural robots. Agricultural robot started late in China. In 1978, domestic universities and colleges introduced foreign intelligent seeding robot for research and successfully developed a new seeding robot, which laid a foundation for future research on intelligent seeding robot. However, the domestic intelligent seeding robot still has some key problems to be solved urgently, such as slow seeding speed, low efficiency, inaccurate path tracking and lack of mechanical auxiliary functions. This paper designs an intelligent seeding robot based on Zigbee network, which has far-reaching guiding significance for the future research of intelligent seeding robot.

2. Overall plan
The design of intelligent seeding robot based on Zigbee network is mainly aimed at the problems of heavy labor force and low labor efficiency in agriculture. The schematic diagram of the system is shown in figure 1. The intelligent seeding robot is composed of robot platform, sensing system, precision seeding mechanism and embedded control system.
3. Key technology

At present, the key technologies that have great influence on the intelligent seeding robot system mainly include: sensing technology, intelligent control technology, seeding robot positioning technology, path tracking planning technology, network communication technology and so on. This paper mainly introduces Zigbee network communication technology, robot control technology and path planning technology.

3.1 Zigbee network communication technology

Zigbee technology is an emerging two-way 2.4G wireless communication technology of short distance, low complexity, low power consumption, low speed, low cost and self-networking [2]. Zigbee is built on IEEE802.15.4 standard, and can connect with multiple network terminal nodes, can provide data authentication and integrity check function, so that the network security is guaranteed. At present, Zigbee mainly has three network topologies, namely network structure, star structure and tree structure, so it can meet the construction requirements of most communication networks.

Aimed at the characteristic that the working area of the intelligent seeding robot can be predicted and determined in advance, the robot is positioned by the position sensor. Visual sensor is adopted to improve the information collection on the ground, through the combination of wireless sensor and Zigbee network technology, build the network topology structure of the wireless sensor network, data real-time access to the work area of the environment, and synchronize with its own location information sent to the intelligent robot, autonomous path planning, planting. Through the construction of database and Web server, the remote terminal can monitor the situation of the field in real time, and can control the action of the seeding robot remotely through the terminal software, which greatly expands the function of the seeding robot. In this paper, the mesh topology structure is adopted and the transmission interval is 1.5s, and the packet loss rate of data transmission is no higher than 2% when the gateway node has no occlusion, which meets the actual requirements of the seeding robot for data transmission. Because of Zigbee's powerful networking ability, it can realize large-area regional monitoring, reduce costs, achieve "smart" status and improve resource utilization and productivity. Zigbee networking diagram is shown in figure 2.
3.2 Robot alignment

The output of the so-called incremental PID controller is index word just control the amount of incremental $\Delta$ [3]. The idealized equation of PID controller is shown in formula 1.

$$u(t) = K_p e(t) + \frac{1}{T_i} \int_0^t e(t) dt + T_d \frac{de(t)}{dt}$$  \hspace{1cm} (1)

Where, $e(t)$ is the input signal of the controller, $u(t)$ is the output signal of the controller, $K_p$ is the proportional coefficient of the controller, $T_i$ is the integral time constant of the controller, and $T_d$ is the differential time constant of the controller.

When the sampling time $T$ is very short, the equation can be directly converted into a difference equation by discretization. Substituting first order difference for first order differential, summation for integral, rectangle integral for approximation of continuous integral.

The PID control scheme is shown in figure 3. Due to the uncertainty of robot characteristics and various disturbance factors, the left and right wheels have different wheel speeds, thus the robot cannot walk in a straight line. In this paper, the compass is adopted to correct the straight line control method of seeding robot [4]. First, the incremental PID closed-loop control robot is used to walk in a straight line, and then the delay is 2S, and the compass is used to correct the offset direction, forming a closed-loop system to correct the walking side, so that the seeding robot keeps walking in a straight line and improves the operating accuracy of the system. Figure 3 is the control flow chart of rectifying robot's straight line with compass.

![Control flow chart](image-url)

Figure 3. Control flow chart

The working environment of the seeding robot is the pretreated flat ground. The robot starts from the end of the cultivated land to sow seeds. Path tracking and motion planning of intelligent seeding robot are realized by adaptive control and ant colony algorithm [5]. Then through the operation and processing of the robot control system, the precise control of the robot movement and seeding can be realized and the seeding robot can be controlled for seeding work. When the seeding robot completes the first field seeding task, it detects the edge through the infrared sensor, and then controls the motion direction and speed of the robot through the combination of angle sensor and speed sensor. The stepper motor is used to drive the steering, and the seeding work of the second field is started, and the seeding work is carried
out repeatedly in a cycle. The main working environment and working form are shown in figure 4.

![Walking map of seeding robot](image)

Figure 4. Walking map of seeding robot

4. Conclusion
Zigbee network-based intelligent seeding robot introduces Zigbee network technology to combine the intelligent seeding robot with wireless network for remote control anytime and anywhere. The incremental PID closed-loop control robot is used for linear walking. This paper improves the control system and uses digital compass to correct the direction, so that the seeding robot can keep straight walking. To prevent the seeding robot from deviating from the working area and improve the operating accuracy of the system. The research of intelligent seeding robot based on Zigbee network has far-reaching guiding significance for the current intelligent seeding robot research, and has a good application prospect and social benefits.

Acknowledgments
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