Journal of Artificial Intelligence Practice (2022)
Clausius Scientific Press, Canada
DOI: 10.23977/jaip.2022.050114
ISSN 2371-8412 Vol. 5 Num. 1

Smart Irrigation Conditioned on Plant Growth Patterns and Weather Conditions

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Keywords: Plant growth, Intelligent irrigation, Weather conditions

Abstract: At present, China's agriculture is faced with serious waste of irrigation water resources, unscientific and rational application of fertilizers, serious pollution of soil and water resources, and decreasing cultivated land area. Based on this, China's modern agriculture is also developing towards sustainable informatization. With the progress and development of science and technology, especially with the rapid development and application of sensor technology, wireless communication technology, computer control technology and intelligent terminals, it has become an inevitable trend and fundamental requirement for the development of precision agriculture and facility agriculture to integrate these high-tech and related equipment and improve the utilization efficiency of water resources in agricultural irrigation. In view of the above situation, combined with the computer Internet of things technology, this paper designs a set of intelligent irrigation and plant maintenance system to collect the parameters related to plant growth, such as light, air temperature and humidity, soil humidity and so on. According to the specific model of each plant, the central control module and water supply module are remotely controlled through the equipment network.

1. Introduction

As a traditional agricultural country, China's agricultural development maintains national peace and social stability. Although the cultivated land area is as high as 2.024 billion mu, ranking fourth in the world, but the world's largest population, the per capita cultivated land area is less than 0.1 hm2. It is only 40% of the world average level, and due to the development of urbanization in recent years, both the area of arable land and agricultural labor have shown a trend of decreasing year by year. Therefore, the efficient use of arable land and the liberation of agricultural labor have become an important issue. [1]. In the 21st century, water resources are becoming a precious scarce resource, which will have an important impact on the sustainable development of national economy and society [2]. Saving Water and energy-saving intelligent irrigation technology has become the general trend of irrigation development, and also provides the possibility to alleviate the pressure of water resources and realize agricultural modernization [3]. Compared with traditional manual control, intelligent irrigation mode has the remarkable characteristics of saving water, fertilizer and labor, and can eliminate the adverse impact of human factors on irrigation, which is more conducive to the scientific management of irrigation and the promotion of advanced irrigation technology [4]. Increasing the yield per unit area of grain is the main way to solve the grain problem, and chemical fertilizer is one of the key production factors to increase the yield per unit of grain [5].

China's water pollution is serious, water shortage is serious, soil erosion is serious, water price is seriously low, water waste is serious, and China is faced with the extremely uneven distribution of fresh water. The present situation of more water in the south, less water in the north, less water in the west and more water in the coastal areas are the main reasons that lead to unreasonable agricultural water use [6]. In order to maintain the sustainable development of agriculture, increase production, reduce emission and save energy, we must implement precision irrigation and precision fertilization technology. At the same time, precision irrigation and fertilization is also the key development direction of precision agriculture. Its goal is to improve the utilization rate of water and fertilizer, so as to effectively reduce soil environmental pollution. The realization of precision irrigation and fertilization must be realized by intelligent irrigation and fertilization technology.With the new progress of irrigation technology and the improvement of water and fertilizer utilization rate, irrigation technology will definitely be combined with some of today's high-tech to maximize water and fertilizer saving. The intelligent irrigation and fertilization technology is born in this way, so this technology must be a development trend of contemporary agriculture, and the development prospect is very broad [7].

2. The Basic Concept of Agricultural Intelligent Production

2.1 The Concept of Intelligent Agriculture

As an emerging industry, smart agriculture does not have a clear definition at present. The mainstream thought believes that smart agriculture is a modern agricultural development model formed by integrating agricultural industry with emerging technologies such as modern information technology and Internet technology. It is an advanced stage of agricultural production [8]. The intelligent production of agriculture refers to the use of sensor technology, automatic control, wireless transmission and other technologies to realize data monitoring, remote control and unattended intelligent control of agricultural production areas, and to improve agricultural production with large-scale and intensive production methods. Efficiency and risk resistance. The first thing to realize in intelligent agriculture is intelligent irrigation and generalization technology, which is to use computer information technology to transport the most appropriate water quantity to water-deficient plants under the condition that crops can grow normally and healthily, so as to reap the greatest benefits with the least water resources [9]. Secondly, after completing the irrigation plan, it is ensured that other needs of the plant growth cycle can be met with the most appropriate resource ratio.

In terms of satisfying the plant growth system, maintaining proper soil temperature and humidity is the main purpose of plant irrigation [10]. Intelligent agricultural irrigation is inseparable from intelligent automatic control, especially the use of sensor equipment to monitor soil environmental indicators. By controlling parameter time, air humidity, soil humidity and soil salt, it can realize remote automatic water supply according to quantity and demand. The modernization of agriculture is inseparable from the modernization of agricultural machinery. Agricultural machinery plays a great role in the process of field experiment, crop production and transportation equipment. In the process of manufacturing agricultural machinery, it is widely used in different types of sensors. The agricultural production factors controlled by intelligent production include: light, temperature, soil moisture and fertilizer in planting industry, environmental temperature and humidity in livestock and poultry breeding industry, CO_2, NH_3 SO_2 and other gas content; Dissolved oxygen, pH value, NH_3-N and conductivity in aquaculture. This topic mainly studies the farmland automatic irrigation system in smart production. The framework structure of smart agriculture is shown in Figure 1.

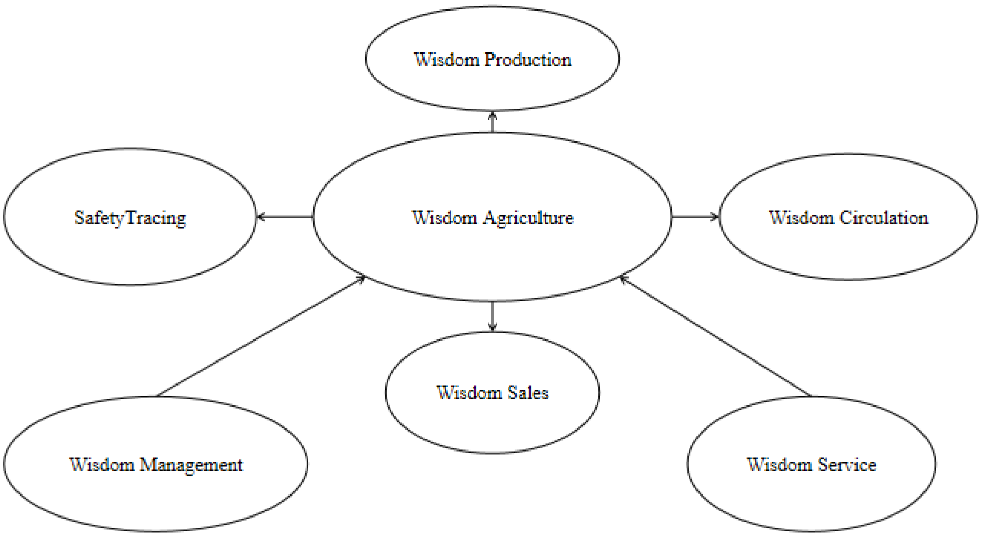

Fig.1 Framework Structure of Smart Agriculture

2.2 Intelligent Irrigation Technology

Intelligent irrigation refers to an irrigation method in which the system can automatically sense the temperature, humidity and other growth environments of crops, and analyze and judge based on various factors such as light and weather, and finally decide whether to irrigate. Drip irrigation is an irrigation form that uses low-pressure pipeline system to drip water into the soil in the developed area of plant roots evenly and slowly, so that the soil in the main active area of crop roots always keeps the optimal water content. Because of the small flow of dripping water and slow burial, the evaporation of water can be minimized, and the evaporation loss will be further reduced if covered with plastic film. Soil physical conditions refer to the size of soil particles and the arrangement of soil particles. The water, air, organic and inorganic nutrients required for plant growth and the free growth of plant roots are affected by soil physical conditions. The second is the acquisition of light and meteorological data.

The light intensity is detected by a photoresistor. If the light is strong at noon, no matter whether the soil is dry or not, it will not be irrigated. The execution module consists of PLC (Programmable Logic Controller) and solenoid valve. When the system is in automatic mode, PLC communicates with the on-site centralized control computer through the network port, and receives the instruction issued by the intelligent decision-making module to control the switch of the solenoid valve. When the system is in manual mode, farmers can realize manual control through the manual button on the cabinet or the virtual button on the monitoring and management interface of the centralized control computer. PLC will switch the solenoid valve according to the changes of the input signal and the variables in the register. In order to ensure the reliable implementation of irrigation instructions, after comprehensive comparison, Siemens S7-200 smart with ST30 microprocessor is selected as the field programmable logic controller to drive the solenoid valve. The control device receives data from the data acquisition device, in which the data includes light parameters, soil stopping humidity parameters, air temperature and humidity and other parameters. In the cloud service, the water quantity and water peeping time of plants are calculated by algorithm. The following is an analysis of the commonly used intelligent irrigation systems in China. The system takes STC89C52 single-chip microcomputer as the core to control the relay to realize automatic irrigation of farmland. The system structure diagram is shown in Figure 2.

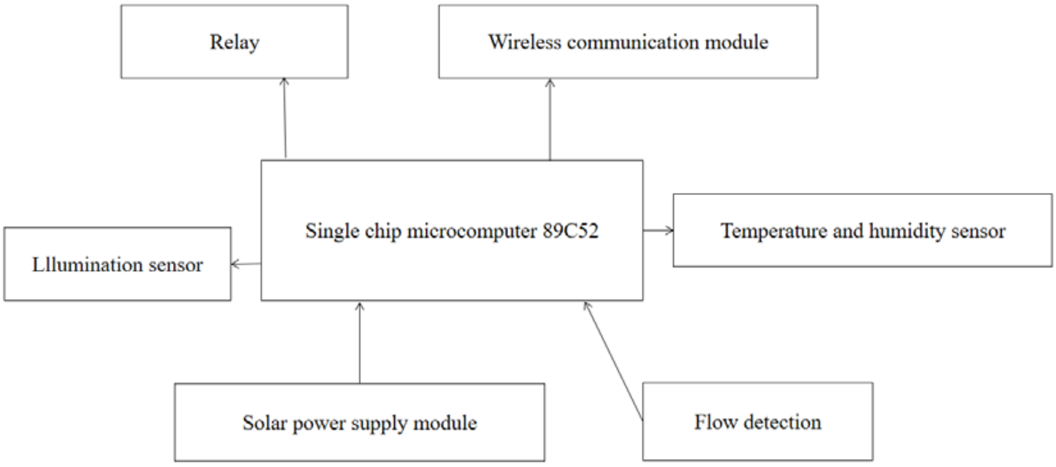

Fig.2 System Structure Block Diagram

3. Application of Intelligent Irrigation Estimation System in Crops

3.1 Experimental Conditions and Materials

The experiment took the common cultivation type "Hezuo" Pink Fanchi as the material (this variety has the following characteristics: first generation mating, super-large fruit type; Hybrid, middle-early maturity type, infinite type; Plants grow vigorously, suitable for cultivation in a wide area, and have strong disease resistance and stress resistance; The fruit is pink in color, high in spherical shape, thick in flesh, bright and tidy, strong in commodity, and durable in storage and transportation. Cultivation points: ① apply enough base fertilizer; ② Cultivate strong seedlings and plant in time; ③ The planting density is generally 1 plant in the greenhouse, the top of the four sequence fruit is artificially capped, and about 1 plant is cultivated in the open field; ④ First, strengthen fertilizer and water management after fruit bearing; ⑤ When the fruit is in harvest, do not flood the fruit to prevent the shoulder from cracking. In order to make the nutrient elements such as nitrogen, phosphorus and potassium meet the growth needs of tomato, fertilizer (urea and potassium dihydrogen phosphate) is applied once a day during the flowering and fruiting period. The amount of fertilizer applied each time is that after the potassium dihydrogen phosphate urea is completely dissolved in water, it is evenly applied to each pot of tomatoes. The function of intelligent irrigation decision-making is mainly realized by the on-site centralized control computer. In order to facilitate the use of farmers and reduce the space occupied by the centralized control center, the system selects an integrated computer with a touch screen to perform irrigation decision-making tasks. APC240 adopts half-duplex channel, which can quickly realize network connection with star structure. The working frequency band is 433 MHz and 470 MHz, and the transmission distance can reach 700m, so it has strong anti-interference ability. In addition, the embedded low-power RF chips sx1212 and ST single chip microcomputer have a transmitting frequency of only 10 m W, and are set in a dormant state, which effectively ensures the endurance time. The upper computer directly stores the received data of the soil water potential measuring instrument into My SQL database.

Although the accuracy of the above methods for monitoring state parameters in the process of crop growth can meet the corresponding needs, the measurement process is manual operation, so it not only consumes a lot of human resources, but also wastes a lot of time. Not only the living leaves of crops need to be picked for measurement in the monitoring process, but also some sensors are used to directly act on the stems and leaves of plants in the measurement process, Therefore, it has caused some damage to crops and indirectly affected the future growth and development of crops.

3.2 Test Treatment

In order to keep the soil moisture in the cultivation barrel within the set range, the experiment began with water sparing every day for days, water bypassing every day, and normal water management resumed after the third ear of fruit was cored. Water treatment is repeated in each barrel, and each barrel is filled with fenliu. The improved single-stalk pruning method is adopted to prune the plants, and the main lotus leaves its ears and fruits for coring, while the lateral branches leave their ears and fruits for coring. The two intelligent drip irrigation modes adopt the same fertilization mode. The concentration of pure nitrogen fertilizer is 120g/m3, the ratio of nitrogen, phosphorus and potassium is 1:0.3:1.5, and the types of fertilizers are CH4N2O, KH2PO4 and KNO3. The area of each community is 3.9 square meters × 7.5m2, each treatment was repeated for 3 times, and arranged in random blocks. The drip irrigation system is adopted for both treatments, and the distance between drippers is 30cm to ensure that each plant corresponds to a drip irrigation port.

During the experiment, except for the different management of water and fertilizer, the other field management was consistent with the routine management of farmers. The angle between the stem and leaf can often be used to represent the spatial shape of the leaf, which is not only affected by nitrogen, but also can cause the movement of the stem and leaf when the crop moisture is too high or too low. The movement of the stem and leaf affects each other through each other. Tomato has a strong advantage of terminal buds, but due to the combination of competitive factors and variety diversity, lateral buds still appear in the axils of leaves during its growth. The growth rules of inflorescences on the lateral branches and the main stem nodes are basically the same, and one inflorescence grows every other node. Therefore, it is necessary to understand the varieties and production needs before tomato cultivation, and then prune, sort out the lateral buds and pick the heart properly during the growth process. Only when the flower buds of tomato are well differentiated can new leaves and branches grow, so the differentiation and growth of the number of flower buds and new leaves directly determine the number of new branches. In order to formulate a reasonable crop irrigation plan and determine the specific irrigation amount, we must have a good understanding of crop growth and environmental conditions. Earlier, we mainly relied on the experience accumulated by growers all the year round to carry out irrigation, or used some single measurement tools such as air temperature and humidity meter and soil humidity meter to measure. The measurement results are not only simple, but also can not accurately and comprehensively reflect the water demand for crop growth. In order to verify the rationality of the control rules, a field experiment was carried out, which proved that the fuzzy expert control method has better water-saving effect than the traditional control method.

4. Conclusions

To sum up, the suitability of climate and soil conditions directly affects the healthy growth of plants and is the main factor affecting plant growth. Informatization, accuracy, identification of water use in crop production and nondestructive monitoring of crop growth and health have become the core trends of agricultural diagnosis and development. The change of length parameters provides a certain basis for the implementation of reasonable irrigation in the growth process of tomato. Combined with the current situation of China's water resources and using intelligent irrigation control technology, a kind of environmental information that can monitor agricultural facilities in real time is studied and developed. According to this information, a reasonable irrigation scheme is formulated, which not only effectively saves water resources, but also enables the crops in agricultural facilities to obtain a balanced environment for long-term healthy growth. The system has the advantages of low power consumption, convenient configuration, low cost and wide application range. Some key grain and cotton production bases in China with a relatively high level of agricultural intensification, such as large-scale state-owned farms in Heilongjiang, Xinjiang Construction Corps farms and other areas with large scale of land management, high degree of agricultural mechanization, good agricultural production foundation, and high-quality employees Or production units, can carry out the production practice of modern precision agriculture with Chinese agricultural characteristics.

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