Research on the Agriculture Intelligent System Based on IOT

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***Abstract*—According to the need for transition from traditional agriculture to modern agriculture in China and the Spirits of 2012 Central No. 1 Document of the People's Republic of China, the agriculture intelligent system based on IOT is introduced for organic melon and fruit production. A number of new technologies were used in the system, such as RFID, sensors and so on. This system contains three platforms. The expert system service platform set up a mathematical model to capture the data of the growing melons, and then make a decision. The intelligent production management platform could control the plant environment, the supply of water and fertilizer. The Internet trading platform with traceability function is an extended service for fruit growers and consumers. It is significative that the Agriculture Intelligent System was developed to control the crop growth environment, and to optimize fruit planting management, etc. If the system is adopted in a large region, it will provide benefits to fruit growers.**

***Keywords*—IOT; agriculture intelligent system; growth model; melon; fruit**

I. INTRODUCTION

Not long ago, the Central No. 1 Document of 2012 pointed out: to improve the innovation of agricultural scientific research, and to make use of information techniques to speed up the development of the three issues in agriculture. It is an important step for the agricultural informationization that the agriculture intelligent system based on the Internet was used [1]. China is undergoing a rapid transformation from traditional agriculture to modern agriculture. It is significant to use agriculture intelligent system based on the Internet for organic melon and fruit cultivation. Organic fruits are cultivated widely in China, such as grapes, melons, watermelon, peach and pears. All of these need to be changed by using modern information technology. The demonstration effect would play a big role for agricultural transformation.

The main content of this project is to develop intelligent agricultural software system suiting organic melon and fruit production. There are three service platforms in the software system: organic fruit production intelligent management platform, an expert system service platform and the exhibition on line platform, as shown in figure 1.

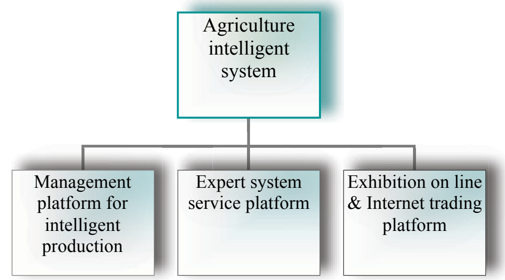

Figure 1. The modules of agricultural intelligent system

II. EXPERT SYSTEM SERVICE PLATFORM

By collection of melon and fruit planting domain knowledge and all kinds of experimental data, the experts system service platform could construct the database of expert knowledge. It adopts advanced data mining technology and a knowledge management engine to establish the agricultural production intelligence expert system model, and to realize the application platform with consulting and decision-making ability.

As an example, muskmelon production in a greenhouse, the rule-based expert system with "IF THEN" drills down into problem detail, captures data and solves problems. It can accurately adjust the melon greenhouse environment. Its control rules are derived from the experience and knowledge of experts. According to reasoning, we mixed the different period of muskmelon environmental factors and continuous correction, the system made the environment suitable for crop growth. It is important to establish the growth model and the expert knowledge base.

A. The Development Stage Simulation Model of Muskmelon

Equation (1) is growing degree days (℃・d).

$$GDD = \sum (T_d - T_b); T_d > T_b \tag{1}$$

Here, T_d is a threshold temperature of muskmelon development, and T_b is a daily average temperature.

The growing degree days in different development stages is as follows:

$$A_i = \sum (T_d - T_b); T_d > T_b \tag{2}$$

Here, A_i is the development stage of muskmelon GDD, the "i" is 1, 2, 3, 4 and 5 to refer to seedling stage, vine stretch, bloom and fruit stage, fruit developing stage, and fruit mature stage, respectively.

B. Photosynthesis Production Dynamic Model

A single leaf photosynthesis production model is such as (3)

$$PG = PLMX \times [1 - \exp(-\varepsilon \times PAR / PLMX)] \quad (3)$$

Here, PG is a single leaf photosynthetic rate of a leaf, $PLMX$ is the maximum photosynthetic rate of a leaf, ε is light conversion factor, and PAR is photosynthetic active radiation.

On that basis, we sum all the leaves, stems and fruit photosynthetic rates together, and define them as the canopy photosynthesis model. We use Gaussian integral method, to get the (4) to calculate the effective radiation absorbed by photosynthesis in the "i" layer.

$$LGUSS[i] = DIS(i) \times LAI \quad \text{(i=1,2,3,4,5)} \quad (4)$$

Here, $LGUSS[i]$ is a canopy depth of Gaussian layered, $DIS(i)$ is distance coefficient of Gaussian integration, and LAI is leaf area index of plant.

And then we get the daily total photosynthesis of the canopy, expressed as (5).

$$DTGR = (\sum (TFG(j) \times WT(j))) \times DL \quad \text{(j=1,2,3)} \quad (5)$$

Here, $TFG(j)$ is the instantaneous photosynthetic rate of the whole canopy, $WT(j)$ is the weight of the Gaussian integration, and DL is a day length.

The establishment of the other models also include a dry matter accumulation model, a respiration of maintain model, a respiration of growth model, a dry matter partitioning model and so on, [2]. In the support of the above model library, the expert system includes three parts: global database, regulation base and the inference engine. The inference engine is responsible for comparative content of the global database and the conditions section of the rules, choosing trigger rules, and solving problems in production.

Intelligence experts system is not only to meet the needs of the production for the organic melon and fruit, but at the same time also solve the problem of the lack of experts.

III. Intelligent Management Platform for Organic Fruits Production

Different from the traditional agricultural system that relies on experience and visual methods, the intelligent agricultural system gains environmental data in real time with IOT technology. We establish the control model for the organic melons and fruits growing environment. Melons and fruits from the sources, production, testing and logistics and other links have been managed with the visualization digital technology in the entire process through the platform, and a visual trace query of the whole production process can be provided for consumers. The project utilizes multiple sensors, such as temperature, humidity, light, chemistry on the fruits of growth process. In conjunction with RFID tag technology, tracing to the sources of fruits, grade, cultivation, production, quality control, transportation and other specific identifiable information can be stored and managed effectively in real time. The function with IOT technology can improve fruit quality and safety levels.

The software reserves control ports for fruit production automation. In accordance with the need, machinery automation equipment can achieve temperature control, humidity control, lighting control, water and fertilizer control. By automatic control strategy, we can complete the intelligent control process in fruits production. After sensors are loaded in a fruits garden, greenhouse temperature, humidity, light intensity, the carbon dioxide concentration and other indicators would be monitored in real time. The system could start the automation devices or notify a warning if it requires manual operation.

For example, there are differences in temperature requirements that the different varieties of grapes require. The most appropriate temperature of maturity time of grape is 28-32 ℃. If the temperature falls below 16 ℃ or increases to more than 38 ℃ is disadvantageous during grape maturation. If the system monitors temperatures higher than the set optimum temperature through expert system, the system would automatically control it, as in Figure 2.

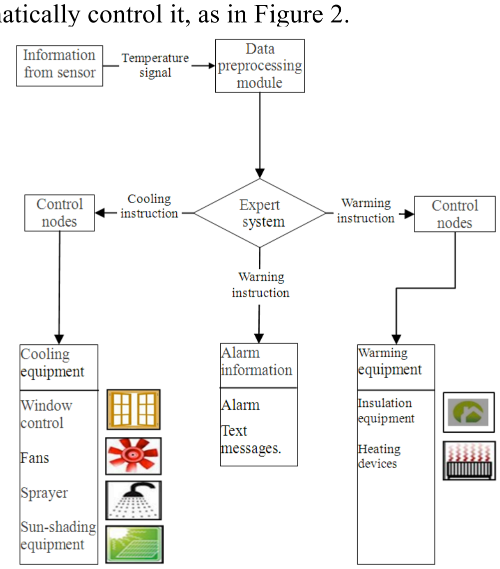

Figure 2. Temperature control

The light, humidity, CO2, water and fertilizer strategy are set by the local fruit experts as well.

IV. EXHIBITION ON LINE & INTERNET TRADING PLATFORM

The part of the online exhibition and Internet trading is the extended service platform. As the extension of melon and fruit production and management, it could enhance the added value of organic fruits and melons. The platform is easy to transact, provides fruit growers the benefit value maximization on one hand, and on the other hand, the platform is opened to the public, through the RFID on each box grape, which not only allows identification of the authenticity online, but also to view which greenhouses the grapes are planted is, and to find out whether they use pesticides and fertilizers. Consumers can also view vineyard production in real time. During the harvest season, consumers can see strings of grapes covered in bags to prevent pests and birds from eating them, rather than to simply use pesticides. This is key for local high quality fruits getting good words and for strengthening local fruit brand building.

B/S design-pattern was utilized to realize the platform of the online exhibition and Internet trading, and the database is an elaborate design. Online, customers can use universal IE or a compatible browser to view local organic fruits production in real time. Through the RFID tag identification code, consumers can query the traceability of products, such as planting date, picking time, product grade and so on.

The innovations of the platform are different from the normal E-commerce, as consumers can search all production data of each of the fruits though the unique identifier, and they can not only just query, but they can also play a supervisory role.

V. RFID APPLICATION & SENSOR LAYOUT

A. RFID Technology Application

In order to connect every melon and fruit to our databases and networks, an unobtrusive and cost-effective system of item identification is crucial. Only then can data about the items be collected and processed. Radio-frequency identification (RFID) offers this functionality. RFID technology, which uses radio waves to identify items, is seen as one of the pivotal enablers of the Internet. RFID systems offer much more in that they can track items in real-time to yield important information about their location and status [3].

RFID technology is a kind of non-contact type automatic recognition technology of making use of a radio wave to carry on communication. It discerns the target and obtains its relevant data automatically through the radio frequency signal. The discerning work doesn't need manual intervention [4]. RFID has great storage capacity, can read and write, and has strong penetrating power. RFID becomes a new technology favor in the recognition area.

RFID technology, the basic working principle may be summarized as follows: Tab to enter the magnetic field, the readers receive the radio frequency emitted by the signal, by virtue of induced current obtained by the energy stored in the chip to send out product information (Passive Tag), or take the initiative to send a frequency signal; readers read and decode information, and send to the central information system relating to data processing. A complete set of RFID systems, are from readers (Reader) and electronic tags (TAG) are the so-called transponder (Transponder) and application software system consisting of three parts, and its working principle is launching a specific frequency Reader radio wave energy to the transponder, to drive the internal circuitry transponder data sent, this time reading Reader will then receive data, and send the application to do the corresponding treatment.

B. Deploy Sensor Nodes of IOT

Under the precision agriculture environment based on the Internet, the wireless nodes are the ends of the unit. To guarantee the most appropriate environment for the melon and fruit, we call for higher requirements of the sensor nodes, and due to this, the nodes should be able to accurately detect the environment parameters as well as design and deploy the node suitably. It should cover the whole environment and maximize the efficiency of the system. The sensor node is usually an embedded system. Each sensor node contains a sensor module, a calculation & memory module, communication module and power module, as shown in Figure 3.

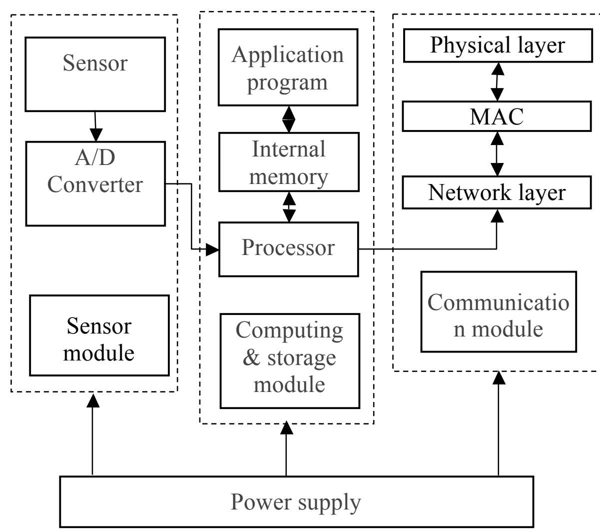

Figure 3. Structure of sensor nodes

In the WSN, the node deploy mode influenced the function and the efficiency of WSN to a large extent. In the demonstration test in the organic muskmelon and grape sheds, the node adopted TI CC2430 chip, with a RF2420 radio chip and 89c51 processor in it. The CC2591 chip is used to expand the communication distance; node-to-node transmission distance is as long as 700 meters. The system monitors the environment data and storage in the sheds. All monitoring nodes are using wireless transmission, and in the shed, according to the air temperature, humidity, carbon dioxide concentration, and illumination intensity of radiation we place the monitoring nodes every 10 meters. There are three levels in each monitoring point, and they are set apart from the ground height at 50 cm, 125 cm and 200 cm. We set three soil temperature and humidity sensor monitoring nodes in each shed. Their monitoring point is at three layers, which is located in soil under 5 cm, 15 cm and 30 cm.

The insertion soil model was used in the construction of deploy sensor nodes; we could place them quickly and conveniently while planting, and in the free season. They can be easily recycled to the warehouse. At the same time, if we have to increase monitoring nodes, we just set them up by the background system, doing no modification with the acquisition data node. Those nodes get power by taking both lithium battery power and solar panel power supply. According to the WSN node collection frequency and power consumption, when the acquisition frequency interval is equal or greater than 5 minutes, and low power consumption mode is used, the node devices can continue to work for 6 months.

In addition to RFID and sensors, the system also uses a number of new technologies such as 3G, ZigBee and so on [5] [6].

VI. CONCLUSION

Now that the intelligence agricultural system based on the Internet is still at the experimental stage, according to preliminary estimate, because we can fine-tune the control, plant diseases and insect pests in time, saving artificial working hours that can reduce the human cost and increase output. Because the network platform spread awareness of ecological melon and fruit production, the price will also get a boost. The intelligence agricultural system based on the internet was applied to the melon and fruit production, and its role is not just to let the farmers have shorter working hours, but more importantly, this has the ability to save costs, and improve the quality of fruits.

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