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Research and Application of Agricultural Intelligent Standardized Production Management Platform

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Abstract. In order to implement the standardization of greenhouse production management model and intelligent early warning mechanism, in this paper, the greenhouse crops such as cabbage and tomato in Beijing Tianjin Hebei region were studied, By studying the standardized process suitable for the safe and efficient production of greenhouse crops cabbage and tomato, a technical knowledge base were established. Combined with the IOT perception system, the author designed the agricultural intelligent standardized production management platform based on the MVC framework. The applicability and practicability of this management platform in the large-scale agricultural park were preliminarily verified, which would help to improve the standardization and scientificity of the production and management of the greenhouse vegetables. The design method of the management platform closely integrated with production management activities has great popularization value.

1. Introduction

China's agriculture is in the process of rapidly advancing from traditional agriculture to modern agriculture. The combination of agriculture and the Internet of things is an important technical support for agricultural modernization[1]. A large number of sensors, computer network technology and sensing technology are integrated and applied to every link of agricultural production. The process mainly includes a series of technical links, such as sensor information collection, wireless signal transmission, standardized storage, comprehensive statistical analysis, remote real-time monitoring and so on. The intelligent identification, location, tracking, monitoring and management of agricultural objects and processes can be realized through the Agricultural Internet of things[2], and the closed loop control of agricultural environment can be realized through intelligent control terminal[3], So as to highly informational, automatic and intelligent agricultural production can be realize.

The research and application of Agricultural Internet of things have achieved certain results in agricultural production management. Such as Jie Duan, Maoli Wang and so on, can monitor the environmental parameters of strawberry in real time and observe the growth of strawberry in the greenhouse with the technology of Agricultural Internet of things [4]. Such as Yanying Fan, Zimin Zhang and so on, can realize real-time monitoring of the height of maize plant height, soil nutrients and insect pests, and other information, and realize the whole process management for the visual distance diagnosis of corn growth with the Internet of things technology[5]. But at present, most of the research on the IOT system only attaches importance to the monitoring and analysis of the system platform for agricultural production environment data [6]-[8], and the lack of standardized planting guidance for crop production, The integration of Internet of things and agricultural production technology needs to be improved.

Based on the technology of Agricultural Internet of things, the author analysed the differences of planting elements of main greenhouse crops in different environments and different periods in Beijing Tianjin Hebei region. The author combed and formulated the corresponding standardized production guidance scheme and treatment technology of disease and insect pest, using digital technology to make the greenhouse crop production technology highly integrated with the Internet of things technology. Finally the author has designed and developed the agricultural intelligent standardization production management platform based on the Internet of things. The task-based production process management means , intelligent early warning and knowledge service are fully implanted into the construction of the Agricultural Internet of things production management system.

2. Analysis and research

2.1. Design purpose

In order to optimize and improve the shortcomings of the traditional agricultural production process in China, aims at the improvement of the quality of agricultural products and the practical demand of the scale production model. From two aspects of greenhouse agricultural production technology and management mode in Beijing Tianjin Hebei region, the main objective of this paper was to solve the following three problems:

2.1.1. Standardization production process. Relying on the professional and technical resources of the Agricultural Digital Resource Center of Beijing Academy of agricultural and Forestry Sciences, it focused on selecting the main greenhouse cabbage and tomatoes in Beijing Tianjin Hebei region as the research object, and combed the contents of agricultural activities, production elements, matters of attention, and technical solutions in the process of production, and taken the timeline as the main line. The distribution and correlation of production work resulted in the formation of personalized standardized production management processes for different regions, different varieties and different planting periods. The design and application of this process could provide standardized operation management and technical guidance for the greenhouse planting process of the above crops.

2.1.2. Design of Task-based management model. According to the standardized production process information, it was divided according to the minimum working unit, and the minimum work unit was managed as the task, and the computer database management technology was used to complete the digital editing and storage of the task information, so as to prepare the system function call. By dividing the tasks of every work in the production process, the task management model of standardized production process was set up, and then the data support could be provided for the realization of intelligent human-computer interaction.

2.1.3. Research and development of modular functional components. In order to ensure the reliability, stability, compatibility, security and scalability of the platform, its functional modules would adopt a component development framework. The development of functional components was based on the business logic of specific functions, which was intended to enhance the independence and applicability of functional components. In addition, in the design of functional components, it should be encapsulated in the form of dynamic links, and fully hidden the details of its content, and then facilitated the loading or unloading of the components.

2.2. Design work flow

The research on the standardized production process data according to the region, category and planting period was stored in the knowledge database of the platform. In the actual production, the platform system could be automatically matched, automatically reminding the production process for different sheds, or pushing the information of the technology, or the number of sensors. The process includes the following steps, as shown in Figure 1.According to the dynamic comparison, early warning and prediction were carried out. The setting of the task management module was equivalent to a "production Stewardship" for each shed. In the greenhouse, when the crops grow to a certain stage,this "production housekeeper" would provide the producer with job guidance, disease and pest guidance and early warning etc.

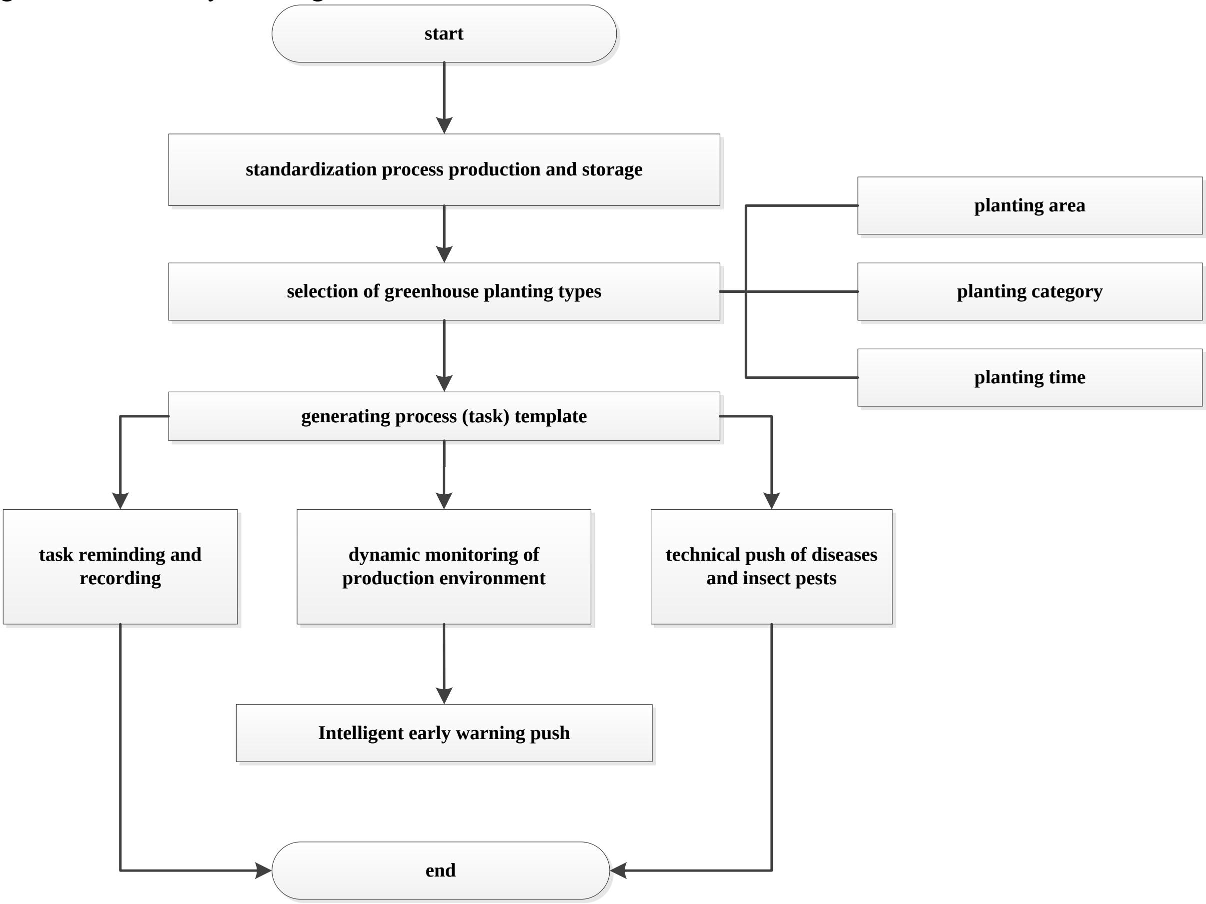

Figure 1. Work-flow diagram.

2.2.1. Standardization process. Taken the whole cycle of crop planting in greenhouse as the management object, maked the standardized production management rules in accordance with different crops, mainly covered the data resources of production environment, production task, disease and pest control, technical guidance and so on.

2.2.2. Standardization process production and storage. Sort out standardized production processes and establish logical relationships, which were eventually stored in the system database.

2.2.3. Selection of greenhouse planting types (planting area, planting category, planting period). According to the different areas and varieties of the greenhouse, we should choose the key information of greenhouse planting, which was the key link of the application of standardized production process and the actual production process of service.

2.2.4. Generation process (task) template. According to selected key information of greenhouse planting, the system automatically matches the corresponding standardization process in the database, and produces task-based modules based on this process to guide production.

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2.2.5. Task reminding and recording. Based on the generated task template, the system would send task alerts in advance to notify the producer or manager to perform specific tasks at characteristic time, and would collect the key information from the task execution to the system database.

2.2.6. The dynamic monitoring of production environment. Based on the production environment data in the standardized template, real-time monitoring data on the Internet of things and dynamic comparison, when the actual production environment exceeds the threshold range, it could automatically trigger the industrial control equipment and adjust the production environment.

2.2.7. Diseases and insect pests technology push. In order to improve the quality and efficiency of the greenhouse products, the system would provide early warning and prevention and control measures that might occur in the current greenhouse crops, in order to avoid or reduce the loss caused by diseases and insect pests.

2.2.8. Intelligent early warning push. According to the result of the production environment monitoring, the warning information was sent to the manager in the form of system information push, mobile end notice and mobile phone short message when it was beyond the normal range, so that the manager could find the problem in time.

3. Platform Design

The design of the agricultural intelligent standardization production management platform based on the Internet of things was designed to use the automatic perception of the Internet of things, the timed reminding of standardized production activities, the dynamic identification of intelligent warning and the active guidance of production technology as the core elements of the business. It adopted the advanced architecture design idea, rationally collocate its functional structure, and make full use of its functional structure. Considering the ease of use and friendliness, we strived to enhance user interaction experience while we met business needs.

The design of the platform would be described from three aspects: frame design, function design and interface design.

3.1. Platform Design

This platform adopts the design pattern of MVC, which was divided into model layer, view layer and control layer as shown in Figure 2. Each layer was absolute with each other. It was beneficial to enhance the robustness and stability of the platform, and was more conducive to the creation and reuse of components after stratification.

The design of the platform requires two aspects: hardware and software as shown in Figure 3. The hardware level mainly includes the selection of the sensing equipment of the Internet of things, the design of the transmission mode of the Internet of things and the access of the control equipment. Among them, the sensor equipment used in this platform should be based on the general standard of the RS485 industry, the network transmission adopted the wireless transmission mode of wifi+ap, and the control equipment need to support the logic switch.

The software level mainly includes the sensing data monitoring of the Internet of things, production task management, intelligent early warning, active technology guidance, automatic control, statistical analysis, related parameter setting and data management. Among them, the data monitoring could reflect the production environment in real time, the production task could be reminded regularly, the intelligent warning could be compared according to the dynamic quantitative index, and the technical guidance could be solved by the specific push technology according to the different production period of different varieties. Automatic control could automatically trigger according to the threshold value, and the statistical analysis could provide multi-dimensional data collection, parameter setting could be used for equipment access and equipment control.

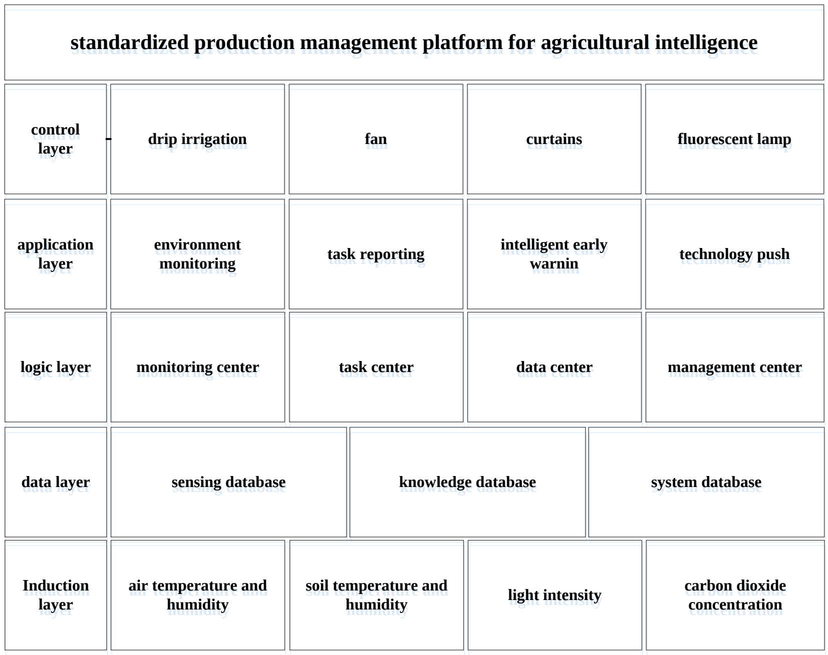


Figure 2. Functional structure diagram.

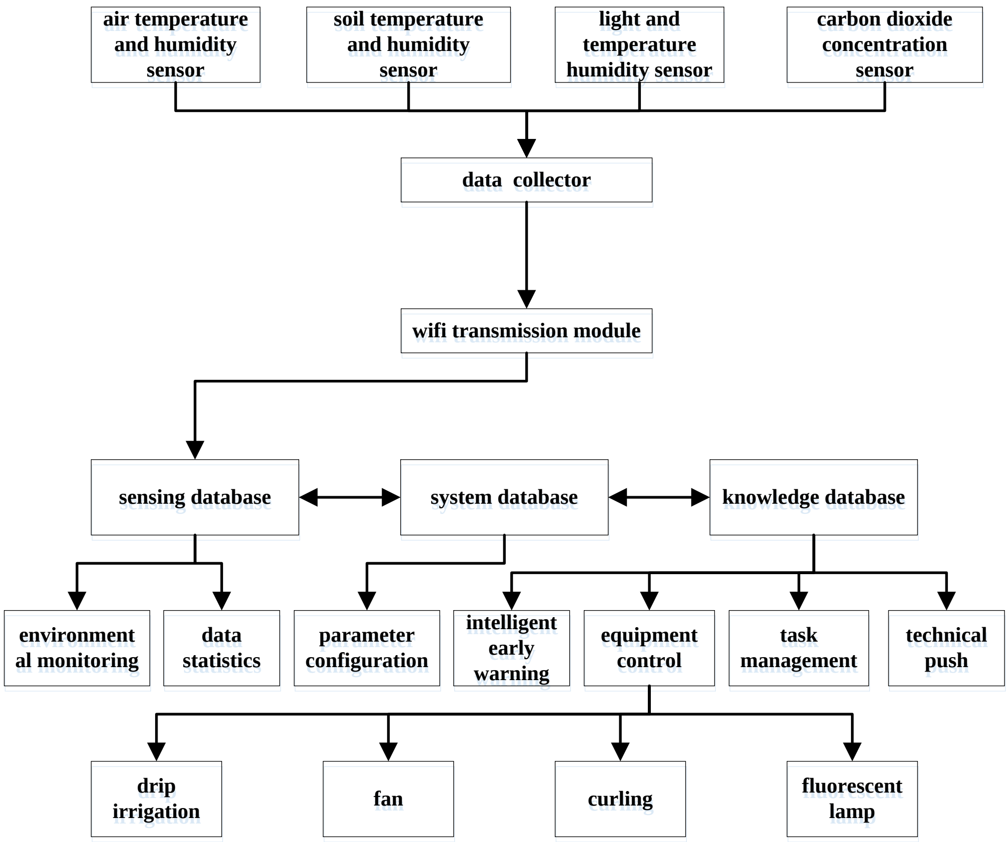


Figure 3. Data flow chart.

3.2. Function design

As the composition of the platform involves two components of hardware and software, its functions would also be explained from two perspectives: hardware and software. The platform hardware mainly includes sensing equipment, wireless network and control equipment .

3.2.1. Sensing equipment. In view of the environmental needs of greenhouse planting, the sensors in this platform mainly included air temperature and humidity sensor, soil temperature and humidity sensor, light intensity sensor and CO2 concentration sensor. In addition, a suitable data collector was needed for each group of sensors to be used for the acquisition of transmission signal.

1.Air temperature and humidity sensor. generally installed in the upper surface of the greenhouse above the vertical high level, used to measure the temperature and humidity of the greenhouse air temperature. The air temperature induction is a temperature measurement when the semiconductor material is changed by the temperature of the thermistor when it is changed by the temperature of the external temperature. The air humidity induction is the wet film of the polymer material covered by the humidity sensor. All measurements are generated in the form of electrical signals. Among them, the air temperature measurement range is from -30 to 70 C, the accuracy is + 0.2 C, the range of air humidity measurement is 0 ~ 100%, and the accuracy is + 3%.

2.Soil temperature and humidity sensor. Generally installed in the greenhouse surface below 1 meter vertically and horizontally placed to measure the temperature and humidity of greenhouse soil. The soil temperature induction is used to measure the temperature when the soil temperature changes with the change of the soil temperature. The soil moisture induction is the application of the circuit characteristics of the triode, which results in the change of the resistance value and the conduction current in the soil moisture content. Among them, the soil temperature measurement range is from -40 to 120 C, with an accuracy of + 0.2 C, and the range of soil moisture measurement is 0 to 100% with an accuracy of + 3%.

3.Light intensity sensor. generally installed in the greenhouse near the top of the canopy, used to measure the intensity of greenhouse lighting. Light intensity induction is based on the photovoltaic effect of semiconductor pn junction, that is, the change of PN junction under thermal equilibrium. The measuring range of light intensity is 0 ~ 200000Lux, and the accuracy is 7%.

4.CO2 concentration sensor. generally installed in the same area as the air temperature sensor, used to measure the CO2 concentration in the air. CO2 concentration induction is measured by different gas absorption spectra of infrared radiation. The CO2 concentration range is 0-5000ppm and the accuracy is 30ppm.

5.Data collector. generally installed with the power supply device in the control box, hanging on the side wall of the greenhouse. It is used to connect all sensors and communicate with them, and it can collect all the induction signals according to the required frequency.

3.2.2. Wireless network. In order to improve the convenience and applicability of the Internet of things, this platform will use WiFi wireless transmission as a data communication mode, and provide AP equipment to increase the coverage of WiFi, and thus ensure the stability of the network.

1.WiFi transmission module. This module is connected to data collector and sends data packets of data collector to target server through WiFi wireless network.

2.AP equipment. AP equipment, which belongs to the selection equipment, needs to be installed and deployed according to the specific network conditions of the agricultural park. It can be used to cover the WiFi signal of a large scale Park, and provide a stable network support for the data transmission of the Internet of things.

3.2.3. Control equipment. In order to improve the automation level of production management and reduce the labor cost, this platform wold adopt automatic control equipment, mainly including drip irrigation, fan, roll curtain and fluorescent lamp. In addition, a logic controller was needed for each control device for automatic control of the equipment.

1.Drip irrigation: a soil saving and water saving device for saving soil moisture.

2.Fan: a ventilation device used for ventilation in greenhouse.

3.Rolling shutter: a device for controlling shading boards, which was used to drive shading boards for shading in greenhouse.

4.Fluorescent lamp: a lighting device for lighting up the greenhouse.

5.Logical controller: it could connect different control devices, and realize the logic control of the equipment by means of digital to analog conversion circuit, logic circuit and relay.

3.2.4. PC end management platform. The platform software mainly includes PC terminal management platform and mobile terminal working software.The PC terminal management platform was mainly oriented to the management of the agricultural park, providing the management means of remote monitoring of the greenhouse environment, the management of greenhouse production tasks, the intelligent warning of the greenhouse environment, the remote control or automatic control of the greenhouse equipment, the standardized process management, the statistical analysis of the environmental data, and the configuration of the system parameters.

The functions of the management platform include: monitoring center, task center, data center, management center and so on.

1.Monitoring center: It mainly provided three functions: greenhouse environment monitoring, remote device control and intelligent early warning. Among them, the greenhouse environmental monitoring function could real-time capture and display its air temperature and humidity, soil temperature and humidity, light intensity, CO2 concentration and other environmental factors. The remote device control function could be used for remote operation of greenhouse control equipment, and supportted manual mode and automatic mode switching. The intelligent early warning function was based on the real-time data of the threshold curve interval and the environment factor in the standardized production process. When the threshold curve was beyond the interval, it automatically triggers the warning information reminding of the form of web page, mobile end and SMS. When the equipment control function of the management platform was in the state of automatic mode, it could automatically start or close the control equipment to regulate the greenhouse environment while sending warning warning.

2.Mission Center: It mainly provides the management function of the production tasks and progress of greenhouse cultivation process. After the standardization of the production process for the greenhouse, the timetable and progress bar of the production task of the greenhouse crop would be automatically generated, and the completion of the production task would be tracked. According to the different state of production tasks, it could be divided into waiting to be received, carried out, delayed, checked, rejected, terminated, audited, etc.

3.Data center: It mainly provided the statistics and analysis function of greenhouse environment information, triggering early warning information, production task information and other business data. Through the form of curve map, pie chart, histogram and data form, it provided the managers with visual analysis of production history data, which could provide the quantitative basis for the follow-up production management.

4.Management Center: It mainly provided the management function of technical resource data, platform user and permission information, platform parameter configuration information and platform operation log. Among them, technical resources refer to standardized production process and knowledge base, which could provide task reminding and knowledge push service for producers, and the users, rights, parameters and logs of the platform could provide the basic guarantee for the normal operation of the platform function.

3.2.5. Mobile end work software. The mobile end work software was mainly oriented to the producer of the agricultural park, which would provided the production services of remote monitoring of the greenhouse environment, the reporting of greenhouse production tasks, the intelligent warning of the greenhouse environment, the remote control of the greenhouse equipment, and the professional and technical guidance. The functional modules of the software include environmental monitoring, task reporting, intelligent early warning, and technology push etc.

1.Environmental monitoring: it could provide real-time monitoring of greenhouse environment and remote operation of control equipment, so that producers could understand the status of greenhouse environment.

2.Task report: it could receive the production tasks set by the standardized production process, and could complete the task report by recording the work situation and the scene photos.

3.Intelligent early warning: it could receive early warning information sent by management platform to remind producers to take corresponding measures in time.

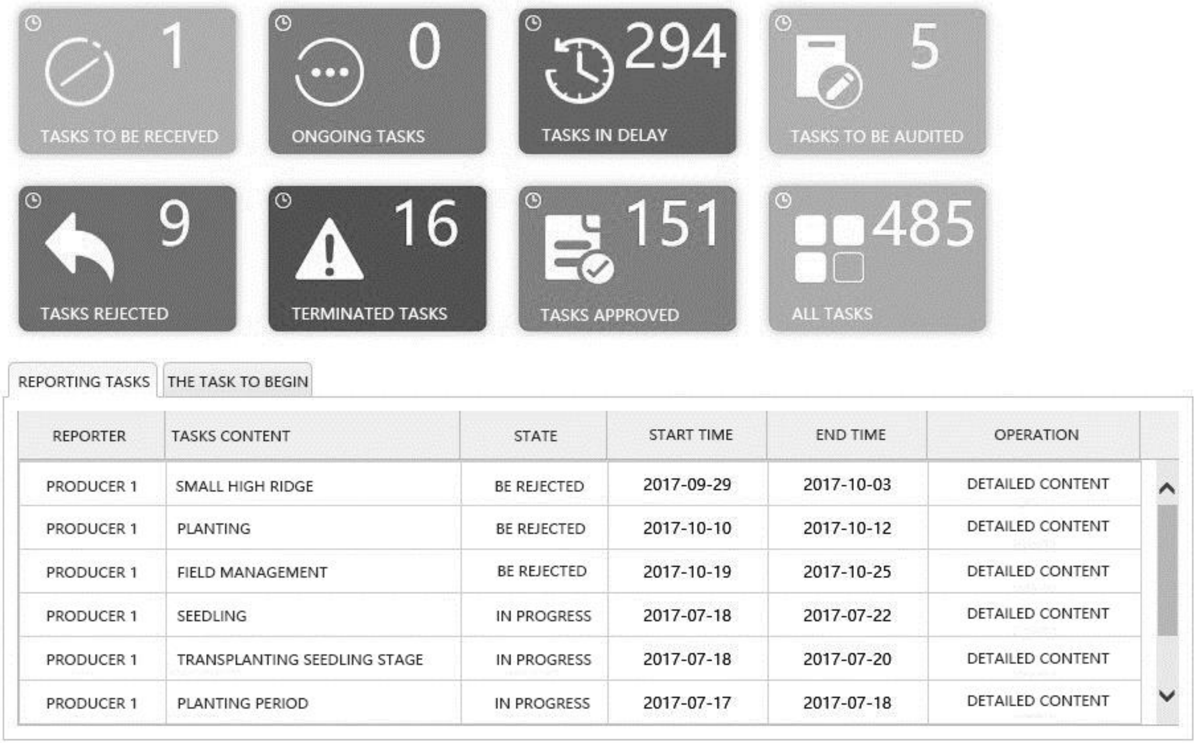
4.Technology push: the disease and insect pest control technology and treatment method set by standardized production process could be used to solve the technical problems in the production process and improve its scientificity and effectiveness.

3.3. Interface design

The design of the platform interface was mainly aimed at the interactive management interface of the software, so that it would have clear interactive logic, friendly operation mode and simple presentation effect, thus improving its good user experience.

The following figure 4 was the picture to show the interface of monitoring center , and figure 5 was the picture to show the task center of agricultural intelligent standardized production management platform , when cabbage was taken as the research object .

Figure 4. Management platform monitoring center interface diagram.



REPORTER	TASKS CONTENT	STATE	START TIME	END TIME	OPERATION
PRODUCER 1	SMALL HIGH RIDGE	BE REJECTED	2017-09-29	2017-10-03	DETAILED CONTENT
PRODUCER 1	PLANTING	BE REJECTED	2017-10-10	2017-10-12	DETAILED CONTENT
PRODUCER 1	FIELD MANAGEMENT	BE REJECTED	2017-10-19	2017-10-25	DETAILED CONTENT
PRODUCER 1	SEEDLING	IN PROGRESS	2017-07-18	2017-07-22	DETAILED CONTENT
PRODUCER 1	TRANSPLANTING SEEDLING STAGE	IN PROGRESS	2017-07-18	2017-07-20	DETAILED CONTENT
PRODUCER 1	PLANTING PERIOD	IN PROGRESS	2017-07-17	2017-07-18	DETAILED CONTENT

Figure 5. Management platform task center interface diagram.

4. Summary

By studying and analyzing the production factors of the main crops suitable for greenhouse planting in Beijing, Tianjin and Hebei Province, this paper has combed the production standardization process for different crops and the solution of common diseases and pests, and made it integrated with the technology of Agricultural Internet of things, designed and developed the agricultural intelligent standard based on the internet of things. The standardized production management platform not only realized the real-time monitoring of ambient air temperature and humidity, soil temperature and humidity, light intensity, CO2 concentration and other environmental factors, but also controlled the remote control of drip irrigation, fan, roll curtain, fluorescent lamp and so on. It also realized the standardization task management and intelligent early warning and technology guidance of the crop production .

Its advantages were mainly reflected in the following aspects:

- to study the standardized planting process for greenhouse crops in Beijing Tianjin Hebei region, and to implant in the knowledge base of the platform.
- according to the difference of planting conditions in the standardized process, intelligent self adaptation of early warning threshold could be realized.
- according to the different stages of the standardization process, the relevant pest control measures could be automatically pushed.

5. Prospects

Through demonstration and application of the agricultural demonstration park in Beijing, Tianjin and Hebei, the management requirements of standardized production operation have been realized preliminarily, and the reliability of standardized planting management method was verified. The platform would meet the needs of large-scale greenhouse production management, and has high practical value. It has a good application prospect and promotion space.

In view of the problems in the application process of the platform, improvements and upgrading are still needed. The following work will mainly focus on the following three aspects: one is to continue to study the standardized production process of other greenhouse crops, enrich the technical resources of the knowledge base, and then expand the extension and application of the platform; the two is the flexibility and applicability of the platform for the sensing equipment and automatic chemical control equipment of the Internet of things. Through the management of the standard interface parameters of the mainstream of the industry, it improves the friendly type of hardware equipment integration, facilitates the promotion of the platform and the reuse of the existing hardware equipment; three is to make full use of professional technical resources, expand the application scene of the production data, and improve the potential value of the data.

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