

The monitoring system for agricultural environment based on point surface fusion with the internet of things and WebGIS

Guifen Chen ^(✉), Yinglun Li

School of Information Technology, Jilin Agricultural University, Changchun 130118
guifchen@163.com

Abstract. Today, the technology of Internet of things in the field of agricultural environmental monitoring has been widely used, but the network monitoring technology based on the node is still faced with the monitoring points distribution design, data space, continuous expression and many other problems. According to the characteristics of agricultural environmental monitoring objects, this paper presents transference of zone simulation and evaluation method, design a set of things based on the "point" of the monitoring data and WebGIS solution based on the "face" of the space data fusion and analysis. In established networking monitoring center system platform based and optimization of WebGIS integrated graphical spatial analysis technology, in Helong and Kaian town of Nong'an County of Jilin Province in the national Spark plan experimental base fusion networking monitoring data and WebGIS spatial data points of agricultural environment monitoring system is established. System to achieve the display of data location map and transference of the regional simulation and evaluation, regional monitoring thematic map management three functions. The results of experimental base in maize field monitoring of growth for the case of application of the system show that the system can effectively realize the transference of agricultural environment dynamic monitoring of the region, corn crop disaster comprehensive monitoring ability can be improved, and can provide a more convenient application services for agricultural production management.

Key words: Agricultural environment · WebGIS · Monitoring · Internet of things · Point surface fusion

1 Introduction

Agriculture plays an important role in the national economy. The monitoring and management of crop growth environment is an important basic work to realize the sustainable development of agriculture. In recent years, with the development of electronics and communication technology, 3S, networking, cloud computing and big data is representative of a new generation of information technology, is constantly application in various fields of agriculture, promote the development of agricultural modernization pace. Geographic information system is a kind of computer support system which uses computer to control relevant data. It is mainly used to describe the distribution and attribute of objects in the real world. WebGIS is the product of the combination of web and GIS technology, the basic idea is based on network to provide geographic information service and WebGIS technology to the network map of this unique visual effects and geographic analysis functions and specific subject area system application and database operation is convenient and efficient integrated together. This feature promotes the GIS technology in the different fields of extensive development and application.

In the field of agricultural environment, the current domestic and foreign related networking

technology and WebGIS technology optimization and integration, real time monitoring of the Internet of things and WebGIS spatial information fusion analysis of the research has been reported^[1]. Internet of things is an extension of the application of the Internet, is the integration of sensing, transmission, intelligent decision-making and control functions of the integrated network system. The monitoring technology of the Internet of things is able to obtain the discrete points and time continuous data in a certain area in a timely manner, but there is not a continuous problem in the space. Therefore, networking and WebGIS technology combined to build things "point" of the real-time monitoring data and WebGIS spatial data based on "face" of the corresponding fusion analysis method based on to achieve expression of monitoring information in time and space, for agricultural IOT application provides more space to play.

This paper based on the pre established in the corn field growth monitoring center system of Internet of things, to maize growth environment monitoring as the research object, in the areas of data analysis and further research to investigate network real-time monitoring data and WebGIS spatial data fusion analysis method and application technology, the proposed transference of regional dynamic simulation and evaluation method, established agricultural environment monitoring system based on WebGIS and Internet of things^[2]. Finally, to national Spark plan experimental base in maize field growth for system application case, to achieve the transference of agricultural environment dynamic monitoring of the region, and can provide a more convenient application services for agricultural production management.

2 System organization structure

2.1 Agricultural environmental data collection based on Internet of things

In this paper, the system is built on the basis of the establishment of the monitoring center system of maize field in the experimental base. Farmland networking monitoring center system is in Nong'an County, Jilin Province maize areas on behalf of regional deployment field monitoring sites and on maize growth environment information real-time data acquisition and remote transmission to the center of the system, realize the dynamic monitoring of Maize in the whole growth process, has maize producing areas in agricultural county deployment complete several monitoring stations, initially built in the region in the monitoring network, but also provides a basic platform for this paper based on the point to plane fusion research of agro - environmental monitoring^[3].

The agricultural environmental data acquisition system based on Internet of things is designed by the three tier architecture of the Internet of things, and the 3 layer is the perception layer, network layer and application layer.

Sensing layer solved the problem of data acquisition of agricultural environmental factors. The sensor network is composed of a sensor node and a sensor network, and is deployed in the agricultural environment monitoring area. Monitoring node timing of regional monitoring environmental factors (such as location of different crops and different high in the air and soil temperature and humidity, precipitation, wind direction and wind speed) and image information such as timing acquisition and transmitted to the sink node.

The network layer solves the problem of long-distance transmission of data. The layer through the Internet and GPRS/3G mobile communication network access to achieve data remote transmission, and combined with the corresponding routing protocol and network security protocol, its security and stability of the transmission to the data center^[4].

Application layer to solve the problem of information processing and human-computer interaction^[5]. The layer composed of servers and other infrastructure platform and web applications, such as software platform, the main function is to agricultural environmental data obtained from each monitoring point for storage, distribution and analysis and other operations, the timely diagnosis and management decisions are made in order to solve the problem of the corresponding agricultural, applications and services for the user to provide. In this paper, in the application layer of graphical WebGIS spatial analysis technology of integrated optimization and establish the Internet of things based on the real-time monitoring data and WebGIS based on fusion of the "face" of the spatial data analysis, in order to realize the transference of agricultural environment dynamic monitoring of the region.

2.2 WebGIS crop growth environment data

The structure design of agricultural environmental data analysis based on WebGIS is composed of three parts: system database server, WebGIS application server, Web server and Web application program running on it. Database system, including database based on GIS, environmental factor database and expert knowledge database. Among them, geographic database for special GIS database recorded map point, line and plane space elements such as topological data and agricultural remote sensing thematic map of raster data, the data base of environment factor, surface storage monitoring sensor real-time acquisition data of environmental factors, expert knowledge database is stored crop seedling and disaster related discrimination indicator, historical experience, management measures, such as the knowledge data and indicators commonly used in statistics. WebGIS Application Server is the system realize the site map data display, regional monitoring thematic map making and other spatial data retrieval and composition analysis of the core of function and application service with a web service interface of spatial data in the form^[6]. The web server by running on a series of web application system has been realized and released to the user terminal data online, crop seedling and plant diseases and insect pests damage diagnosis, regional monitoring project management plan and to other platforms provide web service interface and other functions.

The user through a browser to the web server sends request, web server receives a browser request parsing into the corresponding operation instructions form respectively, access to the corresponding system database server and WebGIS Application Server, enquiries to the information of the monitoring data and GIS data back to the web server, after handle the web server returns to the browser, so as to realize the browser and the server dynamic interaction, and to the whole process of customer service. The structure of agricultural environmental data analysis based on WebGIS is technical route shown in Figure 1.



Figure. 1. Structure of agricultural environmental data analysis

3 System function design

3.1 System function module

Agricultural environmental monitoring network system in function mainly divided into: monitoring data online publishing, seedling diagnosis and monitoring of regional thematic maps of three parts^[7]. Application of WebGIS in the system function is mainly reflected in: data location map display, the transference of agricultural meteorological disasters in regional simulation and evaluation, crop seedling transference regional simulation and evaluation, regional monitoring thematic map management. Location map display data, namely the networking online map location monitoring point and real-time monitoring data display; simulation and evaluation of regional growth approach, is the core part of this paper is the system function, real-time monitoring and diagnosis of crop growth based on the results of monitoring points, according to the same ecological conditions within the region relatively consistent differences and regional between the conditions of apparent principle, simulation and evaluation of dynamic monitoring region; regional monitoring thematic map management, is from the point to the area according to the simulation results, dynamic display of online dynamic generation, storage area and timing monitoring of thematic map, including the monitoring of agricultural meteorological disaster region to obtain the thematic map, thematic map, crop growth monitoring from the region other platform of agricultural remote sensing thematic map, and the information and monitoring results of the corresponding regional expert decision and forecasting and early warning function etc.

3.2 Regional data simulation and evaluation

Usually case, ecological and climatic conditions in the same ecological type region within the scope of the identical or similar, climate and ecological factors in the same ecological type region showed uniform trend, and in different ecological areas is differences between the relatively obvious^[8]. Therefore, the collected agricultural environmental data can reflect the farmland area of the monitoring points on behalf of the state of the environment, and the same type of ecological zone representative farmland area of the state of the environment and further as a condition of the ecological types of regional agricultural environment at the beginning of further reflected. According to the characteristics of monitoring objects

and different precision demand, for a wide range of ecological type region and divided into several types of ecological sub areas, or followed by progressive cycle segmentation multilevel sub regions.

According to the corn growth environment of temperature, light and water content of the main climatic factors, combined with the characteristics of topography, soil types, production conditions, a corn production area is usually divided into a number of different types of ecological regions. This study within the same region in accordance with conditions are relatively consistent and inter regional differences significantly principle, based on networking has been established for maize test field monitoring sites and in corn producing areas of different ecological zones were selected representative monitoring area of farmland, and then in the representative agricultural field monitoring area were selected representative maize monitoring points. By means of monitoring and diagnostic results with a farmland monitoring representative areas in all the selected monitoring points in the region as state of the environment; in the same ecological area in all the selected representative areas of monitoring and diagnosis results of mean as the state of environment in the ecological zones, establish "monitoring points - the representative area of farmland ecological types district - the corn producing areas" from "point" to "face" of the regional dynamic simulation and evaluation.

This paper according to the selected monitoring points on Maize Seedling situation monitoring and diagnosis results of information were constructed from "point" to "side" of the regional dynamic simulation and evaluation and regional monitoring project in the form of graph to achieve regional monitoring data online map dynamic display.

4 System realization and result analysis

System interface using visual studio2012 integrated development tools to develop and networking sensor by multi node layered comprehensive sampling equipment, can be in different depth of the soil in the collection of temperature, humidity, air temperature, wind direction, wind speed, etc. data^[9]. Taking the corn growing experiment in Nong'an County as an example, the monitoring results are analyzed.

4.1 system function and interface

System users can perform related browsing operations to view and manage the location information, running status and distribution of the monitoring points^[10]. Can not only display, but also can be classified to choose to display a certain area or a type of monitoring site, select the user data required to display. The operation of maize growth monitoring system is shown in fig 2.

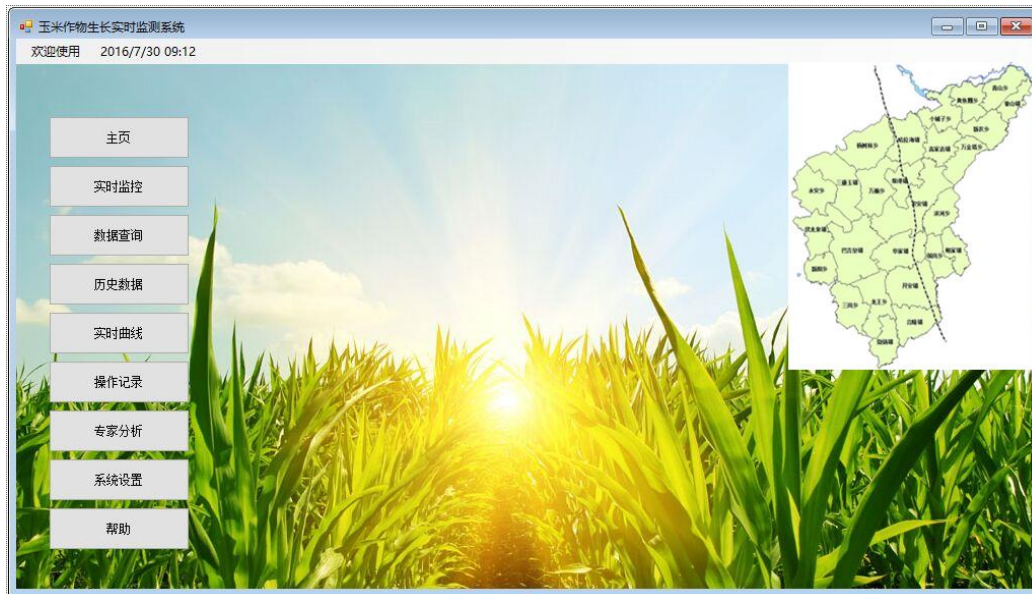


Figure. 2. The operation of maize growth monitoring system

Monitoring data real-time monitoring display, is based on the map and location information, the user through the choice of the monitoring point can query the site real-time acquisition of data and image information; can also through the selected query starting and ending time, historical data query and statistical analysis, such as: some environmental factors variation rule of different period, different years monitoring data of the same site longitudinal comparative analysis and index calculation.

To Jilin Nong'an County monitoring site, for example, in addition to HD camera installed in the field, sensor installation are: air temperature and humidity, soil temperature and humidity, wind speed, wind direction and other. The user through the system online map display interface not only can view real-time monitoring data, can also choose to query the historical monitoring data, and on maize growth, soil moisture content, irrigation and meteorological factors of online browsing and statistical analysis, and can also select the time period, data download.

4.2 real time monitoring of the Internet of things

In July 2016 5 to 11, for example, in Nong'an county corn plots monitoring site, according to monitoring data shows, July 5 to July 11, the time period, maize soil temperature and moisture change trend stationary. The time period can be output diagnosis results: monitoring point crop growth environment is suitable, the crops grow well. The following figure shows the soil temperature and humidity change trend of Nong'an county corn experiment monitoring sites from July 5th to July 11th. Its shown in Figure 3.

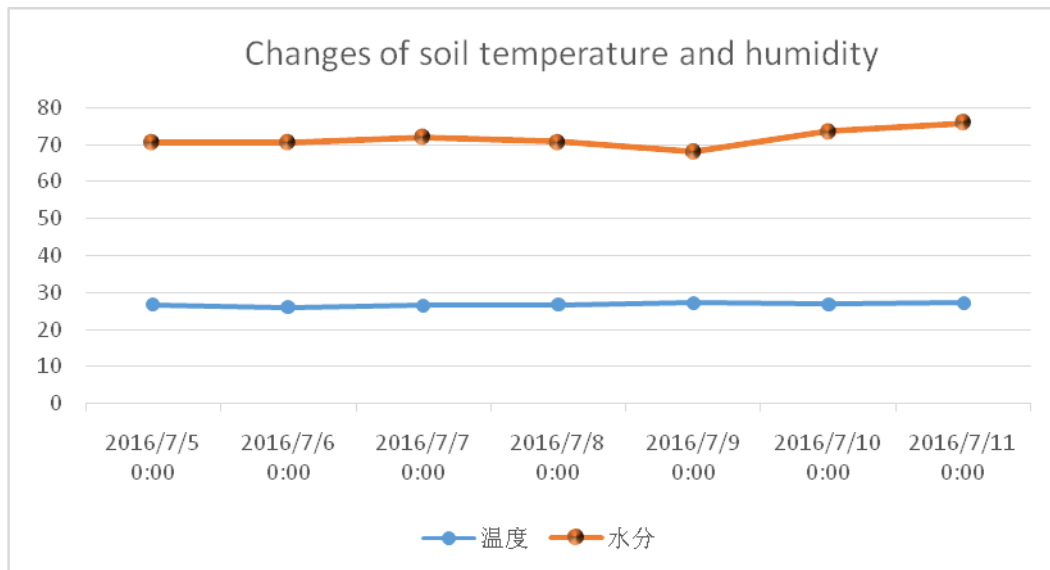


Figure. 3. Changes of soil temperature and humidity

4.3 Dynamic monitoring of soil moisture in point to surface area

According to influencing corn production temperature, light and moisture the major climatic factors, combined with the characteristics of topography, soil types, production conditions, and crop breeding, application status and variety development trend, corn producing areas in Jilin Province are generally divided into ten soil types in different regions: black soil region, chernozem, meadow soil, saline area, alkaline earth region, aeolian sandy soil areas, new product area soil, paddy soil, swamp soil, peat soil area.

For ecological and climatic factors can significantly reflect conditions in the same region relatively consistent characteristics of explicit and inter regional differences, the representative of the monitoring point data in the same ecological type region has strong representation. Therefore, in crop growth monitoring design for regional scale, this study selected representative monitoring area of the Jilin Province in different soil types in the region and in the monitoring area selected a representative maize monitoring site: Nong'an county corn plots, establish "real-time monitoring - representative farmland area monitoring ecological type regional monitoring -- corn producing areas in Jilin Province regional dynamic monitoring.

According to the above, on behalf of the real-time monitoring and diagnosis results of monitoring points, the system can automatically calculate the output of Jilin Province maize producing areas of crop growth situation from the point of regional simulation results. At the same time, the system according to the monitoring of soil moisture forecast and warning level, automatic transfer of expert knowledge database, to correspond to the waterlogging and drought evaluation and decision support and according to the system set respectively feedback to users in the corresponding region. Nong'an County Soil type map and regional dynamic monitoring of soil water as shown in the figure 4.

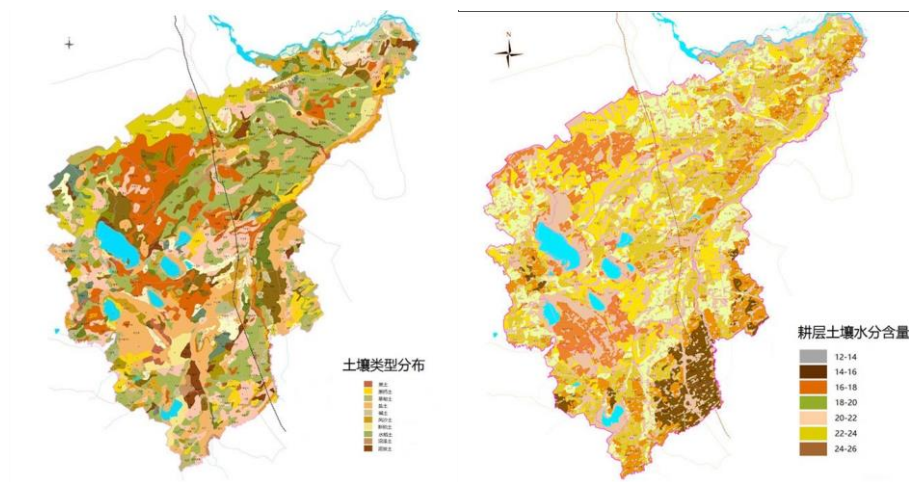


Figure 4. Soil distribution map and Dynamic monitoring of soil moisture

5 Conclusions and discussion

In this paper, agricultural environmental monitoring as the research object, the comprehensive utilization of geographic information system, Internet of things, computer network technology, based on the Internet of things and WebGIS technology of agricultural environmental monitoring system. Put forward the regional simulation and evaluation method of approach, design a set of things will be on the point of the monitoring data and WebGIS on the face of the spatial data fusion analysis solution; corn networking monitoring center system platform, the design and development of networking monitoring data and WebGIS spatial data points the integration of agricultural environmental monitoring system; simulation system realizes the monitoring and evaluation of regional data location on the map display, and based on the point to the surface of the crop growth monitoring and diagnosis results forecast and expert decision support analysis based on WebGIS graphical space function; finally in Jilin province corn growth monitoring for the case of the application of system analysis. The system can effectively realize the transference of agricultural environment dynamic monitoring of the region and to improve the diagnostic ability of agricultural environment and disaster, provide more convenient application services for the management of agricultural production.

The contribution of this paper is mainly reflected in the following two aspects:

- (1)The IOT transference of zone simulation and evaluation method is proposed based on the real-time monitoring data and WebGIS spatial data based on "face" integration;
- (2)Based on the above method, the system of agricultural environmental monitoring system was designed and developed, which realized the dynamic monitoring function of agricultural environment.

References

1. Sun Zhongfu, Du Kerning, Yin Shouyi. Development trend of Internet of things and perspective of its application in agriculture [J]. Agriculture Network Information, 2010(5): 5-8, 21.
2. Du Kerning, Chu Jinxiang, Sun Zhongfu, Zheng Feixiang, Xia Yu, Yang Xiaodong. Design and implementation of monitoring system for agricultural environment based on WebGIS with Internet of Things [J]. Transactions of the Chinese Society of Agricultural Engineering (Transactions of the CSAE), 2016, g2 (4): 171-178.
3. Jia Yangwen, Zhao Hongli, Niu Cunwen. A WebGIS-based system for rainfall-run off prediction and real-time

- waterresources assessment for Beijing [J]. Computers & Geosciences, 2009, 35(7): 1519-1525.
4. NieHongmiao, Jiao Yuntao, Zhao Mingyu. Research and design of Internet of things technology in precision agriculture application [J]. Techniques of Automation and Application, 2012, X1(10): 89-91, 97.
 5. Chen Tianchao. The basic framework of Internet technology overview. Teaching of Forestry Region [J], 2013(3) :64-65.
 6. Fu Jiang. Research and application of key technologies of Internet of things. Academic observation of goods and quality[J].2013 (9) :95-96.
 7. Dou Youguan, Wu Min, Deng Jiang. Discussion on the monitoring system of total cultivated land in China[J].Land science in China,1997, (4).
 8. Chris Hayward, Brian Stump, Paul Golden. The Korean Seismo-Acoustic Array [J]. 21st Seismic Research Symposium, 1999: 92-101.
 9. Eugene T. Herrin, Henry E. Bass. High-Altitude Infrasound Calibaration Experiments [J] Acoustics Today, 2008(4):9-21.
 10. Henry E. Bass, Milton A. Garces, Michael A. Hedlin, Infrasound Monitoring of Atmospheric Events [J]. 25th Seismic Research Review-Nuclear Explosion Monitoring: Building the Knowledge Base, 2003:577-586.