Application of GIS and Proactive Service Technology for Pests and Diseases in Cotton Field

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**Abstract.** Timely access to cotton pest data is the key to monitoring and control of pests and diseases in cotton field. The research which include pest information acquisition, transmission, storage, analysis and service release is based on GIS technology and proactive service model. Optimize made full use of Mobile GIS and LBS to realize collect spatial and attribute information of pests and diseases in cotton field fastly, real-time transmitted it to spatio-temporal database. Realized to spatial analysis on occurrence and extension of pests and diseases. Information services platform for cotton pests and diseases was built based on WebGIS and ArcGIS Server. The deviation of the location was within 15 meters and the whole process could be finished in 5s. Service product was then produced and released by adopting spatial information analysis method, which dynamically solved the key theoretical and technical problems of cotton diseases and pests information proactive service configuration, assembly, polymerization, optimization and data-push. Preliminary application indicates that this research proposes an effective solution for the entire process ranging from cotton pests and diseases information rapid collection, real-time transmission, unified storage, spatial analysis, service release to monitoring and warning.

**Introduction**

As one of the most important economic crops in Xinjiang, cotton accounts for 50% of China’s total in terms of production and the economic losses caused by comes to 15%-20% or so per year on average[1]. Information of pests and diseases in cotton field collected in conventional manual mode are few, resulting in inefficient and statistical analysis difficulty[2-3]. Affected by the passes, monitoring results of pests and diseases in remote sensing are obtained in the middle, late stage of the disaster and supported by validating on the ground[4]. However, GIS technology[5-7] facilitates the management of pests and diseases in cotton field by offering an effective solution for the entire process ranging from pests and diseases information collection, transmission, storage and analysis to service release, which is of great significance to enhance the level of collecting and monitoring pests and diseases information.

This paper mainly focuses on the need of monitoring and warning of pests and diseases in cotton field, discuss the business solution of pests and diseases in cotton field based on GIS, optimize make full use of Mobile GIS and LBS to realize collect spatial and attribute information of pests and diseases in cotton field fastly, transmit it using the JSON data format to spatio-temporal database in the server side via mobile network, build information services platform[8] for pests and diseases in cotton field based on Web AppBuilder. On the one hand, users can browse the current occurrence of pests and diseases, on the other hand, users can not only collect information but also receive infomation services by making the monitoring and forecasting thematic map of pests and diseases in cotton field based on GIS spatial analysis, processing information of pests and diseases visualization and publishing monitoring and forecasting services with ArcGIS Server, pushing the warning to specific users.
Mathematical Model and Methods

The Overall Design

The object of this dissertation is pests and diseases in cotton field. Designing and developing information services system platform for pests and diseases in cotton field. As shown in Figure 1, it includes layers of users, presentation, business logical and data. The user layer represents Android/IOS mobile intelligent terminals platform and Web Browsers. Each mobile phone could come into a tool of data collection as soon as install the acquisition App of pests and diseases in cotton field. Breaking the conventional way of data collection, to realize collect information of pests and diseases in cotton field timely. The presentation layer are the functions of mobile terminal and the PC browser implements, includes data collection and transmission, browsing maps, receiving monitoring service, map navigation, spatial query, spatial analysis, statistical analysis, etc. The business logical layer are the detail technology and service which support the presentation layer. The client include attribute editor, GPS positioning service, JSON data encapsulation and so on. The server include data parse and storage, process it with spatial analysis and publish as service. The data layer represent agricultural disasters comprehensive spatio-temporal database, including basic farmland geography data, spatio-temporal data of pests and diseases, meteorological data, user information, etc.

Information Acquisition Based on Mobile GIS

The study area was selected at 125 regiment, Xinjiang Production and Construction Corps, which is a continental temperate arid climate. The main crops are cotton, tomato, wheat, corn and alfalfa, etc. Cotton planting acreage accounts for more than 200 thousand Chinese acres, 90% of the total acreage.

The number of plants with insects in cotton field was recorded and counted to calculate the proportion. Based on the actual situation of the study area, the incidence of pests and diseases was divided into five degrees. Realized real-time acquisition of time, spatial (location) and attribute data (category and degree) of pests and diseases in cotton field by using mobile GIS technology. Collectors carried mobile phones to complete pests and diseases data collection, including browsing maps, editing point and polygon data, selecting category and degree, reading or selecting time,
using GPS location service. Collected data were unified encapsulated with JSON mode to the server. The server received the data by JSON parsing to storage the spatio-temporal database[9-10].

**GIS Analysis of Spatial Information**

It is of great significance to obtain hotspots of pests and diseases in cotton field by GIS HotSpotAnalysis and analysis the diffusion of pests and diseases using the inverse distance interpolation method in the aspect of monitoring and warning of pests and diseases in cotton field.

Taking an example of cotton aphid, the HotSpotAnalysis is based on the calculation of the Geti-Ord Gi * statistics for each field of the cotton aphid data set. The Gi * statistics returned by each field in the data set are z scores. The higher the score, the closer clustering of the high-value hotspots. For the statistically significant –z score, the lower the –z score, the closer clustering of the low-value (cold).

In the process of Inverse Distance to a Power, the mathematic theory is to calculate the Weighted Arithmetic Mean using the distance between the interpolation point and the known sample point, the weight corresponding to the known sample point. The number of known sample points closest to the interpolation point contribute the most to the interpolated point value, and its contribution is inversely proportional to the distance. During the operation, the Polygon To Point of processing tool was used to process the collected fields (shown as polygons on the vector graphic). Then Inverse Distance to a Power, Re-Classification were carried out to get the spatial distribution vector figure of aphids occurrence level in integer grade on a field scale.

**Information Service Based on Sharing Model**

The sharing-based information services of pests and diseases include making thematic maps, publishing pests and diseases services and pushing warning three parts.

Pests and diseases data was Rendered by marking different degrees. Then simplification or merging some categories, vectorization and registration, adding geographical coordinates were carried out to make thematic maps of pests and diseases.

The thematic map of pests and diseases was exported by using ArcMap to convert pests and diseases data to a vector-shaped (shapfile) map. The thematic map was published as a service for users in the PC browser or mobile phone to browse and obtain the location-based occurrence of pests and diseases.

The thematic map of pests and diseases information and map containing the farmers and lands information were cross-analyzed. Then serious areas were screened out by using QueryLayer of SQL. Finally, all of this precise information would be pushed to the user through the JPush platform.

**Construction of Information Service Platform**

Information service platform for pests and diseases based on WebGIS was designed and created by Dojo Development Components and Web AppBuilder Framework. Information of pests and diseases (including occurrence degree, spatial location, time of occurrence) was collected by using the mobile terminal. It was overlaid to the map containing cotton fields through aggregation and storage in the database. Then the different degree of pests and diseases was shown as the form of different size of aggregation points by the spatial analysis method.

As shown in Figure 2, by logging into the information service platform for pests and diseases in cotton field, users can monitor the serious field or region of pests and diseases. Degree chart of pests and diseases of the corresponding field was generated by statistical analysis. The areas or serious areas of pests and diseases were monitored by creating a buffer, finding hot spots to alert. It is integrated to manage, share and analysis pests and diseases in cotton field of the whole process. The platform can be applied thanks to its interactivity, fast response, rich user interfaces and embody.
Conclusions

According to the preliminary application, the acquisition App of pests and diseases in cotton field was designed and developed based on mobile GIS and LBS. Then loading the map, marking the location of pests and diseases and selecting degree were carried out to realize rapid acquisition, real-time storage and service browsing of the location, degree and time of pests and diseases in cotton field. Monitoring and warning model for pests and diseases in cotton field were built by using GIS spatial analysis and proactive service model to analysis the occurrence and spread of pests and diseases in cotton field and make monitoring and forecasting thematic maps. On the one hand, through publishing the service by ArcGIS Server, users can browse the current occurrence of pests and diseases with mobile phones. On the other hand, the information service system platform for pests and diseases in cotton field based on WebGIS was built to realize the management, analysis, sharing and precision transmission of the information of pests and diseases in cotton field and monitoring and warning service. The next step is to combine the meteorological information. According to the history of the evolution of pests and diseases in cotton field, the collected data will be in-depth analyzed in terms of time and space dimension to provide more accurate monitoring and warning services.

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