Design and Implementation of Service Platform for Wheat Nutrition Diagnosis

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Keywords: Service platform, Data Warehouse models, image processing, nutrition diagnosis model Introduction.

Abstract: For the shortage about research and analysis of wheat farmers for current nutritional status and disease of wheat, diagnosing the disease of wheat reasonably, nutrition diagnosis system was designed and established a wheat nutrition diagnosis platform based on image processing. Combined with the needs analysis, researched the framework design and business processes of wheat nutrition diagnosis system, and designed a massive data warehouse model with complex data structures based on data management and nutritional model based on image processing. Furthermore, in connection with the application of the system in changge, Henan province, the core applications and key technologies of platform during the process of realization were explored and shared.

1 INTRODUCTION

The traditional wheat crop nutrition analysis and disease diagnosis mainly rely on manual visual way and agricultural experts attending the seminar, but because of the variability of the environment and the diversity of growth in different stages of crop, leading to the deviations between diagnosis results and the actual growth of wheat. On the other hand, due to technical or expert personnel cannot arrive to the farmland timely and missed the best time of diagnosis, expert consultation revealed timeliness defects. And with the development and innovation of information industry and the technology, we can solve these problems by means of image processing and pattern recognition techniques. Therefore, we hope to build image recognition and image processing systems for real-time diagnosis of the nutritional status of wheat crop, which makes wheat nutritional management more scientific and standardized.

In recent years, various agricultural expert system based on nutrition diagnosis sprang up and has reached a mature stage. The international community has the majority of agricultural expert systems are widely used for aspects of crop production management, pest and disease diagnosis and so on (Wali, Emal; Datta, Avishek; Shrestha, Rajendra P, 2016, Reckling, Moritz; Hecker, Jens-Martin; Goeran, 2016). Development of Chinese agricultural expert system is also in a period of rapid development, has established a plant protection expert systems, pest control expert systems, and has been widely used (Yin Xiaogang; Wang Meng, 2016, Takashi Ohnishi; Yuka Nakamura, 2016). Although the agricultural expert system has been a maturing stage, the situation on the monitoring of crop nutrition expert systems is mostly for forecasting and diagnosis of pest crop, which is useless for this crop nutrients with normal growth. Therefore, for a large field wheat crop growing normally, we use database model and image processing technology, developing a nutrition diagnostic service platform for farmers timely access to the daily wheat growth status information.

2 PLATFORM GENERAL DESIGN

According to the different developmental stages of wheat growth characteristics, combined with lessons learned and wheat nutrition diagnosis disease cases, and the impact of field weather environmental factors, the wheat nutrition diagnosis service system is established, the process design shown in Figure 1.

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The system can obtain the image of wheat in each period by means of mobile collection device, and the collected moisture and image data is transmitted over the network to a remote database server for centralized storage and management of data classification. Administrators issued request through the Web server to the database to obtain the collected wheat image data, with image processing technology nested to the wheat nutrition model, access to information on the nutritional status of wheat leaves taken, in accordance with relevant knowledge and expertise nutrition diagnostic techniques, diagnostic recommendations are given symptomatic uploaded to the system home page for reference and learning.

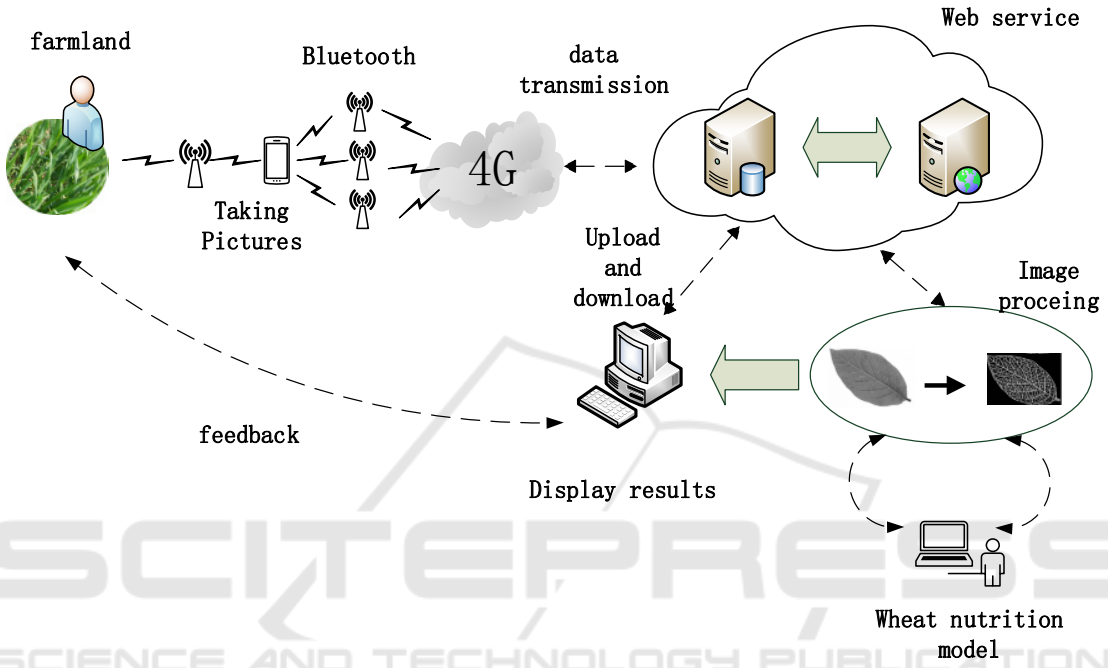

Figure 1: Process of design platform..

3 PLATFORM ARCHITECTURE DESIGN

According to the platform position and social function, considering the current status of wheat nutrition analysis and diagnosis, the overall logical architecture is divided into data service layer, the system support layer and the business application layer (Paradiso, Sean P; Delaney; Kris T, 2016).

i. data service layer

Data services layer achieves the main data collection, classification, storage and centralized provisioning. The system data services layer mainly consists of collection data, storage services data and application service data, which will feedback to the system user by the form of a form, line chart or mail to the system user.

ii. system support layer

System support layer polymerizes the dispersed, heterogeneous application and information resources through a unified access entry, to achieve various types of data resources and a variety of applications across databases and systems with seamless access and integration (Donatas; Aviža;Zenonas; Turskis, 2015). The system support layer mainly refers to safeguard and share common components of data and provide standardized management, including data storage and transmission, user information and administrator rights management, refresh and deploy storage data .

iii. business application layer

Business application layer mainly refers to help user registering wheat nutrition diagnostic services platform to perform operations and implement the corresponding function. Farmers and grain dealers can check the growth of wheat and nutrition analysis results within a certain time, what they acquire as a

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reference to adopt measures correlatively. Administrators need to go through the certification authority into the system management interface, giving a feedback to the user based on the current wheat nutrition diagnosis information, to improve the efficiency of the system.

4 PLATFORM FUNCTIONAL MODELING

4.1 Data Warehouse Modeling

Currently data warehouse modeling methods used commonly are paradigm modeling and dimensional modeling method. The paradigm modeling is mainly used in the data storage for relational database, and the modeling process is relatively simple. Compared with paradigm modeling, the data can be processed more efficiently in dimensional modeling, which method mainly used to solve the performance issues of modeling process. However, these modeling methods are mostly used for traditional structured data and unstructured data with simple construction, but there is a complex multi-dimensional relationship between the data and image information of system, which contribute to the results of using a conventional methods to establish regular contact will become bloated and inefficient, and data processing result will be too dependent on data structure relationships (L. Jiang; J. Xu; B. Xu, 2011).

Based on the analysis of different types of unstructured data, combined with user needs and experience, propose a complex unstructured data for mass data model structure. The system platform data modeling process is divided into four steps: business modeling phase, the concept of domain modeling phase, the logical modeling phase and the physical modeling phase, concrete steps are as follows:

- business modeling phase

Combined with business needs the business modeling phase can divides into four main blocks, including: user information, image acquisition, images processing and nutrition business model. According to the nature of the business, every division within each business module must determine the business topics and establish the appropriate contact, as a basis for analysis of the entire business processes and functions.

- concept of domain modeling phase

In the establishment of business processes, substantializing the abstract business sub-module with complex structure and sub-structure relationships to concrete elements of the system and its internal relations, adopt relational model to express the attribute information of unstructured data. Furthermore, two-dimensional table structure of relational model by adding the extended relational model to express complex structure of unstructured data, use object-oriented model to express the unstructured data (G. Bavota, 2016). Combined with the business needs, the system abstract the specific business template to basic elements, handle events, process results and descriptions. The basic elements include user information, weather, address, soil and other basic information; event processing refers to the various elements collected for processing and integration; process result incorporate nutrition diagnosis results and recommendations; descriptions contain the various indicators and wheat growth period introduction.

- logical modeling phase

Having established the relevance of each abstract entities, adhering the attachment into system during establishing process for data identification is needed (Tsou; Ming Cheng, 2016). Such as handling events for wheat image, also need to get their image numbers, acquisition time, collecting location, upload time and other basic information. After improving the basic attributes of the entities, should find out the relationship between the contact and abstract event abstract entities, and make explanation for which will complete the whole concept model series into an organic entity, and fully express service between associations.

- physical modeling phase

Physical modeling stage aim to incarnate the content of the logical model within implementation of concrete on physical media. Wheat nutrition diagnosis services platform adopts B/S structure, using MYSQL database to store the collected data. For business needs, the collected information and related properties of wheat image stored in the database with categorized, and generated the appropriate fact tables, dimension tables, and line charts on the Web side. In addition, the maintenance chart is established for database metadata and real-time feedback needs, and refresh the uploaded data timely to ensure smooth and safe operation of the system.

The database modeling design shown in Figure 2.

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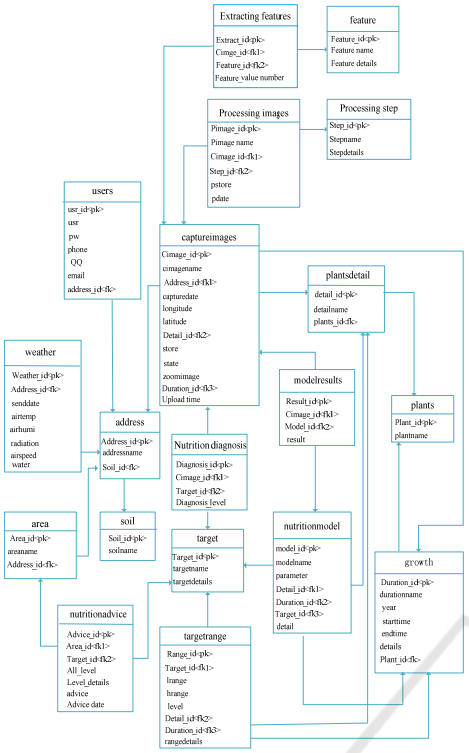

Figure 2: Data warehouse model design

4.2 Wheat nutrition model

Wheat leaf color and leaf shape not only visually reflecting its chlorophyll content, but also can show nitrogen metabolism in the body, therefore, the image of Plant canopy is closely related to the growth characteristics, the Contracts of light function and nitrogen nutrition status (Y. q. Qi, 2013). This system is through image analysis of chlorophyll content and leaf nitrogen content of wheat, in order to determine the nutritional status of wheat crops.

Full coverage sampling for wheat crop during jointing stage, take photos for wheat and get image the same day, moreover, measured the amount of dry matter of leaf stem, the leaf nitrogen content LNC and the values of chlorophyll content. In this study, choose white paper as the background, in order to achieve image segmentation of leaf and background using RGB image setting Thresholds. After the completion of image segmentation using RGB and HSV color model to describe nitrogen status of wheat, calculated hue (H, Hue), lightness (V, Value), saturation (S, saturation) and dark green index (DGCI, dark green Color index) using the average gray hue of all the pixels on the blade RGB channel (P. Wuttisarnwattana, 2016).

The main processing steps are as follows:

1) To overcome the impact of changes in light and shadow on the part of the image, take normalization process for wheat canopy image. In this paper, an improved normalization method is proposed, and the results are more scientific and reasonable, formula is shown as follows:

$$\begin{cases} \mathrm{r} = \dfrac{R}{\sqrt{R^2+G^2+B^2}} \\ \mathrm{g} = \dfrac{G}{\sqrt{R^2+G^2+B^2}} \\ \mathrm{b} = \dfrac{B}{\sqrt{R^2+G^2+B^2}} \end{cases} \tag{4-1}$$

2) Binarization, denoising and morphological opening operation processing were adopted for the object images. Denoising method used adaptive wavelet threshold model, which combines the traditional advantages of wavelet thresholding, while adopting adaptive processing for high-frequency wavelet decomposition coefficients of different amplitude on the basis of wavelet decomposition level (Sushanth, 2011, Xiao Qian; Ge Gang, 2016). Denoising model formula is:

$$\hat{\omega} = \begin{cases} 2^{1-n} \cdot \omega & |\omega| \geq t_2 \\ sign(\omega) \cdot \left\{ \omega - \dfrac{\sqrt{2\ln(i \cdot j)}\left(1+2^{(1-n)}\right)}{2} \right\} & \mathrm{t}_1 < |\omega| < t_2 \\ 0 & |\omega| < t_1 \end{cases} \tag{4-2}$$

Where ω denotes the amplitude wavelet coefficients, i, j denotes the image size, t_1 and t_2 denotes the thresholds, n denotes wavelet decomposition level.

3) Use the Fuzzy C-means algorithm for image segmentation, the objective function is:

$$E^{FCM} = \sum_{i=1}^{C}\sum_{j=1}^{N} u_{ij}^2 d_{ij}^2 \tag{4-3}$$

Where C denotes the number of clusters, N denotes the number of pixels in the image, d_{ij} denotes the gray distance, u_{ij} denotes the fuzzy membership for x_j to v_i, where v_i denotes the cluster center of number I, the Formula is shown as follows:

$$u_{ij} = \frac{1}{\sum_{k=1}^{C}\left(\dfrac{d_{ij}}{d_{kj}}\right)^2} \tag{4-4}$$

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After extracting the wheat based color characteristic, fitted with the same period of leaf nitrogen content in linear, tuning and determine the best-fit coefficients of three primary components, and determine the normalized color mix index under the RGB space (C. W. Lin, 2014). Through correlation analysis with NCMI, wheat leaf nitrogen concentration and chlorophyll content, demonstrate the nutrition diagnosis results based on wheat image processing.

5 PLATFORM REALIZATION

Wheat nutrition diagnostic services platform utilize the incremental development approach, set up the database and nutritional analysis platform based on collected wheat moisture and image data, and enrich the data of database with demand. Firstly, we must continue to improve the existing forms of distribution data in the data warehouse according to user needs. Moreover, it is necessary to continue to add moisture and image information of the respective growth stages of wheat late to the platform, formatting the new data marts and statistics.

The system adopts web Services as the core technology of application platform and information services resources integration, using MVC and Struts + Hibernate + Spring as the standard architecture. Interface performance uses html + css + JS as design framework, mainly utilizing PHP as a carrier to reflect the design concept, meanwhile reduce the interdependence of technology in internal internet system as far as possible (R. Sethuraman, 2016). The database platform store personalized management (authentication and rights of management, navigation, and retrieval), user behaviour log and system administration files. Server database is used to store wheat moisture data and image information, achieve data uploading and management implemented in the MYSQL database management system. In addition, the system management module is designed to provide a platform for the service module, management and maintenance of the database data platform to ensure the smooth and efficient operation of the system.

The primary interface of wheat nutrition diagnostic services platform shown in Figures 3 and 4. Figures 3 shows the wheat image information, users select the time and location information from drop-down box to view the corresponding conditions of wheat growing image. Figure 4 displays the nutritional diagnosis result after the image processing for selecting the wheat images, which analyzes the nutritional status judged by the content of chlorophyll and leaf nitrogen content of wheat.

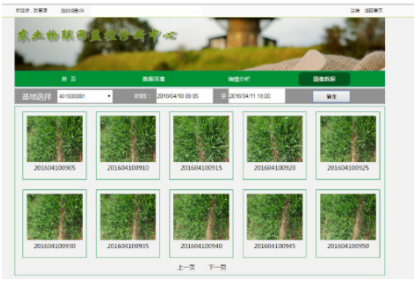

Figure 3: Wheat picture selection screen

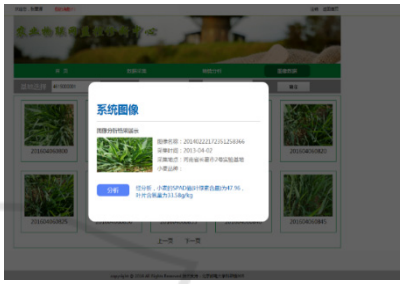

Figure 4: Wheat nutrition diagnosis interface

6 CONCLUSIONS

In this paper, the service platform for the wheat crop nutrition diagnosis and analysis at different developmental stages is established, with the method of rigorous architecture design and modeling analysis, and the platform design and image processing technology as the support. Through rigorous scientific methods and experience in agriculture proposed ways of Wheat Nutrition Diagnosis and put service platform into effect for the majority of farmers to use and reference. The system can meet the application requirements for farmers' judgment of growth of wheat in Plains, providing guidance for agricultural production, which is important for modern agricultural information management.

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