Research and Implementation of Agricultural Information Recommendation System Based on Situational Awareness

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Abstract. With the development of mobile Internet and the popularity of smartphones, the mobile phone has become the preferred tool for farmers to get information online instead of computers. Therefore, the use of mobile phone to solve the information transmission "last kilometer" problem, will be the most convenient and efficient way. On the basis of possessing a large quantity of high quality agricultural information resources, this paper makes deep processing of information, at the same time, based on mobile terminals, collects the multi-dimensional factors such as real-time situation information, user history browsing behavior and interest, expands vector space model, designs the agricultural information recommendation algorithm of situational perception and interest adaptation. Finally, the research and development of agricultural information recommendation system is realized. This system will provide farmers with accurate agricultural science and technology information and expert intelligence to meet the needs of thousands of people.

1. Introduction

2012 Central document first proposed "vigorously cultivate new professional farmers", then the provinces and cities combined with new vocational farmers education and training needs, carry out targeted cultivation work, farmers from the middle school to new agricultural production technology and management knowledge, training has achieved some effect, but there are some problems, such as training period centralized fixed, training content cannot meet the needs of different groups of people, training supporting technical tutorials lack of[1][2]. Thus, traditional training services cannot meet the needs of agricultural personnel for agricultural information, the urgent need to change the traditional training methods of vocational farmers, make full use of the current advanced information dissemination technology, to achieve high efficiency, high-quality information services[3][4].

With the development of Internet and communication technology and the popularity of smartphone, the mobile Internet has been developing in a blowout type. According to the China Internet Network Information Center published in August 2016, "2015 Rural Internet Development Status Research report" shows that as of December 2015, China's rural internet users up to 195 million, of which, the use of mobile phone access to the scale of 170 million, mobile phone has become the most important equipment for rural Internet[5].

Therefore, in view of the problems existing in the training process of the new-type professional farmers, combined with the characteristics of smartphones and the high penetration rate in the countryside, the paper studies the agricultural Information recommendation system based on mobile...
terminals, through the convenience of mobile phones, so that farmers can sit at home and even in the fields, anytime. Low-cost access to personalized training resources to meet the needs of farmers personalized information.

2. System architecture
"Farmer School" mobile learning Exchange system is mobile phone, pad and other mobile terminals as the carrier, the use of Java,.NET technology, developed a software installed on the Android phone app. The system covers more than 40 thousand resources of new varieties, technologies and videos of crops, vegetables, fruit trees, flowers, poultry and livestock. It can provide the users with the technical guidance of the whole process of agricultural production, agricultural video lectures, expert consultation, online learning, experience sharing and exchange, personalized information customization and so on.

The system framework of "Farmer School" is divided into four layers: data layer, language layer, technology layer and function layer(Fig 1).

Data layer: The Integrated breed aquaculture variety storehouse, the technical storehouse, the disease control storehouse, as well as the video database and so on, establishes the breed aquaculture knowledge base. At the same time, it extracts user's preference information from the user registration information, analyzes the user's daily browsing record, and constructs the user's interest table according to the user's current usage situation.

Language layer: The system uses Java, C#, HTML, XML, SQL Server and other languages for development.

Technology layer: The system uses intelligent aggregation technology, data mining technology, personalized recommendation technology, adaptive streaming reading and so on to construct the whole system of "Farmer Academy".

Functional layer: On the basis of data and technology, the system realizes functions such as information customization and push service, VOD service, farming farming services and system management.

The system architecture diagram is as follows:

![Figure 1. The system framework of "Farmer School"](image-url)
3. Technical difficulties and innovation

3.1. Build knowledge grid and user interest model
This system is based on agricultural thesaurus, adopts intelligent polymerization technology, constructs the dictionary of concept relation in agricultural domain, and will disperse the knowledge point in heterogeneous information resource database, and combine into an organic agricultural knowledge network to realize the knowledge association and sharing of agricultural information resources in semantic layer. At the same time, combining the agricultural knowledge grid to construct the user interest model, through the mobile terminal's WAE user agent to the user registration information, the region, the time, the agricultural production category, the interest preference, the browsing record and so on the multidimensional factor carries on the data mining, improves the traditional content recommendation and the collaborative filtering. At last, build a user interest recommendation model composed of multidimensional information. The system generates different resource requests according to different user interest model, translates to the data source server through the WAP gateway, the server according to different user's browsing topic and the real time situation information and the knowledge point in the resource base carries on the similarity computation, recommends the most suitable resources for the users (Fig 2).

Figure 2. Personalized information recommendation model

3.2. Self-adaptive streaming reading technology
Compared with traditional database, the knowledge base of farming industry based on mobile terminals is to realize the adaptive streaming reading for different specification mobile terminals, which needs to organize and transform the information reasonably. HTML-based web page files are converted to SVG (streaming files) based on XML language, through the SVG file of vector graphics, text, multimedia resources combination, custom style and deformation, so that the same information in different specifications mobile terminals can be adaptive to the normal display, user-friendly learning to explore, improve user experience.

4. System implementation
For the Android phone, the Java development language for native programming, the implementation of "Farmer school" APP. Happy Plantation, happy breeding garden, expert consultation, aerial classroom, farming farming and other functions, to provide farmers with the latest agricultural scientific and technological achievements information, expert intelligence, to meet the needs of agricultural technology extension and farmers training in various regions.

4.1. Login and registration
In order to obtain more information of farmers, facilitate the mining analysis of user behavior, the system uses the registration login method, the first login to fill in registration information, after the successful registration, the system will collect user registration information, and in-depth excavation, establish a preliminary user interest model, to provide users with a push of information services. The system mainly includes happy plantation, happy breeding garden, expert consultation, aerial classroom, my micro-video, farming farming, notice bulletin and my management 8 function modules (Fig 3).

Figure 3. Registration information and System home

4.2. Happy plantation, happy breeding garden
The system reorganizes and correlates 8 major species of planting information such as vegetables, fruit trees, melons, crops, flowers, poultry, livestock, and special breeds, and use the knowledge grid technology to combine the knowledge points scattered in the heterogeneous information repository into an organic agricultural knowledge network to realize the knowledge sharing of agricultural information resources in the semantic layer. At the same time, based on the user interest mining technology and situational awareness technology, the thesis develops the topic subscription and the related recommendation service function of multidimensional situational information based on mobile terminals, and realizes personalized subscription and directional push of the learning contents such as fine breed, main push technology, pest control technology, disease control technology and so on (Fig 4).

Figure 4. Happy plantation, happy breeding garden

4.3. Expert consultation
Based on the Expert Consultation service of Beijing New Rural Science and Technology Service Hotline 12396, this paper studies the text and image transmission technology based on 4G/WIFI
network, realizes the function of expert telephone line, expert text consultation, FAQ database query and problem reply, and provides convenient and quick Expert consultation service for farmers (Fig 5).

**4.4. Aerial classroom**

The video resources for agricultural technology, agricultural policy, management and other three categories, and unified transcoding, indexing and classification, according to user characteristics, the large video to break into micro-video, the establishment of training in line with the Farmers Video resource pool (Fig 6). The video resources in the system use H.264 video high compression technology to encode and compress the video, and achieve high concurrent support and high efficiency load balance by nginx the reverse proxy server. Based on the user's personalized recommendation algorithm, the video courseware is provided for the mobile users to meet the needs of the users to receive the education and training and obtain the individualized agricultural information.

**4.5. My micro-video**

In order to provide a platform for farmers to exchange ideas and information, the system uses socket large file transfer technology to achieve the video upload function (Fig 7). Farmers can take a section of their own experience or agricultural practice skills uploaded to the platform, after the system audit, other users of app can on-demand micro-video for learning and exchange.

**4.6. My management**

For the convenience of user management of the system, research and development of my management functions, this module can browse the learning footprint, view the articles and videos have been collected, view the user has consulted the problem, recommend to friends "Farmer School" app and clear system caching functions.

**5. Key technologies**

**5.1. A personalized information recommendation algorithm based on situational perception**

With the change of time, farmers ' demand for information has also changed. The recommendation algorithm based on content and user behavior only takes into account the resources and user level, the situation information such as the time point, geographical location and real time weather of the behavior is not considered, which leads to the deviation of the user's interest. Therefore, the system collects a series of real-time situation information, such as user registration information, browsing time and page residence time, uses Bayesian learning method to calculate the correlation between information resources and the user's current situation, and combining content-based information collaborative filtering recommendation to realize personalized information based on situational awareness recommendation.

**5.1.1. Situational matching based on Bayesian learning method**
Using Bayesian learning method, the matching degree between the target agricultural information resource and the user's real time situation is computed, and the intelligent perception of the recommendation system to real-time situation is realized.

The model of situational matching based on Bayesian learning method is:

$$\mathbf{P}(\mathbf{D}_j|\mathbf{C}) = \frac{\mathbf{P}(\mathbf{C}|\mathbf{D}_j)\mathbf{P}(\mathbf{D}_j)}{\sum_{j=1}^{N} \mathbf{P}(\mathbf{C}|\mathbf{D}_j)\mathbf{P}(\mathbf{D}_j)}$$  \hspace{1cm} (1)

In the formula, the \(\mathbf{D}_j\) (1≤j≤N) is the agricultural information resource, the \(\mathbf{C}\) is the user's current situation information (time point, geographical location, weather, etc.), then \(\mathbf{P}(\mathbf{D}_j|\mathbf{C})\) is the probability that the user chooses to browse the information resources \(\mathbf{D}_j\) under the current user situation \(\mathbf{C}\). N is the amount of information resources; \(\mathbf{P}(\mathbf{C}|\mathbf{D}_j)\) is a priori conditional probability, which indicates the probability that the user accesses the resource \(\mathbf{D}_j\) condition \(\mathbf{C}\) in the past, \(\mathbf{P}(\mathbf{D}_j)\) indicates the probability of the user accessing the resource \(\mathbf{D}_j\) in the past, the above two values are calculated by the history of the user accessing the resource.

5.1.2. Content-based user interest matching

Through analyzing the user's registration information and browsing behavior to obtain the user's interest, using the vector space model to modeling the user's interest\[^6\], considering the change of the user's interest over time, it is necessary to update the interest of the user for a period of time so as to accurately reflect the user's behavior. In the user interest set \(\mathbf{n}\) time interval, each time interval time \(\mathbf{i}\) (0 ≤ \(\mathbf{i}\) ≤ \(\mathbf{n}-1\)) is equal, when \(\mathbf{i}=0\), expresses as the current preference, when \(\mathbf{i} \geq 1\), for the historical preference, sets the user's interest preference for \(\mathbf{p}_i\), then:

$$\mathbf{p} = \sum_{\mathbf{i}=0}^{\mathbf{n}-1} \left( \mathbf{p}_i \times \left( \frac{1}{2} \right)^{\mathbf{i}} \right) \quad (1 \leq \mathbf{i} \leq \mathbf{n})$$  \hspace{1cm} (2)

Calculating the weight of resources by the classical TF-IDF method, the information resources \(\mathbf{D}_j\) (1≤j≤N) can be constructed as a resource semantic vector \(\mathbf{D}_j = \{d_1, d_2, \ldots, d_k\}\) among them, \(d_k \in [0, 1]\), it denotes weight value\[^9\].

In the end, the target resources \(\mathbf{D}_j\) is matched with user interest preference \(\mathbf{P}\) which is calculated by cosine similarity. The formula:

$$\sin(\mathbf{D}_j, \mathbf{P}) = \frac{\mathbf{D}_j \cdot \mathbf{P}}{||\mathbf{D}_j|| \times ||\mathbf{P}||} = \frac{\sum_{\mathbf{k}=1}^{\mathbf{k}} d_{\mathbf{k}} \times p_{\mathbf{k}}}{\sqrt{\sum_{\mathbf{k}=1}^{\mathbf{k}} d_{\mathbf{k}}^2} \times \sqrt{\sum_{\mathbf{k}=1}^{\mathbf{k}} p_{\mathbf{k}}^2}}$$  \hspace{1cm} (3)

5.1.3. Information recommendation algorithm based on situational awareness

Combining the matching of resources and real-time situation and the matching of resources and users' interest preference, the information recommendation algorithm based on situational awareness was formed to achieve the recommendation rating of target resources.

The formula:

$$\text{TargetRes}_j = \lambda \cdot \sin(\mathbf{D}_j, \mathbf{P}) + (1-\lambda) \cdot \mathbf{P}(\mathbf{D}_j|\mathbf{C})$$  \hspace{1cm} (4)

Among them, \(\lambda \in [0, 1]\) is the situational factor, which indicates the importance of user interest preference and real-time situational preference in recommendation algorithms. When \(\lambda=1\), the recommendation algorithm recommends users through the user preference context; when \(\lambda=0\), the algorithm uses the BAYESIAN learning method to implement situational recommendation. Finally, according to the score of the calculated resource, select the TOP-N resource and recommend it to the user.
6. Conclusion
The app is mainly targeted at farmers. It focuses on quality agricultural production management information and seizes the cell phone popularity, portability and other characteristics. It uses the recommendation technology based on situation awareness, and pushes the latest achievements of agricultural science and technology, expert intellectual resources to the hands of farmers by mobile Internet personalized. The APP is convenient for the kinds of farmers that who can query the varieties of information of the current situation, the production information management technology, expert teaching video information at anytime and anywhere. The realization of the APP which solved agriculture information transmission speed slow, low utilization, low radiation scope, the information content universality, simple agricultural experts resource scarcity, education training mode, as the expert intelligence into the fields, in the service of the new professional farmers training education add new way.

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