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Research Article

Personalized Geographic Information Service based on RIA and Data Mining Technology

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Abstract: The integration of GIS and Web technology makes public service-oriented geographic information service feasible. Personalized geographic information service needs geographic information service providers give the correct geographic information at the right time to the targeted users. In Web 2.0 environment, the pattern that users participate in geographic information services marks a new application model. This study studied personalized geographic information service and personal interest extraction and using RIA technology improved the quality of personalized geographic information services, which can provide users with better geographic information services.

Keywords: Data mining, geographic information, personalized service, RIA

INTRODUCTION

With the development of network and GIS technologies, WebGIS has been widely used as a new form of geographic information transmission and arouses more and more attention in our lives (Fuling, 2011; Rezeg *et al*., 2010; Min-Lang and Jung-Hong, 2010). At the same time, the demands of users for geographic information service are increasing gradually and personalized geographic information web services have been from academic research to practical applications (Eoin, 2006). Geographic information service is not only to provide a simple position and location information, but also to provide the personalized geographic information to public users and to give an in-depth and high quality geographic information service. In order to provide the better geographic information services to the users, new technologies and novel approaches are demanded to enrich the contents of personalized geographic information services.

LOCATION BASED SERVICE

Location-based service and Web GIS: Today, location-based service is one of the most popular services based on location. The integration of GIS and web technology makes public geographic information service possible. WebGIS can be simply defined as geographic information service on the web, which is a new technology using the internet technology to improve and extend geographic information system functions. By WebGIS, we can publish geographic data and use the web browser access to the geographic information and find geographic information and analysis spatial information in any network nodes, which gives a necessary guarantee to the socialization of geographic information services.

Compared with traditional GIS systems, WebGIS has the following characteristics: Wider access scope; simpler operation, platform independence and lower system cost etc. and this makes GIS break through the domain limitation and start to socialize with a new application model. This kind of "socialized" demands that GIS faces the entire community and meets needs of the geographic information users from all walks of life, in short, it is "geographic data openness", "to simplify operations," " a personalized service".

Geographic information service: Web Service is a universal model of building application programs, which can be run in any operation systems supporting network communication. Different application programs access web service by internet protocols provisions and some standard data formats (HTTP, XML, SOAP) to get the desired results. Web Service can perform any tasks from simple requests to complex functions. Geographic information service based web service technology has the encapsulation, loosely coupled and standards protocol specifications and high performance characteristics. Once it released, other application programs (web services) can find, activate and use the service. Like components, web service has the reuse functions and can provide inter-operation functions by various integrative function models on different platforms. From this point of view, Web

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service is both software and integrated platform of application programs. Application programs consist of web services from different sources and work together, no matter what they are located or how they are performed. The reason why GIS attaches' weight to web services in that web service has been applied to one layer integrated to the existing system, not to make a new architecture. Although web services are based on client/server technology, web services using the different network layer from client/server, which can be deployed on any open and safe network environment. Web service adopts stateless connection technology and network nodes can be connected when necessary. Such a structure for the implementation of geographic information services has a useful and practical significance, which gives the solutions for many problems such as inter-operation and a cross-platform and help GIS software reuse and decrease the costs.

PERSONALIZED SERVICE AND USER EXPERIENCE

Personalized geographic information service: Today, geographic information socialization is changing with each passing day and the increasing demands of personalized geographic information need the geographic information service providers give the correct geographic information to the users in the right time when they face masses and various geographic information resources. In according to the special requirements of individual demands and environment characteristics, personalize geographic information service providers should gradually toward daily life and provide their services integrating with tourism, catering, shopping and entertainment etc. and this is a new challenge to the traditional information service pattern.

The characteristics of personalized information services are user-centered, user-interacted and service flexibility and these characteristics fall in with information service idea in the aspects as: face to information resource-face to information communication-face to the information users. However, although electronic map service technologies are widely used, for personalized geographic information service, there are some inadequate:

- Lack of effective measures on geographic information service provided for users. Although geographic information resource access approaches increased by geographic information service, however, it could not meet the difference need of the users and can't give a correct matching degree between the demands of the users and the information service provided by the provider, so there can't provide appropriate geographic information service policy and service pattern and service content.
- Lack of expandability and correlativity in geographic information services, geographic information providers should extend the field of the available geographic information service resources by providing more information and services to the users, such as the path information to the travelers for an arrangement. However, as they do not appreciate users' information and don't know the information understanding and digesting degree of the users, therefore, they can't provide more information.
- For professional users, they only obtain (relatively) complete geographic data resources through geographic information resource sharing provided by the geographic information providers, but the providers can't trace the relative information of the users. They don't know what the changes of the personalized demands and they have no means of knowing application model needs of the users, so they can't offer adaptive service for uses' automatic geographic information services.
- Geographic information resource deep-utilization. The construction of geographic information resource sharing is conductive to geographic information resource query and retrieval service. However, from the point of view of resource utilization, the existing geographic information sharing platform can't improve the efficiency and benefits of geographic information resource. Geographic information service providers must provide their resources for user-oriented and achieve geographic information resource deep-utilization.

User experience problem: Multi-Web technology applied in geographic information service represents geographic information system stepping into the era of geographic information service. After years of development and implementation of geographic information service throughout active page technology stages like CGI, Server API and distributed computing technology stages as CORBA, DCOM, Web service, then the system architecture has grown to maturity. However, no matter what technology is used, one issue never got a good solution known as the user experience problem (Timo and Aleksi, 2012; Wei *et al*., 2011). Usually, what the users have to face is weak interactive pictures and because of the interactive response reason, it needs mass and frequent communication to the server for data transformation, so it always falls into a long time waiting. In this case, personalized geographic information service is difficult to have a balance between the performance and user experience. The main reasons lie in synchronization interaction and data transformation model:

- **Limits of synchronous interactive model:** Traditional Web application adopts synchronous interactive model that users send HTTP requests to the server and the sever returns a new HTTP page to the client after process. This is an inconsequent user experience, while the server processes the request and during the time, geographic information user is in a waiting time.
- **Weakness of geographic data transformation model:** As most web browsers only support raster graphics and now, most geographic information services use static raster images, which can't avoid the limits taken by raster images, that is, image display must include information of each point. Usually, the file is big and greatly impedes network transmission. Meanwhile, not having intelligence, static image can't carry the searched information. The image can't have a scalable transform in the case of no loss data compress and thus its resolution and color is affected. The characteristic of raster image make that is not very well interacting with the users and static image is quite limited for complex map server on the web.

From the above, we can see traditional web application is the pattern which is based on HTML pages and static data transfer. Owing to web application complexity, this pattern can't satisfy finer and full range user experience demand, which is called experience matters. In order to advance personalized geographic information service level and quality to meet the users' personalized needs, geographic information service based on rich internet application technology with high interactive and rich user experience is presented and applied. For example, Google Map adopted RIA technology (Ajax) in online map application for the first time [8], its good and powerful user experience completely changed people's understanding for the online map services, but also rapidly promoted the RIA technology in the field of online mapping service application, meanwhile, in some extent, which gives an approach for users' demand diversification of personalized geographic information service.

PERSONALIZED INTEREST EXTRACTION

Towards the diversification of user needs and the deep utilization for professional users, how to get the user's personalized interests becomes a problem to be solved for geographic information service providers. In order to obtain the user's individual interest, geographic information service provider should track and dig on users' needs, especially in the Web 2.0 environments. In contrast to Web 1.0, Web 2.0 is a new class of Internet applications. Web 2.0 provides the user a creation role and share platform with a participation

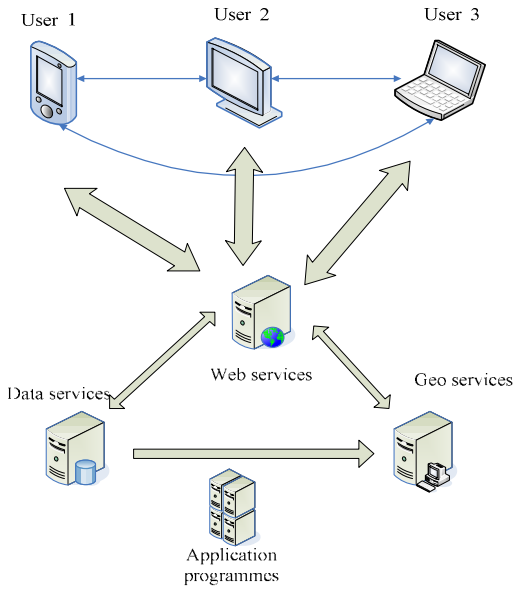

Fig. 1: Personalized geographic information service in Web2.0 environment

role for geographic information service and users become the creator and disseminator of geographic information service (Fig. 1).

Data mining (sometimes called data or knowledge discovery) is the extraction of hidden predictive information from data source and summarizing it into useful information. Data mining is a powerful technology with great potential to help users focus on the most important information in the data they have collected. With data mining technology, how to achieve personalized geographic information service has become the primary problem to be solved in personalized geographic information service.

Personalized user information base construction: The aims of geographic information retrieve is to obtain the most needed geographic information in the shortest time, therefore, geographic information service providers need to collect the user's relative information and geographic information resources queried by users and then to constitute a transaction database from the processes of the information services. For the transaction database construction, we take the following steps: first, feature set is to be identified if the access frequency exceeds a given threshold, which can be calculated by the association rules. Classification algorithms can then be used to match the similarity degree between geographic information users' browse patterns and access frequent item sets, finally, the clients with the similar browse patterns will be organized to a server, thereby, this can reduce the server cache and the number of pages transmission; Second, by use of association analysis, association rule will be saved to a server's knowledge base, when there

is a remote access request, the network proxy can associate the first link with the page in accordance with the user's geographic location, thereby, to enhance the response speed; third, when a user visits, the system can record the user information and user's click-through ratio, residence time, retrieve keywords and other user behaviors, these types of information collection can help to accurately grasp the individual needs and provide more accurate service.

Data pre-processing and data conversion: The collected user information and user behavior information processing and handling, such as data integrity and consistency analysis, is done, then the theme data warehousing is set up for data mining.

Objects of data mining determine and data mining: In according to geographic information users' changing needs, accurate information services is to be provided for specialized topics and personalized and friendly interface is also to be provided. According to the aims of data mining, the appropriate algorithm is selected and then to determine the data mining model, in this basis, the analysis and evaluation is done to test knowledge pattern gained from data mining.

Results analysis and knowledge application: This step is to give an interpretation and evaluation to the results of data mining and convert the results into understandable knowledge to users. In fact, the data mining process is a long process that requires constant testing and modification, until the user satisfaction.

Personalized information service realization: If user transaction database used by data mining technology is set up, we can carry out the user's personalized information services.

USING RIA TO IMPROVE USER EXPERIENCE

Rich internet application: The targets of personalized geographic information services is to conveniently access to the internet, which user can easily view 2D and 3D GIS data at various levels and can locate place by name search and have orientation, distance and area measurement, points of interest marked, screenshots print and other common operations. The public can also access geographic information service portal by the hyperlink, which has been built to obtain a more personalized service, but the current geographic information services have the following deficiencies in personalized geographic information services:

- **The complexity of service process:** Most geographic information services have a relatively complex process, which need to express as multi-option or a multi-step task. However, due to the limited interaction of HTML, it may lead to a very long page, thus, the user is confused. To avoid such intolerable user experience, the task would be required to be divided into multi-step and even by multi-page. As a result, the service process is a slow, unnatural, confusing and annoying geographic information user experience.
- **Combination complexity of geographic information service:** Many web GIS applications allow users to configure their own custom service model. A service can be divided into nearly atomic services. In according to the goals of different users, different services are used to combine complex service. But the service combination process is a very difficult process, especially when users customize the desired service chain from dozens, hundreds or thousands of service options. To express these complexities include the identification of the wanted service, valid and invalid combinations; and input and output conditions of services provided for each choice; and most important is to allow users to watch the final results.
- **Scale complexity:** In the current geographic information service web sites, many retrieve tools are based on text, while, they only provide the appropriate range of map or image. When users enter their retrieve content, there may be names, numbers, or scope; the site then replies a number of standard results which mainly rely on the retrieve text. Conversely, another better idea is to use visualization to simplify the corresponding retrieve process. Visual selection in a geographic information service website, the retrieve process as follows: the retrieve in a website containing all types of services starts from a result as a map image. When the user further refines the results or revises the results obtained via conditions attached, all the services do not meet the requirements will be removed, the services leaved only meet the requirements. Thus, in this process, users can experience a very different, but is more similar to the personalized service experience in real life.
- **Feedback complexity:** The processes of geographic information services is an interactive process, such as map retrieve process, users zoom in and zoom out, pan the map to change the display range and so on. What it needs is a highly interactive client application, so the whole page can be refreshed without interfering with the communication between the server and the client in order to give a response to user’s input and their state or interface change. Geographic information web applications must have the ability to express this complexity to allow users view geographic data, query large data sets and to allow interaction between users and data.

Geographic information service model based on thin-client architecture is that all data processing and calculations are done on the server side and an obvious disadvantage of this approach is that the interaction between user and the application must be passed to the servers, then, the servers response after receiving data and reload the page to complete the interaction with the client. RIA technology diverts the related processing about user interface to the web client and data (state of the application, business data, etc.) are still stored on the application server. The client application adopts an asynchronous mode to communicate with the backstage server, which is a new secure, scalable service-oriented model and has a good adaptability. This model is driven by the web service. The integrated communication technology combines with voice, video and real-time dialogue which has an unprecedented online RIA user experience.

Geographic information service model based on RIA technology fuses C/S and B/S benefits, which is also an improved network GIS. The client has the characteristics, such as rich expressive, high human-computer interactive capability and an expandable agreement between the client and server; meanwhile, it has a low-cost on the development and deployment. Using RIA to improve personalized service has more advantages than the traditional geographic information service model.

Personalized geographic information service: The mainstream of RIA technologies is Ajax and Flex, Ajax is more widely used, such as, online map applications are represented by Google map which is based on Ajax technology, but with the development of Flex technology, Flex-based WebGIS has become increasingly more popular, such as the yahoo map application is based on Flex technology [9]. Ajax and Flex, Each has its merits and are convenient for different occasions.

In our study, we use Flex technology for the development and deployment of personalized geographic information service. The architecture is logically designed as a three-tier model: the representation layer of geographic information applications, geographic information application server middleware layer and geographic database server layer. Server uses ArcGIS Server10 as a GIS application server, IIS as a Web server; database service layer adopts ArcSDE spatial data engine for spatial data management. Database uses Oracle10G to manage data:

- **Personalized geographic information service representation layer:** Personalized geographic information service representation layer is to provide the operation and interaction interface for a variety multimedia expression of geographic information. RIA-based personalized geographic information services is the various types of specific implementation provided by geographic information server layer, which is based on Internet/Intranet network and use the smart client (such as Flash Player) and browser (such as IE) to provide common G1S map operation functions, including, map display, zoom in and zoom out, pan pull extent, measure distance, measure area, clear highlight, print map, layer control, Hawkeye navigation, Meanwhile, the operations also include interest point distribution, personal mark, users link, map switching and other personalized contents, most system functions use web service components on application server as middleware to respond to the request for achieving real-time applications. Various geographic information stores on the web server as files or stores in the database server as database.
- **Personalized geographic information application server middleware layer:** Geographic information application server middleware is the focus of geographic information services. Personalized geographic information service management, resource allocation, database operations and other contents are concentrated in the application server. The middleware layer receives users' response information of the geographic information application representation layer and real-time call web services to connect backstage database layer to complete the personalized geographic information service function such as retrieval, query, location and spatial analysis and information dissemination. The services provide geographic name query and unit name query, road name query, bus stop and bus route information query and location function, especially, it provides bus transfer analysis, self-driving travel path analysis, the surrounding environment analysis and other personalized services, which dynamically real-time response to user requests and refresh retrieve results, so, this improves the user experience.
- **Geographic data resource server layer:** Geographic data resource server layer mainly completes multi-source, multi-scale digital maps, digital orthophotos image and other geospatial data resources storage and management. The database includes map database, thematic databases, remote sensing image database and model database and also include interest point data of the public concerned about. By means of relational database management system, the integrated large-scale storage and management of spatial database provides data backup, data archiving, data service, data security mechanism.

CONCLUSION

Personalized geographic information service is an improvement for public geographic information

services, which is to provide users an important means to enhance the value-added service. Therefore, it has great prospects in the future. RIA-based personalized information services now are relatively mature. Using data mining to get information of users' personalized requirements and to develop personalized information services make value for service providers and users. That can be expected, with the development of the Internet and information technology, in Web 2.0 environment, the emergence of new geographic (Neogeography) and Volunteered Geographic Information (VGI) and other service patterns have brought opportunities for geographic information services and technical support for personalized geographic information services will become increasingly sophisticated and personalized geographic information services will be more and more attention. Personalized geographic information service quality and efficiency will continue to improve.

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REFERENCES

Eoin, M.A., 2006. Personalised multimodal interfaces for mobile geographic information systems: Adaptive hypermedia and adaptive web-based systems. Lect. Notes Comput. Sci., 4018: 452-456.

Fuling, B., 2011. Seeing the World with Digital Eyes. Wuhan University Press, China, pp: 186-187.

Min-Lang, H. and H. Jung-Hong, 2010. A geospatial service approach towards the development of a debris flow early-warning systems. AISS, 2(2): 107-117.

Rezeg, K., M.T. Laskri and S. Sylvie, 2010. Geospatial web services semantic discovery approach using quality. JCIT, 5(2): 28-35.

Timo, P. and K. Aleksi, 2012. Understanding the most satisfying and unsatisfying user experiences: Emotions, psychological needs and context. Interact. Comput., 24(1): 25-34.

Wei, Z, L. Jiajun, S. Ying, Z. Mingfa, X. Limin, S. Yuzhong and R. Li, 2011. Dynamic resource allocation based on user experience in virtualized servers. Proc. Eng, 15: 3780-3784.