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Collaborative Plotting System Based on Web and Multi-Agent

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Abstract

The traditional collaborative plotting system is a single user plot in which users are independent of each other, and the data can't be shared among them. It can't meet the requirements of multi-users to collaborative plot in the modern society. In this paper, we proposed multi-agent technology applying into the collaborative plotting system, and designed a collaborative plotting system based on web and multi-agent, which can solve the problem of real-time collaborative plotting for multi-users. At the same time, it provides the map editing interactive interface and realizes the dynamic exchange of the plotting information. Also, it supports a wide range of collecting effective plotting data, and realizes a new way of information acquisition. Experiments show that the system based on multi-agent can achieve fast and real-time cooperation under the Web environment, and its response time is short and the system performance is stable.

Keywords: *Multi-agent; Web; Collaborative Plotting*

1. Introduction

With the continuous development of information technology, the Internet has become the main way of communication in this era. With the development of GIS, spatial data is becoming an open and shared information resource. The demand for computer supported cooperative work in entertainment, communication, research and education etc has become a trend of research and application. In the mid 1980s, a new research field, cooperative work (CSCW) supported by the computer, has been adapted to the information society in the way people work, group, distribution and collaboration [1-2]. It enables managers, designers and users in different places to participate, finish work together and improve the work efficiency [3].

Cooperative design system is generally divided into two categories [4]: Agent-based collaborative design system and Web-based collaborative design system, these two models have their advantages and disadvantages. Agent-based collaborative design system can realize the complex collaboration and more powerful functions, but the software functions need to be packaged by Agent, which has the requirements of client installation, the difficulty of software design and experiment. Web-based collaborative design system makes full use of the advantages of Web, it does not need to install the client service and access simply. But it can't complete the complex task well and has a drawback in real-time interaction and security. The multi-agent technology is used in the background of the server, and the front-end uses the preferable resource sharing of the Web, this way realize the multi-users collaborative plotting effectively. It does not only realize the complex real-time cooperation function, but also provide the security guarantees and reduce the difficulty of development and design.

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Web-based and multi-agent collaborative plotting system can solve the multi-user collaborative plotting problem, exploits the autonomous and sensing characteristics of agents [5], as well as the hardware and software resources, realizes the intelligent spatial data acquisition and processing [6].

2. The Design of the Multi-Agent Collaborative Plotting System

2.1. The Structure of the Multi-Agent Collaborative Plotting System

The Multi-Agent collaborative plotting model is the basis of the construction of collaborative plotting. It is implemented by the spatial data engine to realize the docking with the underlying data, the control of user access, and coordinate with the target. The key of the system is to construct the overall framework of the hybrid Multi-Agent collaborative plotting model, and study the role access control model based on identity authentication to authorize and access control, and then plots on the basis of it. Moreover, we studied the coordination of multi domain tasks, the mechanism of conflict resolution and the integration of multi-scale spatial data. Finally, this system can achieve the collaborative plotting between million users.

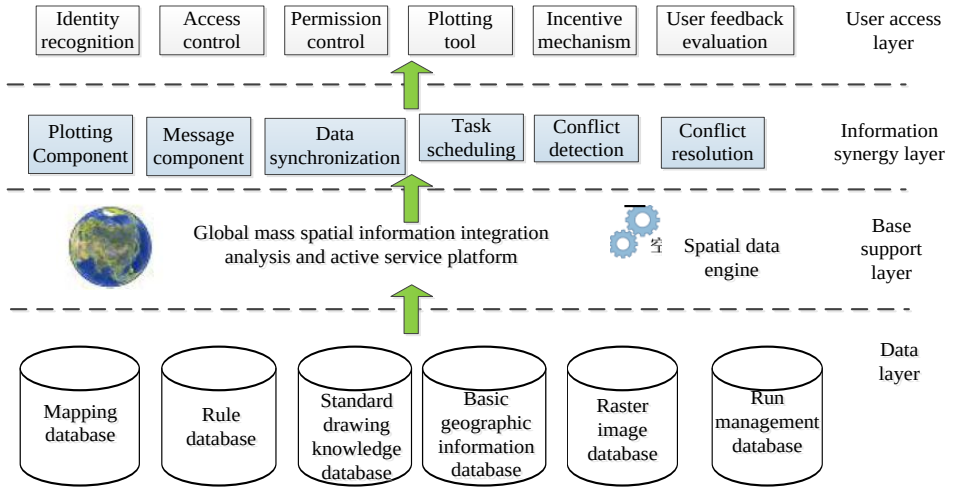

Figure 1. System Structure of the Multi-Agent Collaborative Plotting System

2.2. The Structure of the Multi-Agent Collaborative Plotting System

For the dynamic access of massive spatial information and the demand of global collaborative plotting, the system realizes seamless access and collaborative mapping of the dynamic real time of global massive spatial data. It establishes spatio-temporal association rule of spatial information by analyzing the spatial and temporal correlation properties of massive spatial information at the data level. According to the current processing tasks and the regional scope, and spatio-temporal association rule based on massive spatial information quickly retrieve relevant spatial information data, users realize the dynamic real-time seamless access of massive spatial information. At the collaborative mapping level, the global multi-agent collaborative plotting model provides a synchronous/asynchronous information interactive environment, and breaks through the conflict resolution mechanism of collaborative plotting, supports multi collaborative users to complete the collaborative plotting in collaborative environment.

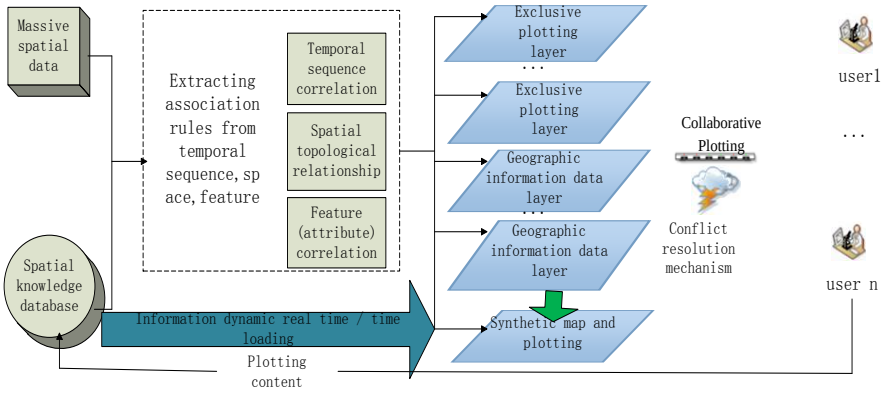

Figure 2. The Strategy of System Technology

2.3. The Service Flow of System

When visiting the Collaborative Plotting System, users should fill in the registration form, create the account after the verification of the mailbox, and then log on the system. New registered users will have the following rights: public editing interface, creating a working group, inviting other friends, chat communication. Flow chart is shown in Figure 3.

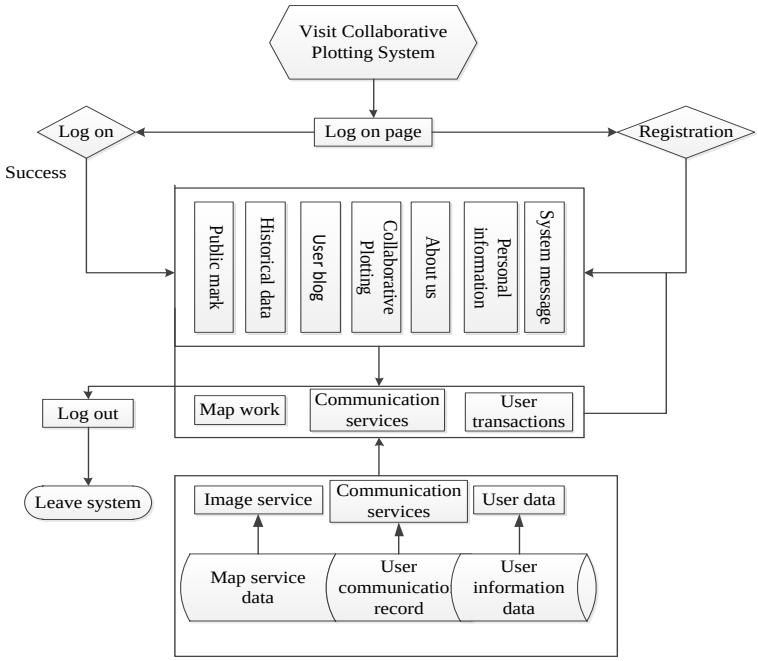

Figure 3. The Service Flow of System

After a user operates a transaction, the system will identify the type of each transaction to determine the final surrogate processing task function. The transaction is submitted to the system agent center, the system automatically senses the user's operation transaction, and calls the agent thread to perform data storage and retrieval. The system can handle different types of transactions in parallel. For example, users can work and deal with the communication transaction at the same time, users can carry out real-time text

information transmission among themselves. The system is effective when a user uploads and modifies existing plotting, and it will use the lock operation for the plotting elements to achieve thread synchronization and avoid the unsafe occurrence of the plotting elements.

3. The Key Technology of Realization of Collaborative Plotting System

3.1. Multi-agent Hybrid Collaborative Plotting Model

The global collaborative plotting has the characteristics of synchronous/asynchronous processing and cross working group/working group. Combining with the multi-agent technology, we designed a Multi-Agent hybrid collaborative plotting model. It provides synchronous/asynchronous information interactive environment and supports multi collaborative users in the collaborative environment for interactive spatial information processing, such as collaborative plotting, collaborative query and collaborative spatial decision *etc*.

In the distributed environment, a large amount of geographic information data, the confrontation property between two sides and interactive data are all reflected in the trend plotting system, the transmission and processing of various real-time data also need more resources to support. The collaborative plotting system is necessary to consider the way of the computer supported cooperative work (CSCW),that is using the multi-agent group cooperative working mode.

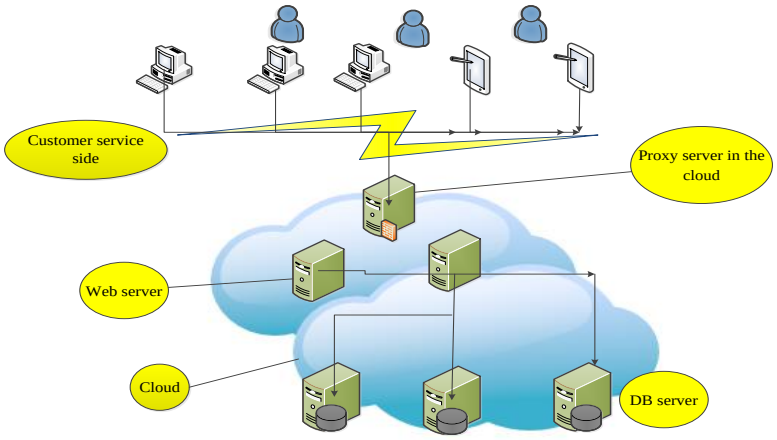

Figure 4. Multi-Agent Hybrid Collaborative Plotting Model

3.2. Role-Based Access Control for Identity Authentication

The collaborative plotting system based on multi-agent needs to support thousands of users to plot, so Role-Based Access Control (RBAC) is used to control these users. RBAC divides different roles according to the security strategy, using the improved RBAC strategy, that is Identity Role Based Access Control (IRBAC) [7]. It assigns users to one or more roles and related permissions. Finally it achieves logical separation of the user's collection and operation authority through the mapping of the user<->role (identity) <->authority.

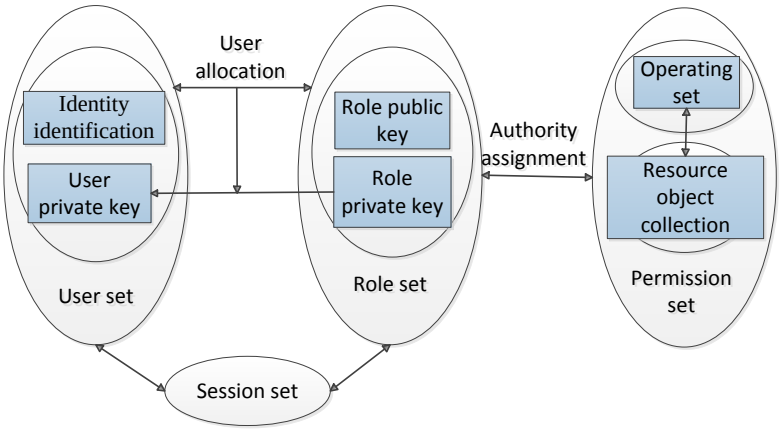

Figure 5. Role-Based Access Control Model for Identity Authentication

3.3. Content Integration of Multi Scale Spatial Data

According to different plots(same name of same place, different name of different place, same name of different place, different name of same place *etc.*), the different plotting data types integrate plotting content automatic or semi automatic. The system analyzes the characteristics of different application types of plotting data, then analyses, extracts and transforms source data. It establishes data integration standards and quality control system (fault-tolerance and accuracy rate), and makes a breakthrough in the standard among data source and the control of abnormal data, then realizes content integration of multi scale spatial data.

The differential elimination of the plotting content, such as elimination of differences of semantic, space-time dimension and coordinate system etc, solves the differences between different standards to ensure the accuracy of data. The integration process of the plotting content is firstly declaring ontology plotting rules by establishing a semantic ontology library. Then it filters the data and data verification to realize the quality control. Secondly, the logical operations of data items are carried out to generate the derived data items. Finally, according to the principle of the classification, data sources and the authenticity of the data, the fault tolerance management of spatial data is integrated, which can guarantee the correctness and fault tolerance of the whole data.

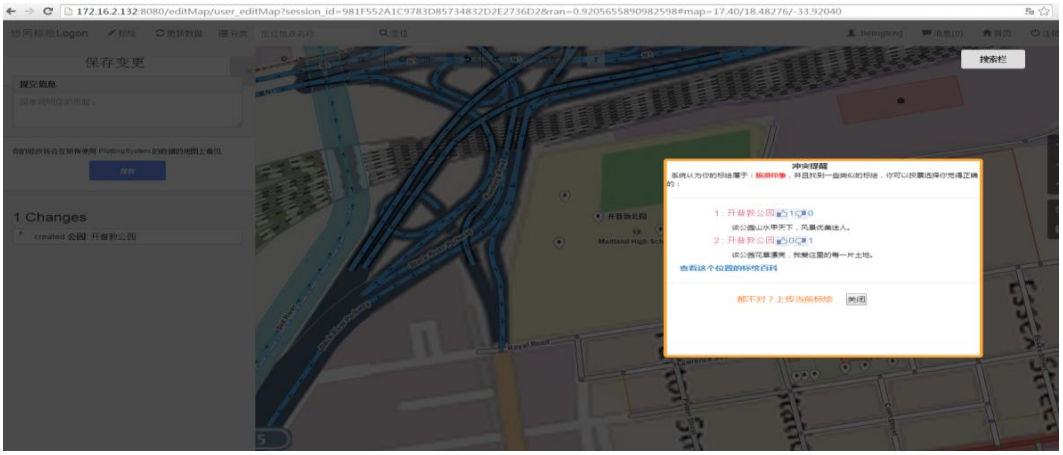

Figure 6. The Integration and Duplicate Removal of the Content

3.4. The Conflict Resolution of Collaborative Plotting

We studied the conflict resolution mechanism of collaborative plotting and collaborative management, which includes the technology of submitting and compensation of the co mapping, the synchronization of collaborative plotting. To resolve the conflicts of synchronous editing and asynchronous processing detection scheme, we designed conflict detection scheme from the perspective of constraint judges and difference compares. In collaborative plotting system, each member is certain independent and autonomic, they can edit the shared data at any time, so it is difficult to avoid the data conflict caused by the asynchronous editing behavior.

There are three ways to resolve the conflicts: knowledge inference, constraint relaxation and arbitration [8]. The conflict resolution mechanism of collaborative plotting that is the conflict resolution mechanism of collaborative plotting and collaborative management, it includes the technologies of submitting and compensation of the co mapping, the synchronization of collaborative plotting etc. We designed the conflict detection scheme from the perspective of constraint judges and difference compares, to resolve the conflicts of synchronous editing and asynchronous processing.

4. Experimental Environment and Experiments

4.1. Experimental Environment

Table 1. Requirements of Software and Hardware

Requirements	Details
Server operating system	Windows Server 2008 version
Database running environment	MYSQL 5.1 version
Software development environment	MyEclipse10.7 version、SVN server
running platform of program	JDK 1.7 version
WEB Server platform	Tomcat 7.0 version
Server hardware requirements	Multi-core CPU above 2.0GHz, Hard disk above 1T, Memory above 2G
Client software environment	Browser software supported by high speed mode
Client hardware environment	CPU above 1GHz, Hard disk above 320G, Memory above 1G

4.2. Experiments

This paper research and design collaborative plotting system based on the global map, which consists of three subsystems, it realizes the acquisition and processing of data plotting and provides users with the map image, content integration and retrieval services. We classify the spatial data types into three basic types: point, line and relationship. Spatial data types are evolved from these three basic types.

This paper is based on Java programming technology, combined with multi-agent technology and web technology. It realizes real-time plotting system in distributed environment. The scene of multi user real-time collaborative plotting is shown in Figure 7 and Figure 8.

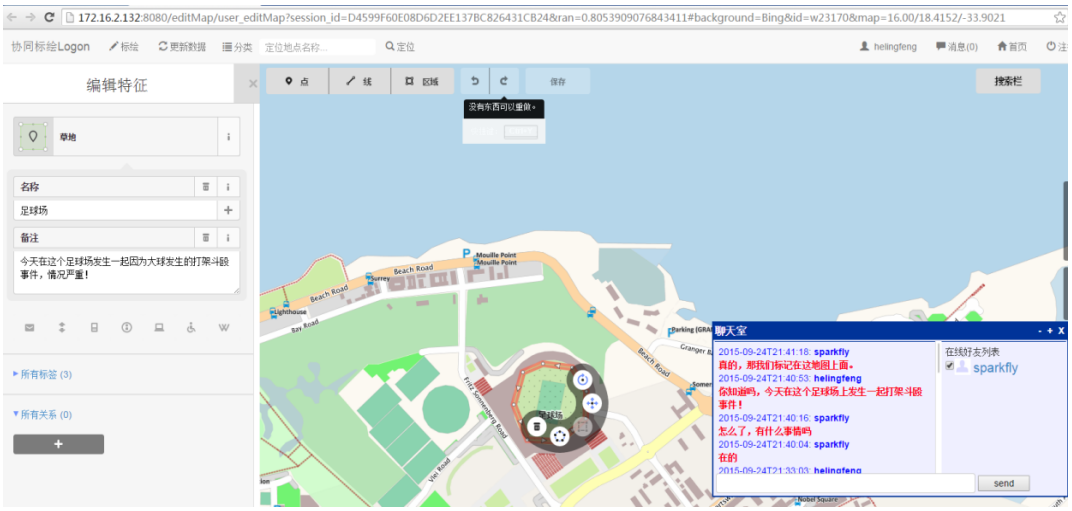

Figure 7. Experiment of Real-Time Collaborative Plotting (User1)

Figure 8. Experiment of Real-Time Collaborative Plotting (User2)

In the school LAN environment (network bandwidth is about 100M/S), five users participate in real-time plotting, it measures response time based on web and multi-agent collaborative plotting system is less than 150 milliseconds. Users can accept this response time, so the system meets the requirements of real-time.

5. Conclusion

The design and implementation of the Web and multi agent based plotting system is introduced in this paper. It is the product of the Big Data Era, it meets the needs of Internet information collection across the field, and realized the real-time data collection and processing, so that users can get a quick, intuitive and valuable information. The project can complete data upload and share, and the data of cutting, classification, conflict processing, structural transfer, the information is presented to the service system platform through statistics and forecast data. The system records, monitors and controls the users' operation behavior by the multi-agent, which real-time detects the whole system running status. So it has a good processing mechanism and fast response speed and good stability etc.

Acknowledgments

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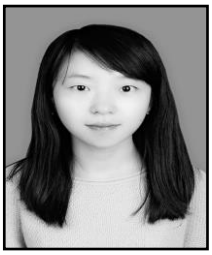

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