AN INTELLIGENT AGENT BASED VIRTUAL GEOGRAPHIC ENVIRONMENT SYSTEM

Dayong Shen[*], Hui Lin[*], Jianhua Gong[**], Yibin Zhao[*], Zhaobao Fang[*], Zhongyang Guo[*]

[*]Department of Geography and Resource Management & Joint Laboratory for GeoInformation Science, The ChineseUniversity of Hong Kong, Hong Kong, China, [**]Institute of Remote Sensing Applications, CAS, Beijing 100101, China

ABSTRACT

Based on previous work, this paper designs an intelligent agent based Virtual Geographic Environment (VGE) system that is characteristic of huge data, rapid computation, multi-user, multi-thread and intelligence and raises challenges to traditional GIS models and algorithms. The new advances in software and hardware technology lay a reliable basis for system design, development and application.

KEY WORDS: Virtual Geographic Environment, Intelligent Agent, System Design

1. INTRODUCTION

1.1 Key Techniques of A VGE System

VGE refer to environments concerning the relationship between post-humans and 3-D virtual worlds (Gong and Lin, 2001). A VGE system is characteristic of [2]:

- distributed, heterogeneous, open environments creation;
- multi-user participation;
- multi-channel, quasi-real time interaction;
- space sharing;
- management of a sea of information;
- visual data mining;
- rapid 3-D graphic computation and rendering; and
- spatial analysis and decision making.

It raises challenges to traditional GIS models and algorithms because they are hardly to meet the newly requirements (Gong and Lin, 2002).

1.2 Intelligent Agents

From user perspective, a software agent is the broker for the user (Cheron *et al.*, 2000). It can perform work for user as directed. From system perspective, an agent is a software object that is situated within a working environment and processes the mandatory agent properties. Intelligent agents are agents with artificial intelligence. Their main advantages are described as follows (Cheron *et al.*, 2000):

- collect data from numerous places;
- searching and filtering information;
- monitoring;
- target information dissemination;
- agent-to-agent negotiation;
- perform parallel computations;
- barter;
- enhance telecommunication network services;
- controller for smart matter;

• enhance entertainment.

The methodologies have been successfully applied in many aspects of geography including (Weghe and Schulte, 1999; Batty and Jiang, 1999; Batty *et al.*, 1998; Jiang, 1998,1999; Matsuura *et al.*, 1999; Kohler *et al.*, 1999; Benenson *et al.*, 1999; Tsou and Buttenfield, 2000; Armstrong *et al.*, 2000; Kray, 2002; Macgill *et al.*, 1999):

• urban environment: pedestrian flow, vehicle flow, real estate-houses for sale; urban land use changes; virtual city design;

• country environment: village formation;

• natural disasters: influence of hurricane on local environment;

• information processing: geographic information management/searches; spatial analysis, spatial reasoning; spatial decision support system; mapping.

Many implementations prove that spatio-temporal changes of a complex system can be simulated through agent-to-agent interactions. A VGE system is obviously a complex system and its key technical requirements can be satisfied if intelligent agents are introduced. Therefore, an intelligent agent based VGE system is designed in this paper.

2. SYSTEM DESIGN

2.1 System Structure (Fig. 1):

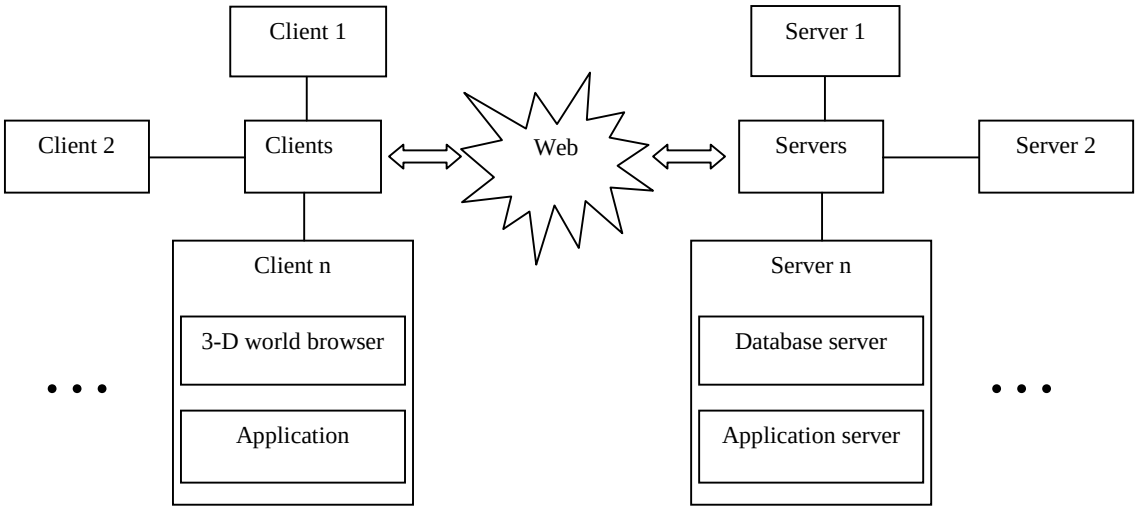

Fig. 1 Structure of the VGE system.

Client/Server structure is used in the system design. On the server side, there are two kinds of servers --- database server and application server, and application server is further divided into: VGE news server, virtual sale server, information filtration server, visual data mining server, intelligent modeling server, data and model precision check server, network security server, agent registration and dynamics management server, simulation and virtual reality server, public decision-making server, and client assistant server. On the client side, it contains 3-D virtual world browser and applications, and the applications are further divided into 12 modules showed in Fig. 2.

2.2 System Modules

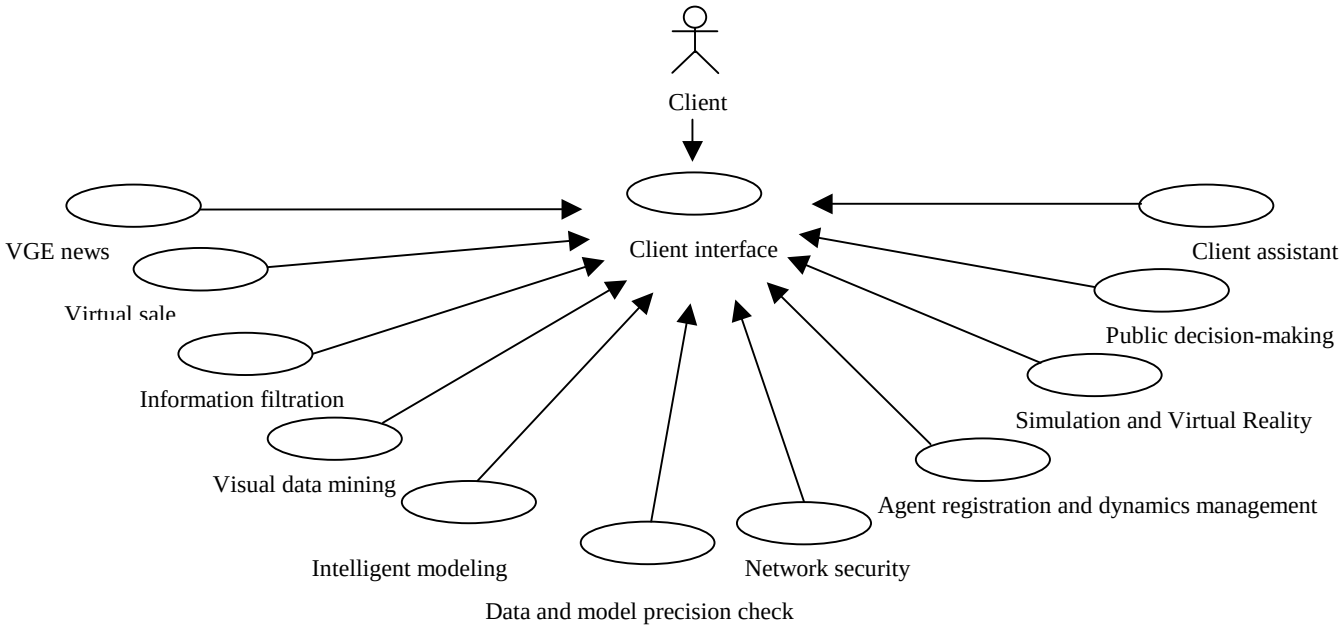

Fig. 2 Modules of the VGE system.

Functions of each module are described below:

• VGE news agent: search information of conferences, news and papers related to VGE on the internet, save it in the database, notify clients and update the information regularly;

• virtual sale agent: buy/sale data and application on the web, including creating scene for negotiation and scheduling the process of negotiation;

• information filtration agent: browse, filter and save data/application according to key words input by clients. Based on client browsing frequency and assessment to the filtering results, learning algorithms are used to strengthen searching algorithms;

• visual data mining agent: linking databases and the application for visualization, data mining and learning algorithms are used based on database, model base, rule base and clients' feedback;

• intelligent modeling agent: modeling step by step based on database, model base and rule base;

• data and model precision check agent: check the precision of data and models; mark data/models with precision and notify clients for further update or improving modeling algorithms;

• network security agent: anti-virus, access control and file status monitoring;

• agent registration and dynamics management agent: user name, password and status input and management; provide a text box for users' communication;

• simulation and virtual reality agent: avatar animation; scene description, simplification and design; parallel computation; perception generator;

• public decision-making agent: select decision models and make decision;

• client assistant agent: search useful information for users based on mouse position and key word; notify the result to users;

• client interface agent: in charge of agent-to-agent cooperation.

2.3 System Software and Hardware Configurations

Basic software configurations:

Windows NT 4.0; Visual C++ 6.0; OpenGL 1.1; Java; Aglets API; Microsoft Internet Explorer 5.0; GeoVRML; Oracle9*i* Enterprise Edition.

Basic hardware configuration:

CPU P4 1.6GHz; Memory 512M; Hard Drive 80G; Network Card 10/100 NIC; 64m Graphics Adapter/ Video Card.

3. CURRENT WORK

• simulation and virtual reality module: use data from the Shing Mun Country Park in Hong Kong as a case study (Lin and Gong, 2003) (Fig. 3);

• intelligent modeling module: simulate the process of overland flow and soil erosion in sub-watershed of Wufendigou, watershed of Huangfuchuan, Inner Mongolia (Lin *et al.*, 2003b) (Fig. 4);

• public decision-making module: use data from Mopanshan Mountain, Sichuan Province as a case study (Lin and Zhao, 2003) (Fig. 5);

• client assistant module: created based on Microsoft Genie. It can help users to familiar with User Interface and technical details (Lin *et al.*, 2003b) (Fig. 6);

• visual data mining module: discover knowledge of influencing the movement of Mesoscale Convective System (MCS) over the Tibetan Plateau as a case study (Lin *et al.*, 2003a) (Fig. 7).

Fig. 3 Virtual country park.

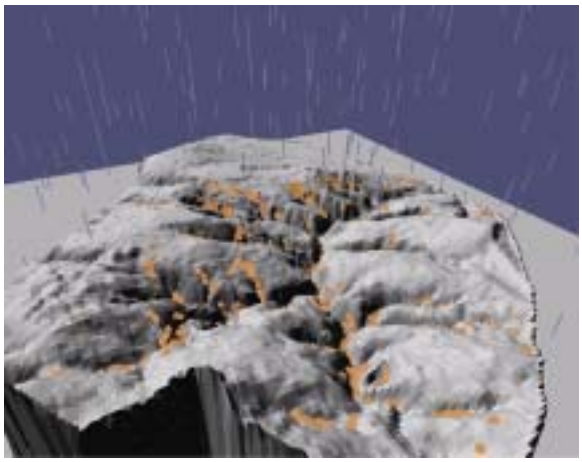

Fig. 4 3-D simulations of the process of overland flow and soil erosion.

Fig. 5 Participatory virtual studio for environment planning.

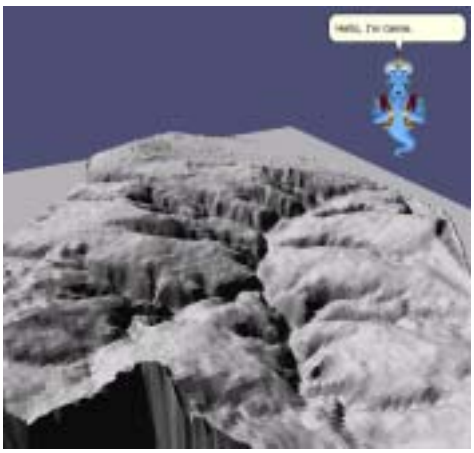

Fig. 6 Client assistant.

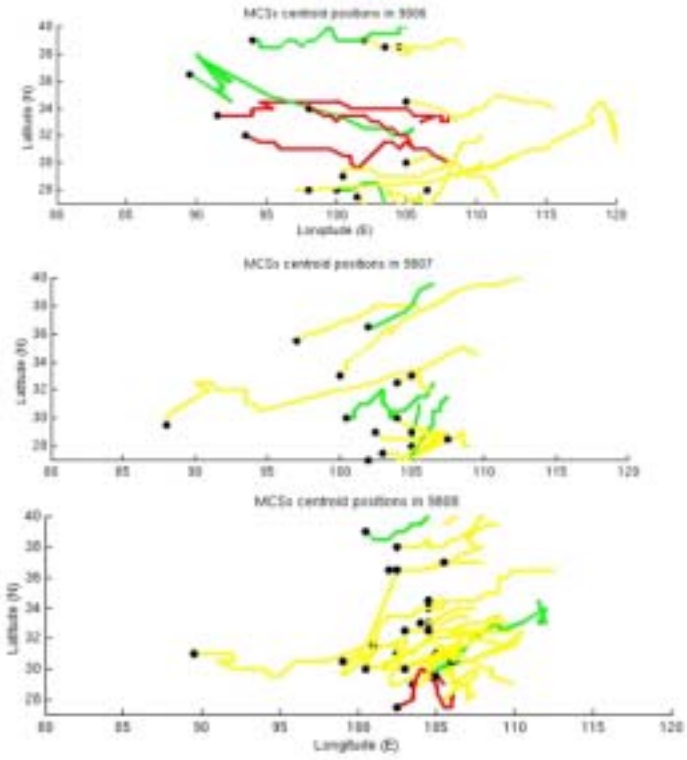

Fig. 7 The moving routes of MCSs over the Tibetan Plateau from June to August 1998.

4. CONCLUSIONS AND PROSPECTS

Traditional GIS models and algorithms are hardly to meet the newly requirements of a VGE system. Therefore, this paper introduces agent techniques to design a VGE system. The system uses Client/Server structure and contains 12 modules. Each module has unique functions. The system has intelligent and can be strengthened. With module-to-module cooperation, clients will accomplish their tasks more easily and rapidly compared to traditional GIS algorithms. The system development is under going. Some modules are showed in Fig. 3 - Fig. 7.

ACKNOWLEDGEMENTS

This work is supported by 863 project 2001AA135130. We are grateful to Guonian Lv for his help and advice.

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