Design and Implementation of Framework of Mobile GIS Based on Phone Terminal for Environmental Monitoring

Adolph Nyamugama DU Qingyun

ABSTRACT This paper proposes a method for constructing an extensive wireless GIS network by utilizing Java cellular phone as GIS terminal for environmental monitoring through dynamic location disaster-emergency notification management of spatial databases. An experimental case study is demonstrated to show its potential in the application field.

KEYWORDS wireless communication; mobile GIS; Web GIS; Java

CLC NUMBER P208

Introduction

At present, mobile GIS, Internet GIS and wireless Web application are increasingly playing important roles through the entire geo-information application. First one might wonder what mobile geographic information is and why they are important. Traditionally, we record and present the location on static maps that show a snap shot in a state of time. This, by large, has continued in the way as we have implemented many of our GIS systems. However, many of the items we want to locate are far from being static. They move, and there is significant value in knowing when, how, and how quickly they move and the direction and route taken. It is valuable to track them in real time. Secondly, this demands the ability to capture the location information on moving objects and transmit events in real time to recipients that may also be moving.

The main objective of this paper is to assess the use of Java cellular phone as a GIS terminal for environmental monitoring through the dynamic location of disasters-emergency notification management of spatial databases. Although a lot of research work has been done on the use of mobile GIS technology, not much had been done in the field of environmental monitoring, by use of dynamic location. This system upon completion will play a vital role in providing disaster, emergency notification information such as floods, fires, etc. This information is in great need for the civil-aviation departments, rescue services and the public in general.

1 Concept of network GIS

Fig. 1 shows six tier models that include a basic GIS service tier in addition to web GIS five-tier architecture model advocated by open GIS consortium.

There are two processes, A and B shown in Fig. 1. A is a server process when the terminal is a mobile phone; B is a server process when terminal is an internet workstation.

In this paper, the network GIS architecture that allows access to single database from Internet workstation and from phone terminal in the same way is considered. Internet workstation
uses personal computer as hardware device. This allows executing application on client machine based on distributed architecture and lowering the workload on server, as illustrated in Fig. 2.

We consider data obtained from two different systems, one from Internet workstation and the other from mobile phone terminal in single database on feature data basis. The method of RD-BMS is chosen here because one record of RD-BMS is composed of geometry data and attributes data. It is easy to be managed in Java class as an object inside the system. The system works as illustrated in Fig. 3, which shows how data is organized in this RDBMS system.

1) Spatial indexing server
One of the disadvantages of RDBMS is that it is weak in spatial query. To overcome this weakness, a display area with coordinates and then acquiring spatial objects that are contained in the area is defined.

With spatial indexing control, spatial object data in the target area can be specified by clients and can be acquired effectively by referring to spatial indexing table.

2) Data updating transaction server
Large numbers of clients concurrently update spatial object data. Data updating transaction control maintains exclusive access to avoid data update conflicts.

3) Display cache server
When data request from many clients occurs at the same time, data process workload on server increases. Display cache control retains data cache that is relevant only to display within the spatial object that is accessed.

4) Space client
Space is the memory storage area for spatial object data in client. It plays the role of client cache.

5) View (client)
View displays arbitrary area of spatial object data that are stored in space. When view displays data, it draws portrayal expressions such as colors and symbols as defined to features by referring to portray class. In addition, view passes input operation performed by users via view onto users' event control.

In this paper, all mobile phone terminal control is executed on server. Switching terminal display picture that calls page which performs terminal control.

All the process described above are illustrated in Fig. 4.

6) Mobile phone GIS browser
Synchronizing the above terminal page control. Mobile phone GIS browser performs map display and control for users.
2 Case study

On the basis of the methodology outlined above, we developed an application of environmental monitoring for dynamic location management to disaster emergency notification by managing spatial information such as hazards floods, fires, frost and earthquakes. The data used in this experiment was obtained from Zimbabwe meteorological service centre. This data was obtained from different observation stations around the country, which monitor fires, earthquakes, floods, weather focus. Satellite images were taken from MODIS system (the rapid response systems) which monitors disasters across the globe. The main aim of this system is to locate and get the information about any outstanding weather phenomenon, such as cyclones, floods, fires and weather focus. This information will be passed to the users at the possibly earliest time. The methodological approach taken in the design of this system is summarized in Fig. 5.

The entire study area is represented by standard coordinate systems; affine transformation is used to avoid errors, distortion and to maintain accuracy on all the maps used in this application.

The database is designed by use of Oracle and SQL. Different regions had been geo-coded by unique numbers. The method of RDMS is adopted to the implementation of the database. It is easy to maintain and update databases.

During the creation and representation of basic elements of map features, a method of Level of Detail (LOD) was adopted. It enables users to zoom a particular area of interest on the maps and determines which area to be displayed at one time. The layers used on this map are grouped into two main categories of vector and raster layers. The vector layers consist of line, points and area (polygon). Line represent highway roads, boundary lines of the map and other features such as rivers. Areas that show zoning in this case represent provinces. Points represent the location of cities and earthquake positions, which are distinguished by different colors. The last category are raster layers which consist of images obtained from satellite, fire images and cyclone images.

In this case, all raster layers are put on the bottom to eliminate shading and to enable users to view satellite images about weather phenomena.

This enables the visual integration of vector and raster layers to be shown on a mobile, at the same time, just as a whole. A method of grade scale enables different maps to display at particular time.

The layers are stored separately for maintaining the same physical design for better performance. The users will be able to query information about the status of weather in the area of interest or receive warning systems about fire dangers, floods etc. Users will be able to select, update basic element layer for particular region using Java cell phone mobile terminals.

Grid and index file method are applied for each layers to enable users to retrieve information
easily about the particular area of interest. In this case, area codes of each region are used. The spatial index method speeds up searching and is easily displayed on mobile screen.

In this application, we used a GIS server system and an Internet workstation. The whole procedures for the design are outlined in Fig. 5, which shows the process and components of the server process for mobile terminal. The Java mobile terminal has a low memory capacity. Therefore, each image was compressed for easy transmission. It allows 10-30 kb for program size and 5 kb for data size. That is what is used for program application. That is the amount of data size that can be transferred at a particular time. The average time of transmission is about 10 s to 55 s for GSM and 1, 2-1. 3 s for GPRS, but this rate of response depends on the other factors like delay from queuing packets. The transmission is also proportional to the size of data to be transmitted, and the quality of the network service. This can be used on a standardized network structure with a speed of 384 kb for inbound and 64 kb for outbound. This application is designed to cater for extensive network area, which means it can enable enormous number of users to connect at the same time. It is subject to change due to network hardware capacity.

In Fig. 6, we outline the components of the interface, which we designed, used for controlling the server updating information on an hourly basis about disaster emergency notification from various regions. Some application programs run here to enable users to use the system effectively.

Text page is composed of menus and buttons. User I/O is mainly performed with text. Map page performs map display and graphic symbol input such as point and line. The page configuration is shown as follows.

1. Label performs the caption display.
2. Image performs captions such as photographs in this application; it displays satellite images, such as the movement of cyclones, fire capture, floods.
3. Button indicates the server Java programs that will be called with the arguments.
4. List Indicates the caption and key that returns the list, when selected. List is used mainly as Menu. In this application, if one wants to search for information about a certain regions, he has to select from the list and press the button OK. And the weather information will be displayed in the display box.
5. Text returns numerical characters and text that are input by users. This is used during the updating of weather data from different weather stations. Nevertheless, for the user to enter the server, they need a security code of the data. This is done to avoid unauthorized persons to access or send information to the servers. The others can only view any weather information of any regions but can not upload data.
6. Map indicates map type and initial display area. In case of a disaster occurring in a place, it is shown at the exact location on the map in animation. The viewers can see the information about it by double clicking that location and the real map. Satellite images of the type of disaster is displayed on the respective location as described earlier.

3 Conclusions

In this paper, it is demonstrated that Java mobile phone with its limited storage capacity plays a pivotal role for environmental monitoring of disasters. It is essential for dynamic emergency notification of disasters such as fires, floods, frost-warning and earthquakes. It allows the remote sense images merging into GIS. Therefore,
it plays an important role for environmental monitoring purposes.

REFERENCES

1. Langran G, Chrisman S (1998) A frame for temporal geographic information. *Cartographic, 25*(3): 1-14
2. Montoya L (2003) Geo-data acquisition through mobile GIS and digital video, an urban disaster management perspective environment and software. The 4th International Symposium on Asia GIS, Kunming.
3. Wang S, Ding Z M, Zhang X (2000) Mobile database technology and its application. *Computer Application, 20*(9)
4. Varshney U (2003) Location management for mobile commerce application in wireless internet environment. *ACM Transaction on Internet Technology (TOIT), 3*(3): 236-255
5. Cheng Z (2003) Design and implementation of distributed Web Services in mobile application, [master thesis]. Enschede: International Institute for Geo-Information Science and Earth Observation.

(Continue from Page 32)

REFERENCES

1. Masters T (1995) Advanced algorithms for neural networks: A C++ sourcebook. New York: John Wiley & Sons, Inc.
2. Bruzzone L, Connese C, Maselli F, et al. (1997) Multisource classification of complex rural areas by statistical and network approaches. *Photogrammetric Engineering and Remote Sensing, 63*: 523-533
3. Bishop C, Radial M (1995) Basis functions. In: Neural Networks for Pattern Recognition. Oxford, New York: Clarendon Press.
4. Zarzt A, Ziou D, Wang S R (2002) Segmentation of SAR images. *Pattern Recognition, 35*, 713-724
5. Stein A, Van Meer F, Gorte B (1999) Spatial statistics for remote sensing. Dordrecht: Kluwer Academic Publishers.
6. Gorte B (1998) Probabilistic segmentation of remotely sensed images. Enschede: ITC Publication Series.
7. Bischof H, Schneider W, Pinz A J (1992) Multispectral classification of landsat images using neural networks. *IEEE Transaction on Geoscience and Remote Sensing, 30*(3): 482-490
8. Ripley B D (1996) Pattern recognition and neural networks. Cambridge: Cambridge University Presses.