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The application of Mobile GIS in Disaster notification information management system

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Abstract

This paper explores the use of mobile GIS computing in its application in emergency disaster notification information management system. We outlined methodological approach architectures. This includes the use of wireless enabled web services, internet GIS, the use of Java mobile simulator for remote access in the field, wireless enabled laptops. We illustrated a detailed explanation on how these devices can be used to deliver data in short space of time. We designed an application based on thin client method, where we consider a user client interface taking into consideration different users, those who are and not using small devices such as mobile phones to view and update the data. For mobile phones we based our study using a Java simulator. The application was tested using weather data obtained from Zimbabwe meteorological center. An analysis of the experimental application of the system shows that the transmission of data depends on the service of the network and technological advancement that implies the state of equipment such as broadband. The other issue noted was of limited memory of the small device, so in this case users can view a limited data at a time.

Key words: Wireless communication, Mobile GIS, Web GIS

Introduction

Mobile computing is becoming more and more popular and common. Due to the advancement in technology people can now access the internet from anywhere and anytime at will. This has been made possible due to the recent development in wireless facilities and mobile computers and some applications. However nothing much had been done to explore the use of mobile computing in it is application to emergency disaster notification management.

The crucial element in this context is to make the information available in time and accessible despite location of the user. This will go a long way in helping to warn the people before a disaster occurs for them to take necessary measures. During the disaster it helps in rescuing operation because rescues workers will know the exact location and surroundings, which enables them to carry out rescuing operations efficiently and smoothly.

In this paper we explore the use of Mobile GIS computing, Internet GIS and wireless web application for disaster emergency notification management. There is need to locate these phenomena because they move, and there is significant value in knowing when and how quickly they move and 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.

Mobile GIS provide the facility to extract particular sets of information where it is needed. Mobile GIS offers users greater flexibility, allowing them to quickly produce results that are tailored to their needs. However, mobile GIS go further as they provide results access to data whenever the user is[17].Related operations such as querying spatial data ,performing spatial analysis or modeling become possible on the go. This makes it suitable for disaster management in the field. For instances, consider disaster response in case of hurricane that can cause infrastructure (e.g. bridges, buildings, railroads) to collapse.

The formulation of spatial queries that allow efficient disaster management require exact and accurate description of spatial configurations, which is inherently a difficulty task if performed solely on the basis of existing maps**[21]**Another requirement is architecture of such application is an architecture that assures immediate response in time in order to ensure security for residents.

As an example, take the hazardous areas in hurricane-prone regions whose condition may change, depending on the movement of hurricane and damage it caused. Residents rely on fast accurate decisions by specialists, however such decisions requires analysis based on the up to date input, which is often not available in static environment .If the query is performed in a mobile environment, specialists will be able to take faster decisions that are more accurate and thus more efficient .

A system assisting in disaster avoidance and relief situations should be able to provide information to planners and rescue workers. This should cover areas non-known to users and provide appropriate guidance. [18]It should provide real time at all levels. A very important aspect of the system of emergency support is the speed of communication.

The best system should be flexible, template driven to allow administrators to pre-plan the notification process including calling trees ,for any number of scenarios such as national emergencies, code events, hazardous materials spills and staffing shortages. This allows users to communicate even notices such as public announcement and meeting notification.

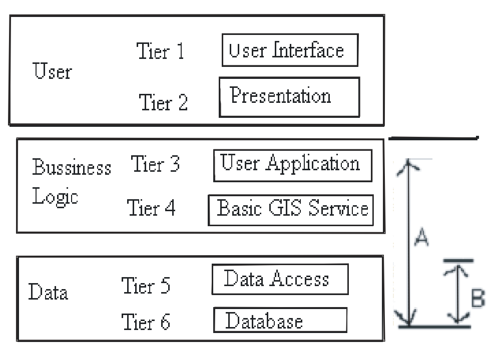
The entire information must be managed, monitored and tracked. Therefore this demands scalable, standards based spatial information, which is highly configured to meet the evolving needs. A lot of efforts and initiatives have been made for this vital information available. In the 90's the International Decade for natural disasters Reduction launched a world wide program

The methodological approach used in the design of this application

To attain the aims and objectives of this paper we designed an application for monitoring emergency disaster notification data, integrating web service, wireless enabled web, internet GIS and mobile web service.

We applied the concept of network GIS which is a six tier model that include basic GIS service, as shown in fig 1 below.

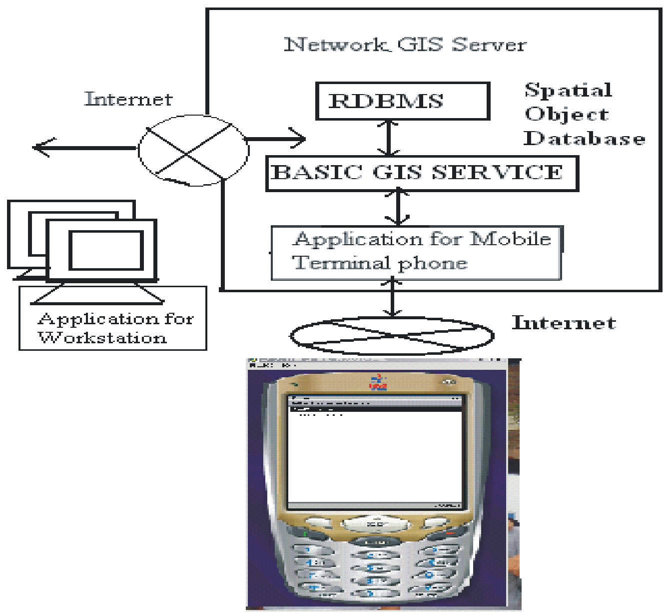
Figure 1 Six tier model



As shown on figure 1, there are two processes [A and B] A is a server when terminal is a mobile phone; B is a server process when terminal is an internal workstation.

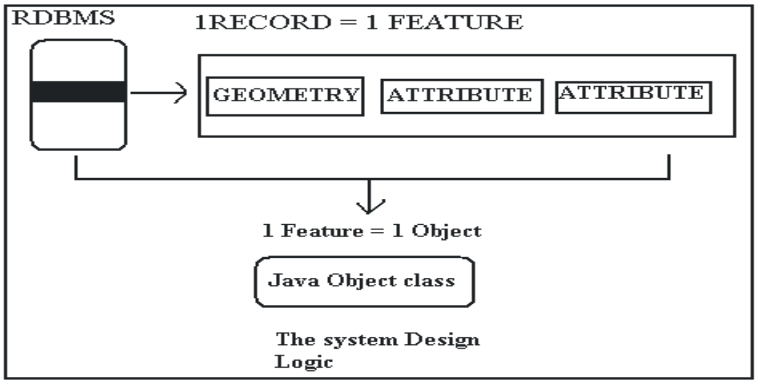
GIS Network Structure

Figure 2 shows the network GIS architecture that allows access to single database from internet workstation and from workstation and from phone terminal.



Data obtained from two different systems: one from internet workstation and the other from mobile phone terminal in a single database feature. We used the method of RDBMS because one record of RDBMS is composed of geometry data and attributes. It is easy to manage in Java class, an object inside the system.

Figure 3: feature base data



The system work as illustrated in Fig 3 Which shows how data is organized in SDBMS.

1. Spatial Indexing server

One of the disadvantages of RDBMS is its weakness in spatial query. To overcome it a display area with coordinates and then acquiring spatial objects that are contained in the area is defined. With spatial indexing control object data area can be specified by clients can be acquired effectively by referring spatial; indexing table.

2. Data updating transaction server

Large number of clients concurrently update spatial object. Data updating transaction controls maintains exclusive to avoid data update conflicts.

I. Display cache server performs control of all the process described. Hence request from many clients occurs at the same time, data workload on server increases. Display cache control retains cache that is relevant only to display within the spatial object is accessed.

II. Space client

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

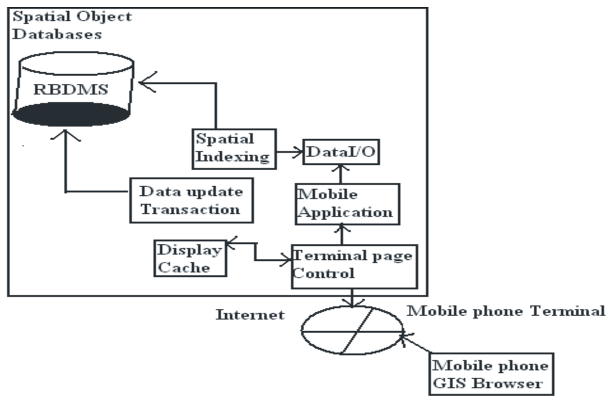
III. View Client

View display arbitrary area spatial object data that are stored in space. When view displays data. It draws portray expression such as color and symbols as defined to features by referring to portray class. In addition, a view passes input operation performed by users via view onto users' event control.

IV. Mobile phone GIS browser

Synchronizing the above terminal page control, mobile phone GIS browser performs map display and control for users.

All mobile phones terminal control is executed on server, switching terminal display picture that calls page, which above are illustrated in Fig 4



Network GIS Server.

Application analysis and design

Object oriented and analysis approaches were used to develop this application. The mobile map is a client/server network application. The client resides in a mobile computer(handled, palm)featuring small memory storage, small display, slow performance, slow network bandwidth, less functionality, and less user friendly input method. The server resides in a large computer or workstation in the internet that has large memory, large storage capacity and fast processing ability, it searches it's map cache for requested map segment at the client side.

a) Client Agent

Its responsibility is to communicate with the server, pass request to the server and receive requested data map segments from the server.

Main components at the server side

b) Sever Agent: It is responsible for the communication with client Agent. When receiving from client agent, it passes the request to the server to search for required map data, sends them back to the client agent.

c) Server: It is responsible for loading all data maps, when receiving a request from the server agent.

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 metrological service centre. This data was recorded from different observation stations around the country, which monitors fires, earthquakes, floods, weather focus. Satellite images were taken from MODIS system (the rapid response systems) which monitors disasters across the globe. Using the Java programming language we designed a connection of the database to each respective city on the map.

The map and the database are stored on the workstations. We wrote application programs for updating the database and connecting to the map server. Only the administrators have full access to some specific functions and updating the database. It is designed so that it can be updated by the central administrations and also through remote access. This implies that information is received in time and the database is updated on time.

In case of a disaster occurs information can be send to various users at the earliest time possible to mobile devices and they can receive text information and can view the map of the area affected using their mobile devices. In this case we used Java mobile simulator for testing to view the selected area on the map and data, and also sending information to the database.

Figure 7 shows the layout structure that had been adopted on the application of this experimental case study.

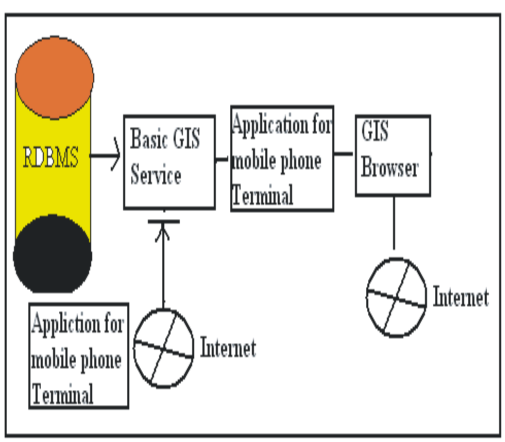
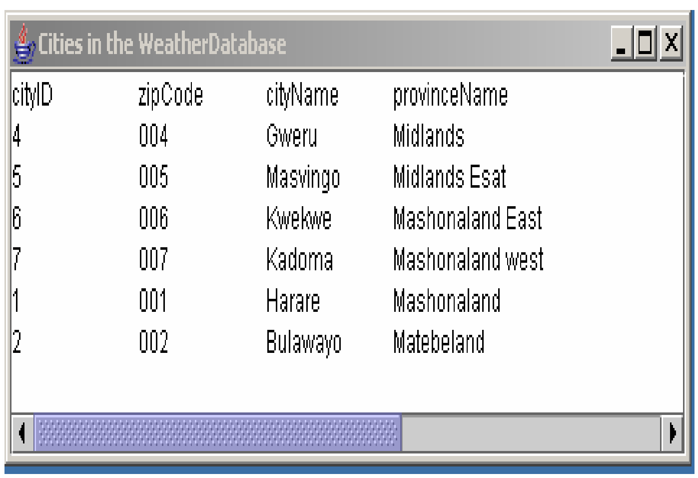


Figure.7 Java mobile system data connection

Clients can access the information on the central workstation regardless of the position, using the wireless connection as mentioned in previous chapters. The system caters for all types of clients, although in this application we focused on those clients accessing the net using laptops, desktops and those with mobile devices such as PDAs and mobile phones. But this system had been tested using Java mobile.

The diagrams below in Figs 8.9 and 10 shows the server control side where only authorized users like administrators are allowed. They have to enter their passwords to access this side. Here they carry out database editing, updating and deleting records etc. through writing a code using SQL programming language as shown on the diagram below.

Fig 11 below shows the server interface for administrators. The main objective here is for routine check about the status of information before it is stored. If they detect an error they then rectify the error immediately before the data is send to users. This is done to check the accuracy of the data and to maintain it updated all the time.



cityID	zipCode	cityName	provinceName
4	004	Gweru	Midlands
5	005	Masvingo	Midlands Esat
6	006	Kwekwe	Mashonaland East
7	007	Kadoma	Mashonaland west
1	001	Harare	Mashonaland
2	002	Bulawayo	Matebeland

Figure 11 Server data verifying

Below are the diagrams demonstrating the display of information on a particular city using a user-friendly user interface by double clicking on a particular area highlighted (Figure 12).

The information about that city will be shown as illustrated in Figure 13 which shows all the information about fire warning, cyclone warning, and floods warning and if there are images of an abnormal hazards occurring at that particular time they will be shown. All the steps are shown on the diagrams below.

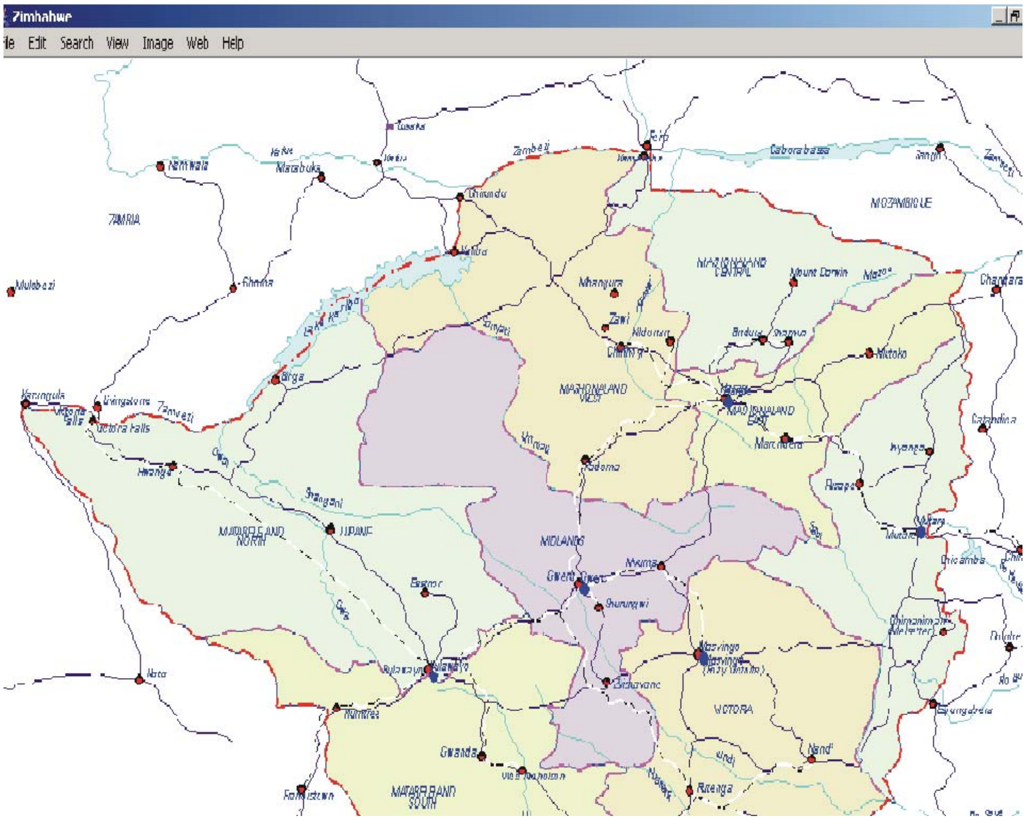


Figure12 Map of Zimbabwe highlighting major cities in red

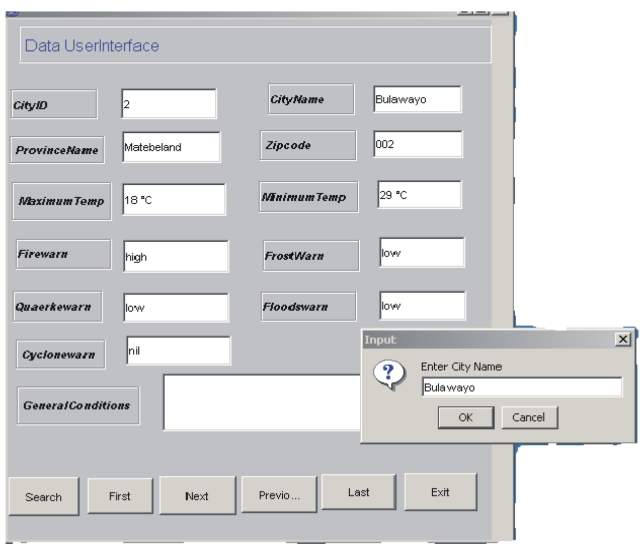


Figure 15 Showing quick search

The Fig 15 above shows how users can search the information of a particular place without referring to a map. They need to double click the search button and a dialogue will appear. They then enter the city name and the information about that city will be displayed.

They use the menu button to select the functions. By entering the city name the information of that city will be displayed. Administrators can send information to the central servers from different observation points. This will keep the information up to date all the time. They can also send information using wireless enabled laptops.

The Data transmission rate

During the experimental application we used the following criteria to measure the effeteness of the transfer rate of data [Jane Juan li 2002], i.e., *user* perceived latency, request meet rate, cache hit rate, and wireless bandwidth efficiency.

- User perceived latency (UPL): time interval between the client's sending request and receiving the request data – measures how fast a user's request is met. The shorter, the better.
- Request meet (RMR): ratio of the number of data/maps displayed to the number of total request-measures how many user request are met, the bigger the better RMR = Maps/data displayed/total requests
- Cache-hit rate (CHR): ratio of the number of requests met in cache to the number of total requests – measures how efficient the catching and perfecting algorithms are. The bigger, the better. CHR = cache hits/total requests
- Bandwidth efficient (BE): ratio of the number of data, map units used to the total number of map, data units fetched from the server – measures how efficient the wireless bandwidth is used. The bigger, the better. However, despite the factors mentioned above we discovered that the transmission rate also depends on other factors such as the quality of network service and rate of queuing packets.

We estimate the transmission bandwidth by transmitting a certain amount of data from the server to the client and recording the transmission time. Since we are using the palm emulator, we noticed that emulator recorded time is different from real time.

Conclusion

In this paper ,a user friendly client and server is demonstrated, which makes information available to the user quickly and the a design of mobile GIS architecture that enables users to view information despite the location, or time .Therefore this enables the smooth transmission of information, which is essential for when carrying out rescue operation. This is vital in the management of information and its application to emergency disaster information is of great significance.

References

1. A.DBlaser(1999)User Interaction in a Sketch Based GIS User Interface in Interface in International Conference COST 97,Laurel Highlands, A
2. A.D Blaser(2000)Sketching Spatial Queries .PhD,Universty of Marine ,Orono ,Me
3. Cheng Z(2003)Design and Implementation of Distributed Web service in mobile application[Master thesis]Enscehede:International Institute for Geo-Information Science and Earth Observation.
4. D.Barbara(199) Mobile Computing and Database-A survey.IEEE Transactions on knowledge and Data Engineering 11(1):108-118.
5. G.Arten(2000)Management of Geographical Information in Mobile Environment.
6. Langran G,Chrisman(1998)A frame for temporal geographic information cartographic,25(3)1-14
7. Montoya(2003)Geo-data acquisition through mobile GIS and digital video, an urban disaster management perspective environment and software. The fourth International Symposium on Asia kunming.
8. Nyamugama A,Qingyun D(2005) Design and Implementation of Mobile Based on Phone Terminal for Environmental monitoring. (Geo-Information science,Vol.8,issue1)
9. Varshney U(2003)Location Management for mobile commerce application in wireless Internet environment.ACM Transaction on Internet Technology(TOIT),3(3):236-225
10. Wang S,Ding Z M,Zhang X (2000) Mobile database technology and it's application,computation,20(9)