ISSN: 2151-1950 (Print), 2151-1969 (Online)   Vol. 2, No. 1, January 2010

Journal of Geographic Information System

Editor in Chief: Prof. Xincai Wu

www.scirp.org/journal/jgis

RCGIS
RESEARCH CENTER FOR GIS SOFTWARE AND APPLICATION ENGINEERING, MINISTRY OF EDUCATION

Scientific Research

Journal Editorial Board

ISSN: 2151-1950 (Print) ISSN: 2151-1969 (Online)

http://www.scirp.org/journal/jgis

Journal of Geographic Information System(JGIS) is a comprehensive international journal published by Research Center for GIS Software and Application Engineering, Ministry of Education, Zondy Cyber and SRP(Scientific Research publishing).

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Journal of Geographic Information System

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Journal of Geographic Information System, **2010, 2, 1-5**
doi:10.4236/jgis.2010.21001 Published Online January 2010 (http://www.scirp.org/journal/jgis)

A Mechanism of Initiative Transmission to Send Message on WEBGIS

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Abstract: The paper researched and realized the initiative message transmission mechanism of WEBGIS server based on the N layer architecture of Internet. According to WEBGIS application long business operation as well as server information visualized in client side in real-time features, this article uses the Socket communication and the client side with JAVA Applet to realize that the WEB server can send message initiative to the client. It comes up and realizes a concrete plan of initiative transmission mechanism in WEBGIS. We run the realization plan based on Winsock through the project practice of Guangzhou cable TV network security monitoring and alarm system. The system operation has been verified in system running. The combination of this mechanism with conventional WEBGIS can greatly improve the performance and the usability of WEBGIS.

Keywords: WEBGIS, message, initiative transmission

1. Introduction

With the development of Internet technology and the rising demand of GIS, using Internet publish spatial data on the Web and providing spatial data browsing, query and analysis capabilities have become the trend of GIS development. Furthermore, WEBGIS and controlling system, mobile location service and real time information exchange are more and more closely connected. It is estimated that 80% information are connected with location. It often costs lots of effort in searching some person or place. To improve the efficiency, location information has become very important for people. With the development of industrial automation, WEBGIS is also used in real time controlling system, which challenges traditional information exchange methods and also proposes higher demands of real-time, security, and timeliness of information exchange in WEBGIS.

At present, WEBGIS can support the GIS functions in Internet very well. In addition to basic display and query functions, many long transaction operations are supported, such as spatial analysis. Because of the disadvantage of HTTP protocol, WEB server can only passively provide information browsing and can't send request to client initiatively. This determines the insufficient support of long transaction operation in general WEBGIS. WEBGIS is a development trend of GIS, which can display GIS functions in Internet. Besides common map operations, WEBGIS provides various [1]basic graphic operations, such as, bus transfer, geographical names information, guiding services, etc. There are two interactive methods from client and server sides,

1) Client side request, server side receive and process and sending back result to client side. This method is often used in basic map operations, such as, zooming, roaming, etc.

2) Client side request, server side accept the request and send back the valid data to client side, the client side will process data timely and display. This method is mainly used in part process of spatial analysis.

Most of client exchange system of WEBGIS is relatively passive. Only when client proposes the request, WEBGIS server will respond to the request, process data, and send the result to client side, then users can browse the result graphs or data in browser. For example, if users want to find the transport routes from place A to place B, after entering a query condition, the information will be send to the server side after processing, server will process the information accordingly and get the relevant information from database and the information will be send back to client side. Client side will display the relevant information in text or graphs vividly.

[1]"863" Project: Research and software application of network oriented 3D spatial information service (2009AA12Z211); Special Funds for basic scientific research and application of Central Colleges (CUGL090235).

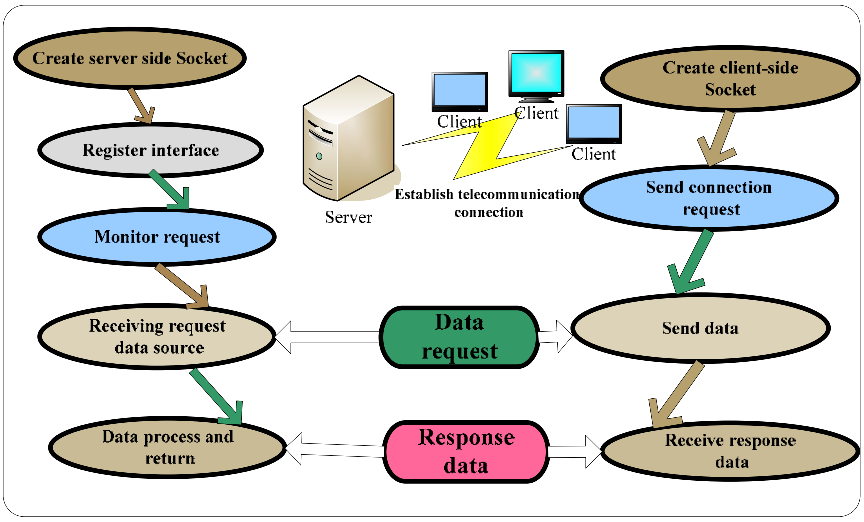

Figure 1. Workflow diagram

2. Propose of Initiative Transmission Message Sending on WEBGIS

Users only need to operate through browsers in existing interactive method which makes WEBGIS accepted by the public. There is one similarity in client interactive operation, that is, one request and one result received. It can't keep the connection with server which reduces the timelessness of WEBGIS.

With the development of technologies, such as communications, GIS and GPS, WEBGIS has got great progress these years. Users are not satisfied with the simple map browsing, and they are more interested in the real-time geological data. If users want to know the exact location by mobile phone or wireless network when using the current WEBGIS interactive approach, firstly, users need to send a request, and the server can only reply one present or out-dated location information to users one time. If the users want to get the constant real-time location information, they have to send the request continuously. This approach is increased burden of users, and a better solution should be proposed.

When using the HTTP protocol, the connection of server and client will disconnect after a communication. To improve the communication method, this paper proposes using Socket communication approach in research and realization of initiative message sending mechanism. In the communication process of user and server, the server can send the real time information to user and receive the request from user timely. The combination of this mechanism with conventional WEBGIS can make the WEBGIS better developed.

The mobile communication and internet are two hot-pots of information industry, the combination of them leads to the mobile wireless internet application, and it will be the important development direction of information industry. China has the biggest mobile phone users group for years, the value added service of mobile phone based WEBGIS will be popular in many areas, such as travel, transportation, medical treatment and police. It will be a very important part of people.

The development of spatial position technology and mobile communication technology makes fast information transformation be possible. Driven by market and technology, LBS (location based service) development very quickly, and with the help of mobile terminal and wireless network, it will determine the exact location and provide all the location information to users. LBS have become a hot academic research area.

LBS ensures the future of spatial information service and blueprint of mobile position service, that is , when users interact with a model of real world, this model can dynamically provide different information to various users in different time and place. When the mobile users interact with this model, the view of user's will change with different users' role and environment [4]. Spatial information technology, especially the development and integration of GIS, GPS, RS, VR and computer graphics shorten the distance of spatial information and people's lives. The development of mobile service can match the requirement of further socialization and popularization of spatial information.

The combination of initiative sending message mechanism and WEBGIS meets the requirement of real time communication requirement of LBS, which plays the linking role. The initiative sending message mechanism uses stream socket approach in TCP protocol which ensures information accurately sending and its integrity and security.

The main purpose of this paper is to provide a solution to realize Web Server initiative transmission to send message to client side on WEBGIS.

3. Key Technology for Initiative Sending Message Mechanism

Based on the Initiative sending message mechanism system of this paper, the server-side program is developed in Visual C ++ and the client-side is developed in Java. The following introduction is the of Socket communication of Visual C++ and Java. The working mechanism of Applet and Socket are similar with typical client server. The server will connect third part server, so we uses the Visual C + +, and client uses Java Applet. The working steps of Applet and Socket are as follows.

The server needs to establish a socket for monitoring, after allocating port for the socket, a new client monitoring thread will be established. Client side establishes socket for connecting servers, then call function to request the connection with server. After receiving the request monitored from client socket, server will allocate receiving function to establish a connecting socket; the transfer the data between the server and client-browser by the sockets of server and client. The Server will send the result data after processing to client; Client Applet will process data and display the data in browser; at the same time, Applet will send the control instructions of client to server, according to the corresponding control strategies, the server will instruct inputting port of data connection controlling card change operation status of controlled object; in the end, client server close socket, and the server will use close function to disconnect the Applet connected socket.

4. Initiative Sending Message Mechanism Design

4.1. Design of Server-side

When received the connect request form client-side, the primary server will creates threads to ensure independent connection to multi-client side. To ensure data accuracy, each thread will send different request to third party server according to different needs for different data. If user wants to get current location information, the primary server will only send result data to user for one time; after user receives the information, probably the connection is not closed, but user still needs to send request for more service. If the user want to know the transportation route, when user send request to primary server, the primary server will interact with the third party server, then the third party sever will send information of route to primary server in certain time interval; the primary server will send the information to user. This is the purpose of the primary server in initiative sending message mechanism.

Multi-threading is to establish communication between multi-clients. To receive information from the client side timely, and send data to client timely, we use two nested loop. One is for receiving real time user information, the second one is for real time sending information and accept third party server data; identify users' requirements to select sending approach.

The primary sever side design should ensure the following orders, a) to ensure the effective connection of multi client-side. b) receive client-side data timely and effectively. c) transfer information from the third party accurately and timely. d) when the primary server side are connected with the client side, it can receive the upload information from client side and send information to client side freely. e) receive information from the third party sever, and feed back to client timely. f) inform user timely when the third party server shutdown

The following diagram illustrates the workflow of server side. Socket communication is only methods we using. A more specific solution needs to be provide for specific operation process. Figure 2 is the main workflow of server side.

4.2. Design of Client-Side

After client-side Socket established, users choose required services. According to the types of services, client-side will send service request to server. Since the long time receiving data will occupy the main tread, in order not to affect the WEBGIS basic graph operation, a sub-thread needs to be established to take charge of data reception. Since the data reception process is not continuous, several loop receive mechanism needs to be established to ensure data accuracy and data reception.

The client-side should realize the following functions, a) start the connection program with the primary server at any time, and also terminate the communication with server. b) timely inform user if there is any exception in communication process. c) user can freely carry out client side operation in the course of communication, such as, graph zooming, roaming, etc. d) receive data information from primary server. e) identify whether the primary server is shutdown, and send back the abnormal result to user.

If user wants to get the needed data, the first step is to start the connection with the primary server. The communication between the client-side and server is through Socket. It's necessary to establish Socket communication mechanism.

5. Specific Realization and Application

The detailed initiative message sending mechanism technology in WEBGIS has been introduced above, and the internet communication program development on Windows system is also mentioned. The following introduction is about the remote controlling software platform on TCP / IP-protocol, Guangzhou CATV Network security monitoring alarm system.

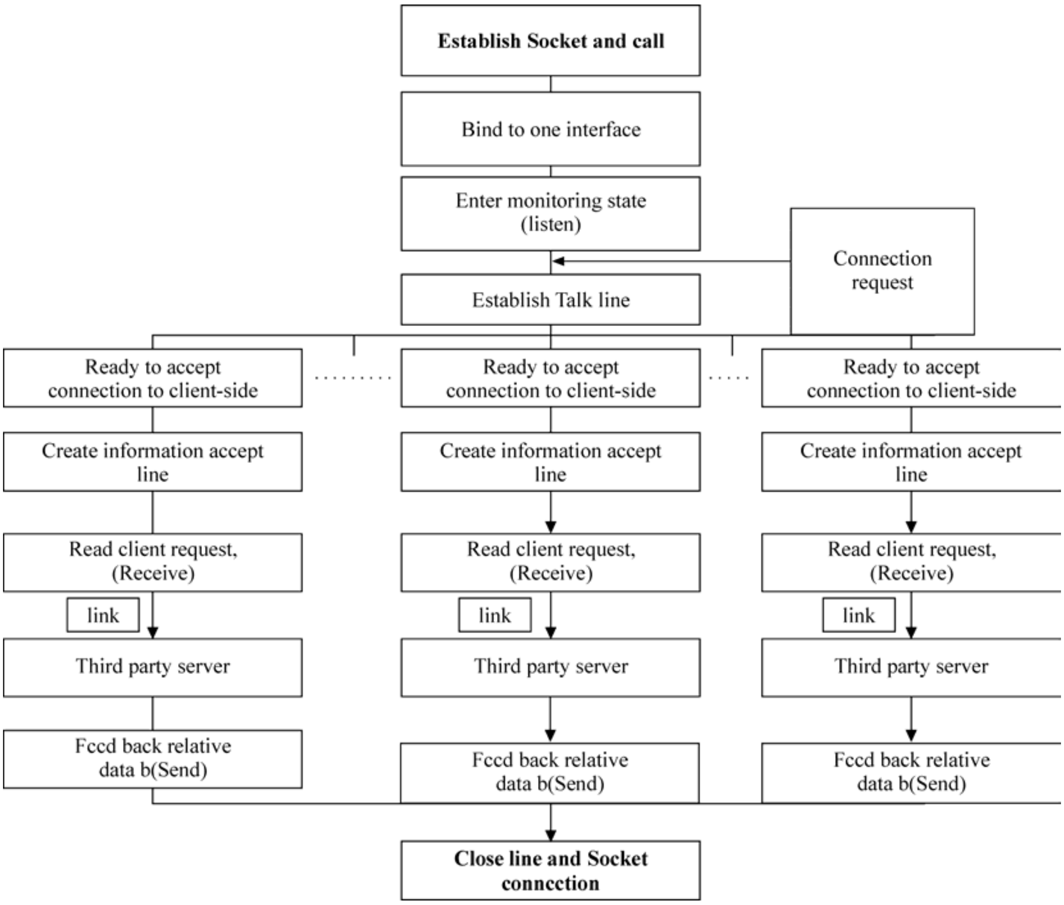

Figure 2. Workflow diagram on server

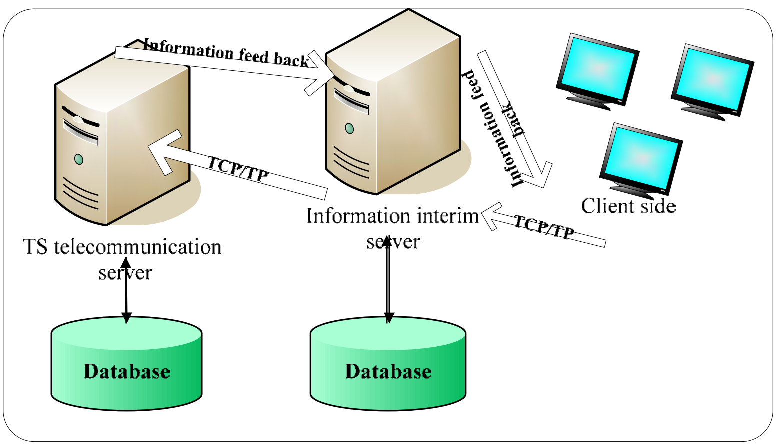

Figure 3. Monitoring and warning system structure diagram

Figure 3 is the diagram of remote controlling software platform on TCP / IP-protocol.

The main function of Ts communications servers are, communication with information interim server, log management, server address setting, GSM port settings, etc. The communication between Ts communication server and information interim server adopts Socket. Information transfer server is designed in Visual C++ to realize the real-time message receiving and sending. It also can save and distinguish the connected client side, and save all the client side landing information; set port and IP of communication interface and ensure the usability of real time communication port.

After receiving message from Ts communication server, transfer sever will analyze the message according to the "GIS Communications News norm" and get the type of message. When received the alarm information, it will parse out the alarm monitoring machine number, alarm time, alarm type, alarm channels, etc; the alarm data table and history alarm data table will be written; when received discharge alarm message, all the information in the alarm data table will be deleted; it will also inform user to update the information.

6. Conclusion

This paper discussed key technology of network communication and proposed the detailed program on realization of initiative message sending mechanism on WEBGIS. The Guangzhou CATV Network security monitoring alarm system is designed based on Winsock which has proved the feasibility of this program.

This paper has discussed the following from theory and practice two aspects.

1) specifically introduce application and development trend of WEBGIS. The combination of initiative message sending mechanism and conventional WEBGIS will foster WEBGIS development.

2) explain specifically the principles of socket communication mechanism, as well as the implementation process of communication.

3) specifically analyze the framework and workflow of initiative message sending mechanism on WEBGIS, and also propose detailed design program.

4) realize coding of initiative message sending mechanism server and client side server, which ensures information timely exchange.

5) successfully apply the research to practical project.

Due to time limits, this paper only studied the initiative message sending mechanism and simulated information interactive process. As to how to integrate to the conventional WEBGIS, and display it in digital maps hasn't been realized yet. Furthermore, data transmission doesn't involve complex data transmission security problem, so it has deficiency in data security. All of above problems are the key filed that needs to improvement in the near future. With relevant technology development, we fully believe that WEBGIS will do better.

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Journal of Geographic Information System, **2010, 2, 6-10**
doi:10.4236/jgis.2010.21002 Published Online January 2010 (http://www.scirp.org/journal/jgis)

Study on 3D Geological Model of Highway Tunnels Modeling Method

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Abstract: Geology is the base for highways and tunnels construction. With the fast development of national highway construction, highway tunnel construction project are more and more complex. The completeness and accuracy are essential for the planning, design and construction of projects, while the ground information is quite poor in systematic, reliable and timely aspects. Therefore, the development of underground road tunnels, and the implementation of informationized spatial information management is urgent for highway construction. 3D geological tunnel model is intuitive, high efficient and convenience which greatly facilitates the maintenance and security of highway tunnels construction and it will be the trend for the future highway tunnel development.

Keywords: oriented structure, semantic topology, rule base, 3D spatial data model

1. Introduction

GIS based technology plays a very important role in promoting the digitalization and informationzation development of highway tunnel projects, especially for surveying project which needs to store and manage large database and geological information. This method will solve the problem in highway tunnel project data application. The result data in traditional geological construction are relatively abstract. The information is partial information not overall information. What's more, there is no unified standard among the projects which is difficult to understand.

In general, most of highway tunnel geological data are profile information. These profiles are mostly along the tunnel direction while most of them are parallel sections. By 3D GIS technology to convert these geological results to 3D geological modeling which is easy to understand and analyze. 3D geological model can clearly reflect the geological structure of inner tunnels. This has great significance in highway tunnel option, construction early warning, security and latter conservation. Two parallel plane structures usually uses contour lines connection algorithm. However, this algorithm is based on the single model between parallel shared profiles. It can't ensure consistency of adjacent surface data[11]. In geological profile, the geological bodies are adjacent with each other, so the classic contour lines connection algorithm is not suitable in 3D geological modeling based on approximate parallel profile.

2. Highway Tunnel 3D Geological Modeling Based on Approximate Parallel Profile

In geological surface building process, we must ensure that two adjacent geological bodies only have one common geological surface, and this surface is generated once. Only this can ensure the geological body modeling consistency. How to ensure that two adjacent geological bodies have a unique geological common interface, the key is that every formation line has one unique corresponding relation.

For two adjacent geological bodies, the adjacency relations of the two polygons will be embodied in one geological profile. The common arc of the two polygons is the common interface expression of the two adjacent geological bodies. Therefore, to construct the unique common geological interface of the two adjacent geological bodies, the key point is to find the unique corresponding from the adjacent profile for the common arc.

In the geological profile, there are nodes, arcs and polygons and other spatial objects. Most of geological cross-section data (such as MapGIS format) only store the topological association of objects and other topological relations are not stored. Other topological relations can be derived from the topological association. The "polygon and polygon" adjacency relationship can be get from the "arcs and nodes" association. The "polygon and polygon" adjacency relationship can be get from the "arc and polygon" association. The topological relations can be get from the arc formed by polygons. As the topological relation of geological body and geological surface in profile are embodied in the topological relations of polygon and arc of geological profile, it will be an effective solution to search for the correspondent relation of arcs from the object topological relations of geological profile.

However, due to the complexity of geological bodies, using the computer to automatically search for corresponding relationship of arcs are not realistic. Therefore, timely intervention is essential for the user. In principle, only when there are multiple solutions, can the geological staff changes the multi solutions to unique solution.

In building a geological body surface, there are two common algorithms, the optimized algorithms and heuristics. Heuristic algorithm can be divided into three types: the largest volume method, the shortest diagonal method and the adjacent contour lines synchronized forward method. [10]. All these methods can be used in building process [1].

In summary, 3D geological modeling based on approximate parallel profile can be divided into four steps, as shown in Figure 1. Profile data processing is to standardize different data and specifications which is the basis of modeling; Geological surface construction is to use the correspondence of profiles to construct 3D geological surface automatically or semi-automatically; Geological surface smooth is to use interpolation algorithms (such as the B-spline) in constructing geological surface, to make it more attractive and realistic; after geological surface construction, the closed surface model of all geological bodies in this area can be get; the geological block construction is based on the closed surface model according to the approach to topological adjacency relationships of profile.

3. Key Problem of 3D Modeling of Highway Tunnel Geological Model

Since highway tunnels are in mountains, so the geologi cal condition is complex and difficult to describe. In 3D modeling process, there are several problems to solve, including the completeness of profile data, the profile corresponding problem, the stratum pinch-out, fault, etc

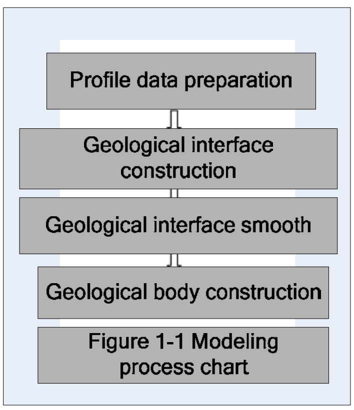


Figure 1. Modeling process chart

3.1. Profile Data Standardization

Geological profile data preparation consists of two aspects, one is section data standardization, and the other is the generation of 3D element of profile data. Profile data standardization includes data modification and data information definition.

a) Profile data correction

The purpose of profile data correction is to ensure the model accuracy and morphology effect. It has the following processes, 1) profile extension and cutting[9]. According to profile size and the regional geological structure, extend the small-size profile and cut larger profile to ensure the size of profiles is appropriate. 2) the profile contour rarefying and encryption. Due to cartographer differences, the point coordinates string model on the profile contour is non-equilibrium which will affect the outlook of modeling. The purpose of rarefying and encryption is to ensure the distance of the contour point. 3) topology correctness checking. The topological relationship of profile is the key point of modeling. Before modeling, the topological relations of elements of geological profile data should be corrected.

b) the definition of profile data

Profile data contains two layers, profiles and arcs. In profile, the stratum name and stratum code should be added in attribute. The arc main includes stratum line, fault line and boundary line, etc. The arc should contain the two-side stratum information. To express the information, the attribute structure design of the profile arc is as follows, Table 1

It should be explained as follows: 1) Arc top / bottom (left / right, inside / outside) attribute can't be affected by direction of arcs, and the same geological boundary label on different profiles should be consistent. If this arc only associates one stratum, then it should be boundary arc; 2) the area outside the boundary arc of modeling should be in specific number, e.g., -1 (upper), -2 (lower), -3 (left), -4 (right); 3) the faults in profiles should be identified in unique code.

Table 1. Line feature (are) attribute structure

Data name	Data type	Note
Linear	Short int	Required
Arc upper/left/inner stratum	String	Required
Arc lower/right/outer stratum	String	Required
Fault code	String	Required
……	……	Required

3.2. Geological Profile Matching

When carrying out geological boundary matching, the common step is, first match stratum and then the strata line.

Stratum matching: firstly, find two corresponding stratum surface from two adjacent profiles, if the stratum on one fault don't have a corresponding stratum in other profile, then this stratum should be pinched, or carry out contour matching.

Stratum line matching: if the stratum line has matched and constructed network, then it doesn't needs reconstruction. If this stratum line doesn't have a corresponding line, then this stratum line should be pinched. Use point-line method to match.

Usually the matching has five methods, points - lines, points - ring, line - line, line - ring, ring – ring. As shown in Figure 2. The contour of two adjacent geological profiles can use the five methods.

Based on this rule, when matching contour, if the model is relatively simple, and then automatically match, or appropriate user intervention is necessary,; user can search relative contour polygon or contour by user' designated method

Actually, geological phenomenon is very complex, such as, stratum pinch, lens, stratum unconformity, fault, folds, etc. In this condition, it's very difficult to automatically find out the correct relative fault polygon and arc relative relations of two adjacent faults. In this situation, based on common geological rules, use interactive method to solve this problem.

3.3. Stratum Pinch-out Processing

Stratum pinch-out refers to the appearance of certain stratum in current profile, but not in the adjacent profile. To deal with this fact, usually use the areas - lines and lines - loop approach to identify the corresponding relations, while for a non-pinch lens, usually use polygon-line corresponding relations, and the ring – line corresponding relations is rarely used. The purpose of this is to ensure the geometry and topology consistent of stra-

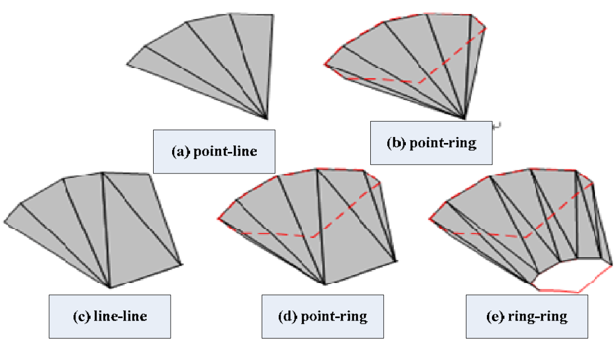
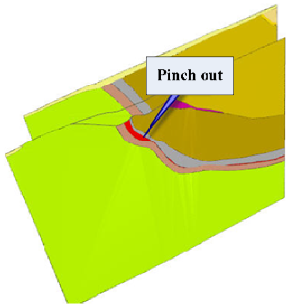
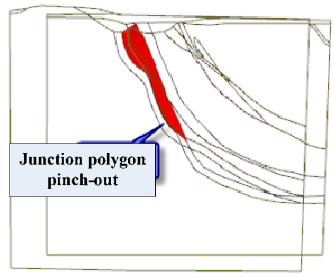


Figure 2. Contour matching forma



(a)Stratum SK pinch-out



b) Construct two geological interface

Figure 3. common stratum pinch-out

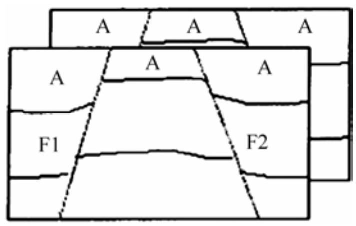


Figure 4. Fault

tum. Figure 3 display the stratum pinch out processing diagram. The red stratum in Figure 3 (a) doesn't have a corresponding stratum in adjacent profile. Figure 3（b）construct pinch-out area of red stratum and adjacent profile corresponding arcs geological surface.

Generally as shown above stratum pinch-out, you can specify the correlation of pinch-out polygon and certain arc of adjacent profile, that is, the correspondence of several arcs in pinch-out polygon and one arc.

3.4. Fault Processing

Fault cut object and cause polygon with the same attributes lots problems. Shown in Figure 4, the two profiles, fault F1 and F2 cut stratum A into three parts. When query relative polygon on one profile, it will cause "multi to multi" phenomena, while actually there is unique acceptable junction method.

In Figure 4, although the fault cut the polygon on profiles into different polygons, but in the same faults, the correlation of polygons in quite clear. The fault polygon is the enclosed by area of two faults, faults and boundary. Identify the fault separation area of polygon by right and left fault number of every polygon. It can be clearly seen that, the left and right fault numbers of polygon are the same in one fault polygon. Therefore, according to left and right fault number of each polygon, start from one polygon without cross fault tracing polygon, all the right and left fault number of polygon along are the same; at the same time, it can record the value of right and left fault number in searching, (the boundary is -1). This approach can be realized by recursive method.

(SearchPolys), algorithm is described as follows:

SearchPolys

{

start from input a polygon, then annotate the access bit；

save the poly pointer in one polygon pointer array（the right and left fault number of polygon of this group is the same）

for (every arc of polygon)

{

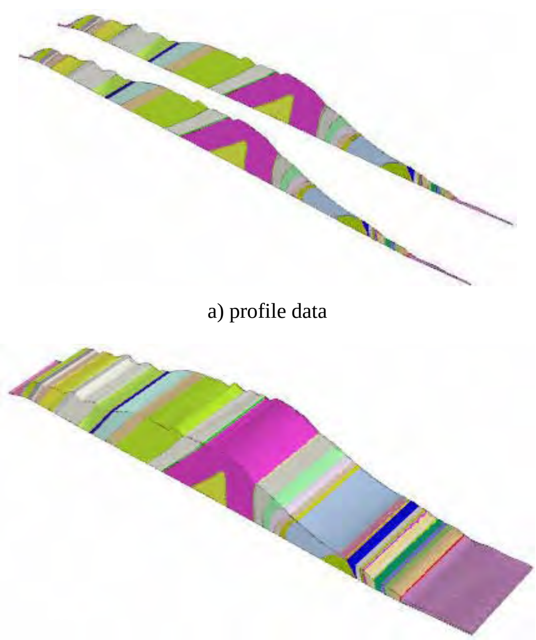
When the current arc is fault line, then according to the attribute of left and right polygon arc to identify it's left or right fault, and then record the fault number;

When the current arc is boundary, continue；

If it is common stratum line, then abstract the other polygon2 adjacent the current arc, and then take poly2 as input parameter to SearchPolys

}

}



a) profile data

b) Geological body model

Figure 5. Tunnel model

When function exits, return to the one polygon associated with initial input polygon, and the fault area is the same; return relative left and right fault number. By doing this, we can find the relative polygon according to polygon attribute, then according to the contour of simple model matching method to find the relative polygon arc.

4. Application

This Paper presents a highway Modeling based approximate parallel profile method which is used in 3D digital platform system. Here take Chongqing tunnel as an example. Baiyun Tunnel is a one-way road, double-hole and very deep tunnel. The axis distance of the two holes is 30 to 40m, and the hole plane is linear-shaped which is 7.1km. The maximum height difference of tunnel axis ground elevation and the designed road elevation can be 800m. Establish tunnel 3D geological modeling by two surveying parallel profiles' data along the tunnel. Figure 5(a) is the tunnel parallel modeling data. Figure 5(b) is the final geological modeling.

5. Conclusion

Highway tunnels are usually in complex terrain condition, which covers all types of constructs. The spatial object based 3D modeling of highway tunnels is the key of highway tunnels 3D visual design [1]. The author uses 3D geological modeling of approximate parallel profile method, and analyzes the key problem in highway tunnels geological model 3D modeling. Through experiment, it verifies that this method can improve 3D simulation of highway tunnels geological construction model. This method can provide designer a vivid and easy method to analysis. It improves efficiency and quality of highway tunnels 3D design and also foster the visualization, digitalization and intelligent.

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Journal of Geographic Information System, **2010, 2, 11-14**
doi:10.4236/jgis.2010.21003 Published Online January 2010 (http://www.scirp.org/journal/jgis)

ASTER DEM Based Studies for Geological Investigation around Singhbhum Shear Zone (SSZ) in Jharkhand, India

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Abstract: Singhbhum Shear Zone (SSZ) is a geologically rich belt with structures like faults and folds being the distinctive features. Due to these characteristics this area has been an important centre of studies since past few decades. With the advent of Remote Sensing and GIS, it has been possible to study and interprete geological setting of any area in the laboratory itself without even visiting the field again and again. The present study aims to investigate the geology of the SSZ from ASTER DEM by observing the elevation, aspect, texture, pattern etc of shaded relief images. This can prove to be an excellent supplementary information database for interpretations along with other data.

Keywords: RS-GIS, ASTER DEM, Singhbhum Shear Zone (SSZ), geological structure

1. Introduction

With the introduction of computer technologies the relationships between the map and map documentation is subjected to the GIS standards. However, the modern computer technologies may provide additional tools for geological mapping which may improve better agreement of determined geological units with the terrain topography. One of such tools is the Digital Elevation Model (DEM) which can serve both as information source for finding geological boundaries, controlling elevations, and at the same time play a role in preparation of the base map as well as various surficial thematic maps.(S. Ostaficzuk, 2005). A digital elevation model (DEM) is a digital representation of ground surface topography or terrain. It is used for many purposes like providing flood and landslide risk zone, highways and corridor selection including cut and fill estimation etc. These data are also good for geological interpretation particularly in terms of geomorphology, rock type and structure (Sarapirome et al. 2002).

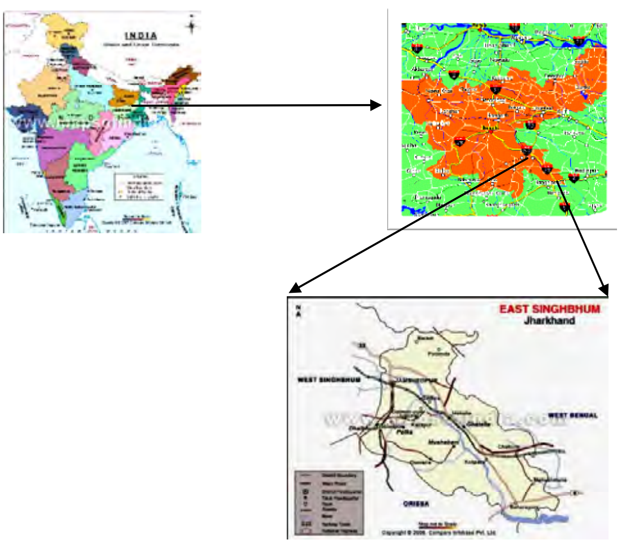

Figure 1. Location Map (source: www.mapsofindia.com)

SSZ is an arcuate belt which is one of the most well known mineral abundant zones in the country and extensive mineral exploration has been carried out in this zone since long. The study area falls in the SSZ and is extended between 22° 41'N: 86° 14 ' E and 22 ° 28 ' N: 86 ° 27 'E in the south east confined in the East Singhbhum district of Jharkhand (Figure 1).

2. Materials and Methods

Data used:	Software used:
ASTER DEM	1. ERDAS IMAGINE 9.1
	2. Arc GIS 9.3

The input data for the present study is ASTER DEM having 15m resolution. The aspect mapping which may help in knowing the topographical and geological features is generated from the DEM in ArcGIS platform. A number of shaded relief images are also generated from the DEM having different azimuth, sun angle and vertical exaggeration. It is seen that different sun angle and

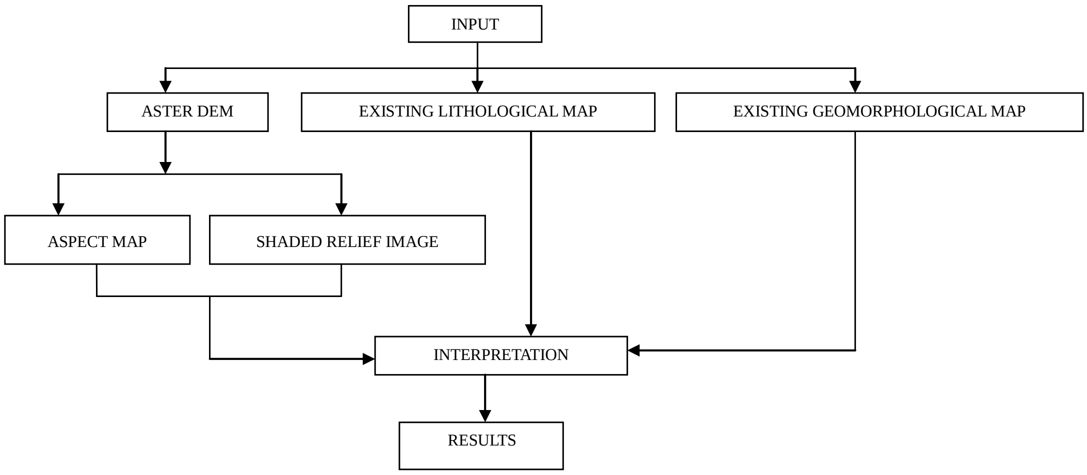

Figure 2. Flowchart showing methodology

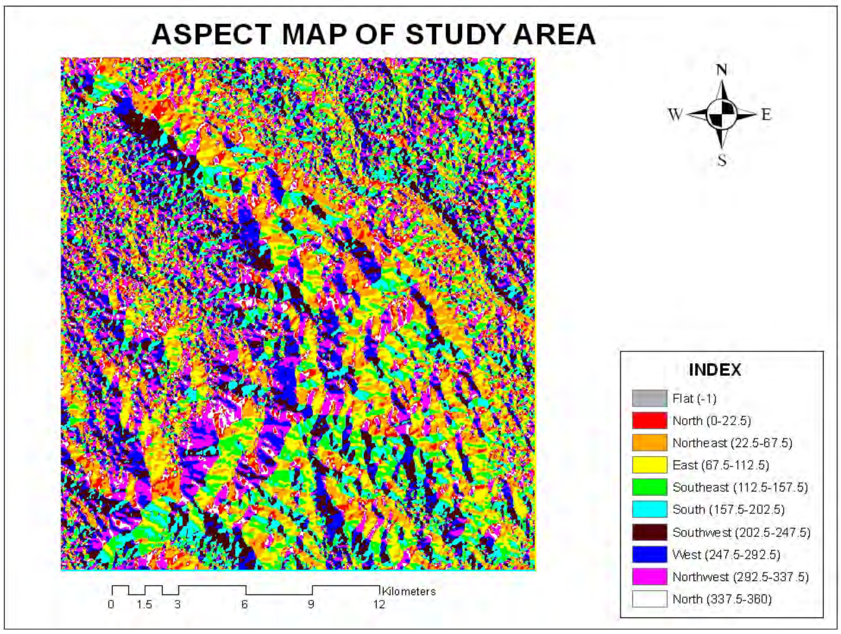

Figure 3. Aspect Map of study area

azimuth help in enhancing different features. On these parameters the various interpretations are made based on the shaded relief images, aspect map with reference to the existing geomorphological and lithological maps. The results are hereby presented in this paper (Figure 2).

3. Data Interpretation

Shaded relief images can help in extracting information about geomorphology, rock types and structure of an area. From the shaded relief image, the morphology which is described as extent, size, shape, height, variation of slope and aspect on the surface can be identified. Geological structures look curvilinear or linear on an image, out of which the curvilinears may indicate dome structures and the linears may indicate faults (Lillesand et al.1979)

In the present study, aspect map of the study area is prepared from the ASTER DEM and the shaded relief images are enhanced by changing the sun angle, azimuth and height exaggeration in different images. Changes in texture and pattern are seen in different parts in different images after the enhancements. It also helps in enhancing the rock type and structures to a certain extent. The enhanced features observed when the sun angles and azimuth are changed are as follows-

1） The NW elongated and arcuate shaped hilly areas associated with faults are seen in the middle part of the images. (Figure 4 & 5)

2） The NE-SW flowing water body on the NE side of the images indicates presence of lineaments. (Figure 4,6 & 8)

3） The intermontane areas in the mid and southern part of the images with scattered hills indicate surface beds of the outcrops. (Figure 6,7 & 8)

In the process of identifying the geology of the study area from the shaded relief images, an already prepared lithological map of the same area was referred to. Hilly range is found running diagonally across the study area in the shape of an arc and it is supposed to be made up of quartzites. To the NE portion of the hilly area lies a rugged topography without much drainage and without much change in slope and elevation. These are made up of metamorphic lithotypes of schists and phyllites. The SW portion of the study area seems to be made up of hard granitic rocks due to the texture and its association with the mountains. Intrusive rocks like dolerites are also supposed to be present in the intermontane valleys.

Figure 4. Shaded Relief Image (Azimuth 315, Sun angle75, Vertical exaggeration 5x)

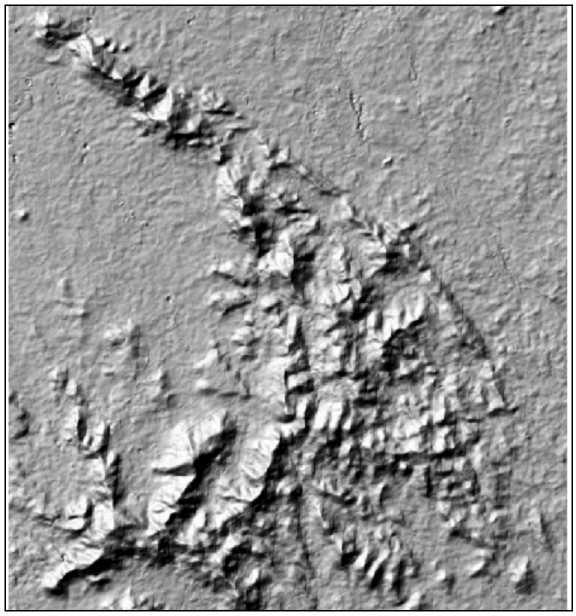

Figure 5. Shaded Relief Image (Azimuth 315,Sun angle 45, Vertical exaggeration 3x)

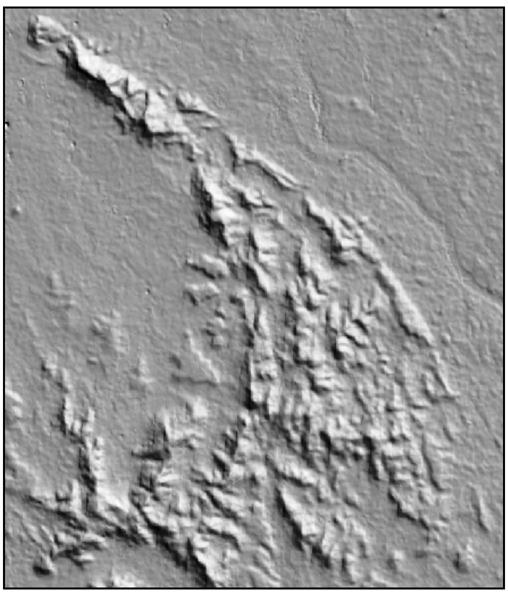

Figure 6. Shaded Relief Image (Azimuth 45, Sun angle45)

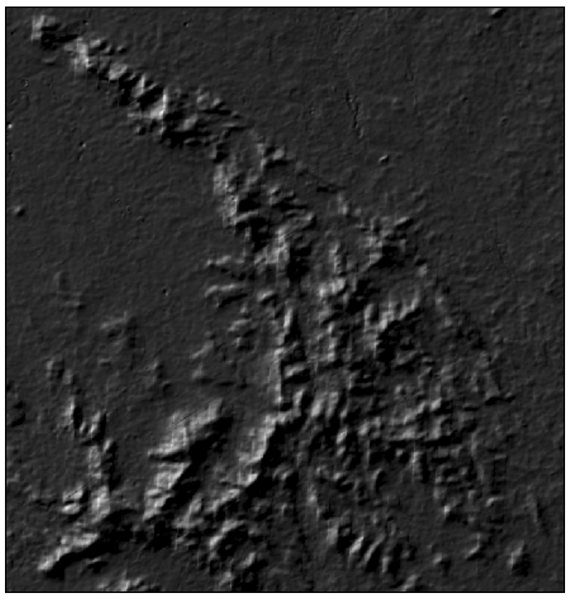

Figure 7. Shaded Relief Image (Azimuth 315,Sun angle10)

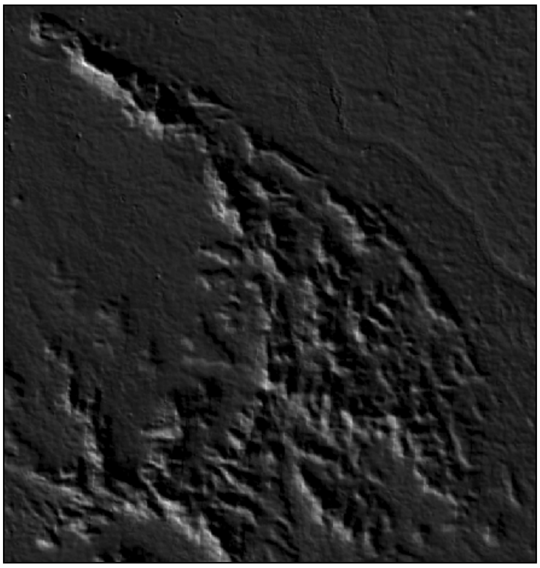

Figure 8. Shaded Relief Image (Azimuth 225, Sun angle10)

4. Conclusion

It is seen that DEM data can be used for geological interpretation in terms of geomorphology, materials and structure/ lineaments recognition but not to a very detailed level (Drury, 1987). It can be used for defining the structure, morphology etc of an area but as it lacks information like that of vegetation cover or soil moisture it cannot be trusted to give an accurate interpretation of the geology. DEM data, however cannot be ignored altogether as it can be very useful in giving an overview of the geology of any area especially where no other data is available for study. It can also prove to be a reliable source of supplementary datatabase in the visual interpretation as far as Remote Sensing and GIS is concerned. Reconnaissance survey before the interpretation can further help to identify the characteristic features seen through the imageries.

For better results an integrated datasets like topographical maps, aerial photographs, satellite data and ground data generated by previous workers can be highly useful.

5. Acknowledgements

This work has been carried out under the ISRO-SAC (RESPOND) Project (SAC Code: 0GP62, ISRO Code: 10/4/556), Department of Space, Govt. of India. We are thankful for the support provided by the Head of the Univ. Dept. of Geology, Ranchi University. We also thank Dr. A.T.Jeyaseelan, Director, JSAC for his kind motivation and co-operation. Dr. T.J.Majumder SAC focal person under the project is also gratefully acknowledged for his sharing and academic comments.

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Journal of Geographic Information System, **2010, 2, 15-18**
doi:10.4236/jgis.2010.21004 Published Online January 2010 (http://www.scirp.org/journal/jgis)

Research on Key Technology of General Embedded GIS

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Abstract: With the development of mobile devices and digitalization of information, the GIS system will be more popular than before. For the variable of mobile devices and different system structure, the design of universal embedded GIS system will be more difficult. In this paper, we talked the features of embedded GIS and the key techniques, design a highly portable general embedded GIS platform, and by using some applications to tested the advantages of the new system.

Keywords: embedded GIS, spatial data, portable

1. Introduction

Computer has moving fast into the mobile times. With the support of hardware, operation systems, GPS application and network technology, the access real-time location information, visit information and seamless combine the mobile object with the large geographic spatial database by wireless network have become the reality.

Embedded GIS is the combination of embedded technology and GIS, which is the extension, complementation and development of the former GIS.

This paper aims at meeting the demands of the fast-growing graphical mobile information service, combining the current embedded system and GIS theory, and highly portable development embedded GIS.

2. Feature and Key Technology of Embedded GIS

Embedded GIS integrates most GIS functions and combines fully of hardware and software. It's also an ideal solution for navigation, position, map query and spatial data integration which can be used in various areas.

2.1. Embedded GIS Feature

The main feature of embedded GIS is its diversity in facility, data management and function design. Heterogeneous embedded chip diversity results various product branches. Different system structure and embedded operating system are the main difference between facility and data management. In addition, because of different concerns of users, results the big difference between data management and visual demand. For the mobility of embedded GIS and hardware are closely combined, thus embedded GIS can better achieve various functions that can't be realized by PC, such as, GPS or base station positioning, wireless data telecom, etc. All of the above, expands GIS application areas, and generates more demands for embedded GIS.

2.2. Key technology of general embedded GIS

2.2.1. Spatial Data Organization

GIS mainly deal with geological spatial data [1]. With limited memory and storage space, high performance data model is essential for the mobile terminals. Besides, data management and applications of embedded GIS system should be closely integrated, so as to ensure its utility. Hardware platform in a PC or workstation used for Data management of GIS is not feasible for embedded devices, such problems as Memory size, Data read-write speed limit and spatial analysis performance and display performance. Only the pure usage of vector or raster storage can not meet the needs of the embedded platform [2], [3]. It's necessary to analysis smart mobile terminals such as, PDA or PMP and design a hierarchical sub-blocks vector data model. This data structure is applicable to all kinds of intelligent terminals for the hardware platform embedded GIS system is the key technology to achieve rapid storage and display of vector data.

2.2.2. Spatial Index Technology

The key of spatial data organization is data index and query. The performance of spatial index will directly affect the whole system performance. General spatial index are BSP trees, KDB trees, R trees, CELL trees, quadtree, etc. In addition, simple grid spatial index has been widely applied. To most mobile applications, spatial index design will start from the analysis of embedded file system which was highly limited by display screen, memory and operational performance. Fast and short index structure and data access are key elements for index design.

2.2.3. POI（Point of Interest）Data Organization

The data which integrated with various industries has been an important context in Embedded GIS products. While the performance of database technology in common PC is limited for embedded system. Combining actual applications and designing separated data storage management is the general method for embedded GIS products.

2.2.4. Network Data Organization

The high efficient topological spatial data organization, management and analysis are basic functions of GIS. The various application network topological data should be included within this system. Path analysis is widely used in GIS application operation. Network data organization and management program will better serve embedded GIS system in limited computer performance. Path analysis is one of basic function of embed navigation product, so the platform design should organize network data carefully and optimize network analysis strategy and solution.

2.2.5. General Design

To meet the demands of embedded GIS system general versatility, the thoroughly analysis of mobile terminals is needed. At present, most embedded GIS related systems are designed for specified area, the data organization, data storage, memory management and GUI interactive design are limited by the designed functions. For high portability, the system needs to be designed from the bottom layer, especial the independence design of data access, GUI system and hardware abstract layer.

3. General Embedded GIS Design

From the above, we can see, embedded GIS is quite dependent in data management and application design, which integrates better with the basic layers. It tells us that system design and analysis should be conducted from bottom layer.

3.1. Spatial Data Organization Module and Index Design

The paper adopts the following design methods according to the embedded GIS system analysis.

Firstly, data access optimization design, which will fully carry out integrity optimization management for accessing data to reduce the times of data access. It is applicable to use data-layer and data-block method to manage the spatial data, and establish quadtree index structure according to data sparse density to achieve read and operation. Graphic data are composed by multi-scale maps for different scale embedded GIS data different accuracy display. Thus, all the graphic data are layered quadtree grid structure, all networks ID will be generated according to different scale and be indexed. All the corresponding data can be fast stored and accessed.

Secondly, to ensure data space utilization, optimize data storage, without storing by floating point data, and data are stored according to size and non-floating point.

Finally, to achieve GIS related functions, spatial data use data packet storage method[6].

It mainly has the following types, display data packet, POI data packet, network packet, the attribute data packet, etc. Every packet contains the following components, packet header information and inner packet data information. The former refers to the physical data index information and the latter refers to data stored in physical media. The following are specific explanation of various packets.

Display data block: Spatial data organization and management is to improve data fast transfer and zooming, and also store spatial data annotation information (figure 1).

POI data block: Spatial data organization and management design should in accord with high performance index, to meet various queries and index demands.

Network data block: network data organization and management in graphs main refers carrying out network analysis of these data.

Attribute data block: Various spatial data and attribute information storage and management, including various industry data management.

3.2. POI and Network Data Organization Model

POI data shorts for "Point of interest", which is abstract from spatial entity concepts. It has been widely used, and

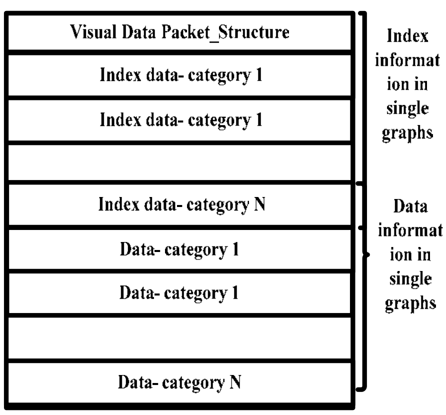

Figure 1. Display data packets structure

lots of field has detailed classification and coding specification. It is main method for fast information query in common GIS. To achieve high performance POI query and index, data should be carefully organized and designed. This system main carries out multi-layer index and queries according to the administrative divisions.

Network data is mainly used for network analysis which is very important in GIS system. Network data mainly stores data and mutual topological relations, which is the basis of network analysis. In this system, data are stored after compression which greatly reduces storage space.

In addition, it mainly stores network topology and node information.

3.3. System general design

One of main features of GIS is that it is applicable for various embedded platform, that is, it has high portability. It has two main parts, the visual module and data storage module which will greatly affect the product performance.

3.3.1. Data General Storage Design

Because of different terminal device and various API interface operation system, to ensure system independence and portability, it's necessary to design this part separately. The adopted approach is to use text document to manage data and only design basic data read and protection function. But this method increases difficulty of system design such as, massive data storage, data fast read of different region, etc.

This system design bases on physical document storage management method. For single physical document (figure 2), this system uses sub-page management method to save memory and sets page size to compose one physical document by multi-pages. The storage sector main consists of documents basic information and data. According to the operation system supporting storage method, the physical documents have two storage sector, physical document management and data. Physical document management start from the beginning to data sector and data sector start from its beginning to the end.

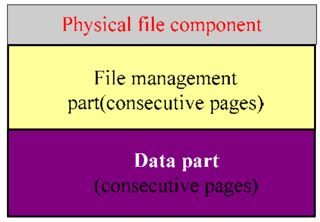

Figure 2. general data storage structure

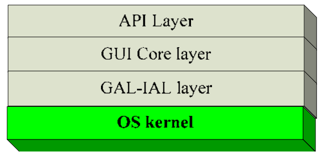

Figure 3. GUI layer

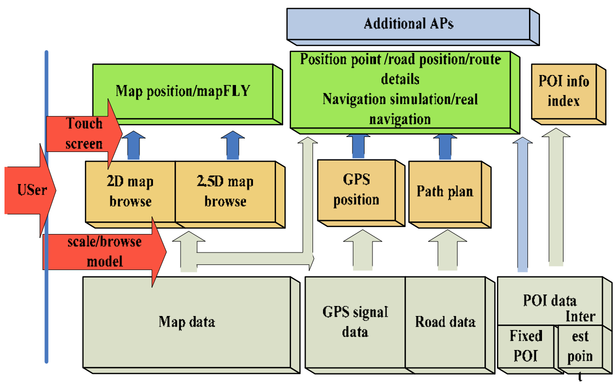

Figure 4. Embedded navigation system design graphs

3.3.2. General GUI Design

Embedded GUI design usually adopts hierarchical structure and starts from OS kernel. As shows in figure 3, it has three layers, the bottom is GAL(Graphics Abstract Layer)-IAL(Input Abstract Layer), which is above the system hardware OS kernel and closely related to hardware drivers. The middle of the kernel layer is the most important part of GUI, which is usually C/S model. The top API layer is the users programming interface provided by GUI. The GUI system isolated GAL and LAL layer, which can isolate the underlying graphs device and upper interface which greatly improves GUI portability. Actual display in embedded device is Frame Buffer operation [7].

GUI is built on operation system, so the design should take full advantage of operation system function, such as, process creation and cancellation, various communication mechanism, etc. These are interface provided by OS(Operating System). GUI system has the following functions, 1) Window's management, creation, destruction, switches, mobile, focus switch. 2) Message package, access and input events from the device file and convert it to the message structure. 3) The timer management, send the message to the server timely. 4) Memory management, use buffering mechanisms to improve the display effect. 5) Event management, window object communication, user and GUI object interaction, OS kernel and the GUI information exchange and synchronization.

4. System Application Development Cases

The embedded navigation system is designed by using the embedded GIS system on uc/OS2 system in this paper. This system also be ported to eCos, Linux and Windows Mobile and be tested on hardware platform such as, ARM, MIPS, etc. It has been testified that there is no difference between the systems.

Since the application layers are the same, only data access and message and timer modules need to be adapted. Figure 4 is the product function structure.

5. Conclusion

Embedded GIS will be widely used in personal and spatial information management, since 80% human activity relates to spatial information. Embedded GIS development is inseparable from the relevant hardware and software technology development. The device performance improvement, wireless communication and Internet technology will foster embedded GIS system application in mobile terminal development in all GIS sectors.

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Journal of Geographic Information System, 2010, 2, 19-22
doi:10.4236/jgis.2010.21005 Published Online January 2010 (http://www.scirp.org/journal/jgis)

Webgis-Based Telecommunication Resource Management Auxiliary Wiring System

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Abstract: This paper introduces the necessity and superiority of auxiliary wiring WEBGIS, as well as system implementation difficulties and countermeasures. Then explained the general concept of auxiliary wiring systems, data interface response, and finally introduced the system wiring switchover function, and gave an example.

Keywords: WEBGIS, ancillary wiring systems, flow chart

1. Introduction

According to China Telecom overall planning, the existing machine-line resources in the 97systems will gradually transfer to the existing pipeline resource management system (ie, China Telecom Network Resource Management System) for unified management of resources and processes so as to achieve the separation of resource and process. The involved machine-line resources also need the auxiliary wiring capabilities to be integrated into the existing pipeline resource management system.

As Internet technology continuous development, the demand for GIS is growing. Using Internet and Web to publish spatial data, provide spatial data browsing, query and analysis functions has been the inevitable trend of GIS development. The current WEBGIS technology with cross-platform, low development and application management costs and extensive space characteristics, will provide effective measures for auxiliary wiring of pipeline resources. This paper introduces wire resource auxiliary wiring realization measures and process based on WEBGIS.

2. System Design Thought

To facilitate system extensive application in near feature, system design intended to follow Microsoft, NET Development and Web Application System's three-tier architecture ----presentation layer, logic layer and data layer. To realize automatic wiring and auxiliary wiring functions by combining GIS network resource spatial and graph data. Online business SOCKET + XML data will be obtained through 97 system and interact by the interface server and WEBGIS application service.

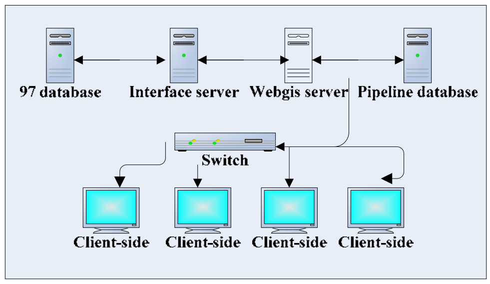

Figure 1. System physical structure chart

3. Design Difficulties and Countermeasures

3.1. WEBGIS Auxiliary Wiring Design Difficulty is as Follows

1) To achieve the basic GIS operations and analysis in the WEB page

2) Can quickly and easily access and configure the resource management system of China Telecom (Professional GIS) (C / S mode) in the resource data by the WEB; it can interact with large-scale heterogeneous 97 databases; it can realize real-time access to their online business resource occupation situation, because the wiring to be related to the occupied information modification of auxiliary wiring

3) 97 systems, professional GIS and WEBGIS has high demand in system stability, accuracy and response time, especially in 97 systems, as it is the telecommunications company's online operation system for its business and services which can't tolerate slightest error.

To solve these problems, the auxiliary wiring systems based on WEBGIS from Wuhan Zondy T&S CO., Ltd .

Table 1. MAPGIS_IMS6.7 list of common used components

Component name	Function description
MpViewCom.dll	Map display, zoom in and out, Coordinate transformation, etc in WEBGIS
MpMapCom.dll	Realize project load, work area state, project query, etc.
MpAreaCom.dll	Achieve information management and query of point, line, polygon and net
MpAppCom.dll	Provide GIS application functions, map clip, buffer of point, line and polygon, project transformation, distance and area measures, etc.
MpNetOperCom.dll	Provide network operation and analysis function, including network path analysis, optimize path, shortest path, path query, ending query, etc.
MpKitCom	Provide file type conversion, code type conversion file, upload, packet, etc.

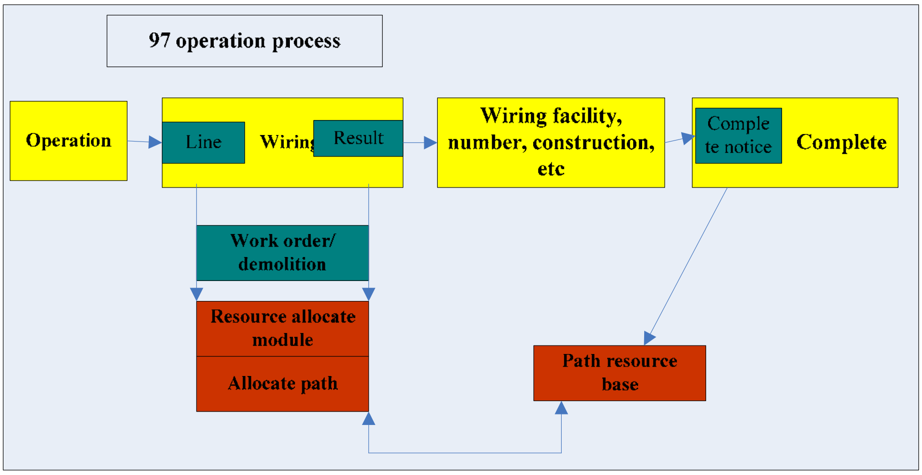

Figure 2. 97 system flow chart

new INTERENT distributed WEBGIS platform (MAPGIS-IMS) is selected.

MAPGIS-IMS based on Internet network, uses multi-tier architecture and integrates several distributed object technology (CORBA, DCOM, JAVA) to build and publish GIS which provides fast and integrated solutions. MPGIS-IMS provides series of COM module such as, spatial data management, map display, project management, work zone management, query and analysis to facilitate ASP.net and also to establish various GIS application solutions through WEB[4].The common function components are shown as Table 1.

3.2. Data Interface Countermeasures

97 databases require timely and strong stability. To achieve heterogeneous database real-time interaction, an appropriate method is through the widely used SOCKET + XML complying with certain norms for data transmission. To run the original 97 normally without large modification, firstly, to copy all the data from resource management system from the original 97 such as, print work orders, inquiries, interfaces, etc. Use redundant data to ensure system function separately running. Finally, part of system wiring 97 functions will be replaced by WEB-GIS and other resources available are from professional GIS. 97 system converts to open system and it's responsible for numbers and single-process management.

Remodel C # component through COM component under VC and NET environment. By taking original large number of C / S functions code to save a lot of research and development time.

System technical framework diagram is as follows:

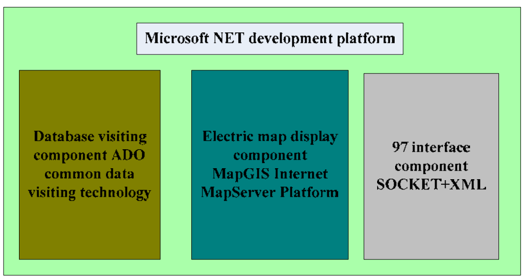

Figure 3. System technical framework diagram

4. System Functions [3]

From fully research telecommunication process, we can see that the new WEBGIS auxiliary wiring is to realize wiring and cutover management.

Wiring management needs to realize the following functions, 1)Automatic with / DISCONNECT 2) artificial wiring 3) Integrated bulk wiring 4) wiring quality sampling 5) Public single fill line, user line and path query 6) wiring Log Inquiries and statistics 7) Line Completion.

These functions are not complex form technical level. Primarily, workflow needs to meet business needs.

After preliminary test, WEBGIS based wiring auxiliary can process these telecom business in WEB page, such as, newly installed or mobile telephone, an inter-bureau telephone, local telephone line, data line configuration. It supports various wiring methods, such as auto-wiring, manual wiring, alternate wiring and other wiring methods. It also support failure wiring returning and outdoor surveying, transfer and ready to install, modification, etc. It provides wiring quality sampling, fast and effective line resource configuration functions.

Cutover management needs to achieve the following main functions: 1) New cutover project 2) divide cutover range 3) cutover close up 4) cutover notification 5) cutover and the allocation of resources 6) removing the cutover 7) cutover completion.

By using GIS electric map, taking fully advantage of graphical operation, system can handle cutover operation easily, establish cutover project, divide cutover area, cutover circle, cutover resource allocation, cutover completion. These functions provide effective technical support for telecom enterprise technology innovation, municipal project, network construction and optimization.

5. Applications

5.1. Manual Auxiliary Wiring

Through the GIS system and 97interface, automatically extracting 97 systems manual wiring work orders. The system automatically matches sub-Box, wiring cables and other wiring information through the user address for user. If there is not eligible information, user can use manual intervention to match. At the same time, according to actual situation, the user can carry out operation as, to be installed, survey, focus operation, etc [4].

①┌ Inquiries junction box close to phone number, and then match;

②┌ According to address fuzzy matching to find sub-Box, and then matching;

③┌ Search the sub-Box within a specified radius, and then matching;

④┌ According to region to find out the respective transfer box, select the box to meet the requirements after handover, and then search the sub-Box within the jurisdiction, and then matching. After the success of wiring sent to the 97, transfer to the next link.

Wiring suspicious or failure, choose re-allocation, or transfer to be loaded links, external survey links or rewiring or re-matching.

Manual auxiliary wiring process is shown as Table 2.

6. Conclusion

WEBGIS technology is the GIS systems and Internet technology, combining the results. It has the following advantages:

1) thin client, a client-side burden on small.

2) No need to download software, image data of high compression ratio and speed.

3) transfer raster data, well data security.

4) client relationship between response speed and the amount of data is small, response time constant, suitable for public viewing.

5)well extension and compatibility, support WAP Search.

With the growing WEBGIS applications, GIS technology is more popular than before. Practice has proved that China Telecom's 97 aircraft WEBGIS in line reconstruction project to address the ancillary wiring

Table 2. Manual auxiliary wiring process

Function structure		Function process
Extract work order		Receive information, batch match wiring work order
Wiring		Receive wiring work order, access user matching transfer box and sub-box, query main cables and terminal wiring cables information, arbitrarily select spare state line, lastly, batch wiring and send back wiring results.
Match wiring sub-box	Match sub-box close to phone number	Extract close phone number, query matching sub-box
	Match sub-box according to address information	Extract user address, fuzzy matching and query sub-box according to address information
	search the sub-Box within a specified radius	Search geographic center, query sub-box according to query radius
	search the sub-Box within the jurisdiction	Take junction box code, then query sub-box according to junction box jurisdiction area
Matching box		Conditional query junction box

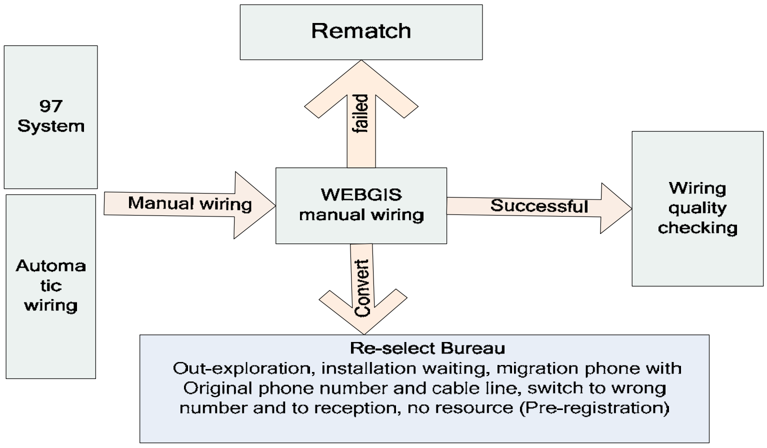

Figure 4. Functional Flow Chart

graphic which provides scientific and effective technical supports, and it provides references for telecommunications resources integration and other telecommunications operators.

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Journal of Geographic Information System, **2010, 2, 23-31**
doi:10.4236/jgis.2010.21006 Published Online January 2010 (http://www.scirp.org/journal/jgis)

Scientific Research

Geospatial Analysis of Geotechnical Data Applied to Urban Infrastructure Planning

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Abstract: The urbanization process inside the State of São Paulo (Brazil) facilitated, in approximately five decades, the migration of thousands of peasants to the urban areas of great industrial centers inducing and requesting, at the same time and very often, an amplification of the systems of local urban infrastructure not appropriate for the natural potential of the physical territory. In this content, the city of São José do Rio Preto (State of São Paulo) with little more than 350.000 inhabitants, currently faces serious problems related to the urban planning originating from the unusual occupation and without previous study of suitability. Therefore, the present paper intends to guide and indicate the areas whose potential of urban development leads to an occupation suitable for the construction of shallow foundations in residential buildings of single floor, using an interpretative chart produced by the software GIS-SPRING-4.0 developed by Instituto Nacional de Pesquisas Espaciais/INPE (Brazil), and based in the methodology of geotechnical mapping developed by the department of geotechnical engineering of EESC/USP (Brazil). The chart for shallow foundation shows that a large portion of the studied area presents serious relationship problems with layers of highly collapsible soils.

Keywords: GIS, geotechnical mapping, urban planning, urban infrastructure, shallow foundations

1. Introduction

Industrialisation in underdeveloped countries is an important part of participation in the urbanization process. We can consider industry as one of the great causal factors of urbanization, and, for this reason, industrialized areas are also the most urbanized. As several examinations have shown, the interior of the State of São Paulo (Brazil) has presented the most significant rates of population growth in the entire state in the last decade (Negri and Pacheco, 1993; Caiado and Vasconcelos, 1994; Campolina Dinis and Santos, 1995).

The migration process to the interior of the State of São Paulo is related to the intervals of proximity to the metropolitan area of the city of São Paulo, according to Birkholz et al. (1983). In the interval of proximities, the important urban centers of Ribeirão Preto, Presidente Prudente, Bauru and São José do Rio Preto are included. The city of São José do Rio Preto (State of São Paulo) is located at an important railway and roadway east-west axis of the State of São Paulo, which offers conditions for its growth, and is set fundamentally in the tertiary sector. However, the constitution of new industrial and agriculture-industrial spaces in the interior of São Paulo was not capable of avoiding the collapse of the basic urban public infrastructure in the development process. This view shows the current situation of the city of São José do Rio Preto, composed mainly of an irregular pattern of single floor residential constructions, which have foundations and urban infrastructure in places that lack previous suitability studies. These often do not satisfy the natural relationship potentials of the urban physical territory/ocupation.

Therefore, in this paper a space analysis of the main attributes of the physical territory of the urban center area of São José do Rio Preto was prepared, with the intention of obtaining, using the database produced by Mendes (2001), interpretative charts for shallow foundations and underground constructions that can evaluate and indicate areas where potentials of urban physical territory are adapted in an efficient way. The objective was to minimise or repair the current problems of irregular urban occupation. These interpretative charts can guide local investigations, allowing us, in certain circumstances, to decrease costs, time and the number of situations to be studied and investigated.

2. Area of Study

The studied area (Figure 1) is located in the Western

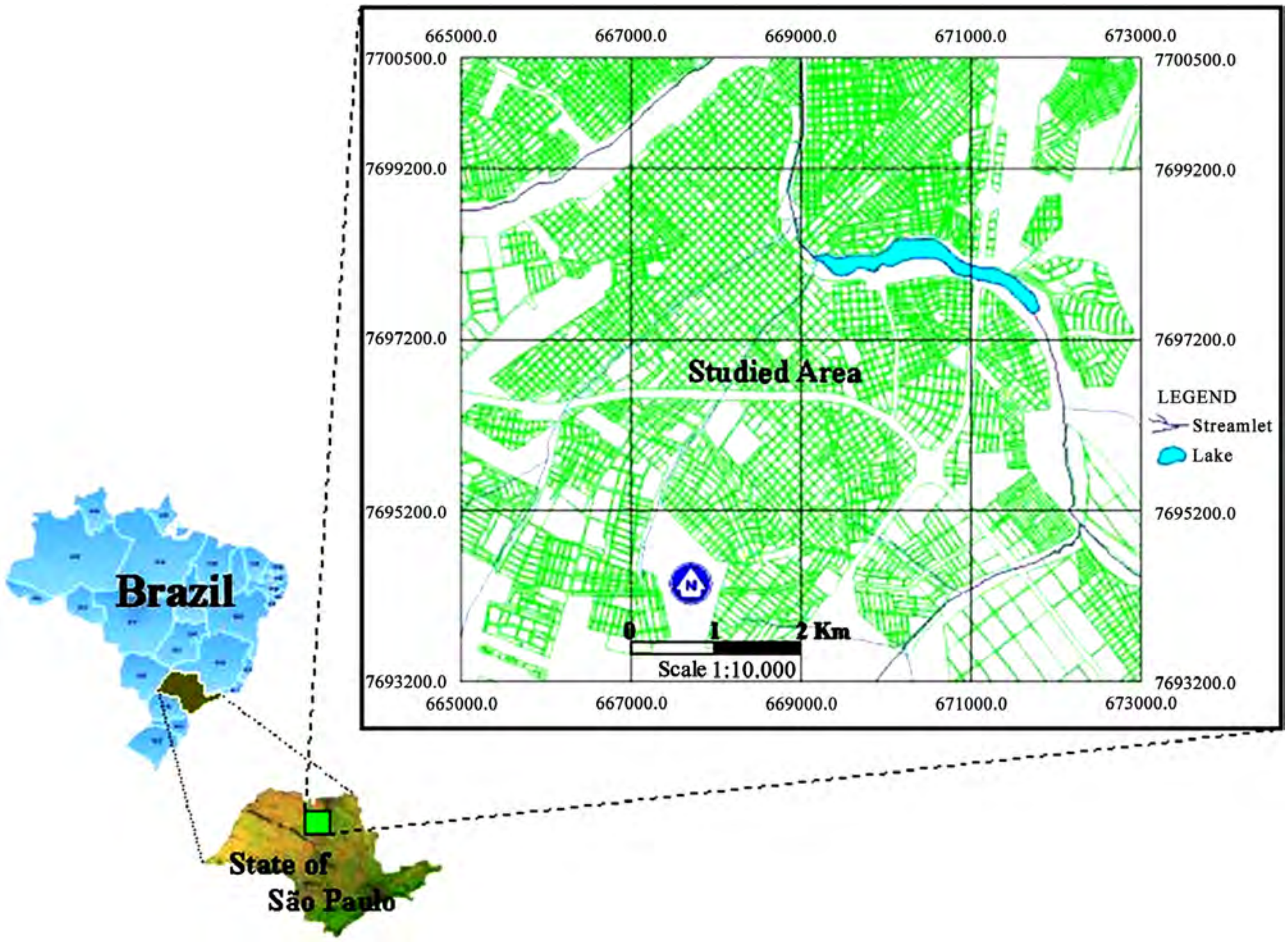

Figure 1. Location of the studied area (Mendes 2001)

Region of the State of São Paulo (Brazil), between the parallels 20º47'00" and 20º51'10" South and the meridians 49º24'58" and 49º20'13" West, possessing an area of 60.0 km^2. According to Brazil-IBGE (2001), the city of São José do Rio Preto presents, in the census of 2000, total and urban populations of 357.862 hab and 336.998 hab, respectively. The resident population in the municipal seat and the demographic density are, respectively, 326.627 hab and 827 hab/Km².

According to Arid (1966), the studied area is classified, as a humid tropical climate that possesses annual medium temperatures around 25.4ºC. A general view of the vegetation shows that it is composed of 10.4% permanent cultures, 18.9% annual, 52.9% grassland, 7.9% forests and 9.9% lazy and reforested lands. In the developed area pedologic formations prevail with thick soils represented by red-yellow latosol and yellow latosol. On the slopes of the main valley and in end northeast of the area, stains of red-yellow latosol intergrade argisol appear, representing an intermediary level of pedologic evolution.

The gleisols distributed along the valleys of the main drainage lines can be associated with conditional specific geotechnics as profile organic clays of low bearing capacity and shallow level of water, with direct influence on the geotechnic properties of the soil aggregate. The other pedological units, such as argisols and cambisols, have restricted occurrence in the study area (Augusto Filho, Ridente and Alves 1999).

According to Barcha (1980), in the studied area the soils sufficiently favour infiltration conditions due to their grain size distributions. They are, for the most part, sandy soils of the Adamantina and Santo Anastácio formations, both belonging to the Bauru group (Cretaceous) where the sand fraction always prevails (± 70%), varying the fine grain size, with a clayey silt fraction around 30%. The Adamantina formation is composed of fine sandstone; quartzose with clayey particles; cementation carbonaceous with plan-parallel stratification and crusades of medium load; clay banks with a massive, brown-reddish tone and recent sediments of the Quaternary composed of fine sand alleviation with beige and light gray tones; and sandy and/or silty clay with light to dark gray tone. The Santo Anastácio formation appears in areas that accompany the quotas with more drops in the river and streamlet valleys, represented by brown-reddish and violet tones of sandstone with fine to medium grain size, generally regulated to bad grain size distribution and rounded particle size covered by limonitic film. On the surface of the studied area only the Adamantina formation appears at the depth of the Santo Anastácio formation. The Adamantina formation is more expressive, with a thickness varying from 58 meters up to 140 meters. The rocky blooming is relatively rare, occurring mainly in the drainage lines.

According to the geomorphological division of the State of São Paulo (São Paulo - FFLCH/USP-IPT-FAPESP, 1997), the studied area is located in the morphostructural unit of the Parana sedimentary basin that embraces a morphosculptural unit, denominated “western tableland from São Paulo”, and presents the following characteristics: the unit occupies almost 50% of the total area of the State of São Paulo, and the relief of this morphosculpture is, in general, slightly waved with a prevalence of wide and low hills with leveled tops. Other characteristics are medium dimensions between drainage lines of 1.750 to 3.750 meters and a medium slope between 2 and 10%. The topography of the studied area is smooth, and the relief is waved and relatively uniform, with wide and low hills (Barcha, 1980). The level differences presented by the greater amounts of discharge and the lower altitude, which varies from 350 to 550 meters, are small.

3. Methodology and Materials

A geospatial analysis of the main geotechnical attributes of the urban physical territory of the city of São José do Rio Preto was performed based on the methodology of geotechnical mapping developed by the geotechnical engineering department of EESC/USP (Brazil) and using a Geographical Information System (GIS-SPRING) developed by Instituto Nacional de Pesquisas Espaciais/ INPE (Brazil).

For the interpretative chart, pre-existing information was used, represented by the SPT – Standard Penetrating Test (1500 boreholes, approximately, in 241 building sites), in addition to collections in the field of disturbed and undisturbed samples for laboratory analysis, which allowed us to determine the geotechnical properties of the unconsolidate materials, such as grain-size distribution, Atterberg limits, permeability, expansibility, compressibility and collapsibility. This study also relied on the production of several intermediary cartographic documents.

Firstly, the boreholes that represented the profile of the land based on the largest investigated depth or largest variability of the layers of the soil aggregate were selected, facilitating the assembly of a geographical database containing all of the information from the borehole profiles.

Later on, a study of the existence or non-existence of correlation was performed with the data originating from pre-existent boreholes, such as texture, the bearing capacity of the layers for N_{SPT} and groundwater levels, with the geotechnical properties determined in laboratory. We later made a comparative analysis of the boreholes that presented properties similar to the soil aggregate, attributing the values of those properties to regions whose geotechnical behavior could be considered homogeneous. Starting from the information contained in the database, it was possible to esteem the values for each attribute in places without sampling by using the geostatistical methodology of the ordinary kriging for the module of the spatial analysis implanted in the GIS-SPRING-4.0, based on the subroutine “kt3d” of GSLIB (Deutsch and Journel, 1992).

Therefore, the geotechnical properties of the unconsolidated material and the values of the attributes obtained by the geostatistical methodology of the kriging were used, and the intermediary charts (bearing capacity, groundwater level, texture, drenability, organic layer, depth of the impenetrable to SPT and collapsibility) were elaborated. Starting from the information of those intermediary charts, the interpretative chart of shallow foundations, with its respective suitability classes according to adopted methodology, were obtained.

The methodology used in the elaboration of the interpretative chart was based on the attributes of the urban physical territory and limits proposed (Zuquette, 1987, 1993). Those limits were defined starting from the experience of works developed in several areas of Brazil and using the information obtained through the referred author’s bibliographical, where the homogeneity of the terrain (in terms of areas) was described in suitability classes (Favourable, Moderate, Severe and Restrictive) that reflect the degree of difficulty in the introduction of buildings in the terrain. Considering the objectives, the attributes, its occurrence levels and purposes were defined according to Zuquette (1993), and four suitability classes were used in that mapping:

a) Favourable: the totality of the attributes presents appropriate levels, where two attributes of secondary importance present levels that would place them in the moderate class. The favourable class means that the necessary technological resources for the occupation or construction will be the simplest and most inexpensive; the potential of negative impacts and of risks will be the lowest within the studied region;

b) Moderate: 80% or more of the fundamental attributes present compatible levels with the moderate and favourable classes. In areas classified as moderate, there are possibilities of the occurrence of negative impacts and risks. During the occupation or construction there can be a need for more onerous operational and technological resources with a certain degree of complexity;

c) Severe: 15% of the attributes present compatible levels with the moderate and favourable classes, and at most 15% are in the restrictive level. An area classified as severe presents concrete possibilities in the occurrence of negative environmental impacts and of risks. It can also demand expensive and complex operational and technological resources for construction or occupation when compared to the favourable class;

d) Restrictive: only 20% of the attributes present levels that characterise them as favourable, moderate or severe. The framed areas in this class should be occupied with the largest care because they will demand complex and onerous technological resources and could affect revenue, due to the problems that could happen, such as the negative environmental impacts and possibilities of risks.

Table 1 shows the attributes and their pertinent occurrence levels in the suitability classes that were used in this paper for the elaboration of the interpretative chart of shallow foundations.

4. Results

To obtain the physical indexes, Atterberg limits, grain-size analysis, blue methylene adsorption test, mini-CBR and mini-MCV tests were used on the disturbed samples of the unconsolidated materials collected in five different places at depths of 1.0, 2.0, 3.0 and 7.0 meters. The points were numbered according to location in the plant (P1, P2, Pi) and collection depth (A at 1.0 m of depth, B at 2.0 m, C at 3.0 m and D at 7.0 m). Therefore, the sample of place P1A represents a disturbed sample collected in place 1 at a 1.0 meter depth.

The tests, traditional geotechnical classifications and determination of physical indexes of the soil aggregate, such as grain-size analysis, unit weight of the soil particles and Atterberg limits, were obtained in agreement with the effective norm of the Brazilian Association of Technical Norm (ABNT).

The geotechnical properties of the materials were determined from tests and/or empirical correlations, according to the effectiveness and credibility of the same ones. The permeability was esteemed according to the empirical correlation proposed by Honorato and Mackenna (1975) for special conditions:

$$k = \frac{14,266 \times \left(D_{50}\right)^{2,19735}}{\left(\rho_d\right)^{8,50784}} \qquad \text{(m/s)}$$

"k" is in m/s; "D_{50}" in mm and "ρ_d" in g/cm^3. This relationship is an expression that allows us to estimate the permeability in the superficial soils (in the case of 1 to 3 meters in depth) by measuring D_{50} and the natural dry unit mass "ρ_d". The composition grain size soil aggregate of the studied area is composed of approximately 65% fine sand fraction, followed by 25% clay fraction and 10% silt fraction, except for the sample $P4_D$, where the increment of the silt and clay fractions indicate the presence of saprolite soil (residual young soil). Therefore, it is classified as (ABNT) small silty clayey fine sand. Comparing the results of grain size analysis performed in the laboratory (Table 2) with the boreholes available in the studied area, a strong relationship texture was carried out, mainly for the first 5.0 meters of depth. The permeability coefficient values do not possess a considerable space variability, once medium values meet between 7.5×10^{-3} and 10.4×10^{-3} m/s and the soil texture is relatively homogeneous in the analyzed depths.

The expansibility was obtained by the analysis of the results of the blue methylene adsorption test, according to concepts established by Hang and Brindley (1970) for that test, used by Pejon (1992) and correlated with the MCT classification (Costa and Gandolfi, 1998) for use in geotechnical mapping, making use of the Mini-MCV and Expansion/Drying shrinkage (Mini-CBR) tests, according to Nogami and Villibor (1979). The expansion potential of soil of the studied area was verified first with the MCT classification, using the Mini-MCV and Mini-CBR tests.

The clayey fraction present in the unconsolidated material is largely responsible for its behaviour not only for the amount of present clay in the soil but also for the quality and expansion potential of the present deleterious clay minerals in the clay fraction, so it was thought best to complement that test using the blue methylene adsorption test because it takes into consideration the physical-chemical behaviour of the fine fraction of unconsolidated material with geotechnical purposes (Pejon, 1992).

Table 1. Attribute occurrence levels for the chart for shallow foundations

LEVEL / ATTRIBUTE	Favorable	Moderate	Severe	Restrictive
Strength (until 5m)	$N_{SPT} > 15$	$10 < N_{SPT} < 15$	$6 < N_{SPT} < 10$	$N_{SPT} < 6$
Collapsibility Collapse Potential (CP)	CP < 1%	1 < CP < 3%	3 < CP < 5%	CP > 5%
Ground water level	> 5m	3 to 5m	2 to 3m	< 2m
Declivity	< 5%	5 to 10%	10 to 20%	> 20%

Table 2. Laboratory results of the MCT classification and blue methylene adsorption test

Samples	Grain size analysi (%)			Mini CBR Test						Blue methylene adsorption test			
				γ_s	W_{opt}	γ_d	Expans.	Mini	MCT	V_B	A_{CB}	CTC_{SOIL}	CTC_{CLAY}
	Sand	Silt	Clay	(kN/m^3)	(%)	(kN/m^3)	(%)	CBR	Group	(g/100g)	(g/100g)	(cmol$_+$/Kg)	(cmol$_+$/Kg)
P_1A	66	10	24	27,3	14,3	18,2	0,05	14,5	LA'	0,74	3,1	2,3	9,7
P_1B	62	10	28	27,5	15,5	18,0	0,09	14,0	LG'	0,81	2,9	2,5	9,1
P_1C	63	10	27	27,5	16,0	18,0	0,05	15,0	LA'	0,91	3,4	2,8	10,5
P_2A	68	6	26	27,6	13,3	18,3	0,02	14,5	LA'	0,64	2,5	2,0	7,7
P_2B	68	6	26	27,5	15,3	18,2	0,02	9,5	LA'	0,62	2,4	2,0	7,5
P_2C	66	6	28	27,6	15,0	18,3	0,05	17,0	LG'	0,55	2,0	1,7	6,2
P_3A	65	5	30	26,9	14,0	18,5	0,03	13,1	LA'	0,62	2,1	1,9	6,4
P_3B	66	8	26	27,2	13,5	19,0	0,01	11,0	LA'	0,53	2,0	1,7	6,4
P_3C	67	7	26	27,9	13,5	19,2	0,07	15,0	LA'	0,75	2,9	2,3	9,0
P_4A	66	10	24	27,3	13,0	19,1	0,07	13,7	LA'	0,46	1,9	1,4	6,0
P_4B	66	8	26	27,3	13,0	19,2	0,06	14,5	LA'	0,57	2,2	1,8	6,9
P_4C	68	9	23	27,7	13,8	18,3	0,04	17,0	LA'	0,45	2,0	1,4	6,1
P_4D	53	16	31	27,8	17,0	18,2	0,09	16,5	NA'	1,08	3,5	3,4	10,9
P_5A	65	8	27	27,3	13,5	18,5	0,06	12,5	LG'	0,61	2,3	1,9	7,1
P_5B	65	7	28	27,5	14,0	19,2	0,05	9,5	LA'	0,66	2,4	2,1	7,4
P_5C	67	5	28	27,4	13,0	19,3	0,08	15,0	LA'	0,74	2,6	2,3	8,3

The expansion values obtained by the MCT classification according to Costa and Gandolfi (1998) is shown in Table 2, as well as the values of the natural dry unit weight (γ_d) and optimum water moisture (w_{opt}), unit weight of the soil particles (γs) and Mini-CBR. Table 2 shows that the preponderant MCT classification is LA' group, followed by the LG' and NA' groups, respectively. Disregarding the appearance of the NA' group (sample $P4_D$), which was collected at the exceptional depth of 7.0 meters, the classification of the soil appears to be exclusively of the sandy lateritic group followed by the clayey lateritic group. The soils belonging to the sandy lateritic group (LA') are typically sandy and constituent of the horizon B of the soils well-known pedologically in Brazil for sandy latosol and argisols or sandy argisols.

Later, the method of blue methylene adsorption was used to establish a relationship among the MCT classification according to Costa and Gandolfi (1998), attempting to relate the behaviour of the soils of the studied area with its mineralogy obtained through of blue methylene adsorption test. Working directly with the values defined by the method of blue methylene adsorption, that is to say, the values of blue methylene adsorpted for 100 g of soil (V_B) and for 100g of clay (A_{CB}), they tried to correlate the values of V_B with the MCT classification results. This classification used to evaluate the studied soils presented lateritic or non lateritic behaviour and the type of present deleterious clay mineral in the clay fraction of the soil with base in the consumption of blue methylene adsorpted for 100 g of clay (A_{CB}). The values V_B and A_{CB} can be observed directly in Table 2 for each soil sample. According to this methodology, the soils present lateritic behaviour for values of $V_B<1.0$ and non lateritic behaviour for values of $V_B>2.5$. It is concluded that all the soil samples analyzed previously belong to soils of a group with lateritic behaviour.

Other information could also be obtained starting from the values of A_{CB} about the most probable composition of deleterious clay mineral in the clay fraction of the studied soil. According to the diagram of activity of the clay for the method of blue methylene (Lautrin, 1989) and of the results of A_{CB} for the analyzed soil, we observe that the type of clay mineral more probable and present in the clay fraction of the analyzed soil is of the caulinita group, considered not deleterious. A summary of the values of V_B and A_{CB}, in function of the clay fraction present in the studied soil can be seen in Figure 2. In that figure the concentration of the samples "in black circle", presenting lineal behaviour of the percentage clay fraction as a function of the values of V_B and A_{CB}, is probably due to the presence in the clay fraction of soil with clay minerals of the kaolinite type. It is also noticed that for values of relatively high and low V_B and A_{CB}, shown by "black arrows", the values of the clay fraction percentage of soil remains proportional to the increase in

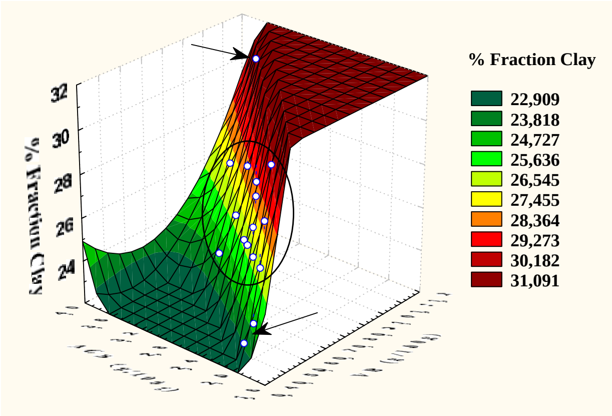

Figure 2. Surface graphic 3D to V_B, A_{CB} parameters versus percentage fraction clay (Statistica/2000)

increments and decrease of those values, determining the presence of non expansible clay minerals of the kaolinite group. Therefore, it was verified that the expansibility potential of the studied soil is very small and almost worthless for use in geotechnical mapping, and we chose not to consider that property in the making of the interpretative chart.

The collapse potential (CP) was obtained for oedometric testing according to ABNT norm using undisturbed samples of the soil collected at several depths. For obtaining the collapse potential, the specimens were submitted to the stress stages of 6, 12, 25 and 50 kPa, according to procedures of the consolidation conventional test. After the verification of stabilization deformations for the stress stage of 50 kPa, the specimens were inundated, and after 24 hours of the inundation stage the variation void ratio of the soil specimens was verified. Soon after, the specimens were submitted to new stress stages of 100, 200 and 400 kPa. In some specimens the stress stage of 800 kPa was increased. This way, the collapse potential (CP) was obtained starting from equation bellow, according to Jennings and Knight (1975):

$$CP = \frac{\Delta e_C}{(1+e_0)} \times 100 \qquad (\%)$$

where Δ_{ec} = variation of the void ratio due to inundation, and e_0 = natural void ratio of the soil specimens.

It should be highlighted that the collapse potential defined according to Jennings and Knight (1975) is obtained starting from the inundation of specimen in the stress stage of 200 kPa, but it was verified that in that stress stage the collapse potential was considerably smaller for the analyzed specimens.

Therefore, it was necessary to modify the stress stage, decreasing the pressure from 200 kPa to 50 kPa, for the specimen inundation stage. The values of the collapse potentials (CP) due to the inundation obtained in the stress stage of 50 kPa, as well as the values of the compression index "c_c" and the consolidation index "c_v" of the specimens of analyzed soil, are shown in Table 3, where "CPe_0" represents the obtained collapse potentials using the natural void ratio of the soil specimens, and "CPe_1" the collapse potentials obtained from the void ratio of the stress stage immediately before the inundation of the specimens.

Table 3. Collapsibility parameters from oedometric test in thin soils of the studied area

Samples	w (%)	w_L (%)	IP (%)	S (%)	e_0	γ_d (kN/m³)	C_C	$C_V \times 10^{-6}$ (m²/s)	CP_{e1} (%)	CP_{e0} (%)
P_1A	5,8	31,4	11,2	16,6	0,96	13,92	0,38	5,62	0,22	0,21
P_1B	10,4	36,0	15,9	27,1	1,06	13,37	0,47	5,44	2,04	2,00
P_1C	8,2	37,0	16,0	22,8	0,98	13,88	0,45	5,08	0,72	0,69
P_2A	5,5	30,0	10,6	15,5	0,97	14,01	0,39	4,43	1,83	1,75
P_2B	6,4	32,7	13,2	17,3	1,02	13,58	0,44	4,31	2,85	2,73
P_2C	5,9	35,5	11,9	15,5	1,04	13,50	0,50	2,87	5,73	5,52
P_3A	5,8	30,0	12,3	17,0	0,93	13,97	0,37	7,14	7,27	7,19
P_3B	5,0	28,7	10,1	13,6	1,00	13,56	0,36	9,50	9,68	9,28
P_3C	4,3	28,0	9,2	11,2	1,07	13,51	0,34	3,06	3,45	3,26
P_4A	5,9	29,0	9,3	18,1	0,90	14,40	0,37	4,41	2,34	2,22
P_4B	8,5	32,3	13,1	22,5	1,03	13,45	0,41	4,74	2,12	2,02
P_4C	5,9	32,0	11,0	16,4	1,00	13,84	0,40	4,36	1,10	1,04
P_4D	11,7	43,5	14,2	35,8	0,90	14,57	0,36	3,79	1,76	1,69
P_5A	8,7	30,7	12,9	22,4	1,06	13,23	0,35	2,35	3,21	2,93
P_5B	7,6	31,0	13,3	26,1	0,81	15,22	0,34	4,45	3,97	3,79
P_5C	7,6	32,7	12,3	21,2	0,99	13,78	0,34	3,44	6,80	6,58

Nevertheless, it is understood that from the site of analysed samples (P_1, P_2, P_3, P_4 and P_5), considering the samples obtained in at least one of the horizons during the analysis (A, B, C or D), all present values of collapse potentials indicate the presence of soils layers with high collapsible potential in the aggregate soils of the studied area. With the intention of discovering possible tendencies of correlations between the obtained collapse potentials and several physical indexes and parameters of characterization of the analyzed soils, investigations were carried out using statistical correlations through the coefficients of lineal correlation.

Mendonça et al. (1993) verified that the physical indexes are the parameters that present the best lineal correlation with the collapse potential; standing out among them are the natural unit weight or natural dry unit weight, the natural void ratio and the initial saturation of degree, in decreasing order of correlation. In the present paper, the parameters of the soils analyzed by statistical correlations that obtained a larger lineal correlation front to the values of the collapse potentials of the soils were, in decreasing order: liquid limit "w_L", the soil natural moisture "w", plasticity index "IP", saturation initial of degree "S", and for the dry unit weight "γ_d" and the natural void ratio "e_0", low values of the coefficient of lineal correlation front to the medium values of the collapse potentials were verified.

In Figure 3 a surface graphic 3D of statistical representation of the collapsibility data of analyzed samples is shown. In agreement with the collapsibility approaches of Clevenger (1956) and Holtz and Hilf (1961), soils with dry unit weight smaller or equal to 12.82 kN/m³ present collapsible behavior. It is observed, in Figure 3, that the soil samples considered as collapsible (letter "C") according to approach of Jennings and Knight (1975) presented values of dry unit weight above 12.82 kN/m³, and the soil samples that were non collapsible (letter "N") presented values of dry unit weight between 13.37 and 14.57 kN/m³, indicating therefore that the approaches of Clevenger (1956) and Holtz and Hilf (1961) are not appropriate to analyze qualitatively the collapse potential of the studied area soils.

Considering the adoption of the compressibility and/or the collapsibility as an attribute that determines or interferes in the behaviour of the aggregate soils, what happens to the compressibility of the aggregate soils before the occurrence of the collapsibility phenomenon was considered. This presents relatively smaller last values when compared with the abrupt reduction of volume due to the collapse (Vargas, 1993). Therefore, an attribute that interferes in the space analysis of the chart for shallow foundations, related with possible problems of foundations, in terms of specific deformations, is the collapsibility, or better, the collapse potentials of the analyzed samples.

In the analysis and in the elaboration of the chart for shallow foundations, a structural element of foundation reference was adopted. A square shallow spot footing of dimension B = 2.0 meters, supported at a depth of 1.50 meters below the surface of the land was used, and the value of a representative medium N_{SPT} of the support layer, estimated at the depth of the stress bulb of the shallow spot footing (~1.5B), was also considered. In that way, N_{SPT} used in the present paper was obtained starting from the simple arithmetic average of N_{SPT} found in the layers located between the depth of the support of the structural element of the foundation and the depth of

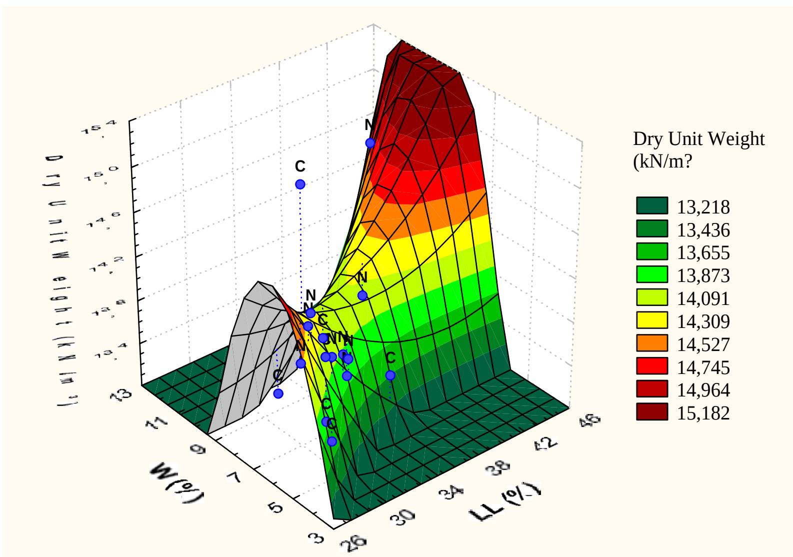

Figure 3. Surface graphic 3D to three parameters of collapsibility (Statistica/2000)

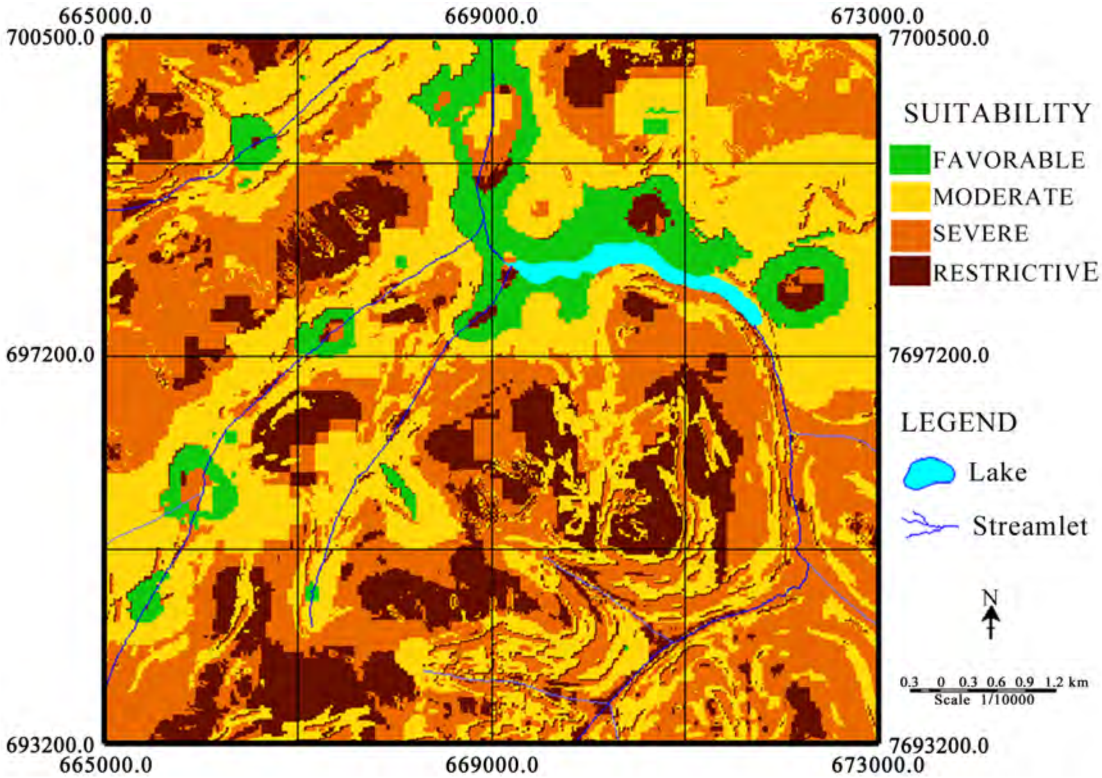

Figure 4. Chart of shallow foundation for residentials buildings ground floor (Mendes, 2001)

the stress bulb. Analyzing the Chart for Shallow Foundations shown in Figure 4, 18.2% of the studied area belongs to the Restrictive class, 37.5% to the Severe class, 36.7% to the Moderate class and 7.6% to the Favourable class.

5. Discussion and Conclusions

The classification of the studied area regarding suitability conditions for the introduction of shallow foundations in residential buildings concentrated among the Moderate and Severe classes represented by 74.2% of the total area, as a consequence of the prevalence of areas constituted potentially by layers of collapsible soils, associated with regions with low bearing capacity (generally presenting value of $N_{SPT} < 6{,}0$ blows/30cm), followed in decreasing order of constituted regions by shallow water level and high declivity.

For this reason, it is recommended not to adopt shallow foundations as an infrastructure solution in single floor residential buildings placed mainly in regions classified as Severe or Restrictive, in agreement with the adopted methodology; this type of foundation in the regions classified as Favourable and also in the Moderate class could be adopted, considering, however, some provisos in the latter case.

A possible solution for the regions that presented unviable conditions in the adoption of shallow foundations would be to adopt structural elements of a foundation that would help to cross the most shallow layers of the aggregate soils to a depth of approximately 6.0 meters because, in that interval, the soil layers tend to present serious problems related to collapse. For example, foundations constituted by piling could be adopted.

6. Acknowledgements

The authors are grateful to the Municipal Town Hall of São José do Rio Preto for the logistical support during the period of sample collection and to the Statistics Department of the Federal University of São Carlos (Brazil) for use of the Statistica/99 Windows software.

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Journal of Geographic Information System, **2010, 2, 32-39**
doi:10.4236/jgis.2010.21007 Published Online January 2010 (http://www.scirp.org/journal/jgis)

The Research and Design of the Application Domain Building Based on GridGIS

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Abstract: According to the characteristic of Grid geographical information system (GridGIS), data distribution, heterogeneity and diversity in the grid environment, combining the high demand for shared resources and the purpose to realize unified and efficient management and sharing of distributed and mass resources, this paper proposed a grid GIS application building program on a number of peer-to-peer global Managers designs. This paper discussed the building process of the application domain, the selection criteria of application domain manager, the database design of application domain, and every service function module design of application domain. The integration of the application domain builds the three-tier management system of the node, the application domain, and the global management. The spatial query tests of distributed environment have shown that, the application domain is established to manage and share the distributed resources efficiently, and enhance the business processing functions in the grid environment.

Keywords: GridGIS, Grid, global manager, application domain, application domain manager

1. Introduction

GridGIS, combining with GIS, is the trend of grid development and grid computing technology, GridGIS integrates the geographically distributed and heterogeneous systems of various spatial data server computers, large-scale retrieval storage systems, geographic information systems, virtual reality systems and so on. By high-speed internet connection, it forms the virtual super-processing environment of spatial resources information which is transparent to the user [1]. With the continuous development and improvement of GridGIS, we must deal with a wider range of resources, and resources will become increasingly distributed and heterogeneous. How to congregate the mass distribution of the resources, carry out efficient and unified management and share application are what we needs to consider.

There is not an ideal model for the grid distributed resource management. The centralized resources management in which system directory is only stored in a central node [2], inevitably can't work well and the node is low self-governing. A number of global managers used in this article solved performance bottleneck of the centralized management and improved the system stability.

The author of this paper discussed the application domain from the following aspects: the program to build the application domain, the application domain database [1]design, and every service function module design of application domain. We build the application domain which discovers resource and meets the high demand of distributed business applications, and achieves efficient management and shares the resources in GridGIS system.

2. The Building Program of the Application Domain and the Selection of Application Domain Manager

2.1. The Grid-Related Definition Set

According to the standard definition of the grid in conjunction with study design of this paper, we give some definitions of terms for this grid resource management and sharing application:

Node: the computer which deploys middleware of GridGIS and provides the local grid services.

Grid System: the collection of all available nodes.

Global Manager: a group of grid nodes provides global grid directory service and the application domain management with the function of simultaneous update features. It is also the virtual organization.

[1] Supported projects: 1,the National High Technology Research and Development Program (863 program) major project "Grid GIS software and its major application"-software development of GridGIS(number: 2007AA120503); 2, The Project was Supported by the Special Fund for Basic Scientific Research of Central Colleges, China University of Geosciences(Wuhan)(number: CUGL090251); 3, Programs national natural science foundation of China(number: 40771165).

Application domain: Based on application requirements, the application will contain the resource implications of nodes, and integrates the nodes to form the application domain.

Application domain manager: a node in an application domain which manages information of this domain, maintains data synchronization with the global manager, and provides customer with management and applications, in order to realize the specific functions of application domain.

2.2. Resource Managing Program Introduction in the Gridgis Environment

The GridGIS system of this paper uses several peer to peer Global Managers and several Application domain managers. The system contains multiple peer to peer such global managers, and every global manager associates with multiple application domains. As global managers are equal, the resource information update and exchange among the global managers, global manager and application domain manager ensures integrity of all information of the application domain. It realized the efficient management of large and distributed resources.

2.3. Build the Application Domain of Gridgis and Select the Application Domain Manager

The application domain is the finer granularity of self-Virtual Organization (VO) which is dynamically composed of grid nodes, depending on the application requirements in the grid environment. Through the grid environment, different people and organizations access a variety of data and have different application requirements. To better manage resources and provide services, GridGIS administrator must analyze the requirements, and propose common attribute, according to a specific application to construct the application domain from the information in Global Manager.

GridGIS administrator inputs conditions of application domain constructing, global manager queries all nodes information which stored in itself, and then sends back the qualified nodes to the global administrator. The global administrator selects appropriate number of nodes according to the node information, service information, spatial data directory information, as well as specific application. At the same time the GridGIS system automatically specify a node from the selected nodes for the application domain manager, and then the construction of an application domain is completed.

At the time of the application domain construction, the information related the application domain is stored in the global manager, and the global manager maps the information to corresponding application domain manager. So, from the global manager, this application domain gets information table of the nodes, the application domain services table, the application domain resources directory table, the application domain roles table and the application domain permission table.

In fact, application domain manager should be selected in accordance with optimal principles. And this paper adopts such principles: the best machine performance of all nodes in this application domain, shortest path, and the highest score for the quality of service. Based on all the above principles, application domain manager will automatically select a node as the application domain manager.

As shown in Figure 1,The functions of the application domain manager can be mainly divided into: nodes information management of the application domain, security management of the application domain, and spatial processing operations and life-cycle management.

Node information management mainly contains: add, delete, search and change the node information. Application domain security management mainly contains control and manages the roles and permissions. The maps processing function of application domain manager is mainly to provide a number of map operation services, such as space for display, query and analysis.

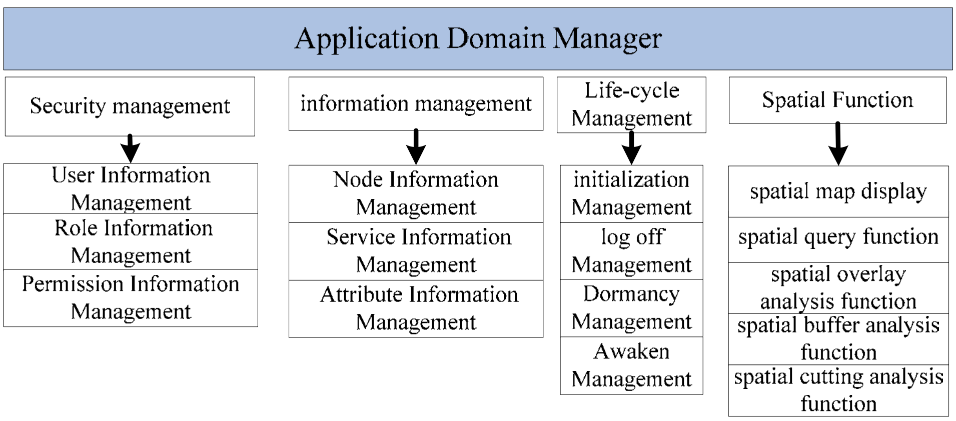

Figure 1. Modules introduction of the application domain Manage

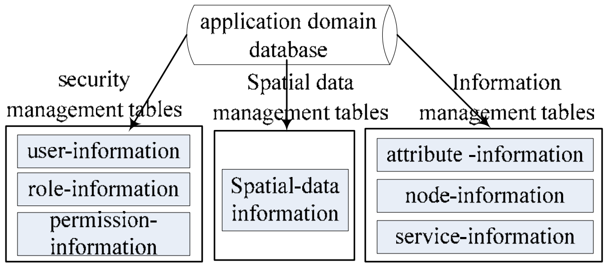

Figure 2. the tables design of application domain database

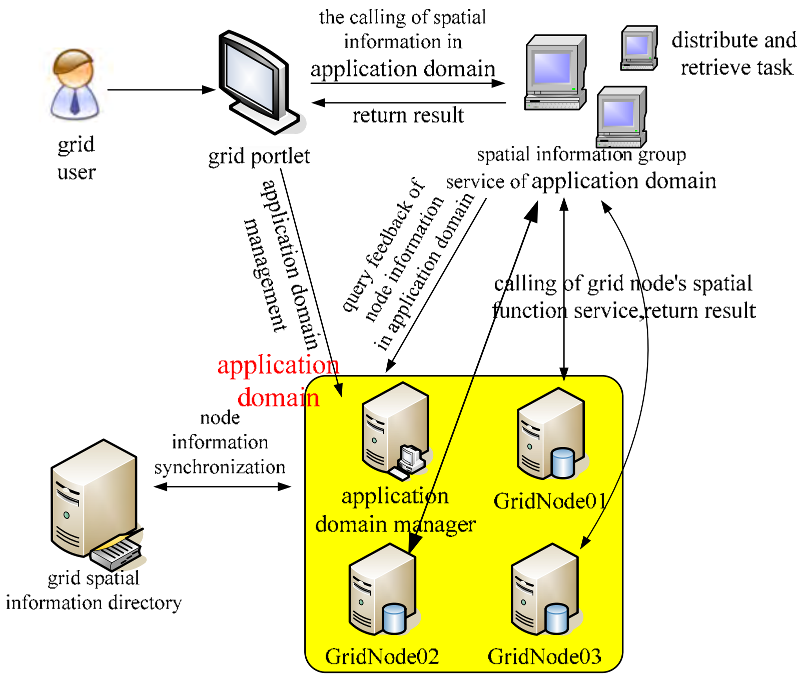

Figure 3. the entire call flow figure of the application domain services

3. The Application Domain Database Design

Application Domain Manager uses Oracle 9i database to store all the information of the application domain. The nodes where each application domain manager located all deploy a database. Tables in a database are mainly-consists of three categories: security management data tables, application domain information management data tables and spatial functional data tables. As shown in Figure 2.

Security management data tables are used to store the information of users, roles, permissions, and mapping relations between the roles and the permissions. The corresponding data tables are D_UserInfo(user information tables), D_RoleInfo(role information tables), D_PermissionInfo (permission information tables), and D_RPMap(mapping relation tables between the roles and the permissions).

Information management data tables of application domain are used to store their own attribute information related to the application domain, the provided service information, and the node information managed by the application domain. The corresponding data tables are D_Domain(attribute information of application domain tables), D_ServiceInfo(service information of application domain tables),and D_Node(node information of application domain tables).

Spatial functional data tables are used to store the spatial data information of the nodes managed by the application domain. The corresponding data table is DomainSpatialMetadata (spatial data information tables).

4. The Application Domain Service Function Design

The entire call flow chart of the application domain services is shown in Figure 3:

4.1. Security Management Service of Application Domain

This Service provides security management function related to the application domain, which divides into user information management, role information management, permission information management and rolepermission mapping relationship management.

4.1.1. User Information Management Service

User information management has two parts, one is that the user manages their own information, such as registration and personal information changes. The other is the administrator manages user information, such as delete and modify user information.

User needs to register first, and after the successful registration, some of the information can be modified. Figure 4 shows the scheme of user registration and management. During the registration, through the portal client, the user logs on to the registration page, by filling out the registration information, sends a request to the global manager which accepts the request and judges the information the user filled out, if the validation is went through then sends update information request to application domain manager and notifies the user that the registration is successful. Otherwise, refuses user to register, sends failed registration message.

Administrator manages user information service which mainly provides modify and delete user information When a new user register, the administrator assign roles to user. Administrator also has the right to delete users. The process of user information management is shown in Figure 5.

When a new user registration is successful, the application domain administrator calls the user information management service to set the user's role information and other information, and assign user specific roles.

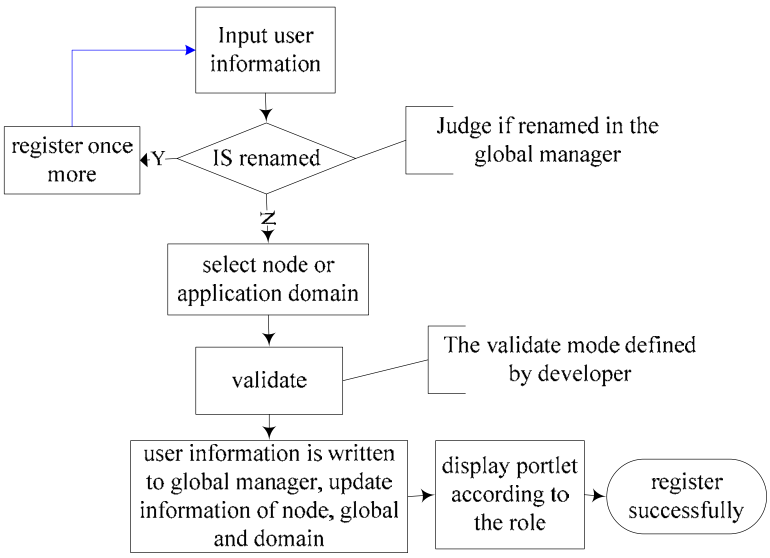

Figure 4. User Registration and Management

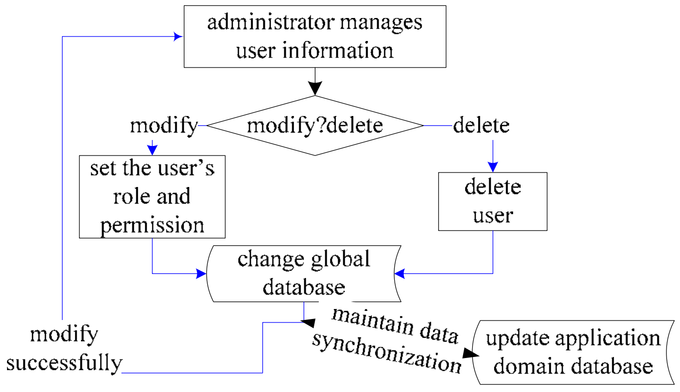

Figure 5. User Information Management

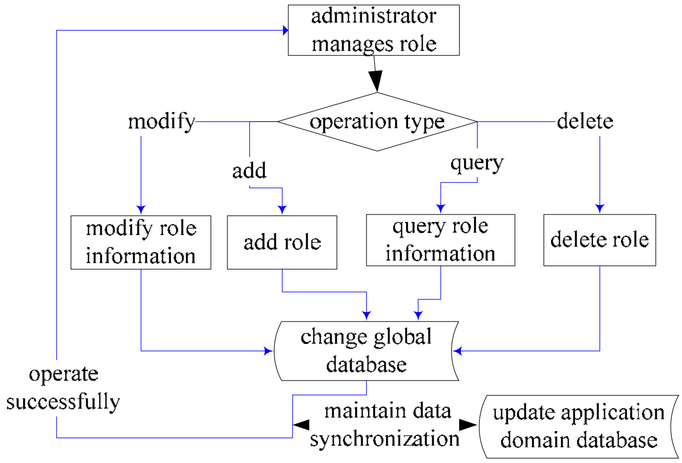

Figure 6. Role Information Management

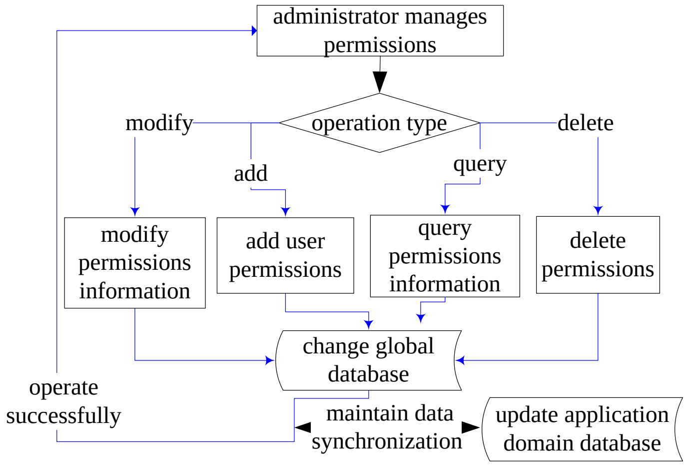

Figure 7. permissions management service

When you modify the data table of user information successfully, it will send the successful operation message to the client. Otherwise, send the failed operation message. During the running of application domain, the application domain administrator can modify specific user information according to the requirement.

After modify the user's information in application domain, it also needs to maintain data synchronization with the global manager. The application domain manager will send update request to global manager to maintain data synchronization.

4.1.2. Role Information Management Service

The application domain administrator designs the types of roles according to the requirement. Each role corresponds to a certain degree of Permission. The application domain administrator develops new roles, modifies and deletes the roles through the portlet managed by portal-side role. Figure 6 shows the scheme of user information management.

The application domain administrator manage roles in application domain by calling roles management service, it mainly includes add, delete, query and modify role information. It will return the successful operation message after the roles database is modified successfully, otherwise return failed operation message.

It is required to maintain data synchronization with the global manager while application domain administrator modifies the role information in application domain. The application domain manager will call the synchronous updating service to the global manager to ensure the information consensus at both ends.

4.1.3. Permissions Information Management Service

The administrator of application domain can add, modify or remove permissions according to the application requirement. Figure 7 shows the scheme of permissions management service.

Through calling the permissions management service, the administrator can manage the permissions which mainly includes add, remove, query and modify permissions information. It returns successful operation message when the permissions of database are modified successfully, otherwise returns failed operation message.

4.2. Application Domain Information Management Service

The application domain node management service provides information management service of application domain, node list information and service description list services.

4.2.1. Node Information Management Service

The application domain manager needs to preserve the address of the node information, the spatial data information in node, and the service information in node. Application domain obtains node information from the global manager which updates the node information in application domain by calling the update service of application domain to modify the node information in the application domain manager. Application domain manages nodes information, as shown in Figure 8.

The application domain manager can delete its nodes, and when it delete a node, the information of this node will be deleted from application domain database, At the same time, the synchronous update service of global manager is called to send update request to global manager in order to ensure the consensus of node data information at both ends. Figure 9 shows the process of application domain to delete node.

4.3. Application Domain Life-cycle Management Service

The application domain life-cycle management functions provide functions needed by the implementation of application domain, such as create, suspend and log off application domain.

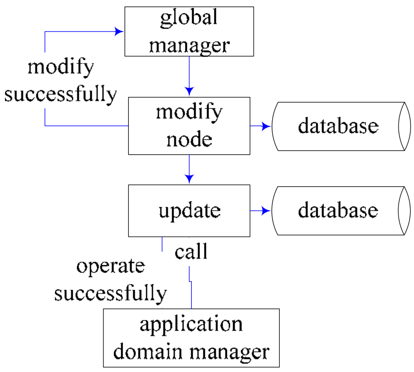

Figure 8. Application domain manages nodes informa- tion

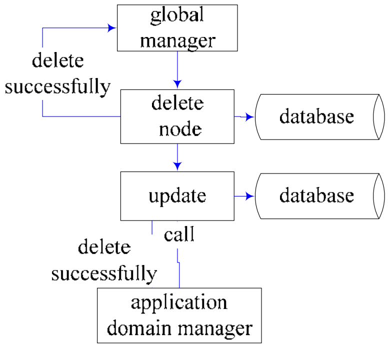

Figure 9. Application domain deletes node

The initialization functions of the application domain are used to initialize the required information when application domain is created. It mainly includes the creation of data table of application domain, getting node information and user information from global manager.

After an application domain is created, it needs to temporarily close the service on account of management demand. You can use the hibernation function, through the wake-up function to restart service.

It is required to log off service to release resources which the application domain owned when an application domain is removed or exceed the valid time, including removing all the information in data table of the application domain and stop application domain function.

4.4. Application Domain Spatial Function Service

The application domain spatial functions inquiry and determine the request information which is sent to the portal client. Get the node information which meets the requirements through querying the node information in database. And then sends the request to corresponding node for the actual function operation. When the node processing completed, the results will be returned to the application domain, and application domain analyses and integrates all the results. Finally returns to the portal-side to display(see Figure 10).

The application domain spatial map display function needs to calculate the scope of the map corresponded to user role in application domain firstly, that is, the scope the user can see according to corresponding permission; then the application domain will send request to nodes which can change the map to ask for a map of the designated area. After each node processing is completed, the picture will send to the application domain manager by binary stream, and the application domain manager overlay all of the pictures. Finally, the results will be returned to the portal-side to call.

The application domain spatial query function is to query a scope option through dragging a box and after selecting a certain map scope firstly; the coordinates of the scope are sent to the a application domain manager

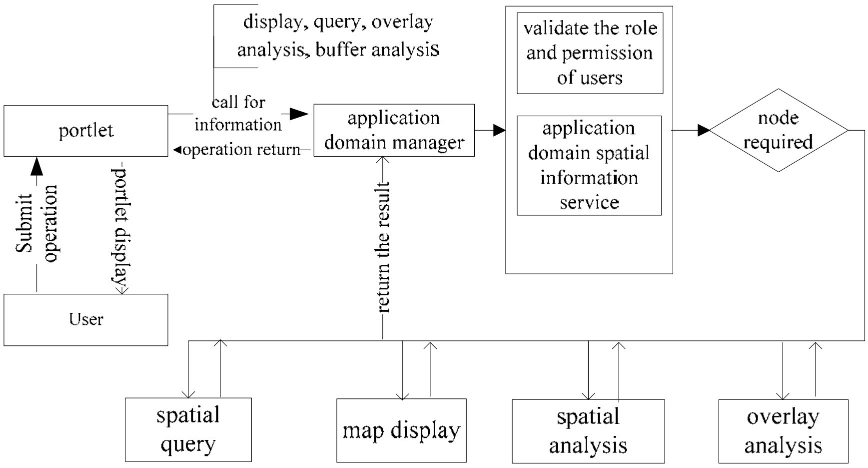

Figure 10. Application domain spatial analysis service

Figure 11. The management interface for application domain administrator

where the query scope will be parsed and judged in order to determine which nodes need to send request; after the request distributed is completed, the queries will be sent to the corresponding node; then the node processes the request and returns the results to application domain which will integrate the results of all nodes and return it to portal to display.

The application domain spatial overlay analysis function needs to select the overlay layer required to overlay analysis firstly; then sends the request to the application domain manager which will sent request to corresponding node according to the location of layer node; the node processes the request and returns results to application domain; the application domain manager then returns the results to portal to display.

The application domain spatial buffer analysis function needs to select the layer required to be analyzed. You should set the layer to be edited firstly, and then select the region of buffer analysis, and send a request to the application domain manager. The application domain manager will parse and process the request in order to get the nodes to meet the requirement. Then send the buffer analysis request to nodes. Each node processes the request will send the ultimately results to the application domain manager which integrates the results and returns the results to portal to display.

5. The experiment

In our lab, we deployed eight machines to form a distributed computing environment.

It establishes a small application domain formed with four nodes in the spatial information grid support plat

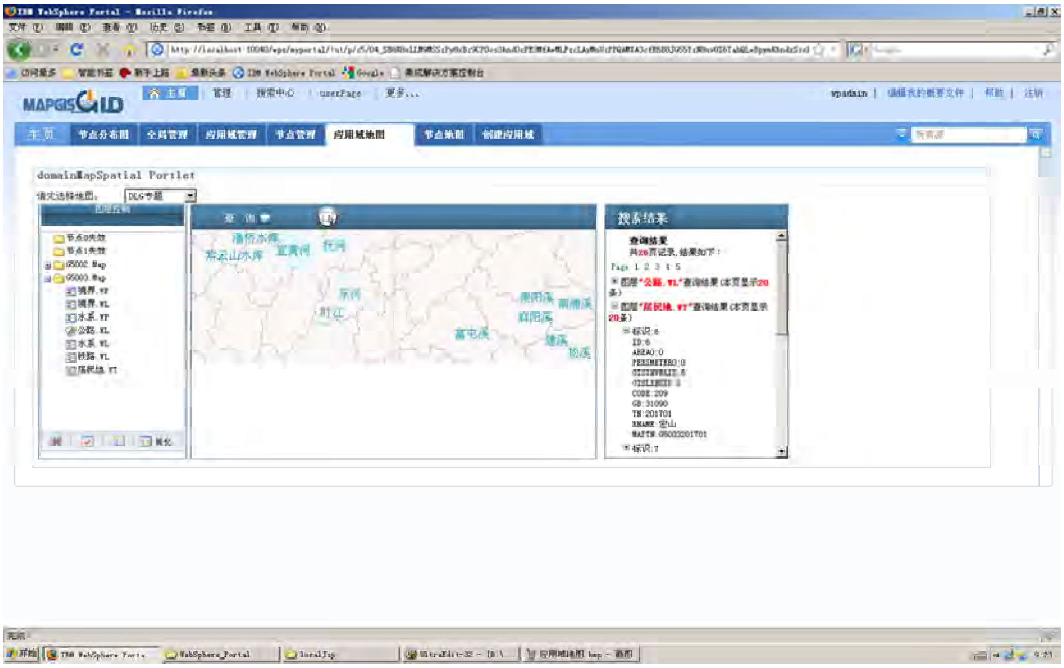

Figure 12. map query interface of application domain

form system--MapGIS Grid. Each node is installed on distributed query vector analysis software, and database is installed on the application domain manager. We carry out spatial query test for the distributed system, and get accurate and fast query results. This is the login interface for application domain administrator in figure 11. And figure 12 is query and test result figure of the application domain.

6. Conclusion

This article is supported by the National High Technology Research and Development Program (863 program) major project “Grid GIS software and its major application” and the project of the Special Fund for Basic Scientific Research of Central Colleges, China University of Geosciences (Wuhan).

In order to effectively manage and expediently use these large distributed data in the grid environment, we proposed a complete application domain building program based on the grid resource system management of multi-global managers. The integration of the application domain builds the three-tier management system. It makes the system nodes and global manager to play their respective advantages: the node has the greatest competence and higher self-governing, the application domain realizes the function classification and quick operation, and the global manager achieves integration and sharing of resources. The application domain manager shares part task of the global manager, the application domain realizes fast and easy call the distributed business, and distributed processing capabilities of GridGIS is enhanced.

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Journal of Geographic Information System, 2010, 2, 40-44
doi:10.4236/jgis.2010.21008 Published Online January 2010 (http://www.scirp.org/journal/jgis)

A QoS-aware Method for Web Services Discovery

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Abstract: The non-functional QoS (quality of service) information helps us to select a proper Web-service from the web applications, by using component services such as UDDI[1](Universal Description, Discovery, and Integration) and MDS(Monitoring and Discovery System). MDS is a suite of web services to monitor and discover resources and service on Grids, but MDS only based on function aspects. This paper studies on an approach to provide the QoS information and a discovery model by using MDS and gives a system deployment and implementation plan. The simulation results show that the method is effective in service discovery.

Keywords: quality of service (QoS), web services, monitoring and discovery system (MDS)

1. Introduction

Web services are frequently used to build a distributed system which can be accessed over Internet. It is loosely coupled to enhance productivity, simplify using, get reusability and improve system expansibility. But with the widespread proliferation, the QoS becomes an important factor in distinguishing the success of a web service application.

QoS is the ability to provide different priority to different applications and users to guarantee a certain level of performance to data flow. Typical QoS properties associates with a web service execution cost and time, availability, successful execution rate, reputation, and usage frequency [2]. The QoS covers a range of non-functional properties of Web-service such as response time, performance, security, availability and reliability. The service providers provide differentiated capacity model for different service types to ensure appropriate QoS levels for different customers' applications. For example, a complex spatial analysis Web service might require good throughput, while a simple searching Web service might require a good response performance.

In order to describe the contract between the service provider, the customer and the Grid system, several specifications defined by XML based language have been proposed such as WSDL, which is complement to the service description implemented, WS-Agreement specification [3] which is used within a framework allowing the management of web services and their compositions.

In this work we propose to modify the WSDL file in order to increase QoS support to the web service. Then we propose a method of web services discovery on GT4 MDS.

1.1. Web Service QoS Requirements

The major requirements[4] for supporting QoS in Web services are as follows:

- **Regulatory** is the aspect of the Web service in compliance with the standards such as SOAP, UDDI, WSDL, etc and the established service level agreement. Strict adherence to correct versions of standards by service providers is necessary for proper invocation of Web services by service consumers.
- **Availability** is the quality aspect of whether the Web service is ready for immediate use. It represents the probability that a service is available. Larger values represent that the service is always ready to use while smaller values indicate unpredictability of whether the service will be available at a particular time.
- **Reliability** is the quality aspect of a web service that represents the capability of maintaining the service and service quality. The number of successfully used per month represents a measure of reliability of a web service.
- **Performance** is the quality aspect of Web service, which is measured in terms of throughput and latency, and response time. Throughout represents the number of Web service requests served at a given time period. Latency is the round-trip time between sending a request and receiving the response. Higher throughput, lower

latency and less response time values represent good performance of a GIS Web service.

- **Security** is the quality aspect of the web services of providing confidentiality by authenticating the parties involved, encrypting messages, and providing access control. Because distributed GIS system is deployed and invoked over the public Internet, security becomes more important. The service providers have different approaches and levels of providing security depending on the service requester.

2. QoS-Based Web Services Discovery Method

MDS is the information services component of the Globus Tookit4 and provides information about the available resources on the Grid and their status [5]. It is a suite of web services to monitor and discover resources and services on Grids[6]. MDS builds on query, subscription, and notification protocols and interfaces defined by the Web Services Resource Framework (WSRF) and Web Services Notification families of specifications and implemented by the GT4 Web Services Core. Discovery is the process of finding a suitable resource to perform a task. This process may involve both finding which resource are suitable and choosing a suitable member from that set. The discovery process requires the ability to collect information from multiple, perhaps distributed information sources. To meet this need, MDS provides so-called aggregator services that collect recent state information from registered information sources. The MDS architecture is shown in Figure 1.

2.1. QoS Properties in WSDL

Web Service Description Language (WSDL) is an XML format for describing network services as a set of endpoints operating on messages containing either document-oriented or procedure-oriented information[7]. Specifically, it defines via its portType component, the Web service's abstract interface, specifying the operations that the service supports and for each operation, the format of the messages that the service sends and receives. The client programs read the WSDL files to connect and communicate with the service. The current WSDL file contains the following information: the number of inputs and outputs, the variable type of each input and output, the order the inputs are given and outputs are returned, and how the Web service should be invoked. But from the WSDL file, we can not get the QoS information. To solve this problem we propose to extend the WSDL to support the QoS information description.

The hierarchical QoS semantics model[8] which is an extension of WSDL document structure (shows in Figure. 2), can be used to describe the quality information of Web Services. Specifically the method for describing the quality information of GIS Web Services properties is to increase QoS elements through the extension of WSDL protocol. Add atQualityInfo property in the WSDL tport element to describe the five QoS attributes of Web services, the tport elements are regulatory, response time, availability, performance, and security level.

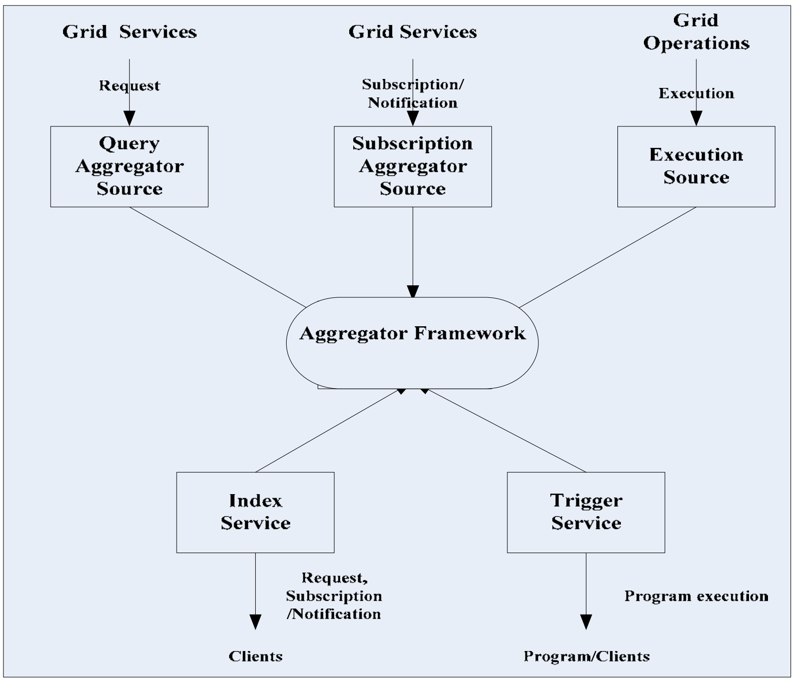

Figure 1. MDS architecture

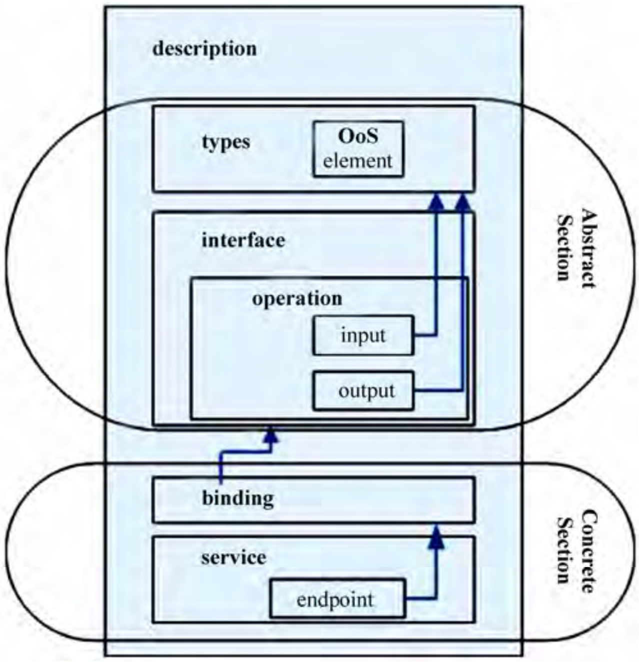

Figure 2. WSDL document structure

The Web services function elements correspond with tport in the general WSDL documents. So add the qualityInfo attributes into the tport element of WSDL to describe the QoS[9]. An example is as follows:

```
< wsdl: qualityInfo name="approve"
qualityID=
"DAJD0891-28da-48B3-234J-24IA2394C342">
< wsdl: constraintInfo name="regulatory" value="75" probability="9"
constraintID="D2JD2371-4H7P-15A3-414f-15I323r4C342"/>
< wsdl: constraintInfo name="ResponseTime" value= "27" probability="28"
constraintID="QEJD1851-RF36-41G6-414f-15I323r4C342"/>
< wsdl: constraintInfo name="availability" value="65" probability="39"
constraintID="DBYT5769-2T4P-W1A3-414f-15I323r4C342"/>
< wsdl: constraintInfo name="performance" value= "23" probability="27"
constraintID="FUJJ3861-1G5P-1EA7-414f-15I323r4C342"/>
< wsdl: constraintInfo name="security level" value= "7" probalility="56"
constraintID="D2JR3431-Y68L-D2A3-414f-15I323r4C342"/>
< /wsdl: qualityInfo>

<types>
<xsd:schema targetNamespace="http://localhost/examples/core/QoS_instance"
xmlns:tns="http://localhost/examples/core/OoS_instance"
xmlns:xsd="http//localhost/2012/XMLSchema">
...
<xsd: element name = "regulatory">
<xsd:complexType>
<xsd:sequence>
<xsd:element ref="tns:Value" minOccurs="1" maxOccurs="9"/>
</xsd:sequence>
<xsd:complexType>
</xsd:element>
...
</xsd:schema>
</types>
...
<xsd:element name="Value" type="xsd:int"/>
...
```

2.2. Modifying Query Aggregator Source Configuration File

Besides editing WSDL documents. another necessary step is to increase QoS support to the Web Services' XML schema documents, and through the extension of the GetMultipleResourcePropertiesPollType which is one of the parameters for Query Aggregator Source in configuration file. The QoS properties can be retrieved from a Index Service as resource properties.

The Aggregator Framework is a software framework used to build services that collect and aggregate data.

Index Services built on the Aggregator Framework are sometimes called aggregator services. The Index Services collect XML-formatted data via Aggregator Source. The Query Aggregator Source is a java class that implements an interface to poll a WSRF service for resource property information. An example is as follows:

```
<Content
xmlns:agg="http://mds.globus.org/aggregator/types"
    xsi:type="agg:AggregatorContent">
  <agg:AggregatorConfig
xsi:type="agg:AggregatorConfig">
    <agg:GetMultipleResourcePropertiesPollType>
<agg:GridGISServices>Spatial_Operations</agg:GridGI
SServices>
<agg:ResourcePropertyNames>rp1_namespace:regulator
y</agg:ResourcePropertyNames>
<agg:ResourcePropertyNames>rp1_namespace:response
_time</agg:ResourcePropertyNames>
<agg:ResourcePropertyNames>rp1_namespace:availabili
ty</agg:ResourcePropertyNames>
<agg:ResourcePropertyNames>rp2_namespace:performa
nce</agg:ResourcePropertyNames>
<agg:ResourcePropertyNames>rp3_namespace:security_
level</agg:ResourcePropertyNames>
    </agg:GetMultipleResourcePropertiesPollType>
  </agg:AggregatorConfig>
  <agg:AggregatorData/>
</Content>
```

Then Query Aggregator Source will request five QoS properties in the Grid services. There is no limit on the number of "ResourcePropertyName" parameters that can be specified.

Qos properties provide support for service publishing and selection, but how to select web services that can well meet the requirements of Web services' consumers becomes a problem.

2.3. Web Services Discovery from MDS

The users use the web browser to send a HTTP request, including some web form arguments, to the web server container. The web server invokes the MDS servlet, which uses the form arguments to determine what plugins to use to retrieve the request GML data and the XSLT transform tools to apply to it. Then use the standard WSRF resource property query interfaces to retrieve service WSDL information from an Index. Every GT4 web services container includes a default MDS-Index service with which any GT4 services running in that container are automatically registered. Thus, each Grid system has an index that allows one to discover what services are available. GT4 is configured to use MDS mechanisms to good effect for discovering and monitoring of GT4 services. Every GT4 web services supports a minimal set of QoS properties and thus can be registered easily into one or more aggregators for monitoring and discovery. The MDS use servlet passes arguments to the transaction tool, which then retrieves the appropriate data and XSLT transform. The MDS servlet applies the XSLT transformation to the XML data and returns the result to the web server, which sends it back to the client's web browser. The discovery model is shown in Figure 3.

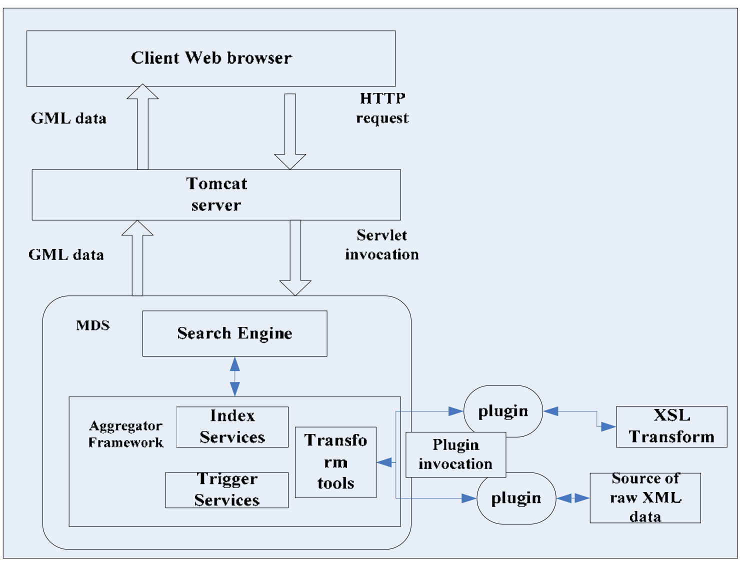

Figure 3. Discovery model

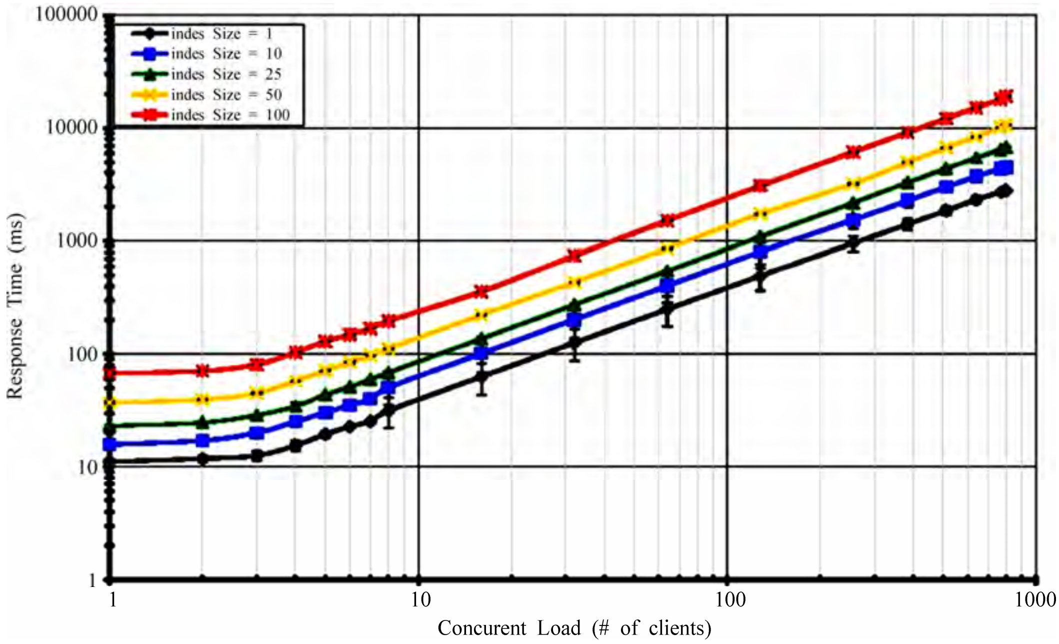

Figure 4. Testing performance

3. Deployment and Testing

Testing executions were performed on a Intel Core 2 Duo T9300@ 2.5GHz machine, with DDR 666MHz 3.0G of RAM and Windows XP sp3 operation system as web server. Java as Developing language, IDE: ecplise5.0, Apache Tomcat as web services container IE7.0 as web browser, GD4 as Grid container and Grid system environment Figure 4 shows the testing results.

4. Conclusion

The work proposed in this paper provides an approach to describe Web services QoS information in WSDL and a discovery model in which the functional and non-functional requirements is to be taken into account for the selection. The test results illustrating the method have high performance in practices.

5. Acknowledgments

We would like to thank Professor Fujiang Liu for his valuable comments and suggestions which have helped us to improve the quality, organization, and presentation of our manuscript.

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Journal of Geographic Information System, 2010, 2, 45-48
doi:10.4236/jgis.2010.21009 Published Online January 2010 (http://www.scirp.org/journal/jgis)

A Novel Statistical AOA Model Pertinent to Indoor Geolocation

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Abstract: A novel statistical angle-of-arrival (AOA) model for indoor geolocation applications is presented. The modeling approach focuses on the arrivals of the multipath components with respect to the line-of-sight (LOS) path which is an important component especially when indoor geolocation applications are considered. The model is particularly important for indoor applications where AOA information could be utilized for tracking indirect paths to aid in precise ranging in harsh and dense multipath environments where LOS path might be blocked due to obstructions. The results have been obtained by a measurement calibrated ray-tracing (RT) tool.

Keywords: angle-of-arrival, indoor geolocation, statistical modeling, ray-tracing

1. Introduction

AOA modeling for indoor channel can be considered as a relatively recent area compared to time-of-arrival (TOA), since earlier systems were mainly omnidirectional and hence did not exploit the direction of multipath component (MPC) arrival. With advances in antenna technology and signal processing techniques, AOA has gained importance for MIMO systems employing spatial diversity and beam-steering techniques.

Some previous works in AOA modeling include the Geometrically Based Statistical Channel Models (GBSCMs) [1] and measurement fitted statistical models [2]. However, most of these studies are aimed at telecommunications applications. Spencer's Laplacian model [2] is particularly useful for MIMO telecommunications applications in which data rate and coverage are important factors hence relative positions of the transmitter and receiver is not of primary concern. When indoor geolocation applications are considered, AOA information can be used to increase ranging and hence positioning accuracy coupled with additional information such as TOA [3]. AOA information becomes particularly useful in tracking certain indirect MPCs when these MPCs can be used to aid in precise TOA ranging when the LOS path gets blocked due to obstructions [4, 5]. For these applications, relative positions of transmitter and receiver gain importance, since path arrivals will be affected accordingly. In this paper, we propose a novel AOA model for the arrival of MPCs with respect to the interconnection line, or equivalently LOS, between the transmitter and receiver based on an extensive set of RT results. The outline of the paper is as follows: Section 2 presents the data collection and simulation platform. Section 3 gives the overall indoor propagation channel and the proposed model. Section 4 presents the comparison results of the model and empirical data and finally section 5 concludes the paper.

2. Data Collection and Simulation Platform

Since exact modeling of indoor channel requires tedious solution of Maxwell's wave equations for complex structures it is not time-efficient and requires high utilization of computational resources. As an alternative there exist RT solutions which are based on ray shooting principles. In terms of speed and conformance to real-world measurement data, RT techniques are preferred for most indoor propagation prediction studies [6-8]. Given a transmitter location, rays are shot in every possible direction (with a certain discretization) and they interact with the objects through either reflection or transmission. The rays that can reach the receiver through geometric propagation are considered to be the components of the channel impulse response (CIR) if they are within the detection threshold. For the purposes of our study a measurement calibrated RT tool has been utilized to collect CIR data [7].

For our simulations, we collected approximately 14000 CIRs for each of the three different transmitter locations for a total of about 42000 CIRs on the 3rd floor of Atwater Kent (AK) building at Worcester Polytechnic

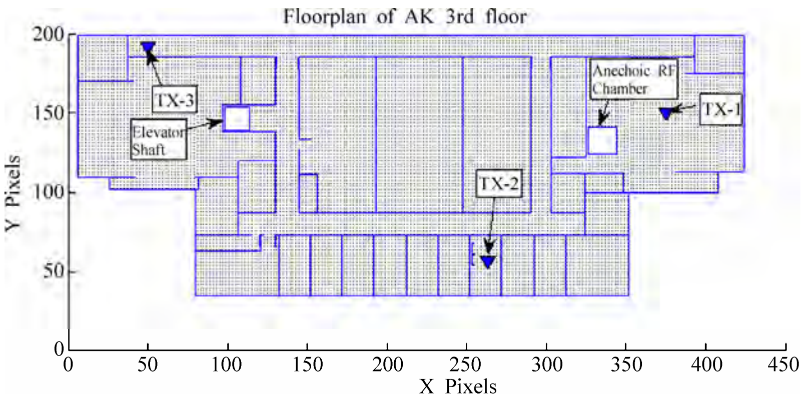

Figure 1. Simulation Environment

Institute, Worcester, MA as shown in figure 1. AK building, being a typical office environment, is representative of a diversified RF propagation medium and has been particularly chosen for this study.

The scale of the floorplan is 7pixels/m. RT tool gives all relevant information for each MPC such as absolute AOA, TOA and path gain. The anechoic RF chamber and the elevator shaft are the metallic obstructions on this floor hence LOS path cannot be detected if the receiver is shadowed by these structures. In about 45% of the receiver locations LOS path was blocked due to these obstructions and in the remaining 55% of receiver locations LOS path was available. Since the percentages are similar, our modeling is not biased towards LOS or NLOS conditions. It is thus a joint modeling effort motivated by the general fact that LOS and NLOS conditions will be present at the same time in typical indoor scenarios.

3. Indoor Propagation and the Proposed AOA Model

Indoor multipath propagation is dictated by various interactions of the MPCs by the various types of objects such as furniture, walls, doors and windows which have varying degrees of effect on signal propagation. The two main interactions are the reflection and transmission. Diffraction and diffuse scattering can be ignored for indoor environments [9]. Based on the material properties, these objects will have different reflection and transmission coefficients. Metal and steel surfaces, for instance, can be considered as specular reflectors but no or very little transmission will take place. On the other hand, materials such as wood or brick will both reflect and transmit the incoming ray after a certain loss. Each reflection and transmission has a corresponding loss coefficient and will decrease the path power accordingly. In RT techniques, each ray is considered to be an infinite bandwidth optical ray. This representation of MPCs is also in line with the channel model that was first proposed by Turin [10] and is well suited to describe RF propagation in multipath-rich indoor environments. The general multipath channel can be given as

$$h(t,\Theta)=\sum_{i=1}^{N}\beta_i e^{j\phi_i}\delta(t-\tau_i)\delta(\Theta-\theta_i) \quad (1)$$

where N is the number of MPCs, and β_i, τ_i, θ_i and φ_i represent the path gain, TOA, AOA and phase, given by $\varphi_i = -2\pi\tau_i/\lambda$, of the ith path, respectively. In this paper our focus will be on the AOA component or equivalently θ_i.

Based on the collected database of CIRs, we observed strong dependence of the MPC AOAs on the interconnection line between the transmitter and the receiver. In other words, the MPCs tend to arrive close to LOS path. We should point out that actual LOS path might not be available due to obstructions, however the arrival of MPCs were still observed to be in the vicinity of transmitter-receiver interconnection line. In order to describe this behavior, we define the MPC AOA relative to the AOA of the LOS path which is a deterministic value given the locations of the transmitter and the receiver. This is depicted in figure 2. Expression of MPC AOAs

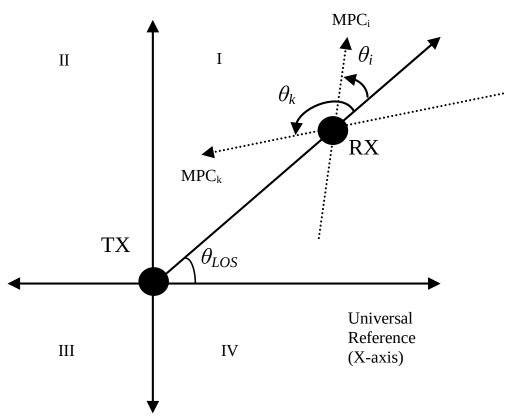

Figure 2. Illustration of MPC arrivals

relative to the LOS path takes into account the receiver and transmitter locations with respect to each other and hence allows for a more descriptive model. As a matter of fact, the placement of transmitter and receivers are generally done according to the building layout and the uniform assumption of transmitter and/or receiver locations inside a building may not be always be a realistic assumption. Hence dependence of the AOA on transmitter/receiver placement should not be included in the modeling approach; nonetheless, its effect should be explicitly given as a separate variable.

MPC AOAs can be uniquely identified in the range [-π, π] with respect to the LOS path which is assumed to be the reference axis for all MPC arrivals. Our observations indicated strong angle components at -π, 0, and π finally leading to a distribution model that is in the form of a classic "bathtub" model similar to Doppler power spectral density. We have found this model to show an accurate representation of AOA distribution around the LOS component.

The proposed model for the relative AOA can thus be given as

$$f_\theta(\theta)=\begin{cases}\dfrac{1}{\pi^2\sqrt{1-\left(\dfrac{\theta+\pi/2}{\pi/2}\right)^2}} & -\pi<\theta<0\\ \dfrac{1}{\pi^2\sqrt{1-\left(\dfrac{\theta-\pi/2}{\pi/2}\right)^2}} & 0\le\theta<\pi\\ 0 & \textit{otherwise}\end{cases}\qquad(2)$$

The piecewise integration of (2) gives the CDF as

$$F_\theta(\theta)=\begin{cases}\dfrac{1}{2\pi}\sin^{-1}\left(\dfrac{2}{\pi}\theta+1\right)+1/4 & -\pi<\theta<0\\ \dfrac{1}{2\pi}\sin^{-1}\left(\dfrac{2}{\pi}\theta-1\right)+3/4 & 0\le\theta<\pi\\ 0 & \textit{otherwise}\end{cases}\qquad(3)$$

The distribution presented in (2) is the relative AOA. The absolute AOA of a certain path with respect to a certain universal reference is thus given by

$$\theta_{abs}(\theta_{LOS})=\theta_{LOS}+\theta \qquad (4)$$

where θ_{LOS} is the LOS angle expressed as

$$\theta_{LOS}=\text{atan2}(TX_y-RX_y,TX_x-RX_x) \qquad (5)$$

with respect to a certain universal reference.

In (5), atan2 is the 4-quadrant inverse tangent and TX_x, TX_y, RX_x, RX_y denote the *x,y* coordinates of the transmitter and receiver respectively. 4-quadrant inverse tangent takes on values from [-π, π] and is particularly useful for identifying angles with respect to a certain reference axis such as X-axis. Its formal definition is given by

$$\text{atan2(y,x)}=\begin{cases}\tan^{-1}(y/x) & x>0\\ \tan^{-1}(y/x)+\pi & x<0, y\ge 0\\ \tan^{-1}(y/x)-\pi & x<0, y<0\\ \pi/2 & x=0, y>0\\ -\pi/2 & x=0, y<0\\ \textit{undefined} & x=0, y=0\end{cases}\qquad(6)$$

4. Model Evaluation

The comparison of the proposed model and empirical data can be seen in figures 3 and 4 which are the PDF and CDF graphs for the relative AOAs of MPCs respectively. We can see a very good match between the experimental data and the proposed model and the conformance of data to our model shows the feasibility of this multipath arrival modeling approach for indoor environments.

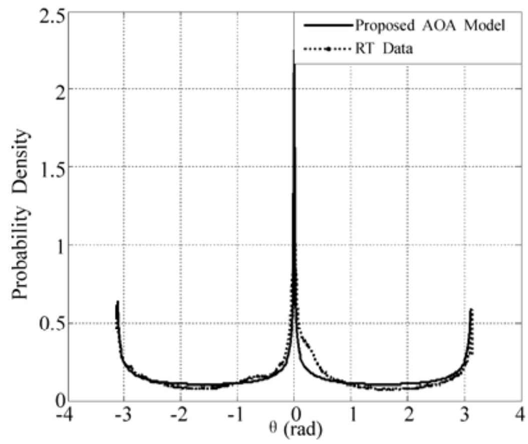

Figure 3. PDF Plot for the proposed AOA model vs RT data

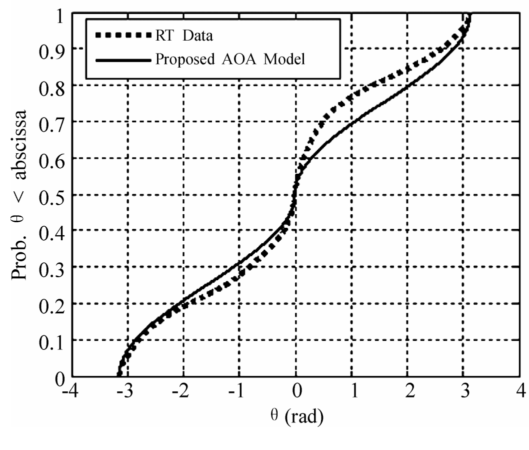

Figure 4. CDF Plot for the proposed AOA model vs RT data

5. Conclusion

In this paper, we have proposed a novel statistical indoor AOA model. The main difference of this model from previous models is the relative modeling of multipath arrivals with respect to the interconnection line between the transmitter and the receiver. Hence a more descriptive distribution of arrival angles is obtained given the transmitter and receiver locations. This model is particularly useful in situations where direct path is blocked due to certain obstructions and multipath AOA information can be utilized together with TOA for high precision ranging.

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Journal of Geographic Information System, **2010, 2, 49-53**
doi:10.4236/jgis.2010.21010 Published Online January 2010 (http://www.scirp.org/journal/jgis)

The Design and Realization on Effectively Fire Tower Planning Based on MapGIS-TDE

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Abstract: Fire-tower is effectively applied in forest fire prevention and commanding system, especially in fire monitor and position. After explaining the significance of scientific planning of fire-tower, this paper analyzes GIS`s functions in building forest fire prevention system. This paper uses case study method, which designs a model, fire tower planning and analysis, based on MapGIS platform. After that, it directs us how to realize these functions based on MapGIS-TDE which is a 3D platform belonged to MapGIS. This paper gives us scientific ways to fire tower planning in forest fire system which promotes informationization of forest fire prevention management.

Keywords: MapGIS-TDE, forest fire prevention, 3D, fire tower planning, visual analysis

1. Introduction

Forest fire prevention has already become a global question. Countries around the world put plenty of money in researching forest fire prevention technology to reduce loss in fire accident. Fire tower, cruise aircraft and satellite monitoring are three ways to monitor forest fire, but fire tower is the major tool for forest fire prevention in china so far.

Fire tower `s primary target is to find and report fire in time. To avoid blind spots in monitoring and provide more accurate fire information in limited time, scientific planning fire tower become very important. On the other hand, it will save a great deal of money if we can scientifically plan fire tower and maximize the actual performance of fire tower.

2. System Introduction

Location principle is primary for fire tower planning and analysis. Under the designed principle and powerful GIS spatial analysis capabilities, the fire tower can realize visual analysis functions, which will be explained in three layers specifically.

One is support layer which includes entire operational environment and core technologies. Fire tower`s visual analysis function mainly based on 3D information which is different from many others functions in forest fire prevention system. Fire tower visual analysis will lose effectiveness even without 3D information. We can conclude that 3D visual technology is the key.

The second layer is logic layer. When we build an application system, we have to make sure that technology is appropriate to actual work flow.

The third layer is interaction layer which is used by customers. When we designed this layer, we need to consider customer`s habits.

3. System Design

3.1. General Program

By fully considering these three layers, this paper proposed the overall design program, including data, model, and function shown as in Figure1,

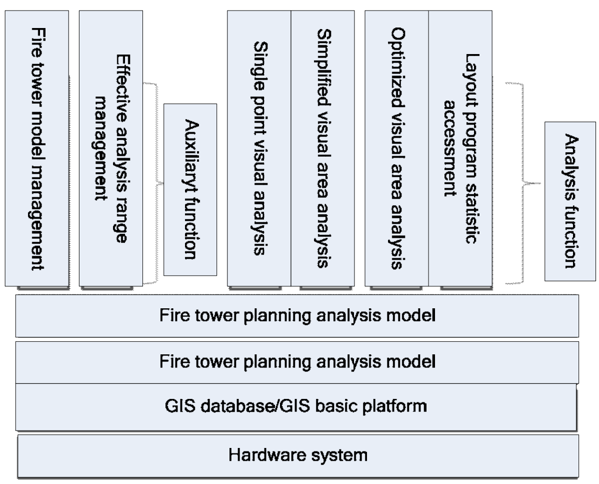

Figure 1. General structure

Fire tower planning required at least two type data: first is digital elevation model (DEM) in planning area; the second type is specialized drawing and 3D model of fire tower.

Planning analysis model defined as an algorithm is to realize planning analysis function. We must consider two professional concepts based on purely geographic and spatial analysis: one concept is effective planning scope. We need to define analysis area, for a municipal forest fire prevention system are based on the city`s terrain map. Second is effective resolution range. The pyrotechnic devices which installed in fire tower such as (camera and supporting software) just like human eyes, which only can view a limited distance. Fire town can not monitor things beyond the distance which is the inevitable factor.

System functions design is based on data and model, combining with actual work flow.

3.2. Design Application Functions

There are two core parts in fire tower planning analysis: one is analysis, which calculated and showed varies of visible and invisible result and also the visible scope. The other is access which is to give quantitative suggestions for multi-location selection and layout program.

Based on the cores, we can realize system functions from four following aspects:

1) Analysis of single visible point

Single-point analysis is based on single observation tower, which research visible situation of any point within effective planning area. There are two results from that analysis: visible or invisible. Fire tower and target point will be connected and the results will be displayed in connected lines.

2) Simplify analysis of visible area

Visible area analysis also uses single fire tower as analyzing objective researching coverage of single fire tower within the effective scope. The analyzing results which included visible and invisible areas are distinguished by different colors, so we can compare with scopes of two kinds of areas very intuitively and qualitatively.

3) Optimizing analysis of visible area

It introduces fire tower resolution range factor from “Simplify analysis of visible area”. All the area beyond the scope will be invisible and the result will be closer to the fact.

4) Layout program statistic and assessment

It analyzes multi fire tower. In addition to consider single fire tower, it also considers the overlapped area of the visible area, and finally quantitatively evaluates the solutions.

4. Realization of Major Functions

According to scheme of fire tower planning and analysis, the system adopts MapGIS K9 as basic platform and MapGISK9-TDE as 3D platform which mainly uses C/S model. The following are simple function realization ideas.

4.1. Single Point visual Analysis

It has two steps:

1) get distinguishable distance of fire tower

In order to enhance system`s portability ability, system will take distinguishable distance as fire tower attribute. We can automatically obtain its attribute information when we choose analyzed objective.

Because fire tower is stored in 3D model, and its attribute query interface is slightly different with the general3D elements:

```
long flg = Get3DFeatuLayer(m_pGdataBase, "fire tower", Temp3DLayerInfo){}
```

This interface includes three parameters: m_pGdataBase represents the geodatabase pointer in current operation; the “fire tower” string constants are the names of the 3D layers defined by database; Temp3DLayerInfo the 3D element layer information input after pointer visiting designed layer, which includes distinguishable distance information.

2) judge fire tower visibility

From the technology point of view, fire tower visibility can be abstracted as inter-perspective analyses of two points. The call interface can be defined as,

```
VisiableBetweenTwoDot(start3Dot,end3Dot,visiableDist)

{
    //get the straight-line distance, if it beyond the distinguishable distance, then “invisible”
    long distance = GetDistanceBetweenTwoDot(tart3Dot,end3Dot);
    if(distance > visiableDist ){
        return false;
    }
    //inter-perspective analyses of two points
    bool flg = VisiableAnalyByTwoDot(start3Dot,end3Dot);
}
```

The effective picture of single point visible analysis is shown in Figure 2:

Figure 2. Single point visible analysis effective picture

4.2. Simplify Analysis of Visual Area

Simplify analysis of visual area has three steps,

1) get effective analyzed scope

There are several methods for effective analyzed scope setting. Subjectively, manually set forest geological scope; objectively, take the pre-selected location as circle and observations distance as radius, since this method is interfered by lots of factors, which will not be the key point of this paper.

Obtain a valid analytical range is to read the predetermined range results, and pass to the following up process module. The interface is as follows:

```
Polygon polygon = GetAnalyRange1(RegDotArr){}
```

The interface only has one parameter that is the boundary string coordinates in effective range. After setting the scope, the boundary string coordinates can be stored in any visiting database table by string splicing or point by point record method. RegDotArr is defined as 3D coordinates object C3DotArr in MAPGIS-TDE. After convert the string coordinates to interfaces by definition, we can return to polygon region object which consistent with the effective analyzing scope.

2) fire tower visible area analysis

In fire tower visible area analysis, the effective scope analysis obtained in the previous step will be transferred to the following interface,

```
bool flg = VisibleAnalysysByPolygon(m_pGdataBase,3dDot, polygon, visiableId,invisiableId)
```

m_pGdataBase also represents geodatabase pointer in current operation. 3dDot is a 3D point object, which is used to indicate the location of fire tower. After that, the analyzed results will be stored in geodatabase in raster image. visiableId and invisiableId are the output image identification.

3) Visualized visible area analyzed result

After analysis, the results need to be displayed for user identify. The interface is designed as follows,

```
bool flg = ShowVisibleAnalysysRlt(m_pGdataBase, visiableId, invisiableId){}
```

VisiableId and InvisiableId are the analyzed resulting images stored in geographic database. This method is to add image into 3D scene through geodatabase pointer and image ID.

4.3. Optimize Visible Area Analysis

The realization method is quite the same with the above. It only adds one process in effective analysis scope.

1) get effective analysis scope

Optimized analysis of the visible field needs to take the fire tower distinguish parameter into practice, while the camera in fire tower can adjust the horizontal and vertical viewing angle in both directions. The system design takes the fire tower center as circle and the distinguish distance as radius to form a circular region, that is, the fire tower visible range. Then overlap the previous set area. The intersection regions can be seen as the effective range of optimized visible field analysis. Shown as follows:

```
Polygon polygon = GetAnalyRange2(RegDotArr,3dDot,visiableDist)
{
{
    //calculate fire tower visible area
    Circle circle = GetVisiableRange(3dDot,visiableDist)
    //get planned analysis scope
    Polygon polygon = GetAnalyRange1(RegDotArr)
    //calculate the intersection of visible area and planning analysis
    Polygon polygon = GetCrossingRange(circle, polygon)
}
```

2) fire tower visible area analysis

Similar to the simplified visible area analysis of fire tower, call visible area analysis interface gets gird image analysis result. The difference is that, system will get visible area in this area, not only take the left part as invisible area. It takes invisible area expands to "planning analysis scope" and shaded areas are not visible. As shown in Figure 3.

3) display the analysis results of visible area

The last step analysis result display effect is as follows. We can see effective picture from figure 4 that the boundary of red outline is circular, and the left blue area is invisible, not only the blue in the circular are invisible.

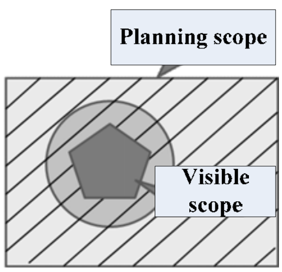

Figure 3. determine scope of invisible area

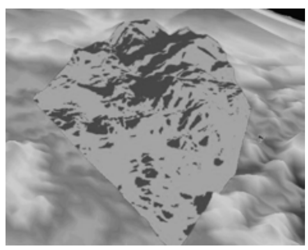

Figure 4. Optimized visible area analysis effect picture

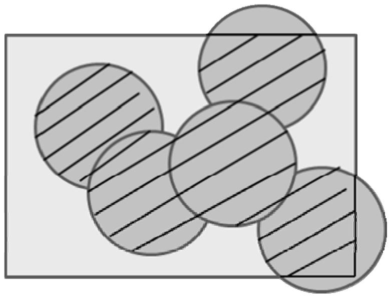

Figure 5. Determine effective area analysis of multi-fire towers

4.4. Layout Program Statistical Planning Evaluation

Layout program statistical planning evaluation is to compare multi layout programs and select optimized program as the reference for planning construction. First, we should standardize the rules and design access. In this system development, we use relative percentage of blind-area, targeted-area and non-targeted area as the criterion. Blind-area is defined as area which can not be monitored by any fire tower. Non-targeted area is defined as area which can be monitored by only one fire tower. Targeted area is defined as area which can be monitored by two or more than two fire towers. High percentage of targeted area and low percentage of blind-area is the best planning.

To achieve this function, the system has the following four-step processing:

1) get effective analysis scope

Effective scope analysis for several fire towers can be viewed as a collection after superposition of several regions, which shown as the shaded area in figure 5:

2) multi-fire tower visible area analysis

After determining the standard, we can refer the single fire tower visible area analysis method to get related visible and invisible area.

bool flg = VisibleAnalysysByPolygon(m_pGdataBase, 3dDotArr, polygon, visiableId,invisiableId)

In the above-mentioned interface, 3dDotArr represents all the location of fire tower in layout program. VisiableId and invisiableId respectively, are the visible and invisible analyzed results image identification. From the above, we can see that the visible included single-visible fire tower and several-visible fire tower which are distinguished by stored colors.

3) statistical area of the three regions

In the layout program statistical evaluation, one of the most distinctive features is the quantitative evaluation, not only the direct display of visible condition.

The so-called quantitative evaluation is to determine the area of the targeted-area, non-targeted area and blind area. Since analyzed results are stored in raster format, thus the statistic will take full advantage of raster image grid characteristics, and determine the overall percentage of the three regions by "grid numbers".

4) display coverage and statistical results of three regions

System will load the images which get from the last step into the 3D scene, to get the figure 6 as effect picture. At the same time, the system will display the percentage of targeted-area, non-targeted area and blind area in pie charts.

5. Conclusion

As the development of forestry information, GIS and 3D visualization have been the main technology applied in building forestry system. This paper designed and realized the fire tower planning analysis sub-system. This

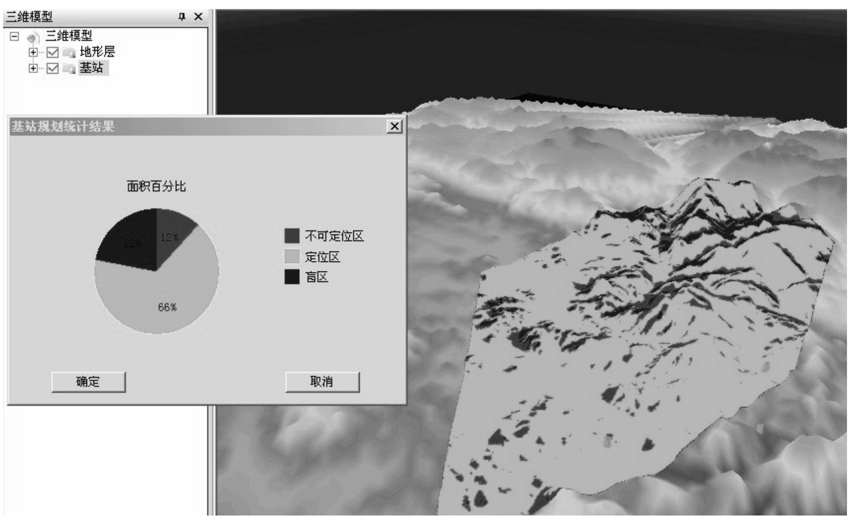

Figure 6. Layout program statistical evaluation effect picture

system uses GIS and 3D viewable analysis technologies as key technologies. It uses MapGIS platform and 3D platform as developed environment and shows how to realize the fire tower planning analysis sub-system. This system not only benefited forest management departments, for they can scientific planning fire towers, but assistant setting new fire towers location planning, which helps to cut the operational cost and improve forestry management.

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Journal of Geographic Information System, 2010
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Volume 2 Number 1 **January 2010**

ISSN: 2151-1950

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