

ORGANIZING AND MANAGING OF DISTRIBUTED GEOGRAPHICAL INFORMATION

Jianya Gong
Wuhan Technical University of Surveying and Mapping, Wuhan, China
Jgong@rcgis.wtusm.edu.cn

KEY WORDS: GIS; distributed; Internet

ABSTRACT

The development of Internet provides convenient environment for information searching and browsing. It also offers a new platform for geographic information processing and analysis. This paper discusses organization and processing approach to Internet geographic information, and provides a new method to cross-platform and distributed geographic information and its software implementation. The example is used to show the practicality and superiority of this method.

1 INTRODUCTION

With the development of Internet, especially the development of Wide World Web (WWW) technology, the distribution, searching and browsing of information has had a revolutionary change, no matter with which format or by which means, which has brought great convenience for human beings. Various industries related to information have managed to run their corresponding information system on WWW (Badget, 1995; Strand, 1996b). After years of efforts and reconstruction, relational database management system is gradually adapting to the requirements of the development of Internet technology. At present, most commercial relational database management systems can run on the Internet (Zhuang, 1997; Oracle, 1997). Web GIS or Internet GIS is an important orientation for the development of the current GIS (Coleman, 1997; Evans, 1996; Peng, 1997&1998). There are several directions for the development of GIS, in which the open system based on Internet, that is, Internet GIS, is the most important one (Korte, 1997).

WWW has got three remarkable advantages (Lennon, 1997; Hall, 1996). One is the friendly interface. The current popular WWW browsers, either Netscape Communicator or Microsoft Internet Explorer, are not only of high visibility, but also easy to learn and operate. The second is the multi-platforms and their easy linking. On the WWW, you may browse information from different types of computers or different operating systems. When people are browsing the information, what they care for is just the address of the website. They need not care about that which platform or operating system the information comes from. Moreover, it is quite easy to link different platforms. Third, the most remarkable advantage is the hyperlink. When people are distributing information and making Homepages, they just need to link the website to the corresponding hypertext markup word according to the Hypertext Markup Language (HTML) grammar (Berners, 1994). When users are browsing the homepages, they can go to another homepage by clicking mouse to activate the hypertext markup word. The other homepage may be from a different place, even from a different country. This is a prominent characteristic of distributive information.

In recent years, software manufacturers of GIS are accelerating the development of GIS based on WWW. They promote their productions one after another. For example, MapGuide of Autodesk Company, MapObjects IMS (Internet Map Server) and ArcView IMS of ESRI Company, GeoMedia Web Map of Intergraph Company, Proserver of MapInfo and so on (Limp, 1997). According to the technology foundation and developing orientation of each company, some have adopted Common Gateway Interface (CGI), such as MapObjects IMS, ArcView IMS, MapInfo and Proserver. Some have adopted Plug-in mode, such as MapGuide, Geomedia Web Map. They can all run on the WWW browsers. However, they have not adopted hyperlink technology. Thus, they are restricted in organizing and managing of the distributed geographical information.

This article first introduces the conception of organizing and managing of distributed geographical information. Then it discusses the implementation method of multi-platforms and distributive GIS. At last, Internet GIS- GeoSurf developed on the basis of this idea and its application instances are to be illustrated.

2 THE CONCEPTION OF ORGANIZING AND MANAGING THE DISTRIBUTED GEOGRAPHICAL INFORMATION

Distributed Geographical Information (DGI) means the geographical information distributed by means of various formats on the Internet with the WWW technology, such as, maps, images, data set, analytical operation and reports and so on (Plewe, 1997b & 1996). The current application modes of DGI include downloading the original data, browsing the static images and dynamic images, browsing the metadata index, the query and analysis of geographical information based on WWW and intelligent network GIS. DGI now is still in the phase of developing (Plewe, 1997a).

Geographical information possesses the characteristic of regional distribution, so the occurrence of distributed organizing and managing of geographical information is very natural. Geographical information relates to two aspects of distribution. One is the plate distribution, which is something like the two-dimensional distribution of maps. For example, a Chinese map involves provinces and municipalities. According to the concept of WWW, if the Chinese map is the homepage, it involves the essential fundamental information of the country and provinces. Make each province of the map the Hypertext markup words. Link the markup words to the webpages of those provinces by means of the relevant web addresses. Thus users can query the information of the sub web addresses of the map. Searching in this way, users can get the information of a certain county or town. By means of the hyperlink, users can index and query information of different places and layers from wide to narrow on the map.

The other is the vertical distribution. A map based on the same scale may have geographical information at different layers. For instance, a city GIS includes multi-layers of geographical information of real estate management and pipelines under ground. Geographical information at different levels may be collected and maintained by different departments. Therefore, the database servers may be distributed in different departments with different web site.

Out of question, these two kinds of distributions both relate to the problem of distributed organizing and managing of geographical information. Each department of each region establishes and maintains their own systems. These systems are linked by hyperlink for users to cruise and navigate, index and query relevant geographical information among different systems. There is off-the-peg technology to establish GIS of various regions and departments. At present, the key problem is how to establish a navigational hyperlink that can directly enter another system by means of markup words or figures.

In addition, there are other problems to be settled. One is the expression and relating of multi-scaled map. The scales of GIS for a country and for a city are obviously different. How to coordinate is a problem to be studied and settled. The second is that information of different layers may be integrated for browsing. This is not as same as the browsing of a common homepage. In the process of browsing homepages designed by HTML language, when entering the next webpage, the previous webpage has been turned over. However, the integration of geographical information of different layers needs to display geographical information acquired from different web sites in the same window interface of the same webpage. The third is multi-platforms. The establishment and maintenance of GIS generally adopts the ready-made software. These systems may use different platforms such as image workstations or PCs, different operating systems as Windows, Macintosh or UNIX packages and different software packages as Arc/ Info, MapInfo and GeoStar. How to work harmoniously on the Internet is a big difficult problem. This is in fact a problem of information management of multi-platforms. The next section will discuss the implementation method of distributed organizing and managing of multi-platforms geographical information in detail.

3 ORGANIZING OF DISTRIBUTED GEOGRAPHICAL INFORMATION

The organizing of DGI is the same as the common geographical information, according to a website. The supporter and maintenance man of the geographical information data may establish a project or a workspace on the database server. These data are organized according to their own software. Take GeoStar as an example to introduce the spatial data organizing of a workspace. Suppose that Guangzhou Geography Institute is a network node. Its database server has installed the district map of Guangdong Province' which includes important feature class layers as regionalism, roads, water system, toponym annotations. Figure 1 shows the tree structure of GeoStar's workspaces and layers information.

This figure is completely accordant to the conceptions of workspaces, projects and feature class layers of GeoStar. In fact, the basic data structure of Internet GIS-GeoSurf of GeoStar package is the data structure of GeoStar NT. Thus, we can establish our own workspaces in Fushan, Dongwang, Shenzhen and so on. The key problem is how to join the GIS Spatial Databases established in different places and with different software packages.

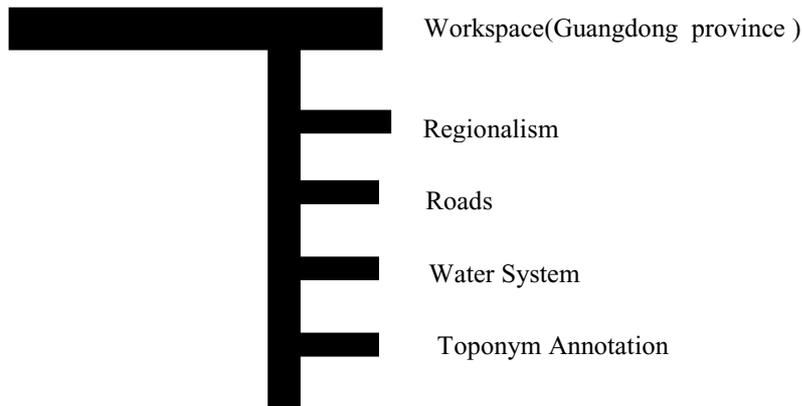


Figure 1 The Tree Structure of Workspace and Layers Information of GeoStar

It is required that Spatial Data Service Directing Department of each region provides the domain name addresses, the software to establish the database, the map range and projection information of the server for the spatial database. According to the workspace at provincial level, the geographical information workspaces of each region are considered as the sub objects. A kind of hyperlink is established by establishing a relational table. Generally speaking, the range and name of cities in each province and territory are presented in the provincial map. Thus, the name or polygon of cities can be taken as the node of the hyperlink. A relational table of the hyperlink is established, as Table 1 shows:

Object ID	Description	Geographical Range	Super Object Domain Ad.	Data Acquiring Software/ Component	Sub Object Domain Ad.	Data Acquiring Software/ Component
12	Fushan	(x1,x2,y1,y2)			Xx.xx.xx.xx	ArcInfo
13	Shenzhen	(x1,x2,y1,y2)			Xx.xx.xx.xx	GeoStar
14	Dongwan	(x1,x2,y1,y2)			Xx.xx.xx.xx	MapInfo
15	Zhanjiang	(x1,x2,y1,y2)			Xx.xx.xx.xx	GeoStar
...

Table 1. Hyperlink of Distributed Geographical Information

If double click the position of Shenzhen on the provincial map, the system will contact the domain address and data structure of spatial data of its sub node. Then the system will start up the corresponding data acquiring software or component to pursue more detailed information about Shenzhen. However, sometimes users do not think that the city map is detailed enough. They want to get information of towns or counties and even administrative regions. A sub spatial database can be established at the time. Then a hyperlink at the county level can be built on the city map. As Table 2 shows, it is a sub map related to the city map of Shenzhen. We may search for more detailed information step by step with this hyperlink.

Object ID	Description	Geographical Range	Super Object Domain Ad.	Data Acquiring Software/ Component	Sub Object Domain Ad.	Data Acquiring Software/ Component
201	Fu Tian	(x1,x2,y1,y2)	xx.xx.xx.xx	GeoStar	Xx.xx.xx.xx	ArcInfo
202	Luo Hu	(x1,x2,y1,y2)	xx.xx.xx.xx	GeoStar	Xx.xx.xx.xx	GeoStar
202	Bao An	(x1,x2,y1,y2)	xx.xx.xx.xx	GeoStar	Xx.xx.xx.xx	MapInfo
...

Table 2. Sub Hyperlink of Distributed Geographical Information

4 IMPLEMENTATION OF DISTRIBUTED GEOGRAPHICAL INFORMATION

It should be said that the technology to establish distributed geographical information system (DGIS) on the Internet is mature. It is easy to realize the navigational query among any homepages similar to the hyperlink, if a unitive GIS software is adopted and a hyperlink between nodes and sub maps is established.

However, GIS and hyperlink is different. Hyperlink has restricted regulations and adopts HTML language. Homepages established according to the regulations and HTML language is easy to achieve navigational query with the hyperlink. However, there are no unitive regulations for GIS. Even the data structures differ from each other. As a result, the problem to establish DGIS is the mutual linking among data of different structures (Wilson, 1998).

So as to settle the problem, the GIS software industries in U. S. A. and Europe are discussing and drafting “Open Geodata Interoperability Sophistication” (Buehler, 1996; OGC, 1997). According to the distributed component principles, it has drafted a set of protocols and function standards of spatial data interoperations. If this set of protocols

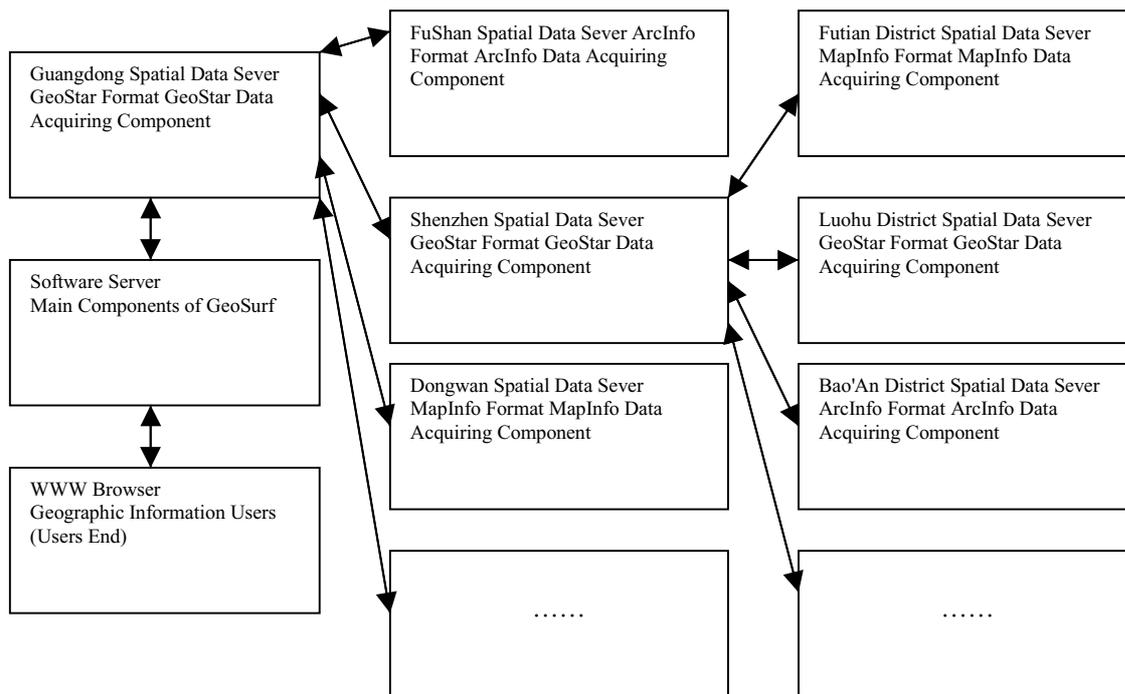


Figure 2 The Distributed Information and Organizing Structure of the Distributed Components

and functions is implemented, geographical information data stored by different software can be manipulated. However, this set of protocols is quite complicated, which still has a long way to go.

Another scheme to manipulate the spatial data of different structures is to redact functions, COM or components that can directly read the spatial data structure. There is no external data structure for the Internet GIS. However, the Internet GIS can read and input spatial data stored by various GIS software packages into its own memory so as to carry out operations as displaying, query and cartography. It is required to learn about the data structure and data organizing mode of various GIS software. Moreover, it is required to acquire the legal permission to read the data structure. In addition, when organizing the data structure memory, a strong compatibility is needed. It is necessary to take data with both topological and non-topological relations into consideration.

When writing software and creating software components, it is promoted to redact software with distributed components, especially the component that can read and write spatial data. In the organizing of DGIS, according to the Internet GIS, the software of spatial database is different only means that the spatial data structure is different. That is to say only the software to read and write this data structure is different, while memory management, graph displaying, spatial query and special cartography are the same. At this moment, the software that reads and writes spatial data is designed to be the distributed software. And the software is even stored with the relevant spatial data. If it is required to use the data, start up the component to read the spatial data and transmit the result to the users' end. It is obvious that the distributed component has decreased the transmission pressure of the network, and the burden of users' computers to acquire spatial data of various formats as well. Figure 2 is a sketch map of DGI and organizing structure of the distributed components.

5 INSTANCES AND CONCLUSION

In the light of the above ideas, we have developed an Internet GIS software of multi-platforms distributed geographical information named GeoSurf. This software is written in Java language. It can be operated in platforms of different operating systems and GIS software. It adopts the distributed component object model (DCOM) to read data of various GIS software. It adopts the organizing mode of DGI to link maps of different scales and carry out navigational spatial query, cruising and cartography. Figure 3 is a world map. Double click China on the world map, the Chinese map will be displayed (Figure 4). Double click the Three Gorges Area on the Chinese map, the map of Three Gorges Area will be displayed (Figure 5). Each map can carry out query and special cartography respectively. Certainly, if the projection system is accordant to the coordinate system, they can be overlapped to display and query.

Since the current speed of Internet is rather slow, different users can acquire information of different levels if they adopt the DGI management. Moreover, this kind of navigational query is much similar to the query on WWW homepages that people are accustomed to. People can roam in the DGI.

On the other hand, the organizing of DGI has turned its integrated management and maintenance of Geospatial data to the distributed management and maintenance. As a matter of fact, with the accelerating updating speed of geographical information, the integrated management is hard to adapt to the circumstance. For example, the social economy requests that the geospatial information of Comprehensive GIS of social economy change monthly. It is impossible for one department to manage and maintain the social economic information from the Central Government to a county and a town. Each department should take its own responsibilities. Each area and department take in charge of the updating and maintenance of the data in their own database, and adopt the organizing and navigational query of DGI. Any user can find the geospatial information of the social economy in each area rapidly.

The Internet technology provides the establishment of DGIS with technical foundation and platform environment. In the practical application, the main problem to be settled is the mutual operation of data with different data structures. The Internet GIS- GeoSurf in the GeoStar family introduced in this article has had a successful attempt in the organizing and managing of DGI and has presented a favourable application prospect.

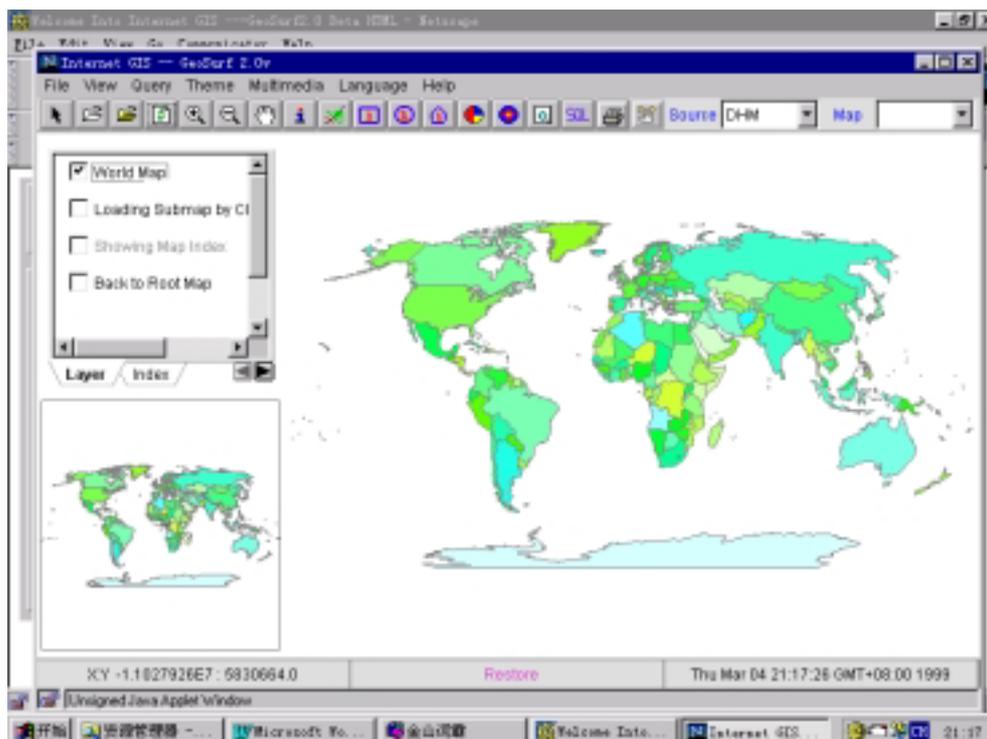


Figure 3. Map of World

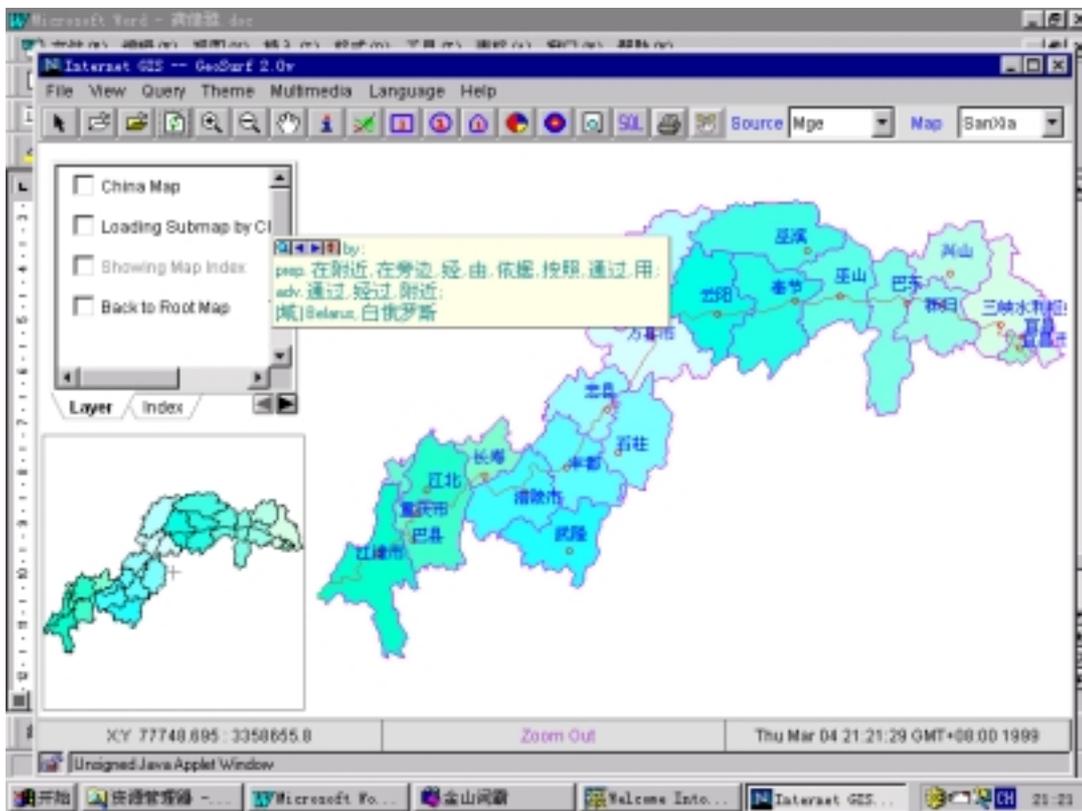


Figure 4. Map of China

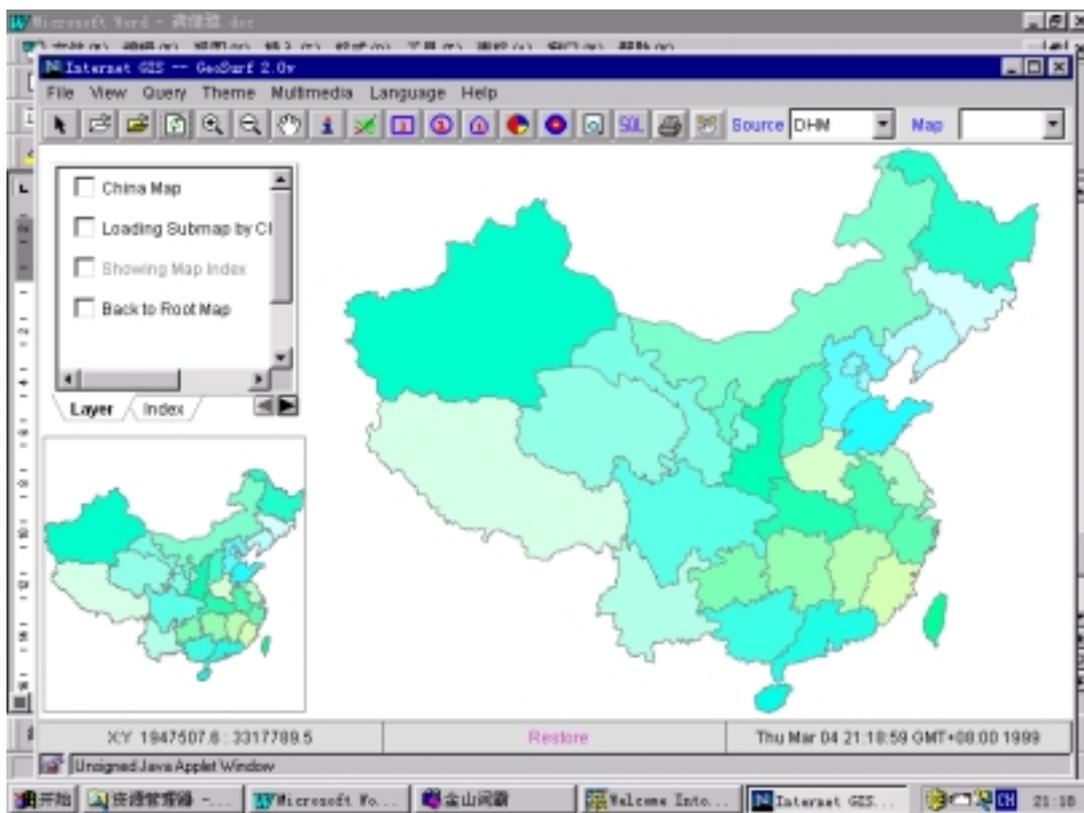


Figure 5. Map of Three-Gorges

REFERENCES

- Arnold K., Gosling J., 1996. *The Java Programming Language*. New York: Addison - Wesley Publishing Company.
- Badget T., Sandler C., 1995. *Welcome to - The Internet: From Mystery and Mastery*. Second Edited, New York, MIS: Press.
- Berners L. T., Cailliau R., Groff J., Pllermann B., 1994. *World Wide Web: The Information Universe*. *Electronic Networking: Research, Applications and Policy*, 1 (2), pp. 52-58
- Buehler K. , McKee L., 1996. *The Open GIS Guide: Introduction to Interoperability Geoprocessing*. OGC TC Document 96 – 100.
<http://www.opengis.org/guide/guide/>
- Coleman D. J., Mclaughlin J. D., 1997. Information access and network usage in the engineering spatial information marketplace. *Journal of Urban and Regional Information Systems*, Spring, pp. 8 – 9
- Evans D., 1996. Enterprise GIS: You take the high road. *Proceedings of the 1996 URISA Conference*, Vol. 1, pp. 424 – 429.
- Hall W., Davis H., Hutchings G., 1996. *Rethinking Hypermedia: The Microcosm Approach*. Boston: Kluwer Academic Publishers.
- Korte G. B., 1997. *The GIS Book*, 4nd ed. Santa Fe: On Word Press.
- Limp W. F., 1997. Weave maps across the web. *GIS World*, 10 (9), pp. 46 – 55.
- Lennon J. A., 1997 *Hypermedia Systems and Applications: World Wide Web and Beyond*. Berlin, New York: Springer.
- OGC., 1997. *The OGC Technical Committee Technology Development Process*. Open GIS Consortium, Wayland, Massachusetts.
<http://www.opengis.org/techno/development.htm>
- Oracle Corp. Oracle 7 Spatial Data Option Release 7. 3. 3: *Spatial Solution Center Training Class Notes*, 1997. 87
- Peng Z, Nerbert D. D., 1997. An Internet - based GIS data access system. *Journal of Urban and Regional Systems*, Spring, pp. 20 – 30.
- Peng Z., 1998. *An Assessment of Internet GIS*. Department of Urban Planning, University of Wisconsin – Milwaukee.
- Plewe B., 1996. A primer on creating geographic services. *GIS World*, 9 (1), pp. 56 – 58.
- Plewe B., 1997a. So you want to build an online GIS? *GIS World*, 10 (11), pp. 58 – 60.
- Plewe B., 1997b. *GIS online: information retrieval, mapping, and the Internet*. Santa Fe, NM: Onward Press.
- Strand E. J., 1996a. Java - enabled browser provide geographic services. *GIS World*, 9 (1), pp. 38.
- Strand E. J., 1996b. Vectors maps weave their way across the Web. *GIS World*, 9 (11), pp. 32 – 33.
- Weber J., 1996. *Spatial Edition Using Java*. Second Edition, Indianapolis, in: Que Corporation.
- Wilson J. D., 1998. Interoperability: opens the GIS cocoon. *GIS World*, 11 (3), pp. 58 – 60.
- Zhuang V., 1997. Spatial engine drive web - based GIS. *GIS World*, 10 (10), pp. 45 – 58.

AUTOMATIC PATTERNING OF THE MIDDLE SCALE MAP USING DATA OF GIS

Naoki GOTO, Kosuke TSURU, Tsuyoshi TAKENOUCI
 AERO ASAHI CORPORATION, JAPAN
 e-mail: Naoki.Goto@aeroasahi.co.jp

Working Group II/7

KEY WORDS: GIS, Automatically, Patterning

ABSTRACT : On this study, As for making a work of digital mapping of middle scale, It does the research of the way of automatic translating process from the Geo Information System (GIS) data to completely different property of printing data, and automatic patterning programming was developed. In this programming, With corresponding to the basic five kinds of patterning method, it will possible to correspond to almost all the patterning with their matching. Therefore, we could process the work shorten which we took five days work into three hours.

1. Introduction

Up to now, two purposes of making digital maps is divided into two in a large scale. One is to make the printing map and the other is to make the digital data for using of GIS. As for the printing map, it is emphasized on representation. And as for the usage of GeoInformation System, it is emphasized on classification of layer and structure of data. However, these two purposes hold the same map data, but they hold a quite different property of data. Up to now, we don't have any suitable things to fulfill and we must work hard individually, giving a lot of burden on it. Then, in order to fulfill these two purposes, we developed automatic patterning program as well as the research of the translate method from GIS data to printing map data. This time patterning was referred to the map symbols of 1 to 100,000 of U.S.S.R.

2. Classification of patterning process

2.1. Previous process

That data for process must be concentrated on a single line or polygon as a previous process. This matter is the same condition to make use of GIS.

2.2. Patterning of line element

As for the patterning of line element, it will divide line into a dot line with established interval (Figure 1). In this process, With corresponded to three kinds of line, those are broken line, one dotted line and two dotted line.

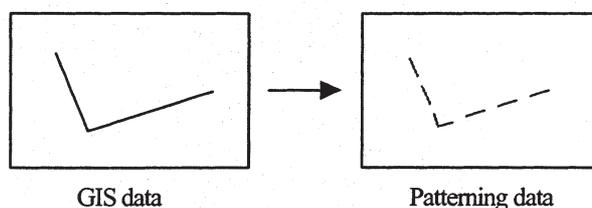


Figure 1. Patterning of line element

2.3. Patterning with marks to line element

As for the patterning with marks to line element, it is able to patterning by attaching many different kind of marks for line data (Figure 2). This is to put on marks on a line data, according to the established interval and the kinds of marks.

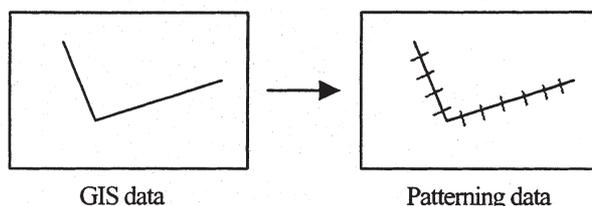


Figure 2. Patterning with marks to line element

2.4. Place marks to polygon element

As for the place marks to polygon element, it is the patterning of the arrangement of the marks equally on inside of the polygon (Figure 3(a)). This is the arranged interval of established marks and kinds of marks, which were input inside of the polygon. It will arrange the marks equally. But on the representation of the maps, it will exist a large unequal arrangement (Figure 3(b)). In this case, against the parallel line from X-axis, represent of unequal situation by moving alternately the start position.

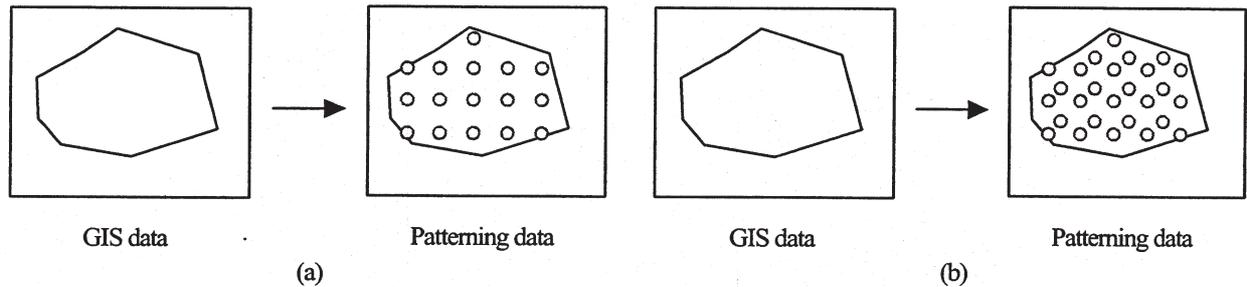


Figure 3. Place marks to polygon element

2.5. Curvilinear place marks to polygon element

As for the curvilinear place marks to polygon element, it is the patterning of the arrangement of the figure of curving marks on inside of the polygon (Figure 4). According to the established arrange interval of marks, kinds of marks, width of curve line, which were input inside of the polygon it will temporarily generate a sine curve and it will arrange marks on the curving line. The direction of the generation of the line, two ways were possible. There are the horizontal line and vertical line.

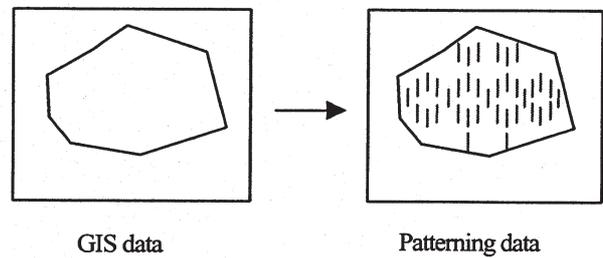


Figure 4. Curvilinear place marks to polygon element

2.6. Generate lattice lines to polygon element

As for generate lattice lines to polygon element, it is the patterning to generate the lattice line on inside of the polygon (Figure 5). According to the established arrange interval which was input inside of the polygon it would generate a lattice line.

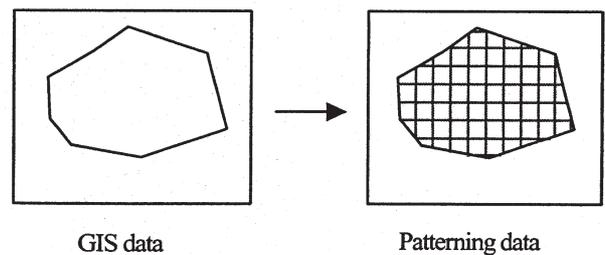


Figure 5. Generate lattice lines to polygon element

3. Method of patterning process

3.1. Place origin of marks

At first, the origin of the generation was adopted the left bottom of position of polygon range. But it of case once in a long while it can not place marks. Therefore we adopted the gravity of center position of polygon for the origin of the generation the polygon (Figure 6). Doing this, we can arrange one point of mark at least.

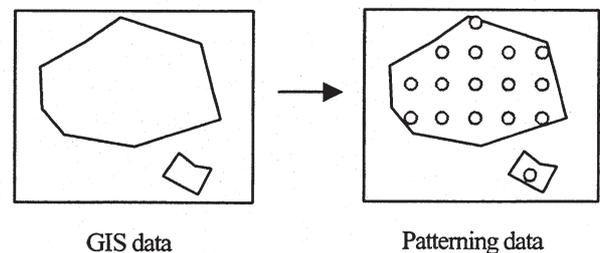


Figure 6. Place origin of marks

3.2. Place interval of marks

Depending on the polygon area, we adjusted place interval of marks (Figure 7). Doing this, we can cull the developing marks by the size of the polygon, and we coped with the visual identification for the printing data.

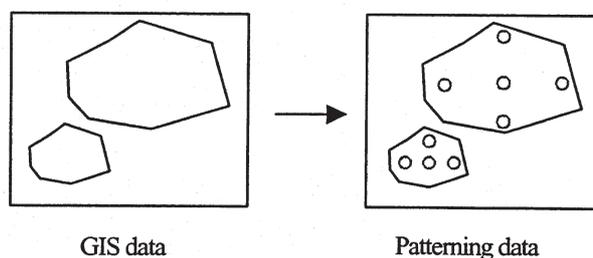


Figure 7. Place interval of marks

3.3. Place marks to retrenched polygon

When we do the arrangement of the marks, we can arrange the marks on the retrenched polygon (Figure 8). Doing this, we avoided some of the shape marks, which were arranged near the borderline to go out of the polygon. At first, we arranged the marks on the original polygon. But it of case which were arranged near the borderline, a partly of the marks to go out of the polygon, according to the symbol size. Therefore we can arrange the marks on the retrenched polygon.

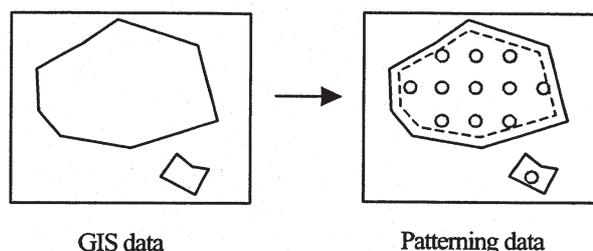


Figure 8. Place marks to retrenched polygon

3.4. Multi process

On the representation of the maps, it is not necessarily always arrange the one type marks. So we made possible multi processing against each data. Therefore against polygon data, it is make it possible to make attached patterns of borderline and patterns of inside of polygon.

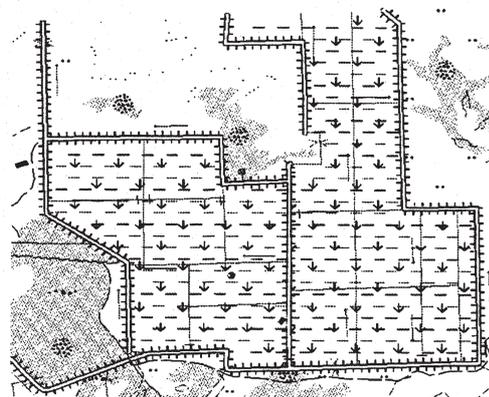


Figure 9. Multi process

3.5. Outline

As for the printing data, showing on the polygon or line is better than showing on the text character and marks.

Therefore we put them into these data of outline. "Outline" means "Holding outside of the text characters and shapes of the marks and transform them into line or polygon data".

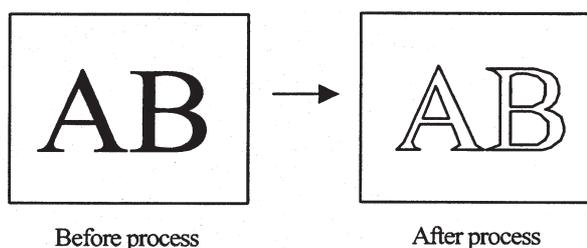


Figure 10. Outline

3.6. Classifying data

As for the printing data, each data of the relation of high and low is getting more important.

For this problem, classifying the each data, and filed them separately and it is possible to give priority to show the high rank (figure 11). According to this, we could make out printing map from each of classified layer.

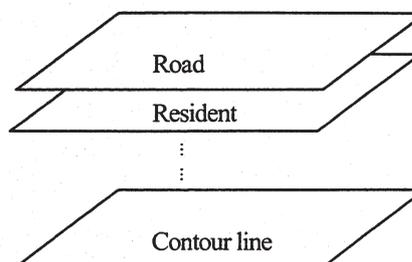


Figure 11. Classifying data

4. CONCLUSION

This table shows the difference between current method and new method.

Table-1. compare of current method and new method

	current method	new method
work time	5 days	3 hours
quality	super fine	fine
work form	manually	automatically

According to Table-1, those methods most different are work time. This matter is due to work form. In case of work using current method, it is under the influence of experience and technique of worker. But as for the new method, we can get easy for fine quality result. Every time.

REFERENCE

Military-Topographic Administration of the General Headquarters, Moscow-1983. SYMBOLS



Figure 12. GIS data

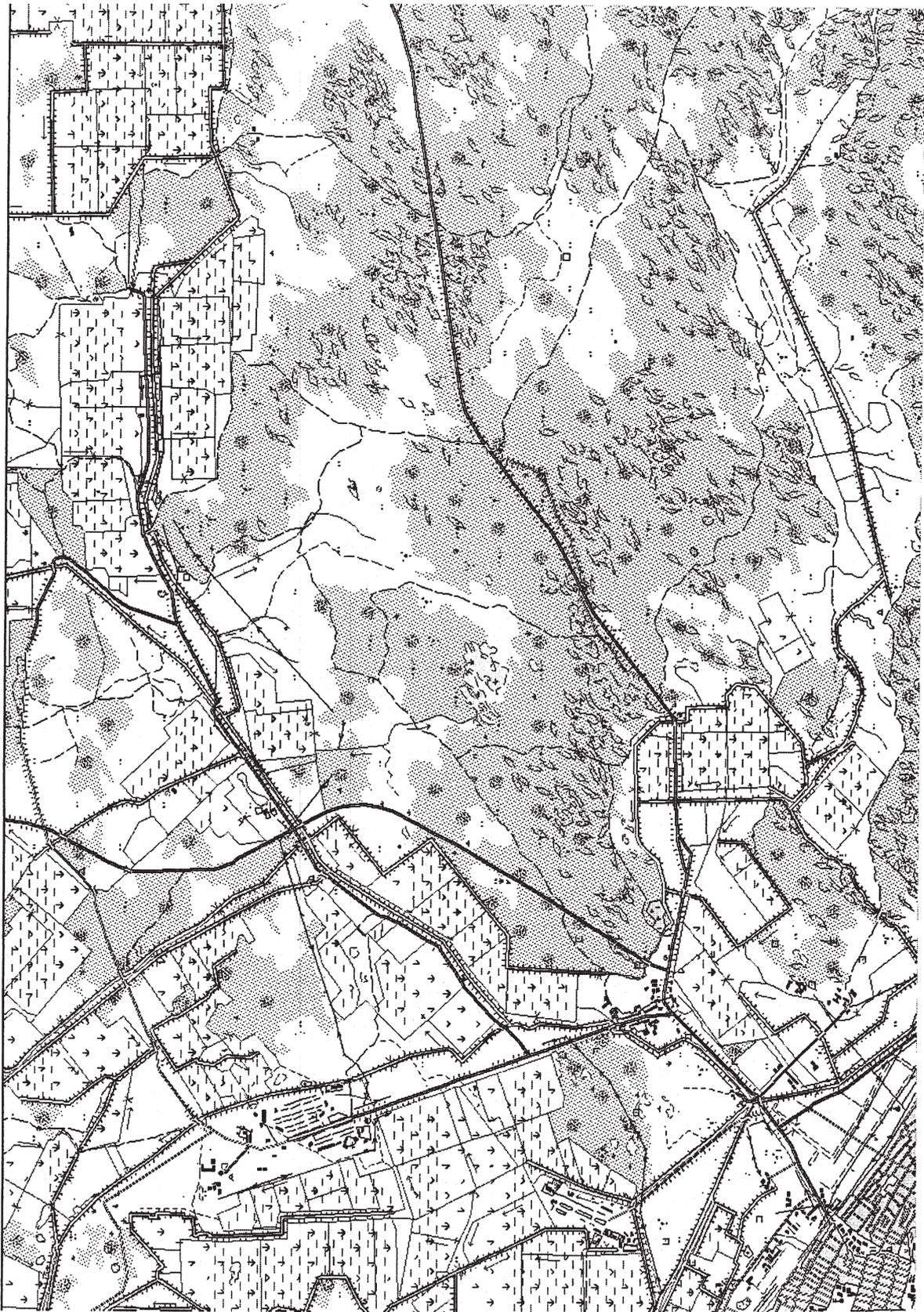


Figure 13. Patterning data