THE ESSENCE OF GIS AND THE TASK OF CARTOGRAPHY

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Abstract

This paper discusses the essence and the feature of GIS, analyzes the main techniques faced by GIS, and finally gives some views on the task of cartography.

1   The essence of GIS

All activities of man are in some spatial geographic environment and closely related to spatial geographic environment. Then what can be used to know geographic environment and utilize geographic factors ? As the development of science technology and the enlargement of cognitive space, the approaches of man's knowing geographic environment and utilizing geographic factors have been changing continually . What can be used to know the space environment are traditional maps, map database and geographic information system . Map is the graph and symbol model of geographic environment . It is a carrier of recording spatial geographic environment using symbol system according to strict mathematics rules and scientific cartography generalization rules . It can reflect the spatial distribution ,combination, relationship and restriction of physical and social phenomena, and be capable of simulation, information load , information transfer and cognizance . But as the information times comes , the traditional map is facing a serious challenge ,which reflects in the follows[1] ; firstly ,traditional map production method has some weak points , lower speed , longer period and difficult renewal,so it can not transfer geographic environment information effectively and can not meet people's requirements ; secondly , traditional map with the medium of paper describes geographic environment as a relatively static status, so it can not reflect real—timely and continually changing geographic environment ; thirdly ,fewer types of map and little quantity of information in traditional surveying and mapping methods can't suit the rapid increment of spatial data , and can't meet the increasing manifold needs . Map database belongs to spatial database which stores geographic elements on the computer recognizable media with locational data , attribute data and relationship data , and then implements data inquiry and retrieval , addition and deletion , change and update under the support of map database manage-

ment system. As the core of computer cartography , map database can produce various digital maps , electrical maps and paper maps , so, it can transfer geographic information with the data carrier, the video disk media and the way of digital map and electrical map . Obviously , the new carrier media and methods with the core of map database really are a thorough progress . But the requirements of cognition and spatial geographic environment needed by society become more and more high no matter in depth or in scope, particularly in large quantities of statistical data , various analysis and auxiliary decision — making . Obviously , map database can not meet these needs, while GIS based on geographic database has these functions . It reflects the entire information transfer and feedback process including collection , storage , transformation , analysis and utilization of geographic environment information . It is the most effective method of spatial cognition . It's main feature is to extricate people from the predicament of phenomenon description and static analysis , and gain the freedom of simulation and forecast . So, the essence of GIS is that GIS is a modern tool to transfer geographic information and the most effective way to know geographic information and utilize geographic factors .

2 The features of GIS

2. 1 The theory feature of GIS—the support of " Geographic System " and " Space Cognition "

In view of epistemology and methodology , " Geography System " and " Space Cognition "can be regarded as the theory base of GIS .

Qian Xueshen , the famous scientist of China, has advanced the concept of " geography system " from the level of system science . Geography system , a huge and circulatory system , is a subject studying the whole physical and social economical environment , consisting of different levels of several subsystems . The relationship between geographic system and GIS is that geographic system is the science basis of GIS , and GIS is the science guarantee of geographic system study . In this sense , geographic system has laid epistemology foundations for GIS .

Space cognition , an important area of cognizance science, is a subject studying man's perception and thought information process . D. A. Norman presents that[1], cognition science is a subject of mind intelligence , thought , and knowledge and its applications. Cognition science aims to explain how man manipulate information during cognition process . Space cognition studies how man to know the environment man living in , including the relevant location , the qualitative and quantitative features , and cooperation of every things and phenomenon within the environment, and their timely and spatially changeable regulars . Comparing man's space cognition system with a GIS , we see they are similar exactly , namely they have the same work principle —.— information process system ; information input , encoding , storage , decision — making and results output . This is the reason why the manipulation process of environment information stream

in man's brain is duplicated GIS . Of course , they also have many differences . GIS can regard-
ed as the supplement and enhancement of man's space cognition , and intelligent GIS is actually
the simulation of space cognition . So, the introduction of cognition science can improve the de-
sign of GIS and enlarge its functions . In this sense , space cognition theory has laid methodology
foundations for GIS .

As the foundations of epistemology and methodology of GIS,geographic system and space cogni-
tion theories have theory direction effect on GIS in a great degree.. At the same time , advanced
GIS can support geographic system and space cognition theories . Technology without the direc-
tion of basic theory is blind , and theory without the direction of advanced technology is back-
ward . We must well deal with the dialectal relation of the two aspects during the whole process
of the study and development of GIS .

2. 2 *The technology feature—the intersection , mergence and integration of different subjects*

The intersection , mergence and integration of different subjectsis an obvious feature in the devel-
opment of modern science . GIS as an advanced technology system the feature , this feature be-
comes more and more obvious .

GIS is the intersection , mergence and integration of computer technology ,photogrammetry and
remote sensing , image processing , space locating , computer cartography and map database ,
expert system and communication technology . Space locating ,photogrammetry and remote sens-
ing , image processing technology are the main ways of quickly getting and updating geographic
information ;computer cartography and map database techniques are mainly applied in the analy-
sis , process, application , transfer ,display and output of geographic information ; expert sys-
tem technology can make the data input , update ,analysis and application of many media intelli-
gent , and will improve the automatic degree and results of GIS ;modern communication technol-
ogy can make different levels of GIS network in a broad area at a rapid speed and make GIS sys-
tem suitable to China ; computer technology can offer to get ,store , manage and process huge
quantities of geographic information quickly . No computer , no GIS . So, the development of
GIS is first attributed to computer technology .

The intersection , mergence and integration of different subjects in GIS gives us more and more
requirements . On the one hand , we must value the new development of different related sub-
jects and their status in GIS and effect on GIS ; on the other hand ,cooperate with different re-
lated subject experts . Only these can facilitate GIS to develop contiuningly.

2. 3 *The application feature of GIS — practicability*

The practicability of GIS reflects in the six aspects ; firstly ,store and manage huge quantities of

geographic information . The high speed of update and real—time transfer of various media data can make database of GIS in the status being often updated , secondly , produce various digital products needed by national economy and defense construction ; thirdly , practice quick and effective geographic analysis including thematic and synthetic application analysis, and offer various analytic products ; forthly, use geographic information offered by GIS to simulate and forecast the results of various plans ; fifthly, collect , process ,inquiry and extract various geographic information locatingly and qualitatively and quantitatively ; and at last,utilize the strong functions of data storage update, analysis and map design , edition and sub color film output to produce different maps quickly .

3 The problems GIS facing

3. 1 *The techniques and methods of quickly collecting and inputting multimedia data*

One of the main differences between GIS and general map database is that GIS has rich sources. Map database of GIS includes graph ,remote sensing picture ,field survey data ,digital survey data ,statistical data , text , sound and audio signal . How to quickly input multimedia data into database of GIS is always what surveying and mapping people pay more attention to . Among these , quick data collection of object—oriented map database and the unity of map data and remote sensing pictures is a more prominent question . These involve the theory and method of digital image recognition . As to field collected data and digital survey data , they can enter into GIS only by data format transfer. Statistical data can be input by edition or transfer from different database . Text data can be input by scan method . Sound records , CD—ROM and text can be input into sound database via sound card , synthesizing speech card and voice recognition techniques . Audio signal (camera ,videocorder and laser disk)can enter picture database via video card and compression card . So, the key is the quick collection and input of map data and remote sensing information .

3. 2 *Multimedia geographic database and its management system study*[2]

The multimedia geographic database of GIS includes space database , attribute database ,text database ,sound database and image database . Among these , space database and attribute database are more important . It involves two problems related to system function directly : one is data structure and data model ,and the other is geographic database management system . The currently used vector and raster data structures have their advantages and weaknesses . Mixed data structure is to store the two kinds of data separately and call different data when implementing different tasks . Traditional level ,network and relation data models especially relation model , have some serious weaknesses expect many advantages ,especially in processing complex objects . So, it is an urgent task to study object—oriented data structure and model and its database management system[5]. Object—oriented method is not equal to object—oriented programming

techniques such as $c++$ etc. ,while reflects in how to map objects of objective world to be objects expressed by computer . But this is a difficult thing . In theory , we should master the " graph " nature of map and study spatial relation theory and algebra base ; in practice , analyze deeply currently used data structures , data models and database management systems. Experiment on them seriously and repeatedly to establish an object—oriented methods suitable to geographic data gradually .

3. 3 *The geographic analysis application of mathmatic modelling and computer analog theory and method ,and establishment and management of geographic model base*

One of the important aims of GIS is to establish a practical and perfect geographic model base which relates to GIS function directly. General GIS software only offer basic tools for pattern study , but do not offer usable models ,let alone spatial analysis and application models . No the support of practical and perfect model base , no analysis and application and auxiliary decision— making . So, model base is the core of auxiliary decision—making . The main contents of model base include : the definition of model base and model dictionary , establishment ,storage ,inquiry ,edition , deletion ,insertion and reconfiguration ; the selection ,establishment ,pasting and combination ; the running control of models ;and the interface and transfer of model database etc. Theory and method of analog modelling must be studied to solve these problems .

3. 4 *The study of intelligent GIS and auxiliary decision—making*[3,4]

Auxiliary decision—making is implemented under the support of geographic database , model database and knowledge database of GIS . From the point of auxiliary decision—making , we must study computer analog , forecast and evaluation of the results ,the selection of alternatives, namely modelling ,solution ,evaluation ,optimum selection etc. The high stage of auxiliary decision—making is intelligent GIS . This needs to integrate GIS with ES to form intellectualized and high integrated GIS . So, we must study the summarization , expression ,storage ,management and application of ES knowledge . In this aspect , we are still facing many problems .

3. 5 *The exploitation and application of GIS data sources*[1]

The diversification of GIS information ,the synthesis of techniques and the comprehensiveness of function will make GIS widely applied . How to convert this brilliant prospects into reality is a serious problem we are facing ,because it relates closely to the economic results of GIS . So, we must fully take advantages of many science results ,for example ,thematic map design expert system , map color design and color management system , auto—editing system based on map database, and thematic map data process system etc. , to study the unified practical production system of ' map design — map edition — subcolor film output ' based on GIS and make it update timely . And this study will make the long exiting traditional map production system change

thoroughly .

4. The task of cartography

Cartography is a subject of studying the collection ,storage ,management ,analysis and transfer of spatial geographic environment information , and establishing relevant GIS . The study and practice of GIS shows that cartography is facing vital changes. This reflect in the follows :

- The users of map can find the results directly from the database of GIS rather than through the visualized display or products .
- The visualized display accuracy is not beyond eye's resolution but the display effect of visualization is vital .
- The definition of map scale has changed . The conversion of map projection and scales becomes very easy.
- Map database divided by levels and stored by classes makes map contents from single and stable to diverse and changeable.
- Digital storage and remote sensing information make map contents update real—timely or quasi—real—timely.
- Traditional interpretation and measure of map have been replacedby quick data inquiry and retrieval , and accurate spatial analysis and measure.
- Map has changed from single analog into digital and analog ways exiting simultaneously The production way has changed from handy work to the unification system of ' map design — map edition — subcolour film output '.
- On condition of the digital cartography based on GIS , traditional interpretation synthesis theories and methods are facing a challenge .

It can be seen that cartography has penetrated into many aspects of the collection ,process ,graph display and map products of spatial geographic environment information . Facing the current problems and challenges of GIS, cartography must pay more attention on the follows:

- the process control , control model and transfer way of GIS as ageographic information transfer tool, especially the effect of space cognition theory and geographic guiding information system on the design ,establishment and application of GIS ;
- the science visualization theory and method of geoscience space information including visual thinking and visual communication man—machine interactive system ,animation techniques , hypermedia techniques and theirs application in GIS;
- the quick collection and update of geoscience space information ,especially the pattern recognition of graph and remote sensing data , to make geographic database of GIS really being the status of dynamic update;
- object—oriented GIS ,including adopting object—oriented system analysis and design , data structure ,data model and database management system , and object—oriented user interface based on windows etc. ;

• space analysis theory and method based on the geographic database of GIS , especially space analysis models and methods (including space location analysis , space distribution analysis , space shape analysis ,space relation analysis and space correlation analysis etc.) , and space data operation (including the operation based on vector data ,raster data and unified data etc.);

• the establishment and management of model database and knowledge database ,the interface techniques of database ,model database and knowledge database , and the implementation of auxiliary decision — making based on database , model database and knowledge database , to make GIS intelligent gradually and more practicable ;

• the establishment and implementation of the unified map automatic production system of " map design — map edition — subcolor film output " based on GIS ,to make GIS really become a modern tool of map production ;

• and the theorization issures of cartography itself including the modern definition ,science system and structure of cartography the theory and method of generalization on condition of GIS , the types of map products and its application based on GIS .

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