DIGITAL PHOTOGRAMMETRY AND CYBERCITY CONSTRUCTION

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ABSTRACT:

This paper discusses the content of the fundermental spatial information of Cybercity and the obtaining methods of them. It also discusses the function of digital photogrammetry in the process of cybercity construction. We took XuanWuLake region in Nanjing city as a study area to obtain the fundermental geographic information by digital photogrammetric system and pursue a method to construct cybercity by some software such as GIS, VR and simulation etc.

1. INTRODUCTION

Cybercity is also called net city, or intelligent city, but more correctly should be called information city. Cybercity may be comprehended as an important composing part and a supporting way of digital earth. Synthetically using the digitizing methods of computer (such as GIS, Remote Sensing, Telemetry, Network, Multi-Media, VR and Simulation etc.), it completely collects and deals with the infrastructure and the function mechanism of city. It has powerful functions of digitization, network, optimization and decision-making on some complicated systems (such as urban geography, resources, entironment, population, economy, society etc.). It is a technique system for effect previewing of some important decisions and predicting future development[CHEN et al 2000].

We can generalize the key technique of digital earth as three aspects. The first is to obtain the fundermental spatial information and construct the database . The second is to build urban geographic information system. The third is the transmission technique of mass information. Among the three aspects, the first is the foundation of cybercity building. Spatial information is related to the space and geography distribution. By statistic, geographic spatial information is 80% of the general information of the world. It is the important fundermental information for the sustainable development decision-making of regional economy, resources, environment, population and society. It is also an important composing part of the national economy information system and the national information infrastructure.

2. CONTENT OF FUNDERMENTAL SPATIAL INFORMATION OF CITY AND THE OBTAINING METHODS

The fundermental spatial information of city mostly comprise the benchmark of spatial data such as the covering area and including region of urban control network, the amount of control points and the status which they fill the demand, digital line vectorgraph (DLG, comprising transportation, hydrology, boundary etc.), digital elevation model (DEM), digital orthophotomap (DOM), urban real 3 dimension frame model etc.

The traditional mapping science study how can we obtain the fundermental spatial information. We obtained every kind of map and data via geodetic survey, air photogrammetric survey and cartography. By the construction ministry of China currently investigating some cities, the spatial data of the cities in our country have some characteristics as follows, the scale is large, the resolution is high, the content is abundant, the efficiency of the information transmission is low, the speed of the information aging is fast, the period of the data producing and updating is long and the cost of them is high, the different city has different data reference benchmark because each city uses distinct surface reference system, the kinds of data is monotone and can not present the circumstance well, the usability is low, however the status of the data producing and providing can't satisfy the applications, the data is still the bottle-neck of the building and serving of GIS and other relative systems[HU, 2001].

The occurrence of the situation hereinbefore is nearly related to the policy, legislation, management, region etc. It is also indiscerptibly related to the ways which the data are obtained. The production of the fundermental spatial information is the precondition and the restricting factor of the construction of digital city. This is a project which demands a large quantity of investment and quite complicated technique. It demands but high precision production, also the comprehensive content of information. The traditional analogue mapping system and analytic mapping system can't meet the needs of the production of the complex fundermental spatial information. Digital photogrammetric system is the third era bran-new high automated photogrammetric system after the analogue mapping system and analytic mapping system. It can provide corresponding resolving scheme aiming at multi-requirements of different users.

3. FUNCTION OF DIGITAL PHOTOGRAMMETRY IN CYBERCITY CONSTRUCTION

3.1 Mapping Digital Line Vectorgraph (DLG)

Digital line vectorgraph is the principal form of the basic maps of a city. It is the fundermental information of build vary kinds of geographic information system. It is also the foundation of

planning, designing and managing. Every city uses 5 kinds of topographic maps which have the scale as follow, 1:500, 1:1000, 1:2000, 1:5000 and 1:10000. Digital photogrammetric system can map digital line vectorgraph of different scale. With the whole resolving scheme of automated aero triangular surveying, image matching technique and many kinds of high efficiency and practical mapping methods which were provided by digital photogrammetric system, we can greatly improve the efficiency of production.

3.2 Building Digital Elevation Model (DEM)

Digital elevation model (DEM) is one of the fundermental information building digital city. It is the fundermental information which could be depended on building urban 3 dimension landscape and designing various projects. Now there are just about 1/8 cities in our country building DEM of limited area. The size of cell is 5-25 meter and the elevation precision of cell is 0.25-1.2 meter. Digital photogrammetric system has some functions such as automated mass producing DEM and automated producing contour, etc. It may improve the efficiency of producing contour.

3.3 Building Digital Orthophotomap (DOM)

Digital orthophotomap is one kind of vertical projection image-map which was made by rectifying central projection air photo based on digital elevation model and eliminating projection difference. Because it has been rectified and the scale and the related position are correct, it can be used in many fields such as city planning, environment protection, resource investigating, disaster prevention and cure, military, etc. According to the statistic datum show, no matter the amount or the kinds of digital orthophotomap of city in our country is much less than those of the line map and the recovering area is limited. The kinds of using photo include three kinds, black and white, colorful infrared, real color. They were used mainly on city planning, land investigating and updating topomap. Now digital orthophotomap has been payed much attention all around the world. Especially in company with 1 meter resolution satellite image launching into use and the technique of image recognition and single image character distilling improving, it will get more and more broader use. Digital photogrammetric system can carry out rectifying and mosaiking orthoimage, repairing image, seamless mosaiking of arbitrary image. Furthermore piling digital orthophotomap on digital elevation model can build the 3 dimension landscape of city such as electronic sand table.

3.4 Building Urban Real 3 Dimension Landscape Model

Urban real 3 dimension landscape model is builded according to the practical 3 dimension geographic coordinate of the buildings. Urban real 3 dimension landscape model can be builded according to the large scale air photo through digital photogrammetric system precisely surveying the 3 dimension coordinate of the building and automated building the frame model of the building by software, then affixing the corresponding texture[LI and ZHOU, 2000].

3.5 Other

Digital photogrammetric system and the correlative product can distill the texture of building and build the database of them, carry out 3 dimension geometric reconstruction and build 3 dimension landscape animated drawings, etc. Digital short distance photogrammetry can play an important role in producing very large scale line maps and image maps, archaeology and medicine, etc.

4. INSTANCE

4.1 Area of Interest Selection

Area of Xuanwu Lake is a window on Nanjing. Nanjing is considered as "tiger hiding, dragon concealing" all along. The main four trunk roads around Xuanwu Lake form a circle, north to Nanjing railway station and east abutting against Zijin Mountain. Jiming temple with thousand years history stands to its south. Around Xuanwu Lake, stands the post and telecom buildings symbolizing temporary culture as well as the ancient walls engraving Nanjing's history. A dwelling district is newly built nearby Xuanwu Lake. People lives here can enjoy quite and peaceful life completely. To sum up, area of Xuanwu Lake embodies Nanjing's feature of "city with hill, water and forest" and integrates tourism, business, transportation and residence together. It reflects many characteristics of Nanjing as a famous historical city. Therefore, we choose Xuanwu Lake as our interesting study area to construct digital city, to reappearance this area's scene, and to ramble and navigate in it by computer system. It will help us to know more clearly about Nanjing's present and plan more specifically about Nanjing's future.

4.2 Software and Hardware Environment

（1）Software Platform
Operating system: Irix 6.5 for SGI unix, Microsoft Windows NT 4.0 or Windows 2000;
VR system: MultiGen, Vega;
Full digital photogrammetry system: VirtuoZo;
GIS: ARC/INFO, Imagis etc;
Remote Sensing image processing systems: ENVI, ER-Mapper;
System integrating environment: VC++ 6.0, C++ builder, Delphi.

（2）Required Hardware Devices
2 SGI Octane workstations: 2 CPU 175MHZ, hard disk accommodation>50GB (SCSI interface), RAM: 128M, Texture RAM: 4M, Network card: 100M Ethernet;
Other Hardware Equipments: several Intergraph NT graphics workstations, many PCs，IBM server, multi-data collecting, inputting and outputting equipments, GPS etc;

4.3 Data Processing

4.3.1 Data Collection

（1）Data Sources
Original data: Colorful infrared aero photos of Xuanwu lake area (10 strips, 153 photos, image scale 1:2500, taken in 1995); Camera checking parameter file; Punctured photos of ground control points; Ground control points files; 1:500 digital maps of Xuanwu lake (DWG format).

Meta data: including aero photographic scale denominator, height of aero photographic, camera focus, department, date, aero photo number, serial number; zone of Gauss-Kruger projection, zone partition; central longitude and standard latitude etc.

（2）Data obtaining
First, scan the aero photos, convert digital image format to VirtuoZo image format. Then, process the data, create DEM of

Xuanwu lake area, produce ortho-image and digitize feature data of buildings, roads and water fields of this area.

There exists some technical problems while using digital photogrammetry in collecting data of large area covered by water, such as discontinue of the strip lines, less of ground control points etc. It will bring much effect on data collection accuracy or even lead expanding of the error results to halt the programme. Most part of Xuanwu lake area is water, there scatters several land plot, such as Yingzhou, liangzhou, among the water. This makes it difficult to deal with. Moreover, there are only four strip lines supplied with punctured photos with control points. Control points' number is not enough and their distribution is irregular. We solved these problems as the following:

① Method of photogrammetry with partition field. We divided the whole area totaled 10 strips as two parts to have photogrammetric surveying and integrated them to a whole area after photogrammetric surveying.

②Control points densified. We chose some feature points data from 1:500 digital maps of Nanjing to input digital photogrammetric system as the complementarities of the control points and made the result of automatic aerial triangulation eligibility. Finally we solved some technical obstacles in having photogrammetry of large scaled field with big water area.

③Predict of ground feature points. As big water area spreads in Xuanwu lake region besides the flourish vegetation and dense buildings, this brings bad matching result and affects DEM's accuracy directly. Before perform matching edit, we must have post processing to get better image matching result. The main way is to read some feature points, lines and polygons in stereo models of Xuanwu Lake, use them to create triangulations of irregular network (TIN) and make it tally with the ground surface to improve accuracy of image matching. The workflow chart of using digital photogrammetric system to collect data is as the following.

4.3.2 Data Managing

The data gotten from digital photogrammetric system cannot be input MultiGen to construct models. It must be converted to data format supported by MultiGen through GIS data interface first. We converted DEM and digital vector data (feature data) to DED and DFD format used in virtual city construction in direct conversion mode and successfully realized data interface for different framework systems.

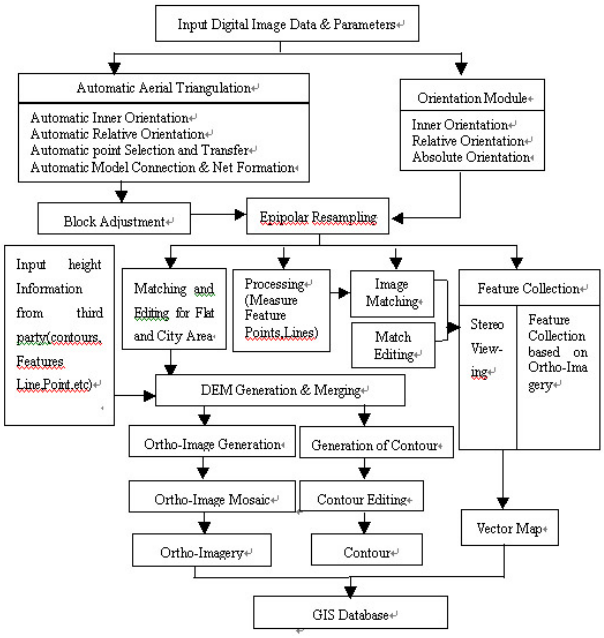

Figure 1 Digital Photogrammetry System Modules & Workflow

4.4 Model Constructing

First, MultiGen's inner digital elevation data (DED) is imported to MultiGen and the proper arithmetic is chosen to create 3D terrain surface model. Second, taken ortho-imagery of Xuanwu lake area as surface texture, the real 3D scene of Xuanwu lake area is produced by Geo-specific texture mapping method.
MultiGen's inner digital feature data(DFD), including roads, lakes, building etc, is imported MultiGen according to different feature layers. The corresponding Feature ID and surface material code(SMC) are chosen or rebuilt for 3D model construction and model database merging. As a result, the simulating models of Xuanwu lake area is created, shown as Figure 2.

Figure 2. Simulating model of Xuanwu lake area

4.5 Virtual Environment Building

Import simulating model of Xuanwu lake area to Vega, software of real-time visual and audio simulation, set the observer, define the channels and set the environment parameters. After configuring proper drive environment, we set display mode as HMD or stereo glasses; define inputting method as mouse or Flybox; add mobile objects in the virtual environment, such as car. We create a virtual environment of the real world. Immersing in the virtual city environment, we can ramble in it and interface with virtual objects through HMD(or stereo glasses) and Flybox(or 3D mouse).

5. CONCLUSION AND EXPECTATION

The construction of cybercity is exactly like bamboo shoots after spring rain to form an inundant developmental tidal in the country. This is an inspiring symbol that indicates IT industry is flourishing and striding toward world advanced level. The paper emphasis on discussing digital photogrammtric system's functions in basic geographic information database organization. The author thinks the following studies are useful in basic geographic information database organization.

(1) Spatial surveying and mapping: with the development of spaceflight remote sensing technique, the number of spatial remote sensing images increases rapidly produced by space shuttles and all kinds of large, middle and small satellite systems. Their spatial resolution, spectrum resolution and time resolution are more accurate than before and they are becoming an important data source for producing global maps. Therefore, international surveying and mapping industry are experiencing rapid change in technology and management mode[WANG,2001]. The study on sensors, satellite systems and surveying techniques are in the ascendant at present.

(2) Study on integration database of 3D visual city landscape: digital city requires a 3D, dynamic and visual scene as well as digital earth. We must create a seamless integrated database to manage vector data, DEM, terrain surface image, GPS data and remote sensing data etc.

(3) Data interface: study data interface among full digital photogrammetric system, GIS and VR, study data interface system based on China Spatial Data Transfer Format (CNSDTF).

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