The Applications of Digital Photogrammetric System and Relevant Technologies for Digital Urban Maps

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Abstract: With the development of modern cities, digital urban maps are increasingly required for urban planning, communication systems, transportation systems, land-use information resources management and environment protection and other applications. In this paper, the digital photogrammetric system and relevant technologies are introduced. The developing approach and technology for "4D", digital elevation model(DEM),digital orthoimage model (DOM),digital raster graph (DRG) and digital linear graph (DLG) are discussed based on digital photogrammetric system in detail. It analyzes the advantages and the disadvantages which construct digital urban maps using technology of "4D" and traditional methods. In addition , the feasibility and methods that construct spatial data infrastructure(SDI), cybercity, and 3D Visualization model are explored using digital photogrammetric system, computer vision(CV) and virtual reality(VR). Finally, The author puts forward his opinion for the development trends of digital urban maps in the future.

Key words: Digital photogrammetric system, cybrcity, virtual reality, spatial data infrastructure.

1.Insrtuction

With the growth of cities, both in population and area extent appears as an inexorable process. Urban-related data and information products are proliferating as remote sensing, digital made-mapping, and geographic information systems (GIS) and databases systems. Urbanization has profound impacts on traditional urban mapping and management. The development and management of cities will face new challenge. A signification number of units and public organizations required up-to-date information about the city and suburban infrastructure. For example, detailed urban information is required by (Cullingworth,1997;American Planning Association,1998):

- City, county, and regional planning agencies and councils of governments that legislate zoning regulations to improve the quality-of-life;
- City and state Departments of Commerce to stimulate development;
- Tax Assessor offices that maintain legal geographic descriptions of every parcel of land, assess its value, and levy a tax millage rate;
- Departments of Transportation that maintain existing facilities build new facilities, and prepare for future transportation demand;

- Private utility companies (water, sewer, gas, electricity, telephone, cable) that attempt to predict where new demand will occur and plan for the most efficient and cost-effective method of delivery services;
- Public Service Commissions that insure that utility services are available economically to the public;
- Department of Parks, Recreation and Tourism who improve recreation facilities and promote tourism;
- Department of Emergency Management and Preparedness who plan for and allocate resources in the event of a disaster;
- Private real estate companies attempting to find the ideal location for industrial, commercial, and residential development; and
- Residential, commercial, and industrial developers.

In order to meet the need of scientific management city, the best way is creating urban geographic information system (UGIS). UGIS contains tow main information that are graph data and attribute data. They have been widely used in geo-analysis, resource management, urban planning, transportation, disaster decision-making and commerce decision-making, etc. Urban attribute and graph information include:

- Digital cadastral map (land use and land cover, building and property infrastructure);
- Digital pipeline map;
- Transportation infrastructure (highway and railway networks, water transportation net etc.);
- 4D creation;
- Socioeconomic characteristics (population estimation and quality of life indicators);
- Energy demand and conservation;
- Meteorological data (weather prediction, creating weather mode and monitoring weather change);
- Critical environment area assessment and;
- Disaster emergency response (pre-emergency and post emergency imagery, damaged evaluation)

Information resources of UGIS comes from the following:

- Total station and GPS collection in the field
- Existing map digitizing
- Photogrammmetry and remote sensing
- Internet GIS and other information

Computer science, spatial information and relevant technologies are foundation of UGIS. Virtual reality (VR) offers new and exciting opportunities to visualize 3D urban geographical information system (UGIS)data. Makers and users can walk through 3D environments, see newly planned buildings and appreciate changes in the landscape (figure.1).

Fig.1 3D buildings model

To create multi-functions UGIS, besides information collection, advanced technologies applied become more important.

The organization of this paper is in the following way: In section 2, the conception of 4D is described. Three dimensional digital city model and cybercity constructed using DEM, DOM and relevant techniques are presented; in section 3, an examples of application of 4D and associated enabling technologies for urban decision support system UDSS are explored. A flood risk analysis model is created. At last, in the section 4,some conclusions are made.

2. 4D and Associated Enabling Technologies for Urban Geographic InformationSystems

2.1 The conception of 4D

Photogrammetry and remote sensing image has created an urgent need for techniques for urban geographic information system. These techniques have numerous applications in urban mapping, urban planning, and other geo-information engineering disciplines and application. However, traditional urban planning and management bases on two dimension. Problems during the existing planning process arise because of lack of 3D functionalities to analyze and visualize the 2D/3D data. However, 4D techniques are Information resources of creating and analyzing 3D city model. 4D products contains digital elevation model (DEM), digital orthophotoquad model (DOM), digital raster graph (DRG) and digital linear graph (DLG). They have been widely used in UGIS to visualize model and to enhance the interaction of the decision-maker with data and image.

2.2 Procedure of creating 4D

2.2.1 DTM and DEM creation

Digital elevation model (DEM) is nowadays important resource for many disciplines and is useful for generated digital products such as contour maps, orthoimages, and perspective views. The main incentive for the increasing popularity of DEM is the ability to generate them automatically from aerial and remote sensing image by image processing and matching techniques.

Digital photogrammetric system (DPS) is main technique for creating DEM (figure2)

2.2.2 DOM creation

The orthoimage is created based on the DEM and the corresponding original image. According to the theory of digital orthorectification, the coordinates of the point projected on the original image are computed with collinear equations based on its ground control points. Height is interpolated from DEM. The orthoimage can be created from one or multi-images, and resample of gray levels can be gotten by bilinear interpolation or other interpolation methods (figure 3).

2.2.3 DLG creation

The DLG created based on digital photogrammetric system. scanning cartographic digitization (figure 4) and other methods.

2.3 4D associate enabling technologies for UGIS

With the rapid development of digital photogrammetry and remote sensing technologies, the amount of image data has dramatically increased, and has garnered more and more attention. Besides 4D techniques, creating UGIS need other new technologies such as 3D city modeling (cybercity) and Virtual reality(VR) technique .

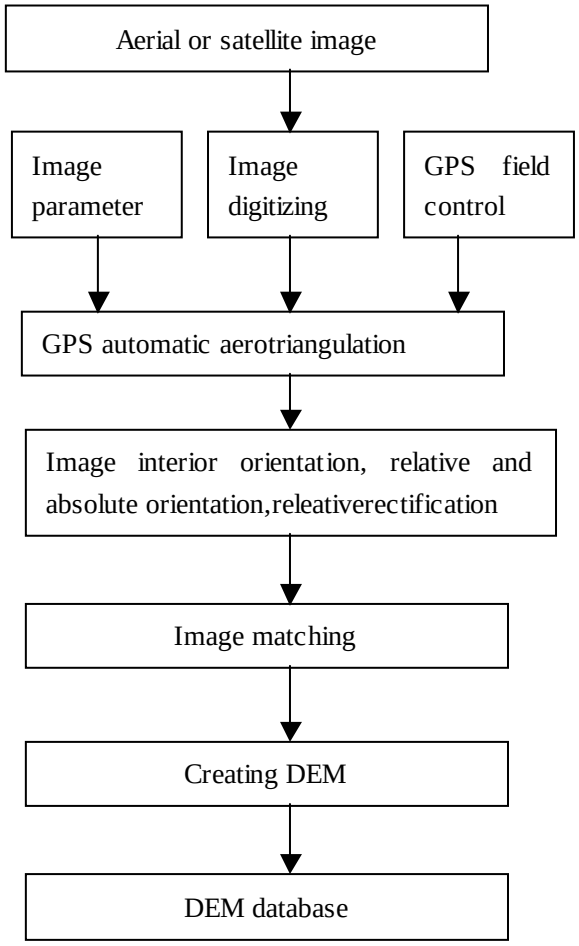

Fig.2 creating DEM using digital automatic photogrammetry

4D and associated enabling technologies offers new and exciting opportunities to create 3D city model. The use of UGIS shifts from 2D to 3D modeling and analysis. Buildings and constructions are modeled with digital photogrammmetrical system (4D products) and linked to data in the UGIS. The 3D information is used to calculate volumes, distances, sound contours, shadowing, line-of- sight, etc.

Once the 3D city model has reached the status of s well-engineered proposal, it will be converted into a form to be present to all participants in the urban decision-making process. This can be either through detail designing, DEM and DOM rending, or with very detailed and realistic scale models. The different variants and alternatives will have to be compared and their consequences and performances clearly outlined for each the different participants. The more realistic the presentation can be, the better the plan is communicated.

UGIS analysis involves the impact of the new design on its environment. The design is evaluate with respect to its exploration, maintenance, usability and environmental quality. Visual analysis is the main task at this stage of the planning process and a more realistic visualization will only improve the presentation of the plans. Form this analysis of the planning process, the most important requirement for UGIS are possibilities for 3D analysis, a good visualization and interaction with the data.

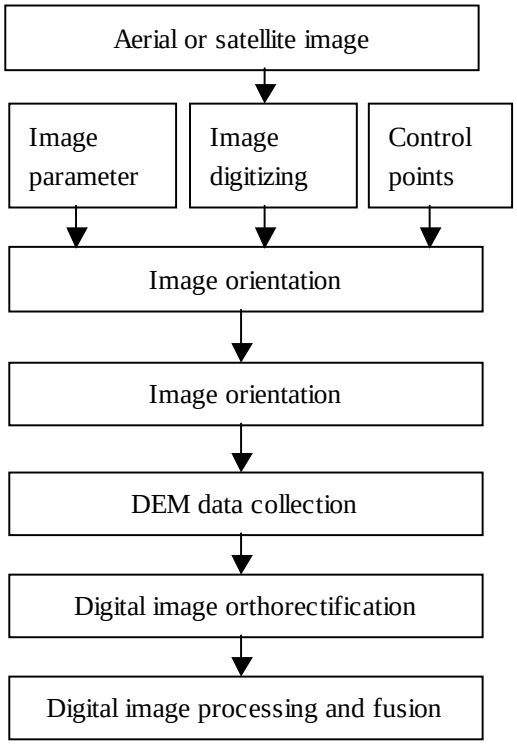

Fig.3 creating DOM using DPS and remote sensing

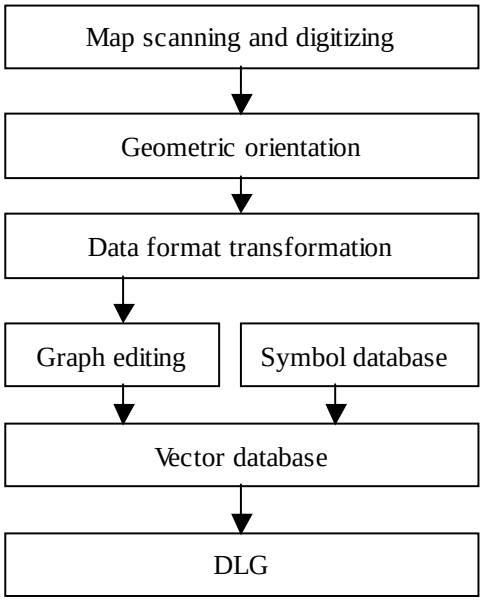

Fig.4 creating DLG with scanning cartographic digitization

3. An example of application of 4D and associated enabling technologies for urban decision support system(UDSS)

There are many applications of 4D and associated enabling technologies for UDSS. Flood risk analysis is one of the applications. Floods are the costliest hazard in the world and account for the economic losses resulting from natural catastrophes (Munich Re, 1997). Riverine flood is a major natural hazard in China. For example, The Yangze River Flood in 1998. UDSS preventing flood is becoming more and more important. Information resources of flood risk analysis model are collected from 4D and relevant investigation and statistics data. Flood risk analysis can be divided in three phases:

(1). Preliminary stage of preventing flood

During this phase, the problem of flood is studied and all relevant information is collected, especially historical flood data, hydrological data, 4D products. Flood risk analysis model is created using 4D and relevant technologies. Two main tasks are done. The first task is flood risk analysis. Historical flood data can be represent and displayed under 4D and UGIS environment. So flood risk analysis and dangerous area predicting can be made in advance. The second task is making a preventing flood plan.

(2). During the stage of flooding

In the phase, flood risk analysis model will play very important role. The flood surface and damage information can be displayed under 4D and UGIS environment. For example, raw flood surface location can be predicted by real-time flood risk analysis model. (figure 4). Decision-maker have many things to do in the short time, making rescue plan, arranging rescue crew, supplying relief material, protecting people safe and so on.

(3). After flooding

During the phase, UDSS supported by 4D and relevant technologies focus on the following tasks:

- Evaluating flood damage
- Planning and reconstructing project of preventing flood
- Creating loss database of an insurance and paying insurance compensation

4D products and associated enabling technologies provide an ideal tool for decision support system for regional flood risk assessment. Photogrammetry and remote sensing provide a unique combination of DEM and DOM, which allows the use of land-use information in the estimation of flood propagation. This is a major advantage over the data sets, and allows a considerable refinement of the flood estimation process with little additional processing.

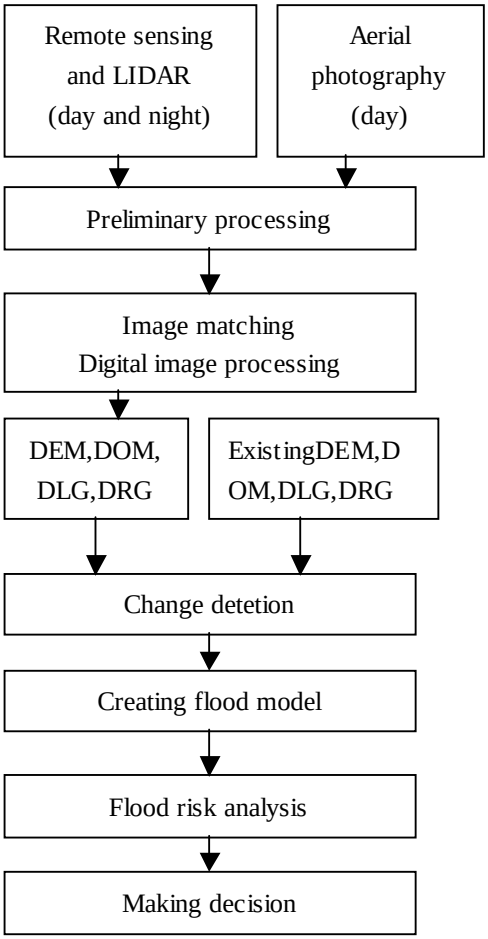

Fig.5 real-time flood risk analysis for UDSS using 4D techniques

4. Conclusion

With the development of modern cities, more and more advanced technologies are applied to urban digital making-map.4D products generated from photogrammetry and remote sensing has constituted a decision support information system. This information has provided anew perspective to decision-makers, planners, government officials, and the public. In effect, UDSS are being used as one of the key element by decision-makers for urban planning and management, environment protection. Additionally, the accessibility to 4D products, as well as digital image has afforded those entities and individuals who wish to utilize these data and image. Digital map and attribute information (control points, the depths of water,

boundaries, place names, and natural and man-made features ranging from mountains valleys to oceans, lakes, rivers, and transportation networks of railways, super-highways, and gravel roads and etc.) can be provided by governmental website.

To this extent, research and development in new spatial data mining, interoperability, infrastructure, standards, and widespread applications are all valuable to the urban planning and environmental management. We believe that have successful in creating UGIS, through 4D and associated enabling technologies.

The study work we have done constitute a first step in both creating UGIS and its application. From this perspective, we see where much more work needs to be done streamlining the processing and handling of photogrammetry and remote sensing data to make the digital products generated more efficient and easier to use and analyze, in particular, 3D city model and 3D spatial analysis. Additionally, more time and added funding will be needed to establish cybercity.

4D products derived from 3S technologies used in UGIS have meaning for those entrusted with managing our urban resources and protecting urban environment. UGIS created by 4D and relevant technologies will benefit us all.

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