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CORE TECHNIQUES AND PRODUCTS OF DIGITAL PHOTOGRAMMETRY AND REMOTE SENSING FOR URBAN INFRASTRUCTURE

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ABSTRACT:

Modern urban infrastructure needs a comprehensive and integrated information science and technology. Global Position System (GPS), Geographic Information System (GIS), Digital Photogrammetry and Remote Sensing (RS) and other spatial information technologies are it's core techniques. Products of digital photogrammetry and remote sensing are its basic information resource. The key tasks of modern urban infrastructure are urban planning and management, city modeling and constructing digital city. Urban planners and administrators use UGIS and RS Technologies both as a spatial database and an analysis and modeling tool. This paper presents the use of UGIS in the urban planning and management, and the application of 4D and relevant technologies for modern urban infrastructure. It contains four sections. Firstly, the contents of modern urban infrastructure are introduced. Some advanced technologies such as 3D city model and cybercity with virtual reality (VR) environment for UGIS are outlined. Secondly, traditional urban planning and management bases on 2D. 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 of resources of creating and analyzing 3D city model. Three dimensional digital urban model and cybercity constructed using DEM,DOM and associate techniques are present. Thirdly, an example of application of integration of UGIS and digital photogrammetry and remote sensing in urban transportation is explored. Finally, some conclusions are made.

1. INTRODUCTION

Modern urban infrastructure needs a comprehensive and integrated information science and technology. Global Position System (GPS), Geographic Information System (GIS), Digital Photogrammetry and Remote Sensing (RS) and other spatial information technologies are it's core techniques. Products of digital photogrammetry and remote sensing are its basic information resource. The key tasks of modern urban infrastructure are urban planning

and management, city modeling and constructing digital city. Urban planners and administrators use UGIS and RS Technologies both as a spatial database and an analysis and modeling tool. In the mean time, the composite application of spatial data and other professional data have also made a great progress, its applications will cover many fields, for instance, environmental monitoring and analyzing, resource investigation and exploitation, disaster monitoring and appreciating, modern agriculture, urban development and intelligent traffic, et al. Integration of GPS, GIS and digital photogrammetry and remote sensing for urban planning and management, the following specific tasks that are required on a daily basis in most planning agencies and planners (Foreman and Millette, 1997):

- Inventory and analysis of many types of spatial information, such as changing patterns of land cover and land use to support master plan development.
- Administration of zoning bylaws, which required determining the location of a parcel in the relationship to established zoning districts.

- Site plan reviews, which examine site conditions such as soils, slopes, ground water, utilities, setbacks, right of ways, and variances to ensure adherence to code.
- Subdivision reviews that identify the potential impacts of residential development on community facilities and services
- Permit tracking to identify the location of building permits issues to determine if development is conforming to master plans.
- Property assessment based on listing requirements such as parcel size, location, address, frontage, building size, condition, and use.
- Facility siting, which involves identifying site conditions and proximity to particular land uses, utilities, and transportation routes
- Infrastructure maintenance to set up a historical database and inventory of installations and provide for inspection and maintenance of roads, bridges, culverts, and sewer, water, and energy utilities.
- Event reporting of crime, fire, and accidents to be for resource allocations of personal and equipment with a strong spatial rationale
- Dispatching of emergency vehicles based on route optimization, given travel distance, road conditions, traffic patterns, and speed limits.
- Vehicle routing for school buses, snowplows, wide loads, and hazardous materials to balance expedience against public safety
- Disaster preparedness to preposition strategic materials, prepare evacuation routes, and identify high- priority facilities including hospitals, schools, and water supplies for emergencies.

- Traffic analysis to identify origins and destinations of traffic at park hours to minimize
- Legal notification for public hearings that require notification of abutters and land owners within a specific radius of a particular parcel
- Acquisition and disposal of property for the purposes of condemnation, foreclosure, and right-of-way acquisition, This requires information on roads, buildings, land use, zoning, ownership, and adjacent parcel.
- Tax listing, revaluation, and abatement programs for management of local land and tax base.
- Redistricting and rezoning for schools and political representation

UGIS is just one of the formalized computer-based information systems capable of integrating data from various sources to provide the information necessary for effective decision-making in urban planning. Other information systems for urban planning include database management systems (DBMS), decision support systems (DSS), and expert systems. Current UGIS support efficient data retrieval, query, spatial analysis, and mapping. Planners can also extract data from their databases and input them to other modeling and spatial analysis programs. When combined with data from other tabular databases or specially conducted surveys, geographical information can be used to make efficient planning decisions. UGIS allows planners to perform spatial analysis using geo-processing functions such as map overlay, connectivity measurement, and buffering. Spatial modeling is used more in strategic planning. General administration employs mainly data management and visualization. Finally, development control uses the visualization and spatial analysis functions of UGIS most .The more routine general administration and development control work of urban planning includes (Newton 1988):

- Management of land use record;
- Thematic mapping;
- Planning application processing;
- Building control application processing;
- Land use management;
- Land availability and development monitoring;
- Industrial, commercial, and retail floor space recording;
- Recreational and countryside facility planning;
- Environmental impact assessment;
- Land use/transport strategic planning;
- Public facilities and shops catchment area and accessibility analysis;
- Social area and deprivation analysis

Visualization, spatial analysis, and spatial modeling are the most frequently used UGIS functions in plan making. Webster (1993,1994) discusses the advantages of using the data management, visualization, and spatial analysis and modeling functions of UGIS as scientific inputs to urban planning. Webster shows that there are significant differences in the degree of UGIS use in the description, prediction, and prescription planning process geo-processing functions geo-processing functions of UGIS as scientific inputs to urban planning.

Different scales of planning require different data and techniques. Raster data are more useful for citywide strategic planning, because large areas are involved and high resolution is not required. The processing of raster data is much faster than that of vector data, especially in map overlay and buffer analysis. On the other hand, vector data are generally used for district and local

action area planning because of the need for very highly resolution analysis.

There are many applications of UGIS in the land use, transportation, housing, land development, and environment sectors. Key examples include site selection and land suitability analysis. In contrast, network analysis and route selection are most frequently used in transport, and environment planning and management use buffer and overlay processing. There is an increasing trend toward the integration of modeling in different sectors of urban planning (Goodchild, 1993).

The role of UGIS also varies in the different stages of the urban planning process. For example, UGIS is more useful in modeling and development of planning options than in the determination of planning objectives. The different stages in the urban planning process can be generalized as the determination of objectives, resource inventory, analysis of existing situations, modeling and projection, development of planning options, selection of planning options, plan evaluation, monitoring, and feedback (Figure1). UGIS can only provide some of the data and techniques that are needed in the different stages of the urban planning process. Any UGIS also has to work with other databases, techniques, and models at different stages of the planning process.

2. 4D AND ASSOCIATED ENABLING TECHNOLOGIES FOR MODERN RUBAN INFRASTRUCTURE

2.1 The Conception of 4D

Photogrammetry and remote sensing image has created an urgent need for techniques for urban planning and management. 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 dimensions. 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 contain digital elevation model (DEM), digital orthophotoquad model (DOM), digital raster graph (DRG) and digital linear graph (DLG). They have been widely used in Urban Geoinformatics 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) are nowadays important resource for many disciplines and are 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 photogrammetry 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.
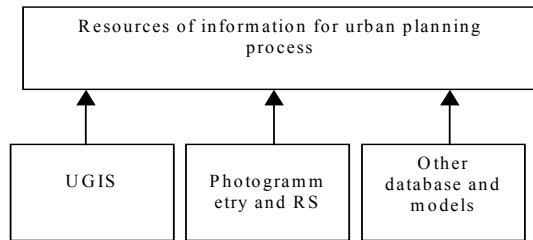

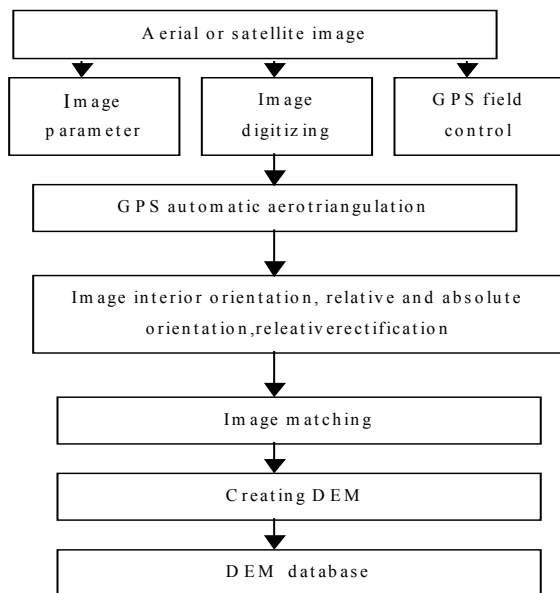Figure 1. UGIS, RS and other database and models in planning process

Figure 2. Creating DEM using digital automatic photogrammetry

2.3 4D Associated Enabling Technologies for Modern Urban Infrastructure

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, modern urban infrastructure needs other new technologies such as 3D city model (cybercity) and urban geographical information system (UGIS).

4D and associated enabling technologies offers new and exciting opportunities to create 3D city model (Figure3, Figure4). Virtual reality (VR) technique can construct a 3D environment. Decision-makers and users can walk through 3D environment, see newly planned buildings and appreciate changes in the landscape.

The other associated technology is UGIS. 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.
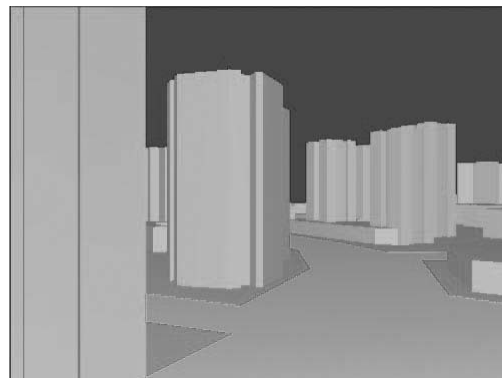

Figure 3. City model without texture based on aerial image

Figure 4. City modeling(texture) based on aerial image

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 UDSS are possibilities for 3D analysis, a good visualization and interaction with the data.

3. APPLICATION OF TRANSPORTATION OF INTEGRATION OF GPS,GIS AND RS

Transportation applications of GPS, GIS and RS have become increasingly popular in recent years. Sources of spatial data of transportation may be obtained from GIS, RS , GPS, and other databases. As the basic geo-spatial data, DEM, DOM, DLG, and

other databases, they have been playing significant roles in urban transportation. For example, DEM is the carrier of any other geographic information and then is considered as the base of three dimension visualization even the virtual reality or digital earth. The integration of DEM, DOM and UGIS becomes the core part of spatial data infrastructure.

Transportation of application of Integration of UGIS and Digital Photogrammetry and Remote Sensing need a geo-spatial data framework. As we know, The GPS-supported fully digital photogrammetric system (DPS) can promptly produce DOM, DEM, and DLG. The digital products with the unit of mapsheet need to integrate a complete spatial database under UGIS environment.

According to the modern urban transportation needs and very fast updating, geo-spatial data transportation framework should include DEM, DOM, and several layers of DLG data. With DLG vector graphic data, at least the following are required:

- Geodetic control network
- Boundaries of administration regions
- Road network
- Waterbody
- Geographic names and relative lettering
- Underground-pipeline system

Modern urban transportation of integration of UGIS and digital photogrammetry and remote sensing should contain the following functions:

- Conduct check , roam and query within the entire spatial database
- Can cover vector graphic data onto image data and update graphic data using image data
- Can realize self-adaptive and multi-resolution display based image pyramid
- Achieve image and DEM's fundamental function such as 2.5D display, query, and roam, etc.
- Output visualization products with mapsheet or given the range in term of user's needs

An example of application of transportation of integration of UGIS and digital photogrammetry and remote sensing is shortest path analysis (SPN). It is critical for route location models for determine the minimum environmental cost route (Tomlin 1997). Shortest path analysis in term of time, distance, and cost may all be relevant. The number of lanes, their height and width, and restrictions such as those on hazardous materials should all be incorporated into the calculations.

Other example of application of transportation of integration of UGIS and digital photogrammetry and remote sensing is that main road network information is collected and updated. Main road network information collected and updated is one of the most tasks in urban planning and management. (Figure 5)

4. CONCLUSION

With the development of modern cities, more and more advanced technologies are applied to modern urban infrastructure. 4D products generated from photogrammetry
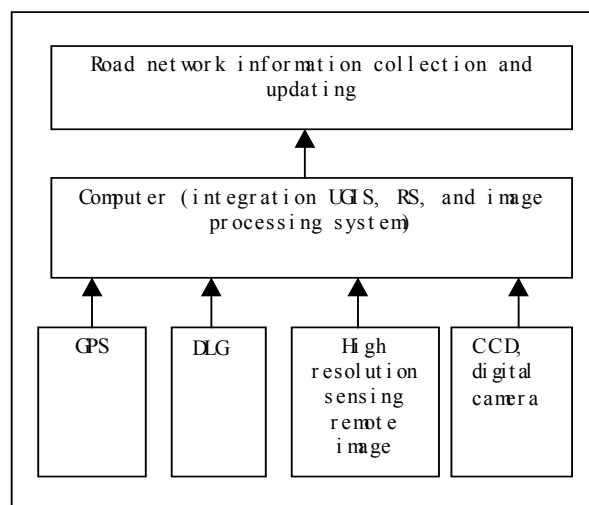

Figure 5. Real-time collection and updating road network information

and remote sensing has constituted a decision support information system. This information has provided a new perspective to decision-makers, planners, government officials, and the public. In effect, techniques of Integration of UGIS and Digital Photogrammetry and Remote Sensing 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 (WebGIS).

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.

4D products derived from 3S integrating technologies used in UGIS have meaning for those entrusted with managing our urban resources and protecting urban environment.

High resolution remote sensing technique (high space resolution and high time resolution), 3DGIS, Web-GIS, Open GIS Standard, Data-house and Data exchange, Data sharing, and Object oriented technique are core techniques of constructing modern urban infrastructure. In this paper, I have explored some core techniques for modern urban infrastructure, especially digital city model. I wish that those techniques can contribute to modern urban planning and management.

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