NATIONAL REPORT OF CHINA

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ABSTRACT

The National Report of China submitted by the Chinese Society of Geodesy, Photogrammetry and Cartography summarizes all major activities and achievements in photogrammetry, remote sensing and GIS, including applications, technologies and research in China in the period of 1992 to 1996. The largest changes have taken place in digital mapping, DPS, RS and GIS, as well as the integration of GPS, RS and GIS.

1. INTRODUCTION

The four-year period from the 17th Congress of ISPRS in Washington D.C. to the 18th Congress of ISPRS in Vienna coincides with the last four years of the eighth five-year plan period of China, during which time the geoinformatics undertaking in this country has experienced an unprecedented boom. In these four years, the National Bureau of Surveying and Mapping of China (NBSM) has organized fifteen large-scale important research projects and sixty-four medium scale important research projects in the relevant fields, all of which have produced outstanding results, and facilitated the transition from the traditional surveying and mapping work to the geoinformatics industry. The main events include:

(1) For the establishment of digital surveying and mapping technological systems, NBSM has made an investment of 130,000,000 yuan, and set up seven pilot bases for digital mapping production. Up to now, a computer-based digital mapping system for digital data collection by ground surveying, aerial photogrammetry and map digitization has been set up. Substantial production capability has been formed for digital mapping and topographic database establishment.

(2) In terms of the establishment of national fundamental geographic information systems, 1:1,000,000 basic GISs have been set up. The 1:250,000 national fundamental GIS is also being set up. And based on the above work, an integrated state condition GIS and a fast flood analysis system have been formed by combining resource investigation, disaster alleviation, macro management support and other application needs.

(3) In the direction of spatial positioning technologies and their applications, the first GPS norm of China has been formulated, together with the first surveying instrument calibration regulations. The first check station for GPS equipment in China has been established. The A order and B order network for GPS have been accomplished throughout the country. And the research on the permanent GPS tracking stations has also started.

(4) In terms of airborne and space-borne remote sensing

and their applications, VirtuoZo, a DPW system is now on the international market. Several experiments have been conducted in kinematic GPS assisted aerial triangulation and the introduction into practical production has proved successful.

(5) In the research and application of GIS, active work has been going on in the research and development of GIS basic software of Chinese copyright, while a number of GIS systems for different purposes have been developed by using the existing commercial software. The different uses include urban planning, land management, resources investigation and environment monitoring.

(6) Scientific exploration activities in the three poles of the earth (north pole, south pole and Mount Qomolangma) have also been going on, such as the extraction of elevation and geomorphological information from remote sensing images of the Antarctic and the research on the monitoring methods for glaciers and coast line changes.

(7) In the area of marine surveying, research has been conducted on the use of satellite remote sensing images to map reefs and underwater topography.

2. DEVELOPMENT OF PHOTOGRAMMETRY

2. 1 Image Data Acquisition

Research has been conducted into the influence of the environmental pressure on the interior orientation elements of optic frame camera, and the conclusion has been reached that the calibration focal distance varies with the environmental pressure (Jiang et al., 1993). The quality evaluation criteria has been proposed for the intensity index of air photos (Li et al., 1992). And research has also been conducted into the feasibility and practical technological requirements for small format aerial photogrammetric data to be used for large-scale topographic mapping (Xuan et al., 1994).

In terms of CCD camera, a software package has been developed for automated calibration of CCD camera on

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analytical plotter (Ge, 1993). A two-dimensional calibration method considering opto-electric errors has been proposed (Tao et al., 1993), together with a robust method of scale factor measurement for CCD camera system calibration (Tao et al., 1995). The design work has been completed for a multi-spectrum remote sensing image forming system by using an enhanced video technology to work within the visible light band and near infrared band, which is able to provide more multi-spectrum image information for agricultural production (Zhou et al., 1994).

Between 1992 and 1996, NBSM has completed the aerial photographic work for an area of 2,530,000 square kilometres of the country, finished the updating work of 1:50,000 scale topographic maps of the economy edition and the 1:10,000 topographic maps, and made 230,000 sheets of topographic maps of various scales.

2. 2 Aerial Triangulation

In the past few years, China has been working actively to carry out experiments in GPS-supported bundle block adjustment, so as to greatly decrease the number of the field control points and shorten the mapping cycle. Success has been achieved in the development of kinematic phase differential GPS software DDKIN to survey the spatial real time coordinates of photographic stations, and a software for combined adjustment WuCAPS for GPS-supported triangulation, which can fulfil the precision requirements for topographic mapping at scales between 1:1,000 and 1:100,000 (Li and Yuan, 1995). Methods have been proposed for the determination of the decentration between the airborne GPS antenna and the camera (Zhu et al., 1995), and exploration has been made for two methods for the determination of the interior orientation elements by using kinematic GPS data (Yuan and Li, 1995).

In 1996, the GPS-supported aerial triangulation was used in the aerial photography in Hainan Island and for the production of 1:10,000 DEM and orthophoto database. This project is part of a program with Australian supporting funds.

In addition, by using simulation data, work has been done for calculating the influence of space-borne GPS positioning accuracy on the estimation of ground point coordinates under the CCD Pushroom Scanning mode (Li and Wang, 1994a).

2. 3 Digital Photogrammetry

In the past four years, analytical plotter has still been the main instrument used in photogrammetric production in China. Each year about fifty pieces of China-made JX-3 or APS-2 analytical plotters are sold on the domestic market, and a few are exported to countries like Pakistan. Analogue instruments like B8S and Topocart B have been transformed into computer-controlled photogrammetric systems.

In the meantime, China has imported 117 total stations, 44 graphics work stations and 1369 PCs for the establishment of seven pilot bases for digital surveying and mapping production in Sichuan, Shanxi,

Heilongjiang, Beijing, Shanghai, Guangdong and Hubei, which are providing necessary conditions for the application of digital photogrammetry in practical production in the country.

After fifteen years of research and development, Wuhan Technical University of Surveying and Mapping has produced WuDAMS--a software package for fully digital automatic mapping, which is known on the international market as VirtuoZo, a joint product with an Australian company taking quite a bit of share of the market internationally. With this system, a series of automated functions can be realized, such as automatic interior and relative orientation, automatic point transfer for aerotriangulation, automatic image matching for DEM generation and digital orthophoto production (Zhang et al., 1994a). Coupled with this development, research has also been done for high precision location operator for straight line and corner point on digital images (Zhang et al., 1994b), relaxation based edge extraction (Qiu and Zhang, 1994) and multi-point least squares matching with array relaxation under variable weights (Zhang and Wu, 1994).

For non-semantic information extraction in digital photogrammetry, the researchs include an automatic quality diagnosis method for digital image matching based on orthophoto and stereo orthophoto pair (Li et al., 1994b), a least squares matching method with dynamic parameter selection for SPOT image data (Tao, 1993), a global image matching method based on dynamic programming (Qiu, 1994) and a feature based matching using dynamic programming (Zheng, 1992).

For semantic information extraction in digital photogrammetry, a lot of active research and studying have been done in the last four years. The main research results are :

An image segmentation method based on Hough transformation (Zhang and Min, 1992), and a snake approach for aerial image segmentation based on active contour model (Liu and Lin, 1995) is proposed. The application of morphological transformation in edge feature extraction are investigated. Some structure elements can be used for edge detection without the influence of bar noises (Zheng and Zhou, 1992). After that the pattern recognition of two-dimensional objects can be done by using dynamic programming (Zheng and Li, 1994). In man-made object recognition, a wavelet method is used for image edge election (Li and Shao,1994a) and a house extraction algorithm with multiresolution wavelet analysis and information fusion has been suggested (Li and Shao, 1994b). Another automated method to extract buildings from the aerial images in consideration of the noise of the surroundings has also been proposed (Tao and Lin, 1994a).

In order to overcome the present difficulties in realizing

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full automation, methods have been proposed for semi-automatic feature extraction in the environment of human-machine interaction (Tao and Lin, 1994b). However, research in these directions will still go a long way before becoming practically suitable for production.

In the past four years, Chinese scientists have made quite a number of research projects in image texture analysis, including algorithms for MRF parameter estimation and image texture classification methods based on MRF parameters (Zheng and Zhou, 1995), texture image segmentation algorithm based on Gibbs distribution (Zhu, 1995), the possibility of application of spatial grey correlation, fuzzy fusion analysis and fractal geometry in image texture classification (Huang and Zheng, 1995a,b,c), and image texture analysis methods based on multi-fractal analysis and based on texton(Zhang and Li, 1995a,b).

3. DEVELOPMENT OF DIGITAL ELEVATION MODELS

The establishment, storage, application and visualization of DEM have always been a concern of Chinese scientists. In the 1992 - 1996 period, in addition to the DEM software further developed by WuDAMS package on SGI work stations, DEM package on PCs considering topographic features have also been worked out (Yuan and Gong, 1995). Besides, research has also been conducted into the methods for contour-generated DEM considering the digital feature and geometric feature of contours (Qiu, 1994). The mathematical morphology approaches for generation of DEM from contour line maps (Li et al., 1994c) and for regular compact storage of triangulated irregular network (TIN) have been put forward (Chen, 1992). A 3-D terrain visualization model based on the combination of interpolation and Delaunay Triangulation has been suggested (Tao, 1995).

4. DEVELOPMENT OF CLOSE RANGE PHOTOGRAMMETRY

Close range photogrammetry and computer vision are coming closer to each other, but in China only in the very recent years has more contact occurred between people working in these two previously separate fields, hence only some of the research and application activities are listed here.

The general development trend in close range photogrammetry in China is towards digital and real time. The WuDAMS package possesses ability to process close range image pairs. A PC-based automatic length measurement system composed of several CCDs has been used to measure the length of steel plate along the cutting lines.

For new method and new algorithm in digital close range photogrammetry, a CAD based line photogrammetry method is given for automatic measurement and reconstruction of industrial object primitives (Li and Zhou, 1994). A 3-D surface reconstruction algorithm based on

the photometer is suggested (Li et al., 1995). A method of overall bundle adjustment of the panoramic photograph by fish eye lens has been investigated (Liu et al., 1993). Besides, the constraint conditions in the calibration of stereo vision system (Feng, 1994) and the principles of structured light photogrammetry based on laser theodolite have been deducted (Feng et al., 1995).

For the application of close range photogrammetry, in addition to many achitectural, archaeological, bio- and medical applications, some experiments and applications of light section photogrammetry (Feng and Li, 1992) and Moire topography have been done in the past four years (Feng et al., 1994).

5. DEVELOPMENT OF REMOTE SENSING

The development in this area features the development of the new types of sensors and the launch of China made remote sensing satellites. In the past ten years, China has developed space-borne cameras, panoramic scanners, CCD cameras, and multi-spectrum infrared scanners for meteorological satellites. The spatial resolution of the CCD reaches 4 - 5 meters. China's space-borne cameras have been on retrievable missions several times in the past four years, which are used for the plotting of 1:100,00 topographic maps, target interpretation and map revision purposes.

The airborne imaging spectrometer of China can cover ninety-six bands and reach a spectral resolution of 10-20 nm. China has undertaken some exploration tasks for Australia. The SAR inclination in L band is still under research. But on the whole, the remote sensing satellite in China has not yet formed a long term service system.

Up to now, the space-borne remote sensing in China still mainly uses satellite image materials from overseas, such as Landsat MSS, TM, SPOT, NOAA AVHRR, ERS-1,2 and JERS-1. In the past four years, use has been made of them to conduct land investigation, resource and environment analysis and study, natural disaster monitoring and prevention, weather forecasting, geological investigation, agricultural crop output estimation and urban housing studies in China. Incomplete statistics shows that over sixty papers have been published in this field. Important application projects include natural disaster monitoring and assessment systems, and agricultural output estimation information systems for crops like corn, wheat and rice in Songliao Plain, Huanghuaihai Plain, Jianghan Plain and the Tai Lake area. The real time flood monitoring system with airborne image radar and real time data transmission is now in use. China has also joined the experiment in its Guangdong province with the Canadian GlobeSAR and the American space shuttle SIR-C/X projects and gained ample results.

Research results have also been obtained in the mechanism of remote sensing, and the techniques and methods for image processing, in which field over thirty papers have been published on journals like the Remote Sensing of Environment China.

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6. DEVELOPMENT OF GEOGRAPHIC INFORMATION SYSTEMS

Since 1990, China has made substantial progress in the application, theoretical research and software development of GIS. In addition to the relevant paragraphs in the previous parts on large or medium scale GIS or GIS-RS integration systems, urban information systems and technologies have found wide applications in the coastal cities of the country, like Shanghai, Shenzhen, Guangzhou, Beihai, Haikou, Sanya, Yantai, Qingtao and Xiamen.

On the present Chinese market of GIS software are mainly those from overseas, like ARC/INFO, INTERGRAPH MGE, SICAD-OPEN, GENAMAP, MAPINFO. But in recent years development work for GIS software with Chinese copyright is going on well. During March 1 to 10, 1996, the two Chinese organizations for GIS, CAGIS based in Beijing and CPGIS based overseas, organized a check and evaluation exercise for GIS software, which attracted over twenty applicants. This event has shown the strength among Chinese colleagues in this particular area.

The theoretical research in GIS has covered the areas of spatial data structure, data modelling, object-oriented methods (Li et al., 1994d, Gong and Li, 1995, Li and Gong, 1995), GIS design of spatial-temporal integration data (Chen and Shi, 1995, Guo, 1993) and knowledge discovery from GIS database (Li and Chen, 1994), among other things.

7. PUBLICATIONS

The books concerning photogrammetry, remote sensing and GIS published in China during 1992 - 1996 include:

(1) Foundmental Photogrammetry, Li Deren et al., 331 pages, Publishing House of Surveying and Mapping, Beijing, 1995.

(2) Analytical Photogrammetry, Li Deren and Zheng Zhaobao, 445 pages, Publishing House of Surveying and Mapping, Beijing, 1992.

(3) Application of Photogrammetry and Remote Sensing in Railway Engineering, Chen Shaoguang et al., 277 pages, Publishing House of Surveying and Mapping, Beijing, 1995.

(4) Principles and Methods for Remote Sensing Image Interpretation, Pu Jingjuan, China Press of Science and Technology, Beijing, 1992.

(5) Remote Sensing Physics, Li Shaoxin, 336 pages, Press of Wuhan Technical University of Surveying and Mapping, Wuhan, 1994.

(6) Wavelet Theory, Image Analysis and Object Recognition, Shao Juliang, 162 pages, Press of Wuhan Technical University of Surveying and Mapping, Wuhan, 1993.

(7) Outlines of Resource Remote Sensing, Zheng Wei and Chen Shupeng ed., 458 pages, China Press of Science and Technology, Beijing, 1995.

(8) Advances in Remote Sensing Science, Institute of Remote Sensing Application at Chinese Academy of Sciences ed., 346 pages, Science Press, Beijing, 1995.

(9) Remote Sensing Terrain Models for Mineral Information, Liu Yanjun, Geology Press, Beijing, 1993.

(10) Models and Applications of Ground Feature Understanding by Remote Sensing Information, Liu Hanghua ed., 212 pages, Publishing House of Coal Industry, Beijing, 1993.

(11) Integration of Remote Sensing, GIS and GPS and Its Application, Du Daosheng ed., 242 pages, Publishing House of Surveying and Mapping, Beijing, 1995.

(12) Basics of Information Theory and Their Application in Geo-sciences, Zhang Renlin, Xi'an Map Publishing House, Xi'an, 1993.

(13) Introduction to GIS, Li Deren et al., 131 pages, Publishing House of Surveying and Mapping, Beijing, 1993.

(14) Data Organization and Processing Methods for Integrated SIS, Gong Jianya, 189 pages, Press of Wuhan Technical University of Surveying and Mapping, Wuhan, 1993.

(15) Research on Spatial Data Structure, Cui Weihong, 225 pages, China Press of Science and Technology, Beijing, 1995.

(16) Error Analysis and Processing for GIS Spatial Data, Huang Youcai et al., 216 pages, Press of China University of Geo-sciences, Wuhan, 1995.

(17) GIS Technology and Its Application in Coal Mine Flooding Monitoring, Zhang Dashun et al., 211 pages, Press of China University of Mineral Industry, Xuzhou, 1994.

(18) The Application of Mathematical Programming in Geoinformatics, Zheng Zhaobao, 232 pages, Publishing House of Surveying and Mapping, Beijing, 1993.

The periodicals on topics of photogrammetry and remote sensing include:

(1) Acta Geodaetica et Cartographica Sinica

(2) Bulletin of Surveying and Mapping

(3) Journal of Wuhan Technical University of Surveying and Mapping

(4) Remote Sensing of Environment China

(5) Pattern Recognition and Artificial Intelligence

(6) The World of Geoinformation

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(7) Geoinformatics in China

Proceedings of international symposiums in this field held in China include:

(1) Facing the Chance and Challenge, Proceedings of the International Symposium of ISPRS Commission VI, Beijing, October 10 - 13, 1994.

(2) Photogrammetry, Remote Sensing and GIS, Proceedings of the First International Colloquium of LIESMARS, Wuhan, May 1992.

(3) Advances in Urban Spatial Information and Analysis, Proceedings of the Second International Colloquium of LIESMARS, Wuhan, October 1993.

(4) Integration, Automation and Intelligence in Photogrammetry, Remote Sensing and GIS, Proceedings of the Third International Colloquium of LIESMARS, Wuhan, October 1994.

(5) Towards Three Dimensional., Temporal and Dynamic Spatial Data Modelling and Analysis, Proceedings of the Fourth International Colloquium of LIESMARS, Wuhan, October 1995.

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Huang, Guilan and Zheng Zhaobao (1995b): On the Application of Spatial Gray Level Dependance Method in Image Texture Classification, Journal of WTUSM, Vol.20, No.4, 1995.

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