

THE DEVELOPMENT OF PHOTOGRAMMETRY AND REMOTE SENSING IN CHINA FROM 2000 TO 2004 (NATIONAL REPORT OF CHINA)

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ABSTRACT:

This paper summarizes the achievements in Photogrammetry, Remote Sensing and Geographic Information System□GIS□in China from 2000 to 2004, which covers the aspects facilities and systems, science research and technology development, applications, training and education, publications, and activities.

1. INTRODUCTION

In the past four years, great progress has been made in the field of photogrammetry, remote sensing and geographic information system in China. The discription of these progress is organized into several parts: Facilities and systems of photogrammetry, remote sensing and GIS; Principles and methods of photogrammetry, remote sensing and GIS; Social activities, conferences, Education and Publications of photogrammetry, remote sensing and GIS.

This Report has been compiled from proceedings of various professional meeting, symposia and conferences, from published papers, and from materials provided by some members of Chinese Society of Geodesy, Photogrammetry and Cartography (CSGPC). We wish to acknowledge the assistance of prof. Deren LI, prof. Zunxun ZHANG, prof. Wenhao FENG, and prof. Ning SHU.

2. FACILITIES AND SYSTEMS

2.1 Photogrammetry Systems

At Present, besides a few DPWs imported from other countries (for example, LH System), the mainstreams DPWs in China are VirtuoZo by Wuhan University and JX-4 by Chinese Academy of Surveying and Mapping Science. They are also extending the function in supporting the Close Range Photogrammetry. Among these systems, VirtuoZo systems have been sold more than 3000 suites in global. Because of the transform of the photogrammetry from analogue to digital systems, image scanner have been largely imported, including Vexcel, LH, and Z/I etc. We also developed the Imatizer 2304 scanner by ourselves. There are more than 100 kinds of imaging scanner in China now. Z/I Digital Camera is in use in China in 2004. We also imported GPS/IMU in aerial photogrammetry, for example, IGI AEROCtrl – IId system, and good result has been gotten in photogrammetry test for 1: 1000 and 1: 5000 mapping.

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2.2 Close Range Photogrammetry Systems

The Photographic Total Station constructed by Wuhan University, based on short base line series image technology, can be used to survey the earthwork and the coal stack. We also construct a system based on approximate-2D control field to establish the model for calibrating the digital camera distortion in School of Remote Sensing and Information Engineering, Wuhan University. Wuhan Hengke Cyber-tech Company developed the Solid 3-D Visualization System with 2 CCD cameras and a 1m length fix-up baseline. Wuhan University teamed up with South Korea developed a vehicle-borne MM system for highway road network generation and surface quality detection and this system had been exported to South Korea in 2002, and its software had been sold to Italy in 2003. Wuhan University cooperated with Shandong University of Science and Technology developed a vehicle-borne system with 2 GPS receivers, 2-D Laser Scanner, CCD camera and control computer, for acquiring the city building vertical surface images. China Academy of Surveying and Mapping Science constructed a Data Acquisition System for Digital City based on low altitude unmanned aerial vehicle (UAV).

2.3 Remote Sensing Systems

In recent years, China keeps developing at a rapid pace in remote sensing platforms and sensors. Different series satellites have been launched since 2000, especially the success first manned space flight in 2003:

- Small satellite Qinghua-1 in 2000.06;
- Geostationary climate satellite FY-2B in 2000.06;
- Oceanic stellite HY-1A with polar climate satellite FY-1D in 2002.05;
- Earth resource satellite CBERS-02 and Probe -1 in 2003.10;
- Spacecrafts SZ-3, 4, 5 since 2002.3;

We are now developing our RADAR satellites. As to remote sensing sensors, there are some achievements should be noted: CMODIS in SZ-series, the second moderate resolution imaging spectroradiometer after USA; Multi-mode microwave sensor in SZ-4; 10 bands COCTS and 4 bands CCD camera in HY -1A. In Airborne remote sensing, we have capabilities to acquire and transmit multi-source digital data in real time, which have high spectral resolution, high spatial resolution and 3-D imaging and

round the clock characteristics. The airborne sensors we developed include: OMIS (128 bands), PHI (144 bands), MAIS (72 bands), and airborne SAR. The first remote sensing satellite calibration field in China was in operation in 2002.10. This means we have gotten a great progress in enhancing the calibration and validation of remote sensing data that will improve data quality quantitatively. We have cooperated with the White Sands Field in USA and Toulouse Field in France. China-made softwares of remote sensing processing and analysis are in developing. We believe there will be some powerful Chinese remote sensing softwares in near future.

2.4 GIS Systems

China has developed copyright-owned GIS softwares since the beginning of 1990s. At present, there are some representative national commercial GIS software, for example, GeoStar, MapGIS, and SuperMap etc. These softwares occupy more and more market share than before.

3. THEORIES AND METHODS

3.1 Photogrammetry

With the continuous expanding and developing of digital photogrammetry, its theories and methods are also rapid in evolution. These theories and methods are also applied in map updating, close range photogrammetry and industry surveying. Some progress are listed below:

- With the powerful capability of corresponding points matching in VirtuoZo, a rapid AAT module along with PATB has been constructed and sold more than 200 suites;
- We have extended the matching module in VirtuoZo to carry out the data fusion, with higher speed and more precision, among multi-scale remote sensing data such as SPOT and TM;
- We have successfully accomplished the matching between DLG (road and water system) and remote sensing image. It would accelerate the procedure of 1: 50, 000 map updating by using SPOT data;
- Prof. Zuxun ZHANG put forward a new theory, named as Generalized Point based Photogrammetry. This theory has been successfully applied in surveying the round or

line + round orifice in industry accessory, surveying the plane attitudes according to plane's profile;

- We can improve the reliability of image matching through digital close range photogrammetry based on multi baselines;
- CCD vidicon with rotating platform has been triumphantly used to survey the industry hardware such as Industrial Sheet Metal Parts.

3.2 Close Range Photogrammetry

Wuhan University proposed a theory and method of establishing the model of digital camera distortion based on the approximate-2D control field. This theory has been used to establish the total distortion of each pixel in different kinds of cameras, including making certain the defect of chip in camera the exact position. The approximate-2D control field is a set of markers that dispose on indoor wall. This kind of markers, with easy establishing and maintaining, lie in the approximate plane. Wuhan University also proposed a theory that are only needed three control points for 2-D perspective transform in industry surveying. This theory simplified the image correction flow of the objects with flat surface. Moreover, we can ignore the non-verticality of the chip coordinate axis and the non-square of the pixel by using four control points. Wuhan University also put forward the theory and method of constructing industry photogrammetry net with inequality internal orientation and of lofting keyholes of bolted bridges and other bolted steel structures and of drilling of numerical control machine tools online. Shandong University of Science and Technology developed the theory and method of digital camera calibration and correction based on multi-image space resection.

3.3 Remote Sensing

In remote sensing theories and methods, Chinese scientists are giving more attention to research the theories of EM characteristic, information transfer law, data calibration and information recombination. In the traditional areas, more researches are conducted in Geosciences, especially in global environment and climate change. The funds for these researches are gradually increased from the government, including 973 Project and the National Natural Science Fund of China. Chinese scientists are more activated in some global research projects than before. Automatic and intelligent target

identification and classification, such as spatial data mining, are still the main research fields. Many new theories and methods have been introduced into remote sensing field and been given more contents, for example, wavelet transform theory in remote sensing data compression and data fusion, Genetic Algorithm and mathematical morphologic theories in image classification, neural network theory in classification and information extraction, robust statistics theory in image feature estimation, and recognition theory in pattern recognition etc. High-resolution remote sensing data processing and analysis methods are still the hotspot. Some application models and methods, such as drought prediction method and flood monitoring model, are still improving. In microwave remote sensing, the theory and methods are continuously being studied, such as, SAR image processing and information extraction, and INSAR data processing and analysis. Some researches begin to enter into culture and social science field as archaeology and demography spatial analysis.

3.4 GIS

There are lots of fruitful achievements in the theories and methods of GIS in China. These achievements have been summarized in the National Report of China for the 21st ICA Conference in Durban. Here just are the brief introductions to these achievements:

- Some innovation in cartology theory have been achieved, such as deepening the theory of map space cognition, deepening and developing the theory of map visualization perception, exploring and investigating geoscience information Tupu, studying the linguistic characters of spatial information and the mechanism of its automatic understanding; establishing the map algebra hierarchy system;
- There are also some research results, for example, multi-scale expression and cartographic integration of the spatial data, data model and data structure of GIS, GIS data uncertainty, spatial information visualization and virtual reality, and spatial data warehouse and data mining etc.

4. APPLICATIONS

4.1 Photogrammetry

With the research, development and generalization of the digital photogrammetry in depth and in strength by the end of the last century, Digital Photogrammetry Workstations (DPWs) have been popularized in China. At present, aside from few analytic plotters in large-scale mapping, most photogrammetry projects are preformed by DPWs. Furthermore, more and more private companies and enterprises enter into these fields, other than the traditional organizations such as some province bureaus of surveying and mapping, some investigating and designing bodies in different ministries and commissions. Some large photogrammetry organizations, for example, Sichuan Bureaus of Surveying and Mapping, Shanxi Bureaus of Surveying and Mapping, and Heilongjiang Bureaus of Surveying and Mapping, could provide some services for oversea projects (USA, Japan, and some European countries). Therefore, it is the rapid development period of digital photogrammetry from 2000 to 2004 in China.

4.2 Close Range Photogrammetry

There are many examples in application of Close range photogrammetry in different fields other than traditional ones. These successful templates are finished by various kinds of sectors, such as China Institute of Geotechnical Investigation and Surveying, Donghuang Research Institute, Wuhan University, Zhongshui Northern Company and Zhengzhou University of Information Engineering. Based on Close Range photogrammetry and 3-D Laser scanning technologies, some applications are involved in surveying and virtual reality wandering of the ancient sites and cultural relics as the Imperial Palace in Beijing, Mocaos Caves in Dunhuang, Mausoleum of the First Qin Emperor and Terra-Cotta Warriors in Xi'an, Three Gorges Project Submerged Area, Linshan Figure of Buddy in Wuxi, Budala Palace in Tibet, the Figure of Buddy in Leshan, the Rock Cave in Yungan, etc. The close range photogrammetry technology is also been used in athletic training in the Sports Research Institute of General Administration of Sports. Other applications include hydroelectric project constructing, hydraulic model monitoring, buccal 3-D model establishing, debris flow monitoring, and hydraulic building distortion monitoring etc. The 3-D CCD camera will be mounted on the Chinese moon-probing satellite. Shandong University of Science and Technology implemented the low-altitude photogrammetry test based on Hasselblad 555 ELD camera mounted on helicopter. Moreover, they also experiment

the micro-photogrammetry of the steel-carbon fracture by electron microscope.

4.3 Remote Sensing

In the area of resource investigation, satellite images have become the primary information sources in China. The application of remote sensing in land resource has widely been adopted by cities and towns and photogrammetry and remote sensing play an important role in these applications. High-resolution images application is highly regarded than ever. When it concerns to key projects in China, such as "South to North Water Transfer Project", "West to East Power Transfer Project", "West to East Gas Transfer Project", "Qingzang Railway", "Three Gorges Project", and some projects for "Digital City" and "Digital River", photogrammetry and remote sensing provide spatial information and have been the technical guarantee in engineering plan, design and implementation. In the areas of environment protection and change detection, photogrammetry and remote sensing technologies provide new methods and approaches to support the researches in atmosphere environment, water environment and ecosystem environment. The application of middle and low-resolution satellite data has gone more and more far and come into being hotspot. For the purpose of disaster monitoring, such as that for fire, drought and flood, photogrammetry and remote sensing technologies have been widely used in disaster's prediction, monitoring, and mitigation. After HY-1A being launched into space, the application of remote sensing in ocean has being to the top. Lots of applications have been carried out in the area of sea ice, red tide, coast zone and the corresponding application template systems have also been developed. With the combination of Electromagnetic remote sensing and sonar remote sensing, 3-D observation for ocean has been formed gradually. The applications in microwave remote sensing become more widely feasible than before, such as in flood monitoring, mine resource investigation, soil erosion analysis, rice planting areas and ocean wave elevation analysis and so on. All of these show that the applications of microwave remote sensing are being on the way to more fields.

4.4 GIS

People pay more and more attention to GIS application in China, and many successful GIS application templates have

been established and operational. Some applications are showed as follows:

- GIS provides the necessary technology platform for the digitization and integration of the digital mapping and publishing. We have established a lot of multi-level basic map databases and many kinds of thematic map databases based on GIS;
- GIS plays a very important role in Digital River and Digital City in China that are as parts of Digital China. In Digital River, Digital Yellow River Project is representative; in Digital City, there are more than 100 cities that bring the digital city project into their strategic plan at present or in the near future in China.
- A great variety of GIS systems have been developing or developed, for instance, city plan and management information systems, environment protecting information systems, intelligent traffic management systems, oceanic information systems, and disaster prediction and emergency information systems, etc.

5. EDUCATION, PUBLICATIONS AND CONFERENCES

5.1 Education

In Aug. 2000, Wuhan Technical University of Surveying and Mapping merged into Wuhan University and Zhengzhou College of Surveying and Mapping into Zhengzhou University of Information Engineering at the same time. With the adjustment of Chinese Universities, Colleges and Schools, the education goes into a new stage.

In the field of photogrammetry, because of the digital photogrammetry being the absolute mainstream in China, the “aristocratic” education mode that just belongs to a few universities or colleges, based on photogrammetry instrument with expensive, precision and bulky, has been broken down. At present, more than 40 universities and colleges provide photogrammetry courses in Surveying Engineering. Because of its differences from Aerial Photogrammetry in contents and characteristics, Close Range Photogrammetry has been offered as a specialty course or selective course in some universities and colleges. M. Sc. and doctoral degree programs are also provided in Close Range field. Their research projects are fitted closely to the need of society and economy.

In the field of Remote Sensing, Wuhan University has offered a new curriculum leading to a Bachelor of Science and Engineering degree in the science and technology of remote sensing in 4 years since 2002. The curriculum includes courses in sensor technology, remote sensing data processing, remote sensing data application, photogrammetry, and GIS. At present, in order to strengthen the remote sensing education and training, Wuhan University, teamed up with more than 10 famous universities, apply for a new M. Sc. and Ph. D. Degree named after the Science and Technology of Remote Sensing from the State Council. At present, there is an integrated education system in the field of GIS, including supplementary education, Bachelor degree, Master degree, Doctorial degree and Post-Doctorial education; the education is oriented to national economy and social informatics. The Mapping Science and GIS in Wuhan University and the Mapping Science and Geographic Information Engineering in Zhengzhou University of Information Engineering are the national key specialties. Other education modes are also developed quickly, including web-based lectures, vocational school, workshop and seminar, etc. More and more people have opportunity to learn more about new technologies such as digital photogrammetry, remote sensing and GIS. There are more than 250 doctor candidates and 650 master students each year in these fields.

5.2 Publications

New version textbooks, including the Theory and Application of Remote Sensing, the Theory of Microwave Remote Sensing, and the Theory of SAR Interferometry, have been used in practice. Based on Remote Sensing researches, some new books are published, for example, the Earth Observation Technology and Continuous Development, SAR Satellites, Spatial Exploration Phased Array Radar, Earth Observation and Space Observation, Space Remote Sensing Engineering, Earth Observation Technology and Digital City, Earth Observation and Precision Agriculture, Multi-Angle and Thermal Earth Observation, Environment Monitoring Laser Radar, The Theory and Algorithm of the MODIS Data Processing, Earth Observation System and its Application, The Theory and Application of Radar for Earth Observation, Space-borne SAR Interferometry, The Basis of Digital Earth, Remote Sensing Thematic Analysis and Geosciences Tupu, Sensing Space and Earth—The Technology of Information Acquiring and Processing, Space Science and Applications, The Integration

and Implementation of Spatial Information System, Remote Sensing Data Models and Processing Methods, Remote Sensing in China—Review of the Last Twenty Years, The Atlas of Land-use Dynamic Monitoring Based on Remote Sensing Data in 2000, Theoretical Cartography, The Discovery of Geoscience Information Chart, The Theory of Spatial Information System, GIS and Its Application in City Planning and management, City GIS, Virtual Reality System, Virtual Geographical Environment, Map Algebra, Spatial Analysis and Geoscience Visualization Based on GIS, Map Projection Transformation Principles and Application, Categorical Database Generalization in GIS, Multi-Scale Expression and Automatic Integration of Spatial Data. At meantime, Close Range Photogrammetry, a new version textbook with systematic structure, rich contents and novelty, has been published. Industry Surveying was published in 2004. In this book, the contents include the methods and principles of industry surveying, structure light industry surveying, laser and scanning system and their applications, modern industry sensors, quick speed photogrammetry and sensor integration technology other than industry photogrammetry.

5.3 Conferences

Some main conferences related to PE&RS are listed below:

2000 - the Symposium of Surveying and Mapping Instruments;
 2000 - the Workshop on New Technologies Applications in Engineering;
 2000 – The 2nd International GIS Workshop at Beijing;
 2000 – The 12th National Conference on Remote Sensing Technology;
 2000 – The 11th National Conference on Remote Surveying and Remote Control Technology;
 2001 – 2001' Plenary Meeting of Chinese GIS Association;
 2001 - the 7th Plenary Meeting of Chinese Society of Geodesy, Photogrammetry and Cartography;
 2001 – The 2nd Forum on Chinese Digital Technology and Applications;
 2001 – The 10th National Conference on Image and Graph and the 1st National Workshop on Virtual Reality Technology;
 2001 – the 20th ICA Plenary at Beijing;
 2002 – ISPRS Commission II Symposium at Xi'an;
 2002 – The Workshop on Geoinformatics Development Strategy;

2002 – The Workshop on the Application of GIS and Digital Surveying and Mapping;

2002 – The Workshop on New Technology of Remote Sensing, GPS and GIS;

2003 – The Workshop on Spatial Mathematical Models;

2003 – The International Conference on the Application of GIS and Remote Sensing in Water Resource and Environment;

2003 - The Workshop on High Resolution Satellite Data Processing and Application;

2003 – Asian GIS 2003 Conference and Workshop on National Digital City;

2004 – The CEOS International Workshop on Rapid Response Information Systems at Wuhan;

2004 – the Workshop on Digital Close Range Photogrammetry

5.4 Activities

In late 70th and the beginning of 80th of last century, Chinese Society of Geodesy, Photogrammetry and Cartography (CSGPC) was authorized to be the adhering body to ISPRS, ICA, FIG, and IUGG/IAG. Since that time, CSGPC has participated in each delegate congress and academic meeting. Many members of CSPGS assume positions in these organizations. For instance, professor Jun CHEN was elected as the chairman of the 2nd Committee of ISPRS in the year 2000-2004. The 2nd technology committee academic meeting of ISPRS was hold in Xi'an in August 2002. In 2000, Department of State granted the 21st delegate congress of ISPRS to be hold in Beijing. Professor Li LI, Kai YANG and Junyong CHEN take part in the activities of ICA, FIG and IUGGVIAG. At the same time, some members of CSGPS are participating in activities in the domain of earth observing. Professor Deren LI and associate professor Liangming LIU as China representatives are participating in the activities of the international organizations such as CEOS, IGOS-P, or GEO.

6. IN MEMORIAM

We regret to announce the death of prof. Zhizhou WANG, in May 18, 2002, our honorable member of ISPRS, honorable member of CAS, Honorary President of former Wuhan Technical University of Surveying and Mapping (WTUSM). We will remember him with respect.