UNITED NATIONS **E/CONF.99/CRP.12**

ECONOMIC AND SOCIAL COUNCIL

Ninth United Nations Regional Cartographic Conference for the Americas
New York, 10-14 August 2009
Item 5(b) of the provisional agenda
Country Reports

The Campaign to Map the Remote Regions in West China at 1:50,000 Scale[*]

[*] **Prepared by the State Bureau of Surveying and Mapping of China**

The Campaign to Map the Remote Regions in West China at 1:50,000 Scale

YAN Qin, ZHANG Jixian
Chinese Academy of Surveying and Mapping, No. 16,
Beitaiping Rd., Haidian Dist., Beijing, 100039, P.R. China

Abstract: about 2 million km^2 in west China never has been covered by 1:50,000 scale topographic maps for several decades. The area contains the famous Qingzang plateau with average 5000m altitude and boundless Talimu basin desert. Mapping this area with traditional methods had unimaginable difficulties and was impossible to complete at all. With the high technology advancing, especially the great progresses in geomatics, it is the time to start to map the area with new geo-information technologies. So in 2006, China decided to initiate a large project, named 1:50,000 scale topographic mapping of west China (ab. west China topographic mapping project), in order to get the 1:50,000 scale topographic maps (DEM, DOM and DLG) of that area within next 5 years. As we know the weather is extremely atrocious and a lot of sites are out of reach in that area, mapping from aero-born and satellite remote sensing imagery with spares ground control points was determined to be the main solution for the project.

The paper will give a brief introduction of the mapping project, present the technical methodology of mapping from remote sensing data developed and implemented by CASM. The Project of Topographic Mapping of West China is going well as planned since 2006. It proved that technique innovation becomes powerful guaranteed for project, and the maps have played important roles for local economy and society development. The success of the west China mapping project can be an example for other mapping projects in difficult mapping areas considering weather, altitude and transport conditions, etc.

Keywords: topographic mapping, West China, technical methodologies, project

1 Introduction

The Project of Topographic Mapping of West China (ab. the Mapping Project) is a mapping project in remote area which has highest government investment and most technically challenge in China.

The Mapping Project covers about 2 million km^2, administrative division relates to the 6 provinces (municipality), which mainly distribute in the regions of Qinghai-Tibet Plateau, Tarim Basin and Hengduan Mountains. Geographic condition of these regions is extremely bad, the weather is terribly atrocious and a lot of sites are out of reach. The condition is hot and dry with frequent occurrences of intensive sand-dust storms in desert area, high elevation with thin air and various weathers in plateau area, and covered with cloud and perennial ice in Hengduan Mountains.

Because of problems of technology, funds and transportation, the Mapping Project at 1:50,000 scale in these regions haven't been carried out by government these years. With development of geographic information technique and communication technique, the methodology and approach of topographic mapping at 1:50,000 scale will be realized at present. So in 2006, State Bureau of

Surveying and Mapping of China decided to initiate “1:50,000 scale topographic mapping of west China”, plan to achieve the 1:50,000 scale topographic maps of 20 km^2 within next 5 years.

2 Project Contents

The Mapping Project consists of five subprojects. Subproject 1 is to establish supporting system of the Mapping Project, which aims at difficult problems in this project, to decide methodology, flow standard and platform for the project by technical tackling and testing, and supplies technical supporting for Mapping Project; Sub-project 2 is images acquirement from airborne- and spaceborne- craft, which aims at acquirement of multi-source, multi-overlapping remote sensing images using airborne and spaceborne data acquirement techniques, Chinese and international satellites, and optical and InSAR approaches, and supplies data sources for Mapping Project; Sub-project 3 is the surveying and mapping of terrain and its features, which aims to produce standard 1:50,000 scale DEM, DOM, DLG and topographic maps using multi-source remote sensing images by combining indoor and field work, and achieves production of topographic maps in area; Sub-project 4 is to establish the fundamental geographic information database and service platform, which aims to build geographic and thematic information database, and build public service platform integrating the requirement of 6 provinces, and supplies mapping service for economy and society developments of local; Sub-project 5 is the equipment arrangement of Mapping Project, which aims to improve equipment level of surveyors by equipping advanced surveying instruments, communication instruments and vehicles, and supplies the capability of security production.

3 Technical Methodologies

1) IMU/DGPS assisted aero-photogrammetry technique

This technique is becoming the mature methodology which can be applied for Mapping Project after years’ development and application. This is a reliable and effective approach for 1:50,000 scale topographic map production which uses sensor automatic orientation technique based on DGPS/IMU integrated system and very high-, high-resolution aero-photos, and utilizes methods with spare or without GCPs and image processing technique based on multi-baselines and multi-images.

Key Techniques:

(1) Adaptive image enhancement of high radiation resolution aerial digital photos, to solve difficulties during information extraction of shadow areas.

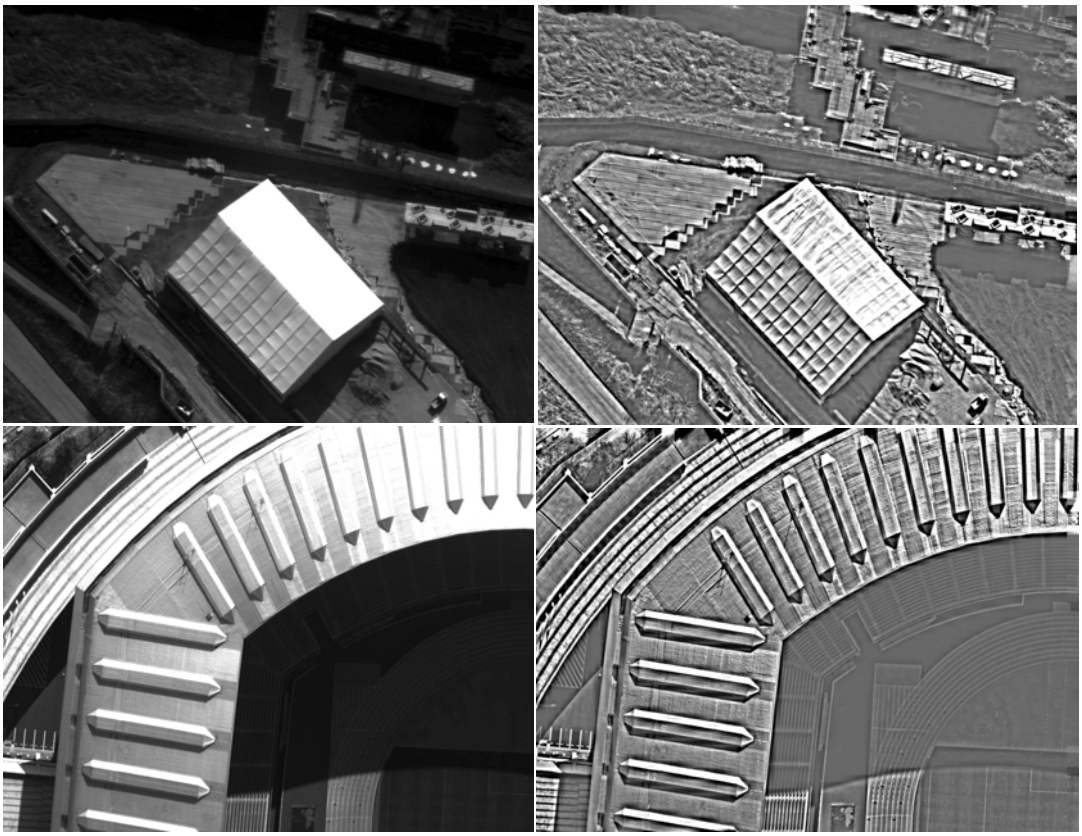
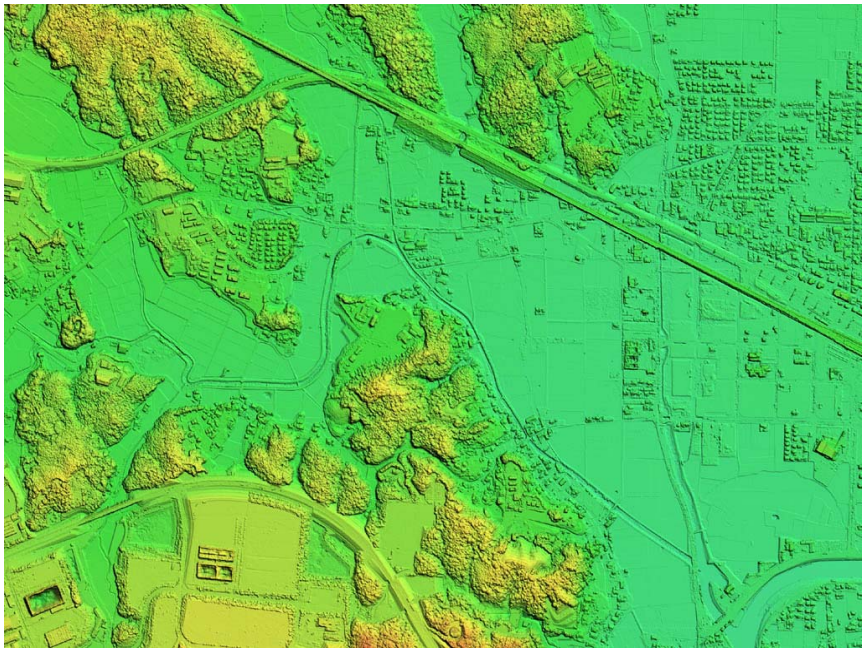


Figure 1: Left column: Original aero-photos after image contrast stretching;
Right column: Aero-photos after adaptive image edge enhancement.

(2) DEM generation based on multi-images (more than two), multiply matching features (feature points and feature lines) high-accuracy image matching algorithm, to improve elevation accuracy and reliability.



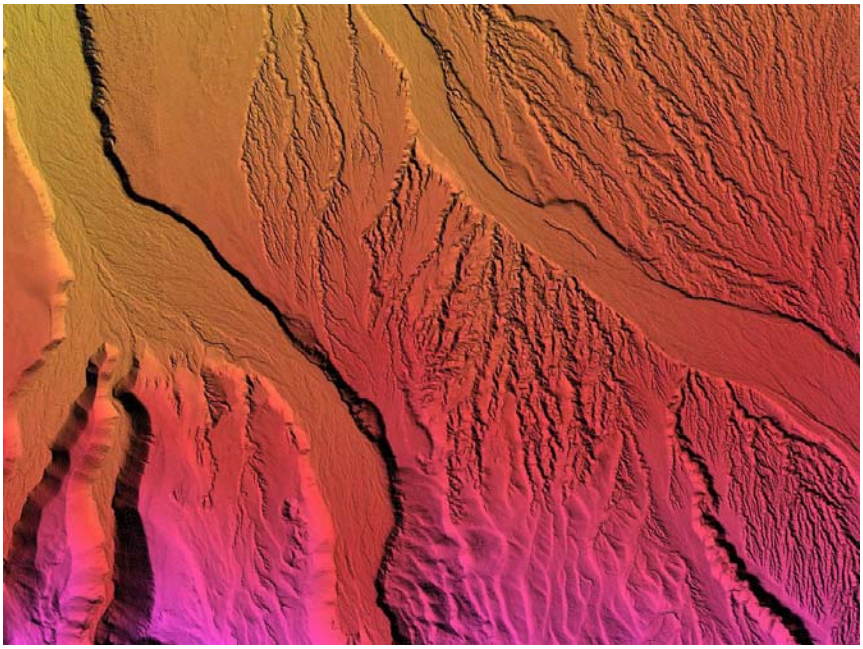


Figure2: 4m resolution DEM from digital aero-photos using multi-baselines, multiply matching features image matching algorithm. Up: urban area. Down: dry, semi-dry deep cutting broken area.

2) Surveying and mapping technique of high-resolution satellite images with spare control

This project firstly uses high resolution satellite imagery to implement large-area topographic mapping at 1:10000, 1:50000 scale, mainly adopts surveying and mapping technique of high-resolution satellite images with spare or without control, topographic mapping technique of large-area and high-resolution satellite images, and several new techniques of identification, interpretation and measurement, in order to solve the difficult problems of field annotation for rough terrain.

Key Techniques:

■ Establishment of uniform RFM model

Satellite imaging system usually adopts CCD linear array imaging technique, to establish uniform RFM model according to characteristics of high resolution linear array CCD sensor: high flying height, narrow imaging bundle and nearly parallel projection. RFM can be used for all kinds of sensors, which include new airborne and sapceborne sensors, be fit for block adjustment of satellite images from different sensors and different resolutions.

■ Large-area block adjustment with spare or without GCPs

Satellite imaging system usually flies in high altitude with large image coverage. Large-area block adjustment using RFM can control large area and reach the standard with spare GCPs. Interval of GCPs can reach to 200 km by using long strip SPOT-5 HRS triplet stereo images. In border area, the method of free net adjustment without control or one-side control can be used to effectively solve the problems of difficult mapping and control.

■ Application of automatic matching method based on multi-baselines, multiply matching

features

Automatic matching method based on multi-baselines, multiply matching features (feature points, grid points and feature lines) is developed to effectively solve DEM/DSM automatic extraction under the condition of complex terrain. The global matching is resolved by a probability relaxation which integrating features points and feature lines, to reduce the workload of manual editing.

3) Synthetic Aperture Radar (SAR) Technique

SAR is mainly used in area of Hengduan Mountains. Hengduan Mountains region is difficult for optical imaging because of rugged terrain with natural moat from north to south, thick forest and cloud and mist all the year round.

Key Techniques:

(1) DEM generation using InSAR images in vegetation-covered area

InSAR is new surveying equipment for efficiently acquiring 3D geographic information of surface and it has the characteristic of 24hours, transmission, and side-looking. With the characteristic of 24 hours, acquisition surface information all day, it can overcome the influence of cloud, mist and rain, and with the characteristic of side-looking mapping, it can acquire geographic information when the carrier far away from survey area. In addition, because Band P can penetrate forest, it will cooperate with Band X to acquire the elevation of tree. The accuracy is higher than annotation production by manual work. Which is the more important, it also can greatly reduce the annotation workload caused by traffic troubles in forest. So it is the best choice to acquire InSAR image in the cloud and mist area.

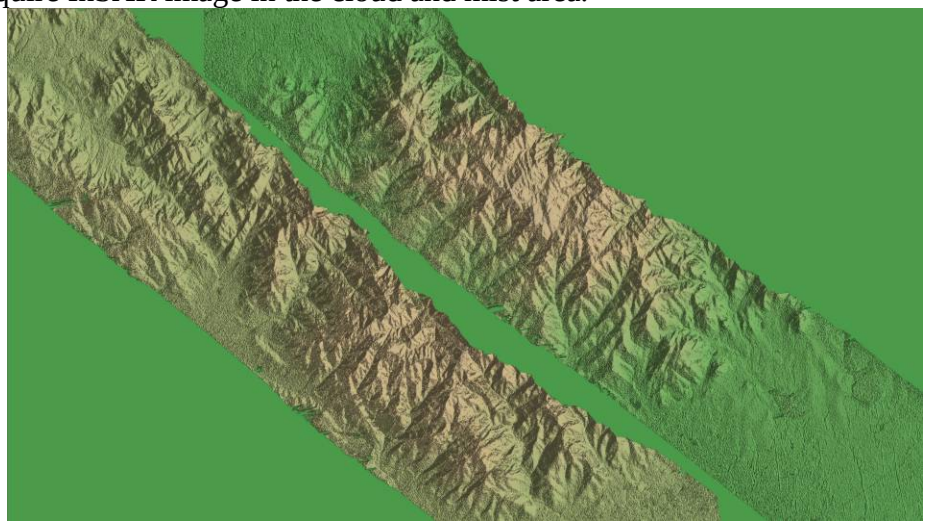


Figure 3: DEM from airborne double antenna SAR (airscape)

(2) DEM fusion and mosaic techniques using SAR images in different directions covered with large-area occlusions

SAR images always have serious shadow problems comparing optical images because of side-looking imaging. So DEM generated from InSAR images will be affected by these shadows. Shadow problems of DOM and DEM from airborne InSAR in mountainous area will be solved by using DEM fusion and mosaic techniques of SAR images in different directions.

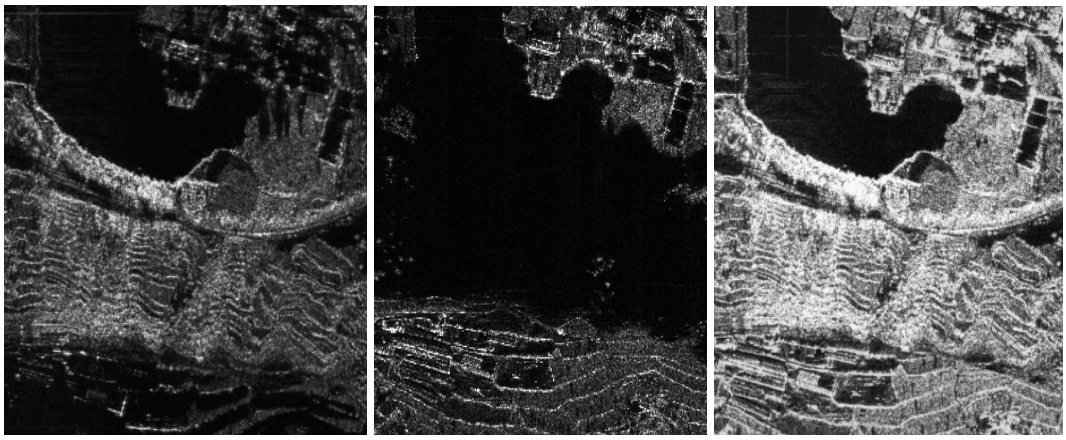


Figure 4: First two: InSAR images in north side-looking and south side-looking. Last: image after shadow processing.

(3) Features extraction technique from multi polarized SAR
At present, single polarized SAR has lower power of identification. Fusing or color combination multi polarized SAR and optical images can improve the capability of image identification.

4) Integrated interpretation technique of multi-source images
Image interpretation of features and surface coverage will be implemented based on geographic information, and mapping productions will be achieved by combining the results of field annotation which reduces the workload outside.

4 Project Organizations and Implementation

1) Set up management organization in different grade, to guarantee scientific organization and management of project
Project sets up 4-grade management organizations under State Bureau of Surveying and Mapping of China, encourage bureaus of each provinces to take part in the project and responsible for project implementation individually.

2) Formulate rules and regulations for project, to guarantee normative organization of project
According to the characteristics and situations of project, Rules and regulations for project management measure, technique management measure, security production management measure and quality management measure which are fit for project implementation, management system which is fit for organization operation and special funds management measure which is fit for financial management will be formulated.

3) Set up information platform of project management, to guarantee high-efficient information system management
Project sets up database group of project management including production management database, technique management database, result database, information management database, security database, funds management database, quality management database, digital office database and etc using Enterprise Resources Planning theory and technique approach and integrating the principle of OA and MIS., and forms standard, scientific and advanced management system of Mapping Project in West China.

4) Implement safety monitoring for field annotations, to remove hidden danger of security production

Project uses advanced satellite orientation technique, maritime satellite communication technique and network technique, supplies navigation and positioning of vehicles and persons based on digital map with mass data, to ensure the personal safety and productive safety by high-powered communication instruments.

5 Conclusions

The Project of Topographic Mapping of West China is going well as planned since 2006. At present, 80% field work and 40% mapping productions have been achieved. Technique innovation system becomes powerful guaranteed for project, and mapping productions have supplied services for economy and society development for locals step by step. We believe that the project will be successfully accomplished in 2010.

References

[1] Qin Yan, “Introduction to SPOT Constellation”, Bulletin of Surveying and Mapping, Dec., 2000. China.

[2] Jianqing Zhang, Zuxun Zhang, “Rigorous Model of High-Resolution Remote Sensing Imagery Based on Affine Transformation”, Journal of Wuhan University, Vol. 27, 2002. China.

[3] Susumu Hattori, Tetsu Ono, “Clive Fraser and Hiroyuki Hasegawa. Orientation of High-resolution Satellite Images Based on Affine Projection”, International Archives of ISPRS 2000 Congress, Vol. XXXIII, B3.

[4] Tetsu Ono, Susumu Hattori, Hiroyuki Hasegawa, Shin-ichi Akamatsu, “Digital Mapping Using High Resolution Satellite Imagery Based on 2D Affine Projection Model”, International Archives of ISPRS 2000 Congress, Vol. XXXIII, B3.

[5] S. Airault, etc, “Reference3D Location Performance Review and Prospects”, International Archives of ISPRS 2000 Congress, Vol. XXXIII, B3.

[6] I. Ewiak, R. Kaczynski, “Accuracy of DTM Generation From SPOT 4 And SPOT 5 Data”, International Archives of ISPRS 2004 Congress.

[7] Daniela poli, Zhang Li, Armin Gruen, “SPOT-5/HRS Stereo Images Orientation And Automated DSM Generation”, International Archives of ISPRS 2004 Congress.

[8] Y.Qin, M.Bernard, G. Wujun, 1:50000 SCALE TOPOGRAPHIC MAPPING IN WEST CHINA USING SPOT 5 DATA, International Archives of ISPRS 2008 Congress