基础地理信息采集中的航测工艺改造

周志诚[1]，杜　新[1]，钟生伟[2]，方　敏[1]
（1. 湖北省航测遥感院，湖北 武汉 430071，2. 湖北省测绘产品质量监督检验站，湖北 武汉 430071）

摘　要：介绍了全数字摄影测量工作站、数码调绘以及 HBCORS 动态 RTK 在大比例尺地形图测量中的应用对航测工艺产生的影响，分析了传统的和新的航测工艺的优缺点；探讨如何面对新的航测生产工艺，提高地形图生产效率。

关键词：基础地理信息；航测；工艺改造；CORS
中图分类号：P208　　**文献标志码**：B　　**文章编号**：1672-4623（2011）06-0027-02

随着计算机软、硬件和虚拟现实技术的飞速发展和相互促进，航测已经进入全数字生产时代。航空摄影测量已经从光学模拟成图发展到全数字摄影测量成图，外业调绘从传统的以纸制地图作为工作底图转变为采用移动设备+电子数据，相片控制方法也从过去的全站仪导线测量、GPS 静态、动态测量发展到利用 CORS 动态 RTK 测量。因此，如何面对新的航测生产工艺，搞好地形图的质量控制与检查工作是非常重要的。

1　传统的航测工艺流程特点

在传统的航测工艺中，一般是获取航测资料后，利用外业相片展开工作，首先是冲洗调绘放大片，外业进行相片调绘，同时外业像控测量，内业空三加密，然后内业立体测图，根据调绘片进行内业编辑，把编辑的地形图喷绘进行外业补测、检测，最后提交检查验收，过程如图 1 所示。

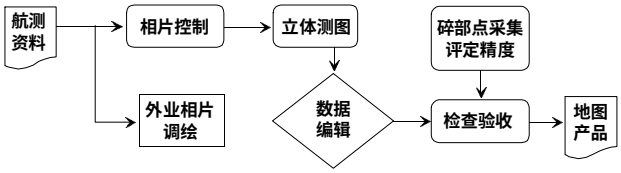

图 1　传统的航测工艺流程

在传统航测工艺流程中，外业相片调绘与外业相片控制是最重要的 2 个环节，其中相片调绘是自动化程度最低的一个工序，其中外业调绘与航测成图的流程关系见图 2。

外业调绘人员利用洗晒的相片及相关的辅助资料进行外业作业，外业分为调和绘两项工作，调绘人员白天在外业判调，在影像上用简单的符号表达，晚上回到住地进行成果清绘。清绘需要使用国家图式规定的符号表达，还要使用小笔尖、曲线笔等专业的清绘的工具，对作业员本身的要求较高，这就需要调绘人员接受过专业的培训。调绘成果清绘在调绘片上，成

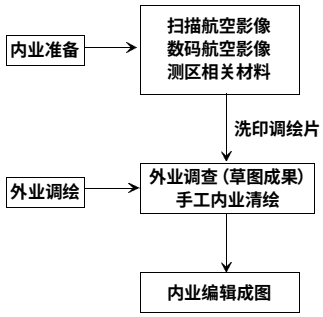

图 2　传统的航测成图与野外调绘的流程图

果以非数字形式提交，内业要经过多次“转绘”方可成图。这样不仅会丢失地物信息，还会损失精度。这一生产环节已经成为航测成图发展的瓶颈。

另外传统的对地形图质量评定的方法是院级检查机构在整个测区完成以后，通过抽样的方法，在外业采集碎部点后对样本精度进行评估，这种方法相对滞后，发现问题为时过晚，不能及时有效地进行质量控制和质量管理。

2　改进后的航测工艺流程

当今手持设备以及 HBCORS 技术的发展使外业调绘、像控呈现数字化、实时化的趋势。手持设备（例如 PDA、MID）可以内置或外挂 GPS 模块，直接链接 HBCORS；各种影像压缩技术也解决了数字测绘产品数据量大，便携带的问题。一台手持式的数码调绘工具，就可以在外业对携带的影像数据进行定位、导航、测量和编辑，完成以往在纸质相片上进行的工作，大大地提高了作业效率。改进后的航测工艺过程如图 3 所示。

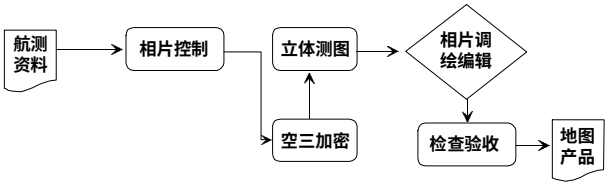

图 3　新的航测工艺流程图

收稿日期：2011-09-07

© 1994-2012 China Academic Journal Electronic Publishing House. All rights reserved.　http://www.cnki.net

基于手持设备的数码调绘方式，工作底图影像为全数字形式，不需要冲洗打印，只需要进行格式处理或数据压缩即可使用，节省成本。内业在室内依据立体影像进行立体测图，按照信息化测绘体系的要求，全面收集测区内的相关资料，如地名志、公开版的交通旅游图、公路图、电力资料等标绘在 DLG 图上，尽可能地将把外业工作移到室内；然后在 AutoCAD 上按比例、地理位置把调绘用数字正射影像（DOM）（TIF 或 JPEG 格式）和内业判绘底图 DLG（DWG 格式）套合在一起，在内业判绘底图上添加内图廓线和公里网，作为外业定向和 GPS 导航的数学基础。

外业调绘人员就根据手持机上的判绘数据和影像，到实地逐一调查，添补上新增的地物和属性数据。由于软件本身已按照规范制作了支持国家的分类标准和地形图符号与线型，现场判调作业多为选择操作，避免了大量的手工绘制工作。白天的调绘数据晚上回到住地后可以直接下载到电脑上，利用 AutoCAD 等编辑软件直接完成清绘，降低了外业作业的专业性，对外业作业员的手工清绘技能也降低了。而调绘成果以数字形式直接转入内业编辑，内业根据调绘成果直接进行成图处理，避免了外业调绘数据的重复作业，减轻了外业劳动强度，提供了生产效率。基于手持设备的外业调绘流程见图 4。

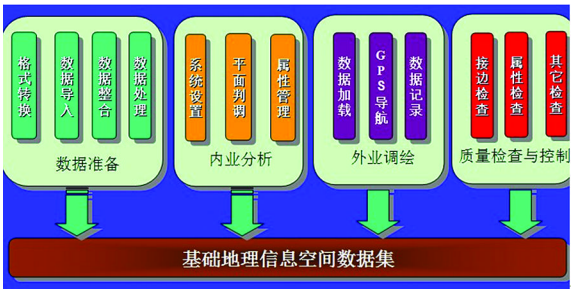

图 4 基于手持设备的外业调绘流程图

3 空三可靠性新方法

随着 HBCOS 动态 RTK 在生产中的应用，外业像控点和碎部点采集的速度与精度大大提高，与原来的导线测量和静态测量有了质的变化。新的工艺流程是相片控制点采集和碎部点采集 2 个工序同时进行。碎部点除了采集足够后期评定地形图精度的点数外，还有选择的采集一些目标明确的平面点和高程点并绘好草图。等内业空三按设计要求完成后，再把外业利用 HBCORS 采集的那些目标明确的碎部点先通过坐标预测出大概位置，然后根据外业草图准确定位，通过在 PATB 中给予和相片控制点中不同的权，重新对空三加密网进行平差。

4 应用效果

在“武汉城市圈”基础地理信息数据采集与更新项目中，我们采用了新的外业调绘、像控模式。工艺流程的改造，避免了繁琐的手工清绘工作，大大提高了生产效率，平均一幅图效率提高 30%，减少了重复劳动，大大地减轻了外业调绘、清绘的工作量，也避免了因为人员专业素质差异造成的成果整饰差异。带 GPS 模块的电子调绘，即使是在无明显方位物的山区也可以很快和准确地定位判读。HBCORS 动态 RTK 的使用提高了野外像控点、碎部点的采集速度和精度，通过把碎部点中的明确目标点导入空三，又大大提高了空三的平面和高程精度。而检查方法的优化，变被动检查为主动，把质量问题消灭在萌芽，最终这个项目取的良好的效果，顺利完成验收。

5 结 语

本文结合测量工作中出现的新技术和自己多年的野外作业经验，详细探讨基础地理信息采集航测工艺流程的优化，总结了一些新的生产方法和措施。通过把上述生产方法和措施放在生产中应用，有效地减少了工作环节，提高了作业效率，减少和控制了各个环节可能出现的质量问题，减轻了外业工作人员的劳动强度，体现了以人为本的理念，充分证明了充分利用现代科技手段来解决传统测绘工作中难题的思路是成功的。

参考文献

[1] 王华.使用电子调绘系统的内外业一体化作业方法[J].地理空间信息,2009(7):15-17
[2] 洪亮.移动设备外业调绘系统研制[J].地理空间信息,2010(8):21-24
[3] 王迪伟.基于 PDA 的 1:10 000 比例尺地形图野外调绘[J].测绘通报,2010(8):59-61
[4] 许捍卫.移动式 GIS 发展的关键技术及应用前景[J].测绘工程,2003(12):34-36
[5] 石伟华. 1:10 000 数字地形图的生产流程探讨[J].山东理工大学学报,2005(85):19-22
[6] 杨晓晶.数字测绘产品数据加工处理流水线的研究[J].测绘通报,2003(6):42-43
[7] 张剑清.摄影测量学[M].武汉:武汉大学出版社,2003

第一作者简介：周志诚，高级工程师，从事基础地理信息数据采集工作。

© 1994-2012 China Academic Journal Electronic Publishing House. All rights reserved. http://www.cnki.net

Theory and Practice from Digital City to Smart City

by LI Deren

Abstract This paper summarized the achievements in construction and development of the Smart City based on the wave of Internet of things including smart sensor networks and earth observation networks. This paper probed the inevitable trends and the basic theories of the development from Cyber City to Smart City, at the same time, this paper implemented the typical applications of the Smart City and also predicted the wonderful prospect of it.

Key words Cyber City,smart sensor network, earth observation network, IOT, Smart City (Page:1)

Transformation of Geographic Information Service Manner in Information Era by LUO Minghai

Abstract Analyze the changes and improvements of geographical information demands of government management, industry application, public life and knowledge dissemination under the information age, put forward the development direction of digital, multiple, systematic, open, integrated and intelligent geographical information service, discuss the emphases of geographical information service system, includes information surveying production system, abundant geographical information data system, scientific geographical information management system, perfect geographical information sharing system and effective geographical information application system, and indicate the historical opportunity and profound influence of geographical national conditions monitoring to surveying and geographical information industry.

Key words geographic information, public service, knowledge servic (Page:6)

Application of D-InSAR in Extracting Information of Ground Deformation by YU Jingbo

Abstract The basic principles of D-InSAR and D-InSAR data processing were introduced and then its application in extracting information of ground was explained by taking two-pass differential interferometry processing the ENVISAT image data from Bam earthquake and e xtracting and analyzing coseismic deformation field as an example.

Key words Differential interferometry, two-pass differential interferometry, Bam earthquake, ground deformation information (Page:9)

Network Structure and Position of HBCORS Reference Station

by YANG Huaxian

Abstract This article described the principles and CORS network structure optimization. Technical requirements were met HBCORS conditions with the minimum number of reference points, a reasonable distribution for maximum coverage, completed the design of HBCORS the network structure and location.

Key words HBCORS, reference station, RTK (Page:12)

Study on Integration Issue of Hubei Established CORS Reference Stations by WEI Zhong

Abstract Continuous operational reference system is one of the infrastructures of spatial data, CORS system nationwide network is imperative. This article simply introduced the present situation of continuous operation of Hubei satellite positioning services system, discussed the main problems of Hubei CORS, and proposed the necessity of integration of provincial CORS and regional CORS. At last,Hubei province integration schemes were studied, and Hubei actual situation was considered.

Key words HBCORS,integrate,reference station (Page:15)

Animal Epidemic Prevention Direct System Based on GIS

by CHI Shuwen

Abstract This paper focuses on the necessity of animal epidemic prevention direct system, and analyses the information of stockbreeding, gives the plan of establishment of database finally. From the point of view of stockbreeding modernization management, this paper makes the detailed analysis on the function of this system. At the end of the paper, the author proposes the method of data update.

Key words GIS, information construction, database (Page:17)

Hybrid Category Data Clustering through Partitioning Methods

by LIANG Hong

Abstract The usual clustering methods based on partitioning mainly process numerical data and it is lack of the clustering method that can deal with hybrid category data. Because of these problems, this paper integrates and improves the traditional and classical clustering methods those are k-means, k-medoids and k-modes in order to propose a method that can solve the cluster analysis about hybrid category data according to those traditional methods' characteristics. This paper's method converts all hybrid category data to same scale range between 0.0 to1.0 in order to computes the dissimilarity according to the compositive formula and updates each kind data of clustering centers independently.

Key words partitioning methods; cluster analysis; hybrid category data; dissimilarity (Page:18)

Approaches and Principles to Improve the Efficiency of WebGIS

by ZHOU Jingchun

Abstract Obstacles to efficiency of WebGIS are classified as hardware environment and software environment. The article focused on the software environment and based on the three layers of GIS construction, point out some available optimizing approaches applied on the data layer, logical layer and transport layer and described respectively technical principles of these approaches. These approaches can be used assembly to improve the efficiency of WebGIS applications.

Key words WebGIS, efficiency, optimizing approaches, technical principles (Page:21)

Integration of Comprehensive Transportation Network in The Zhongyuan Urban Agglomeration by LIU Jingyu

Abstract The development and improvement of the transport network system is a prerequisite and an important means for the construction of urban agglomeration. Using GIS technology, combined with the actual development of Central China Urban Agglomeration, and based on the evaluation of the accessibility of transport network, it showed that construction of the urban agglomeration should focus on the integrated transport network, and by improving the comprehensive services of transport network to meet the need of transport infrastructure networks.

Key words GIS, Zhongyuan Urban Agglomeration, transport network,integration, accessibility (Page:24)

Transformation of Aerial Exploration on the Basis of Geographic Information Collection Process by ZHOU Zhicheng

Abstract This article described a fully digital photogrammetric workstations, digital transfer and HBCORS dynamic RTK painted large-scale topographic maps in the application of the measurement process produces aerial images and analysed of the traditional and new aerial technology advantages and disadvantages. It inquired into how to face a new aerial survey of the production process, improved the efficiency of topographic map inspection.

© 1994-2012 China Academic Journal Electronic Publishing House. All rights reserved. http://www.cnki.net

Key words basis of geographic information , aerial exploration , process modification ,Continuous Operational Reference System (Page:27)

Construction of FJCORS and Its Application in Control Survey

by WANG Yanchun

Abstract Continuous Operational Reference System (CORS),which can provide real time positioning service, is one of hot spots about contemporary GPS development. Fujian Continuous Operational Reference System is illustrated in detail from the system composition and the technical indexes. A new control survey method based on FJCORS and Local Geoid is provided.

Key words FJCORS; Control survey; Local Geoid (Page:29)

Optimal Scale Selection of Rasterizing Vector Data in Guizhou Karst Mountainous Area by ZHOU Xu

Abstract After a series of quantitative experiments, this paper proposed that complexities of study area, requirements of accuracy, and computing efficiency were the most important factors which affect the optimal scale of rasterizing vector data; it also concluded that the 25 m-30 m raster unit is the optimal scale for Geo-spatial analysis in Guizhou karst mountainous area.

Key words rasterizing vector data, optimal scale selection,Guizhou karst mountainous area (Page:31)

Design and Realization of City Flood Prevention Command System Based on Flex and ArcGIS Server by ZHANG Hongwei

Abstract Aiming at and associating with the currently work conditions and problems of the flood control and disaster alleviation in Huai'an, We designed and exploited the WebGIS City Flood Prevention Command System, introduced the functions achieved in the system and the key technology used in the system development process and so on, which is based on related technologies such as ArcGIS Server, RIA/Flex and .NET, as well as analyzed and studied the whole design structure, database management and design and so on. Through the research and application of this system, the researchers can effectively enhance the work efficiency of flood control of city management and scheduling, and which has significant guide meanings to flood prevention and disaster alleviation, thereby minimizing the loss caused by flood damage to the city.

Key words city flood prevention and disaster reducing ; ArcGIS Server ; .NET ; RIA/Flex ; WebGIS (Page:34)

Feasibility Analysis of Anhui Meteorological GPS Data for Deformation Research by ZHENG Haigang

Abstract To demonstrate Anhui meteorological GPS data for crustal deformation research of feasibility. This paper discusses the quality of Anhui meteorological GPS data with TEQC, gives out the quality report according to IGS data quality status, and selects the available data for GPS solution. On this basis, we process solutes available data with GAMIT/GLBOK (Release 10.34) .The results showed that the change trend of sites horizontal components time series is consistent with the research results by associate researcher WANG Mei. Therefore, we consider that Anhui meteorological GPS data applied to crustal deformation research is feasible.

Key words GPS ;TEQC ;GAMIT/GLBOK ;feasibility analysis (Page:37)

GPS Deformation Data Processing Method Based on Wavelet Transform by XIA Qiu

Abstract Described GPS deformation data processing method based on wavelet transform. the data of deformation monitoring sequence as consisting of different frequency components of the digital signal is processed, with wavelet analysis of MATLAB programming, to achieve the gross errors of monitoring data, eliminate noise, trends extraction, examples show that the wavelet analysis theory applied to data processing of the dam deformation monitoring is practical and operational.

Key words wavelet transform; GPS; deformation monitoring; data processing (Page:40)

Idealogy, Method and Tools of GeoDesign by LI Li

Abstract GeoDesign is the most popular topic in GIS industry. It is not means that GeoDesign is designing nature and conquest nature as human beings' subject ideas, but that reasonable and scientific planning and deciding based on comprehensive analysis, and that promote harmonious develop between human beings and nature. GeoDesign Ideology is different in different age. In information age, GeoDesign is more and more tend to be people-oriented and pay attention to the relationship between people and environment. GeoDesign Method requires every link in design be based on geographic analysis. GeoDesign tools are not as perfect as possible in recent years. At the present stage, there are tools such as ArcCAD, ArcGis for AutoCAD, ArcSketch. We believe that GeoDesign will bring GIS far-reaching change.

Key words GeoDesign, GeoAnalysis, GeoDesign Ideology, GeoDesign Method, GeoDesign Tools (Page:42)

Development of Monitoring and Control system of Excremental Residue Collecting and Transporting Based on WS/GPS

by ZHONG Bo

Abstract The study aimed at establishing a monitoring and control system than can efficiently monitor and control the vehicles for excremental residue collecting and transporting.We also created a module for each vihicle that consisted of a weight sensing system.This module sends integrated real-time positions and loadings data for excremental residue collecting and transporting during the daily operating period for each vehicle via the global positiong system(GPS) and the general packet radio service(GPRS).We also created a control center that integrated geographic information system(GIS),enabling the monitoring of possible improper usage conducted by the vehicles.Consequently, the system closely interconnects the delivery information between the vehicles,control center,and supervisor of local government.

Key words monitoring and control system,Weighing System,Global Positioning System,General Packet Radio Service,Geographic Information System (Page:45)

High Performance Parallel Remote Sensing Image Processing Based on CUDA by XU Xuegui

Abstract As the development of space remote sensing technology in recent years witnessed a geometric growth in the data size of remote sensing images. Consequently, the process of remote sensing images is faced with such challenges as large data size, high intensity, high computational complexity and large computational quantity, and so on. Based on the analysis of the parallel architecture of the latest GPU and the flexible programmability of CUDA (Computer Unified Device Architecture), this paper presents an efficient method for processing remote sensing images on the basis of CUDA. This paper takes FFT, edge detection and template matching, three common methods in remote sensing image processing, as examples, and details the efficient parallel processing procedures of them. The experiments on different images with different data size proved that GPU is 10 to 40 times faster than CPU, which is a dramatic progress in remote sensing image processing.

Key words GPU; CUDA; remote sensing image; parallel processing (Page:47)

© 1994-2012 China Academic Journal Electronic Publishing House. All rights reserved. http://www.cnki.net