

GPS 技术在某铁矿控制测量中的应用

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摘要: 结合咸丰县某铁矿控制网布控项目分析传统 GPS 测量技术在工程测量中的应用, 概述了该测区基本情况以及布网情况, 并着重介绍了数据处理方面的内容。

关键词: GPS; 基线处理; 平差

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自 1994 年美国 GPS 卫星投入应用以来, GPS 静态相对定位技术已经广泛的应用于城市和矿区油田地面沉降监测、大坝变形、高层建筑变形监测, 隧道贯通测量等精密工程, 测绘各种比例尺地形图和施工放样等, 因其较常规测量方法灵活、方便, 已经完全可以用来施测各种等级的控制网。

1 研究区概况

测区分为 2 个部分, 其中 A 区面积为 4.5 km^2 , 该区域 GPS 控制点 8 个, 其中已知点 2 个, 未知点 6 个, 网图见图 1。B 区面积为 10.5 km^2 , 该区实测 GPS 控制点 17 个, 其中已知点 2 个, 未知点 15 个, 网图见图 2, 观测时间从 2009 年 4 月 13 日至 17 日, 历时 5 d。

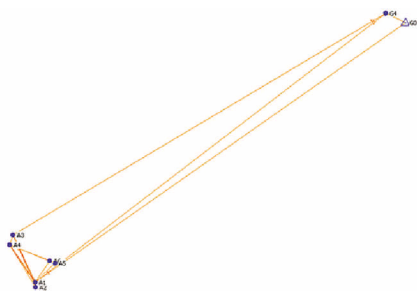


图 1 A 区 GPS 网图

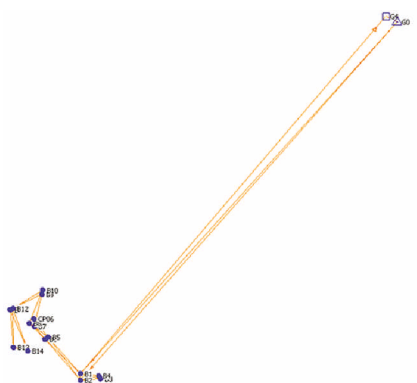


图 2 B 区 GPS 网图

2 作业依据和已有测绘资料

作业依据: ①《全球定位系统测量规范》(GB/18314-2001); ②《地质矿产勘查测量规范》(GB/T 18341-2001); ③《物化探工程测量规范》(DZ/T 0153—95); ④本项目技术设计书。

3 坐标系和仪器设备的选择

测区中央子午线经度为 108° , GPS 网的平面坐标系统采用 WGS-84 椭球, UTM 投影坐标系, 高程采用铁矿区的原有数据。

GPS 测量采用 2 台 Trimble 4600LS 和 2 台 Trimble 5800 接收机, 平面与高程检验采用 Laica TC 307, 数据处理采用天宝随机软件 Trimble Geomatics Office 1.63。

4 数据处理

4.1 基线处理

根据自动处理基线向量结果, 检查基线向量比率 (Ratio)、中误差 (RMS) 及天线高等^[1]。

A 区参与解算的基线共 17 条均为固定解, 最大中误差为 11 mm, 最小中误差为 4 mm, 平均中误差为 6 mm。除有 2 条边长相对中误差分母分别为 2.6 万和 3.2 万外, 其余 15 条边的相对中误差分母均 ≥ 5.4 万, 最大为 293 万。B 区共 37 条基线参与解算均为固定解, 最大中误差为 11 mm, 最小中误差为 3 mm, 平均中误差为 6 mm。除有 3 条边长相对中误差分母分别为 2.6 万、2.7 万和 2.0 万外, 其余 34 条边的相对中误差分母均 ≥ 4.6 万, 最大为 215 万^[6]。

4.2 数据质量检核

根据《全球定位系统测量规范》的要求, 按 E 级网精度要求, 取 $a \leq 10 \text{ mm}$ $b \leq 20 \times 10^{-6}$, A 区与 B 区

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平均边长都为 $D=2.78\text{ km}$ 代入基线标准差公式得： $\sigma=56.49\text{ mm}$ 。

1) 环差检验。按照《全球定位系统测量规范》要求，将同步和异步环进行检验，节点为3，同步环坐标分量闭合差 $W_x=W_y=W_z\leq\pm\sqrt{n}/5\sigma=19.6\text{ mm}$ ，同步环全长闭合差： $W_s\leq\pm\sqrt{3n}/5\sigma=33.9\text{ mm}$ ；异步环坐标分量闭合差 $W_x=W_y=W_z\leq\pm3\sqrt{n}\sigma=293.5\text{ mm}$ ，异步环全长闭合差： $W_s\leq\pm3\sqrt{3n}\sigma=508.4\text{ mm}$ 。

A网中节点为3时，闭合环总数18个，其中同步环10个，最大坐标分量闭合差15.1 mm，最小坐标分量闭合差0.3 mm；异步环为8个，最大坐标分量闭合差为20 mm，最小坐标分量闭合差为0.4 mm，最大全长闭合差为25 mm，最小全长闭合差为8.5 mm，全部符合精度要求^[7]。

B网中节点为3时，闭合环总数为32个，其中同步环为17个，最大坐标分量闭合差为15.3 mm，最小坐标分量闭合差为0.2 mm；异步环为15个，最大坐标分量闭合差为40.6 mm，最小坐标分量闭合差为0.2 mm，最大全长闭合差为41.9 mm，最小全长闭合差为2.7 mm，全部32个闭合环精度符合要求。

2) 重复基线较差。重复基线限差 $ds=2\sqrt{2}\sigma=160\text{ mm}$ ，A区网中重复基线最大较差为9 mm，最小较差为6 mm，B区网中重复基线最大较差为27 mm，最小较差为0 mm，全部基线符合精度要求。

4.3 平差计算

得到全部固定基线解后，在WGS84坐标系中以东经108°为中央子午线，用TGO1.63软件进行无约束平差及约束网平差^[2]。

1) 无约束平差。对A网8个点进行无约束平差，平差后的X坐标最大及最小中误差分别为0.4 cm和0.1 cm；Y坐标最大及最小中误差分别为0.3 cm和0.1 cm。

对B网17个点进行无约束平差，平差后除点CP06外的X坐标最大及最小中误差分别为0.6 cm和0.2 cm；Y坐标最大及最小中误差分别为0.6 cm和0.3 cm。

2) 约束平差。将G0点作为平面起算点，加G0和G4点的高程，对A网进行约束平差。平差后X坐标的最大及最小中误差分别为3 mm和5 mm，Y坐标的最大及最小中误差分别为3 mm和4 mm。将G0点作为平面起算点，加G0和G4点的高程，对B网进行约束平差。平差后除点CP06外X坐标的最大及最小中误差分别为9 mm和5 mm，Y坐标的最大及最小中误差分别为9 mm和5 mm。

3) 可靠性检验。为检验GPS网数据处理的可靠性，用全站仪实测了A区与B区共7条基线边与GPS坐标反算边长进行比较^[3]，其结果见表1。

表1 反算边长与实测边长之比较

序号	边长	实测边长/m	反算边长/m	较差/mm	相对误差
1	A3-A4	269.978	269.975	3	89 992
2	A6-A5	153.148	153.150	-2	76 574
3	B1-B2	311.407	311.403	4	77 852
4	B5-B6	160.899	160.898	1	160 899
5	B7-B8	278.128	278.124	4	141 111
6	B9-B10	196.873	196.870	3	68 066
7	B14-B13	677.118	677.122	-4	102 607

7条边的相对误差最差为1/68 000，证明GPS网是可靠的^[4]。同时用全站仪三角高程法测量了5条边之间的高差，用以与GPS高程差进行比较^[5]。其结果如表2，精度满足要求。

表2 三角高程差与GPS高程差之比较

序号	边长	三角高差/m	GPS高差/m	较差/mm
1	A3-A4	-22.923	-22.937	-14
2	A6-A5	-37.082	-37.091	9
3	B1-B2	-32.132	-32.145	-13
4	B5-B6	-0.767	-0.773	-6
5	B7-B8	47.538	47.537	1
6	B9-B10	-1.764	-1.774	-10
7	B11-B12	4.647	4.647	0
8	B14-B13	-13.889	-13.902	-13

5 结 语

GPS技术历来被作为大范围控制测量的首选，希望本次咸丰县某铁矿控制测量项目的开展，能对今后本行业开展控制测量工作起到一些指导和借鉴的作用。

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Application of Precise Point Positioning Technology to Topographic Surveying and Mapping with Middle and Small Scale

by LIU Tao

Abstract The development and progress of Precise Point Positioning (PPP) were summarized firstly in this paper. The PPP was applied to 1:10 000 map production of Xingjiang Province. The feasibility and accuracy of PPP in such application were analyzed and discussed.

Key words photogrammetric control point surveying, GPS, Precise Point Positioning, static positioning, accuracy (Page:32)

Simulation and Analysis of Construction Land Change of Yongshan County

by ZHANG Jialong

Abstract Sustainable land use is the basis for sustainable social development and construction land change is the key factor. This paper took the surrounding areas of Yongshan County as the study area and the construction land change as the main study object. The temporal and spatial characteristics of land use change over the past 6 years has been studied using GIS and RS technology. The data source was remote sensing images in 2003 and the land use vector data in 2009. By exploring land use conversion rules and using LCM model, CA_Markov model, it had forecasted and simulated the land use change trend of Yongshan County.

Key words GIS, RS, construction land, LCM model, CA_Markov model (Page:35)

Design and Development of 3D Terrian Visualization System Based on ArcEngine

by WANG Fangxiong

Abstract With Visual C# .NET for development platform and ArcEngine for development components, this paper detailed the implementation methods and key technologies of 3D terrain visualization functions, including building a 3D terrain, displaying scene on the surface of 3D, analysing terrain factors and visibility. Finally, we designed and realized 3D terrain visualization system based on ArcEngine.

Key words ArcEngine, 3D terrain visualization, DEM, terrain factor (Page:38)

Research on Conversion between SunwayGIS and CASS

by JU Feng

Abstract This paper thoroughly discussed two data formats created by SunwayGIS and South CASS, and introduced the conversion methods and conversion processes between them in detail. Then, the encoding comparative table including the structure and content was described. Finally, the all-purpose program modules were developed. The practical result indicated: the method was simple and efficient to finish conversion, which made the two data format had the same geography, the correct topology and the same attributes.

Key Words SunwayGIS, CASS, conversion, encoding comparative table (Page:41)

Organization and Management of Mass Geography Information Data Based on GeoDatabase

by ZHANG Yaobo

Abstract The data of provincial foundation geography information has developed "4D" product, that includes many types, multiscale and multi-States. The amount of data will be over 1 TB. Based on spatial data model-GeoDataBase, this paper researched how to organize and manage mass geography information and ensured to construct the provincial database system.

Key words fundamental geographic information database, GeoDataBase, ArcSDE (Page:44)

Research on High-resolution Geoeye-1 Ortho-rectification

by SU Yiping

Abstract In this paper, according to one scene of high-resolution Ge-

oeeye-1 satellite image, a method of SAR image ortho-rectification based on the RPC model was proposed. The experiments indicated that the rms value resulting from the independent check points utilizing four control points in the corner, was 0.335m, which can meet the need of the updating of 1:10 000 ortho-images.

Key words Geoeeye-1; high-resolution satellite images; RPC model; ortho-rectification (Page:47)

Design and Application of the Three Gorges Comprehensive Information Spatial Integration Platform Framework

by ZHENG Lina

Abstract When the world-renowned Three Gorges Project and millions of immigrants project draws to the end, the focus of the Three Gorges Project reservoir area must transfer to the construction and management of maintenance up. The success of the Three Gorges Reservoir Area construction relates to the Three Gorges project and to the safety and economic & social development in reservoir. By analyzing the situation of the Three Gorges Reservoir Area Information Resources to start, from the structure, standards, space technologies and other means of multi-level integrated information space of the Three Gorges reservoir area integration platform integrated framework for project design and implementation.

Key words integrated framework, comprehensive information, spatial, Three Gorges (Page:51)

Application of GPS Technology to Control Survey in a Copper-nickel Mine

by HUANG Dahu

Abstract This paper analyzed the application of traditional GPS technology to engineering survey in a copper-nickel mine combine with an iron control net in Xianfeng county and introduced the basic circumstances of the measuring area. It emphatically introduced content of data processing.

Key words GPS, baseline processing, adjustment (Page:54)

Comparison of GPS and Traditional Measurement Techniques in Geological Exploration

by LI Baojie

Abstract With examples of major projects, by comparing the traditional measuring technology and GPS measuring technology in control survey, topographic survey and geological exploration engineering measurement, we considered that the GPS measuring technology had the superiority of promptness and high quality results that the traditional method can't match.

Key words GPS, traditional measuring method, geological engineering survey (Page:56)

Design and Implementation of 3S-based Land-use Change Survey Information System

by ZHAO Zhongjun

Abstract Based on analysis of procedure of land use change survey, this paper proposed the design and realization scheme of land use change survey system with 3S technology. The key issues of implementation were discussed, and the prototype system was built with Vb. Net and ArcGIS Engine. It was the beneficial exploration of building land use change survey system based on 3S technology. The existing problems and the future research trends were also mentioned in this paper.

Key words 3S technology, investigation of land-use change, system design, system implementation (Page:58)

Quality Control of Digital Products with 1:10 000 DLG

by FAN Haisheng

Abstract This paper discussed the main contents and methods of quality control of 1:1 million DLG and described self-developed quality control procedures With 1:10 000 DLG data products. It researched a quality control system based on comprehensive production process.

Key words basic mapping, DLG, quality control (Page:61)