

DMC 数码航摄区域网布点方案探讨

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摘要:相片控制测量是航空摄影测量的基础工作,传统航空摄影控制测量有成熟的作业方法和相应的技术标准和规范,而 DMC 航空摄影控制测量还没有制定相应的技术标准或规范,特别是在中小比例成图的应用中,更是一个空白。根据 DMC 航空摄影资料的特点和 1:10 000 地形图成图的精度要求,通过实例研究,总结区域网布点方案的规律性。

关键词:DMC;平高点;基线;航线;旁向;中误差

中图分类号:P231

文献标志码:B

文章编号:1672-4623(2011)04-0109-02

随着数码航空相机技术的日益成熟和广泛应用于各部门的航空摄影,而由于种种原因,相应的技术规范往往滞后于实际应用和生产,另一方面,数码航空摄影资料与传统航空摄影资料相比,有以下几方面的特点:像幅小,特别是航向,如 DMC 只有传统航空摄影像幅(23 cm × 23 cm)的 40%;影像分辨率高,一般不大于 12 μm;相机焦距短,一般均小于 120 mm;成像质量高,特别是影像的边缘变形很小。以传统航空摄影测量的相关技术规范用于数码航空摄影测量,在控制测量布点方案方面有一定的不确定性,其理论支撑或可借鉴的生产经验也不多。本文通过茂名测区的实例实验研究,总结利用 DMC 航空摄影资料制作 1:10 000 DOM 或生产 1:10 000 地形图时,外业相片控制测量区域网布点方案的规律性。为茂名、肇庆测区 2.25 万 km² 范围内,利用 DMC 航空摄影资料制作 1:10 000 DOM 和生产 1:10 000 地形图,提供可靠的区域网布点方案。

1 实验内容

1.1 实验区概况

实验区选取茂名测区的一个指定区域作为实验区,其范围为南北方向跨度 18 条基线、东西方向跨度 8 条航线。实验区内的地势是南低北高,平地、丘陵地占大部分地区,山地占少部分地区。

1.2 DMC 数码航摄资料情况

DMC 数码航摄影像,RGB 彩色影像,标称摄影比例尺 1:35 000、实际航摄比例尺 1:37 000,像幅为 9.2 cm × 16.6 cm,像元分辨率 12 μm,摄影焦距 120 mm,航向重叠约 65%,旁向重叠约 33%,南北飞行。

1.3 加密点的精度

依照《1:5 000、1:10 000 地形图航空摄影测量

内业规范》,1:10 000 地形图对加密点的精度要求,如表 1 所示。

表 1 1:10 000 地形图对加密点的中误差要求/m

	平地	丘陵地	山地	高山地
平面	3.5	3.5	5.0	5.0
高程	-	1.0	2.0	3.0

2 实验区的技术方案

2.1 总体的技术思路

在选定的实验区域内,采用全野外布设平高点,为内业加密试验和精度分析奠定可靠的数据基础。内业试验在全野外布设平高点的基础上,分别按照旁向跨 1 条航线、航向分别跨 2~8 条基线,旁向跨 2 条航线、航向分别跨 1~8 条基线,旁向跨 3 条航线、航向分别跨 6、8 条基线,旁向跨 4 条航线、航向跨 8 条基线,共 18 种布点方案进行光束法区域网平差,然后将剩余的平高点成果与加密的成果进行比较,计算其较差,统计其加密精度。

2.2 野外成果和内业成果兼容性检查

根据全野外布设平高点的点位信息,内业量测各平高点的相片坐标及内外方位元素等数据,采用光束法区域网平差,按照平地对定向点残差的要求,对实验区所有平高点成果和加密数据进行整网平差,剔除定向点残差不符合要求的像控点,然后再重新整体平差,确保外业成果和内业成果的兼容性,为布点方案试验奠定可靠的数据基础。

2.3 加密数据可靠性检验

为保证实验成果的可靠性,克服人为、软件等因素的影响,由测绘院、信息中心按总体的技术思路同时进行加密试验,然后对各种加密结果进行比较分析(测绘院采用 VirtuoZo AAT/PATB 软件加密、信息中心

收稿日期:2011-05-16

采用 Geolord-AT 软件加密), 保留一致性(各种限差、精度指标在规定要求的范围内, 视为一致性。)加密方案的成果, 确保试验布点方案数据的可靠性。

2.4 确定满足要求的布点方案

根据测绘院和信息中心一致性的试验加密成果, 根据地形类别对相片加密点的精度要求, 确定区域网的布点方案。

2.5 实验结果

1) 利用全野外平高点的成果, 转刺在相片数据上, 并量测其相片坐标。将全野外平高点的成果视为真值时, 通过对整个加密区的定向(整网平差), 得到所有定向点的残差, 即可反映平高点转刺、联测的综合精度(如表 2 所示)。

表 2 所有像控点综合精度统计/m

	点数	中误差	较差最大值
平面	148	1.85	2.95
高程	157	0.23	0.49

从精度统计结果可见, 外业平高点的成果与内业加密的观测数据的兼容性很好, 为布点方案实验提供可靠的数据基础。

2) 实验区加密点平面精度统计, 如表 3 所示。

表 3 加密点平面精度统计/m

序号	加密方法	点数	中误差
1	航向跨 2 条基线, 旁向跨 1 条航线。	66	2.23
2	航向跨 3 条基线, 旁向跨 1 条航线。	87	1.95
3	航向跨 4 条基线, 旁向跨 1 条航线。	97	2.19
4	航向跨 5 条基线, 旁向跨 1 条航线。	104	1.99
5	航向跨 6 条基线, 旁向跨 1 条航线。	114	2.19
6	航向跨 7 条基线, 旁向跨 1 条航线。	96	2.24
7	航向跨 8 条基线, 旁向跨 1 条航线。	114	2.14
8	航向跨 1 条基线, 旁向跨 2 条航线。	63	2.27
9	航向跨 2 条基线, 旁向跨 2 条航线。	100	2.23
10	航向跨 3 条基线, 旁向跨 2 条航线。	114	2.14
11	航向跨 4 条基线, 旁向跨 2 条航线。	120	2.17
12	航向跨 5 条基线, 旁向跨 2 条航线。	125	2.13
13	航向跨 6 条基线, 旁向跨 2 条航线。	129	2.35
14	航向跨 7 条基线, 旁向跨 2 条航线。	119	2.27
15	航向跨 8 条基线, 旁向跨 2 条航线。	129	2.21
16	航向跨 6 条基线, 旁向跨 3 条航线。	104	2.29
17	航向跨 8 条基线, 旁向跨 3 条航线。	105	2.17
18	航向跨 8 条基线, 旁向跨 4 条航线。	136	2.17

从精度统计结果可见, 不论采用哪一种加密方法, 均可满足平地对加密点的平面精度要求。

3) 实验区加密点高程精度统计, 见表 4。

表 4 加密点高程精度统计/m

序号	加密方法	点数	中误差
1	航向跨 2 条基线, 旁向跨 1 条航线。	70	0.45
2	航向跨 3 条基线, 旁向跨 1 条航线。	94	0.53
3	航向跨 1 条基线, 旁向跨 2 条航线。	68	0.60
4	航向跨 2 条基线, 旁向跨 2 条航线。	107	0.61
5	航向跨 3 条基线, 旁向跨 2 条航线。	122	0.69
6	航向跨 4 条基线, 旁向跨 1 条航线。	103	0.74
7	航向跨 5 条基线, 旁向跨 1 条航线。	111	0.79
8	航向跨 6 条基线, 旁向跨 1 条航线。	121	0.87
9	航向跨 7 条基线, 旁向跨 1 条航线。	103	0.87
10	航向跨 8 条基线, 旁向跨 1 条航线。	121	0.90
11	航向跨 4 条基线, 旁向跨 2 条航线。	127	0.80
12	航向跨 5 条基线, 旁向跨 2 条航线。	132	0.91
13	航向跨 6 条基线, 旁向跨 2 条航线。	137	1.02
14	航向跨 7 条基线, 旁向跨 2 条航线。	127	0.92
15	航向跨 8 条基线, 旁向跨 2 条航线。	137	1.08
16	航向跨 6 条基线, 旁向跨 3 条航线。	108	1.43
17	航向跨 8 条基线, 旁向跨 3 条航线。	109	1.75
18	航向跨 8 条基线, 旁向跨 4 条航线。	145	1.93

3 布点方案的确定

根据以上实验加密精度统计, 利用航摄比例尺为 1:35 000 的 DMC 数码航摄资料, 制作 1:10 000 DOM 或生产 1:10 000 地形图时, 其外业相片控制测量区域网布点方案如下。

3.1 平高点的布点方案

由于外业像控点主要采用 GPS 的方法进行施测, 能得到高精度的平面坐标, 因此, 在相片条件满足的情况下, 宜尽量布设平高点。在一般情况下, 平高点的跨度为 6 ~ 8 条基线。在特殊情况下, 平地、丘陵地平高点的跨度不得超过 10 条基线、旁向跨度 3 条航线, 山地、高山地平高点的跨度不得超过 12 条基线、旁向跨度不得超过 4 条航线。

3.2 高程点的布点方案

- 1) 平地的高程点采用全野外布点。
- 2) 丘陵地的高程点跨度为 6 条基线, 最大不超过 8 条基线, 旁向跨度为 2 条航线, 特别困难地区, 个别点找不到刺点目标时, 可以不做。
- 3) 山地、高山地的高程点跨度为 8 条基线、最大不超过 10 条基线, 旁向跨度不得超过 4 条航线, 特别困难地区, 个别点找不到刺点目标时, 可以不做。

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他用地减少了 37.35 块/km²。建筑用地在区域内破碎化程度加大,主要是经济发展促使区域内建筑用地比例大幅度增加,斑块个数和面积增大而导致;而其他用地在区域内主要是属于未利用地,在人为活动干扰下,大部分未利用地都逐渐被开发出来,从而导致其逐步转化为其他景观类型,破碎化程度降低。

斑块水平优势度可反映类型在景观中的地位,优势度越大,说明该类型在景观中的地位越重要,对景观的支配作用越大。岳池县优势景观主要为林地(见图2),1993年~2007年,林地优势度呈先降低后增加的趋势,主要是早期树木砍伐严重,且林地大多被开发转化为旱地,后期国家退耕还林政策的开展,林地优势度逐渐增加。岳池旱地和建筑用地优势度呈明显增加的趋势,建筑用地增幅最大,由 0.033 5 增加到 0.137 2,增加了 0.103 6,旱地增加了 0.043 7,而水田优势度呈急剧减少的趋势,减幅达 0.151 3。

2.2 景观格局总体变化特征分析

景观水平上的指数能定量反映研究区总体景观空间格局及变化特征(见图3)。景观多样性是指景观在结构、功能上的多样性,用以揭示景观的复杂程度。在景观多样性的测定中,借助信息论中关于不定性研究方法,即在 1 个景观系统中,景观要素类型越丰富,破碎化程度越高,其信息含量的不定性越大,景观多样性指也越大。1993年~2001年,岳池县景观多样性指数由 1.20 增加到 1.24,主要是由于优势景观林地和水田的大面积减小所致,而在 2001年~2007年其景观指数由 1.24 降低为 1.23,则主要是由于国家退耕还林政策的支持,使得该时间段内优势景观林地面积增加所致。1993年~2007年,岳池县破碎度指数由 0.08 上升到 0.12,这说明了在 1993 年到 2007 年间人类活动的干扰不断加强,尤其是建筑用地大量的增加,以及旱地与林地之间相互转化程度的增加,使得整个研究区的景观破碎化程度增大。

3 结 语

随着时间的推移、人口的增长以及经济的发展,研究区景观斑块由大到小、由少到多的变化趋势反映了随着人类对该区资源不断的开发利用,研究区景观破碎化程度正在逐渐增加,区域受到人为活动的干扰正在加强。为此,必须进一步加强和实施科学管理、有效保护资源,建议加强退耕还林和植树造林的力度,作好生态环境改造规划,并在政策上予以扶持。在城镇建设过程中,注重城镇服务功能与经济结构的改善与提升,避免在城镇规划中对面积盲目求大,充分考虑耕地景观要素类型的敏感性和脆弱性,加强生态建设,尽量将工程建设对自然生态系统的影响降到最低水平,实现研究区生态环境保护与社会经济的协调可持续发展。

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tract hazard anomaly area of earthquake. Results showed that rapid extraction of hazard anomaly area of earthquake by remote sensing technology under multi-scale could solve the problem effectively.

Key words earthquake hazard , hazard anomaly area , change detection , multi-scale segmentation , object-oriented classification (Page:88)

Design of a Web-based Distributed Spatial Data Warehouse Architecture by DONG Xingxing

Abstract It is a key to effectively integrate, storage, management, share, analysis and utilize magnanimous spatial information for the government, public sector and geospatial information services by Internet. Combining the principle of the Distributed Spatial Data Warehouse and the physical demand of the magnanimous distributed spatial data management, this paper put forward a structure of the Distributed Spatial Data Warehouse based on the Web, then it deeply studied the application of the architecture. In network environment, this structure could provide a new way to integrate and shared mass polygenetic spatial data.

Key words Web, distributed, spatial data warehouse, architecture (Page:91)

Route Analysis and ComGIS Application in Shopping Navigation System by YANG Xue

Abstract Because of the rapid development of economy, people call for higher quality of shopping environment. So it is necessary to apply scientific methods and format to improve shopping environment and shopping efficiency. This paper presented the realization of shopping navigation system through ComGIS technology and GIS Route Management. Taking the map of Zhongguancun shopping plaza as base subject, we collected and sorted map data (shops, shopping routes etc.) and designed the Network Data Structure of the plaza based on GIS Logical Network, establishing the e-map data that were suitable to route analysis. To meet the need of intelligence navigation, we applied the classic algorithm of Dijkstra to design three types of Path Analysis Algorithm of Shopping Navigation, namely, Clear-aim, High-efficiency and Killing-time. With C# and ArcEngine9.3 development environment, our shopping navigation system has the function of information inquiring and route managing, having considerable significance to the improvement of shopping environment.

Key words shopping navigation , network analysis , Dijkstra algorithm , ComGIS technology , software development (Page:94)

Land Use Changes Analysis of Mining Area Based on GIS and RS by YAN Lili

Abstract Based on remote sensing imagery data of 1997 and 2007, using the technology method of Remote Sensing (RS) and Geography Information System (GIS), land use change data was obtained by applying the method of supervised classification. According to land use change data, dynamical transition matrix, the amplitude of land use change, dynamical degree and state index of land use were calculated to study and analyze quantitatively land use change. Results were showed out: between 1997 and 2007 year, both farm land and grass decreased largely, the rest increased; the amplitude of garden plot was the largest, and the amplitude of forest was the second; the main transition types: grass transferred to forest and farm land, farm land transferred to forest, grass and garden, LUCC was in a state of unbalance.

Key Words Remote Sensing; Geographical Information System; Land Use and Land Cover; land use change (Page:97)

Analysis Method of the Best Benefit of Water Supply Business Based on Business Intelligence by YU Xianyu

Abstract Water supply system is the important national life infrastructure. The combination of water supply system with network created Water Supply Business Intelligence System. In this paper, based on the basic theory of Business Intelligence and the factual situation of water supply, the operation flow of water supply system and factors affecting water supply were deeply analyzed, the concept of water supply priority and the method of best benefit analysis of water supply enterprise were put forward. In the end, a visualization analysis system of best benefit of water supply enterprise developed by the author based on the Business Intelligence and its application were introduced. The results of application show that the meth-

od of best benefit analysis of water supply enterprise and visualization analysis system are of certain rationality and practicality.

Key words Water Supply Business Intelligence System , data warehouse , water Supply priority , best benefit analysis (Page:101)

Design and Realization of Locust Prevention and Control Auxiliary Information System by LI Jun

Abstract This paper was based on information technology and established a framework of the locust prevention and control auxiliary information system, in order to meet the practical information requirement of the locust prevention. According to the feature of the locusts and the prevention demand, the paper discussed the application of GIS technology in locust prevention and control auxiliary information system, including system architecture, division of functional modules and key technology. Furthermore, this paper designed and implemented the locust prevention and control auxiliary information system. System was able to show the information of sample points, map the locust breeding area, displayed the level of the locust breeding area, calculated and analyzed the status of locusts occurrence, created locust occurrence's map, etc. These information provided scientific proof to the decision making about the prevention of the locust and promote the informatization of the prevention.

Key Words locusts prevention , locust breeding area , the level of occurrence , spatial analysis , GIS (Page:106)

Different Control-point Designs in Certain Areas Based on DMC Digital Aerial Photographic Images by WANG Xiaozhun

Abstract Photograph control surveying is the base work for photogrammetry. It has mature methods of operation and perfect standards and criterions for traditional photograph control surveying. So far it hasn't a corresponding standard or criterion for DMC digital aerial photographic images, in particular it's a blankness for middle and small scale map. According to the peculiarities of DMC digital aerial photographic image and required precisions of 1:10 000 scale topographical map, it summarized the control-point design regularity in certain areas based on instance analysis.

Key words DMC , plan and height control points , base-line , strip-line , lateral error of mean square (Page:109)

Dynamic Analysis of Land Use and Landscape Pattern Change in Yuechi County by LI Ting

Abstract Based on the software of ERDAS IMAGINE 9.0 and ArcGIS 9.3 and remote sensing data of 1993, 2001 and 2007, the landscape changes of Yuechi County was quantitatively analyzed by using supervised classification method and landscape ecology theory. The results showed that the area of arid land, woodland, building land and water body area was increased, and the area of arid land and building land had the biggest amplification in the recent 15 years, increased 110.41 km² and 47.99 km², respectively. While the area of arid land and other land use tending to decrease, and the area of arid land had the biggest amplification of 180.03 km². From 1993 to 2007, the patch density of water body area and other land use decreased, other landscape types increased. Disturbed by human activity, landscape diversity index increased firstly, and then decreased. While the landscape fragmentation index increased.

Key words landscape pattern , patch density , dominance , landscape diversity index , landscape fragmentation index (Page:111)

Comparison of Methods of Coordinate Transformation in NET-RTK Application by ZHANG Quankai

Abstract This article introduced the three methods of coordinate transformation in CORS applications, and analyzed their advantages and disadvantages. It gave some effective proposals for CORS applications.

Key words CORS , coordinate transformation , point correction (Page:114)

Distribution of CH₄ Column in China using SCIAMACHY Data by ZHANG Guojun

Abstract Based on SCIAMACHY sensor, WFM-DOAS method retrieval CH₄ volume mixing ratio, the temporal and spatial variation of CH₄ volume mixing ratio of China, included the eight natural region CH₄ column density