

美国地理空间情报技术变革及陆战场 作战支援研究



路威¹, 赵丽君², 王彬²

(1. 陆军工程大学通信工程学院, 江苏 南京 210001; 2. 32142 部队, 河北 保定 071000)

摘要: 深入分析了美国地理空间情报技术的发展趋势, 重点剖析了美国国家地理空间情报局新规划的情报获取、情报分析和机器增强 3 个方面的关键技术和应用模式, 最后结合陆战场地理空间情报支援特点, 研究了新技术体系可能带来的能力提升。

关键词: 地理空间情报; 马赛克作战; 情报图谱; 机器增强

中图分类号: P208

文献标志码: B

文章编号: 1672-4623(2021)08-0023-04

地理空间情报(GEOINT)是指以精确的地理空间数据为基础, 融合多源情报信息, 通过现代信息分析与可视化手段, 并综合利用大数据和人工智能等先进技术, 进而挖掘并可视化有价值的地理时空信息或作战环境情报的学科和技术手段。它将传统的多源遥感影像、地理数据和各种情报进行有效融合, 并通过二维、三维可视化或虚拟现实方法, 为指挥员和参谋人员提供更准确的作战环境信息, 能更有效地指导决策制定和行动实施。

2018 年和 2019 年, 美国相继发布了《商业地理空间情报战略》^[1-2]、《AIM 倡议-利用机器增强情报战略》^[3-4] 和《国家情报战略》^[5], 明确了未来五年地理空间情报体系的主要任务、具体职责和发展模式, 重点强调了军民融合的情报获取模式和基于 3A 技术(人工智能、自动化和增强)的“利用机器增强情报”(AIM)战略思路, 从而确保情报界的战略竞争信息优势。本文正是基于上述三份纲领性文件, 分析 GEOINT 的内涵和新一代技术体系, 并进一步剖析其在陆战场作战保障的主要服务内容和关键技术。

1 GEOINT 内涵与新一代技术体系

2004 年美国对国防部国家影像与测绘局(NIMA)进行改组, 成立了国家地理空间情报局(NGA), 首次确定了 GEOINT 的概念, 将测绘保障从传统的地图制图拓展到多种测绘产品生产和地理空间情报提供领域, 为测绘学科赋予了新的职能。其在 2006 年发布的《地理空间情报基础学说 1-0》中定义, GEOINT 是“对影像与地理空间信息进行开发处理与分析研究, 以描述、

评估和可视化地表示地球上的物理特性及与地理相关的活动。空间地理情报由影像、影像情报和地理空间信息构成”^[6-7]。

近年来美军认为世界战略环境与战略威胁日趋多样化, “多域作战”、“马赛克作战”等^[8]新一代作战理念正发展成熟, 将颠覆传统作战模式, 以跨域、分布、协同、智能、无人、高速为特征的下一代战争模式已呼之欲出。这些将对 GEOINT 系统快速收集、处理、评估、分析数据的能力提出了挑战。为此, 情报部门应高度重视在天基平台、网络空间、大数据、人工智能等新兴领域寻求颠覆性技术创新, 以支持获取自身的战略竞争信息优势, 融入了人工智能、大数据、天空一体化内容的 GEOINT 技术体系将发生重大变化。下面从 GEOINT 的采集手段、作战融合、情报挖掘和产品分发四个方面分析其面临的变革。

1.1 GEOINT 情报采集向“马赛克”模式发展

美军传统 GEOINT 的情报数据主要来源于人工情报、航空情报和地面情报 3 种模式, 其中, 各种天基/航空平台提供的航空情报是主要的情报源。但随着战争环境的多域化发展, 当前的天基/航空平台在覆盖上已无法满足快速响应需求, 并且现有的商业侦察卫星重量和成本正逐渐减少, 性能指标大幅提升, 在全球覆盖成像方面的优势显著凸显。因此, NGA 下一步将采用“马赛克作战”的理念, 将发展重点从过去的高科技平台转变为多碎片的网络化交织集成, 即将军用、商用侦察卫星, 高空侦察平台、无人机遥感勘测、地面单兵勘测等作为系统中独立的“马赛克碎片”, 通过网络链路将这些“碎片”有机地融合在一起, 形成数据互通、弹性组网、灵活机动的网络化结构体, 并针对

收稿日期: 2020-04-24。

项目来源: 国家自然科学基金资助项目(61971440、61931011)。

战场动态变化进行数据流传与合作,实现“马赛克”式的情报获取(图1),达到缩短流传节点,提高系统可用性的效果,通过网络化集成产生非线性增长效果,最终重拾战略情报获取的“不对称优势”。同时明确商业卫星和无人机遥感勘察是最具有发展潜力的“碎片”单元,NGA在未来地理空间情报搜集上将充分添补这两种方式,实现快响型测绘并提升搜集数据的准确性,为军方战争作战行动奠定情报基础。马赛克情报网的重点是体系的消耗性和协同共享能力。可消耗性是指平台的快速生产和补充能力。传统的侦察卫星虽然性能先进,但体积庞大而昂贵,生产周期长,体系组网和作战应用时不具备可消耗性,新型的商业小卫星和无人机平台,体积小成本低,集群组网、协同智能、成像精度和平台稳定性逐渐增加,可作为理想、大量消耗的“马赛克碎片”。协同共享是指体系中的碎片单元通过网络交织集成,并通过协同意图、协同策略等具体算法组成“情报协同网”,最终增强体系的情报获取能力。

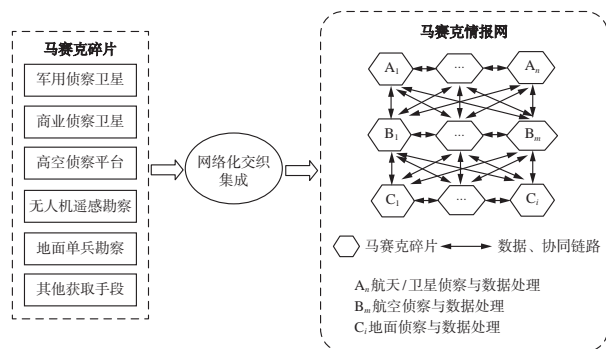


图1 马赛克情报网架构图

1.2 情报单元间更强调“增强协同融合”的发展

随着商业卫星和无人机平台投入使用,情报的数据将急剧增加,传统的信息流传网络将无法快速响应需求,需要新的、增强型的协同机制与之配合,具体可以从以下几个方面进行增强。

1) 协同融合模式。情报单元间的协同融合过程,涉及到碎片与碎片、碎片与系统之间的融合交互。根据碎片在协同融合过程中的主动意图,可以将协同融合过程分为显式和隐式两种模式。

显式的协同融合模式是指碎片通过直接或间接的方式与其他碎片进行数据流传与合作、分配搜索任务等功能。显式模式下,所有碎片单元以公共的情报需求为基础,通过信息需求进行协同融合。信息需求可能随时间和已经获取的信息而进化,但在整个融合任务过程中,该信息需求为网络内所有单元所共享并驱动协作单元的融合过程。显式协同融合的最大特点是为具有相同信息需求的单元群提供一系列支持协调融

合行为的功能。隐式的协同融合模式旨在为每个碎片捕获情报关键词,同时整合兴趣信息,并利用信息关联等方法定位与某一个或某一组碎片有关的其他碎片的相关搜索信息,进而优化碎片间的协同融合。这类协同融合模式是个性化网络融合过程,依据单元的需求定制细粒度的链接与共享信息。隐式协同融合不但利用与碎片有关的局部性趣信息,而且融合与碎片有关的其他碎片的信息,通过协同其他碎片的信息来提高协作双方的融合程度。此外,隐式融合还通过追索和重用碎片的历史兴趣信息来提高单元协同效率。

2) 协同融合策略。调度碎片之间的协同策略需要进一步采用先进的底层协同调度算法。例如,协同过滤和推荐算法,可进一步利用碎片的情报索引需求,建立公共服务节点,并将捕获到的关键信息上传至服务节点,服务节点利用碎片的个性化需求和历史兴趣信息,通过对当前碎片和关联碎片的捕获信息进行加工与整理,形成推荐信息,并通过网络体系传送给碎片,使其与捕获引擎默认的返回结果进行有机集成。这不但为碎片推荐了其他碎片的相关历史兴趣信息,也为碎片避免重复分析以前分析过的情报内容起到提醒作用。如商业卫星平台、军用卫星平台侦察到类似的情报信息,则可以将已挖掘的信息推荐给双方单元进行比对,进一步分析战场环境的变化信息。

1.3 情报分析突出“机器增强”的3A模式

NGA认为,在多域作战环境中,原始情报数据内隐含的可用信息将以指数级增长,远远超出了人机交互分析处理的能力,如何合理利用3A技术(人工智能 Artificial Intelligence、自动化 Process Automation 和情报人员增强 Intelligence Community officer Augmentation)增强情报分析效率是未来占据信息不对称优势的关键。

人工智能情报增强主要侧重智能分析和智能决策^[9],以情报大数据^[10-11]、情报云等平台为基础,建立情报图谱^[12]和作战应用模型,加深机器学习、智能计算、数据挖掘等关键领域的研究攻关和技术突破,实现多模异构、多维互联、自动研判的“人工智能+”型情报分析体系。

情报智能分析,也称为智能情报体系的“脑层”,指利用人工智能的高性能运算功能,以情报图谱为基础从海量、多模态情报数据中挖掘信息并建立相关的情报图谱,进行情报信息有效管理与结构化表征,组成智能分析结构数据,实现对海量信息的学习、加工、识别与挖掘,进而提高情报分析过程的智能性,同时也提升了情报分析结果的客观性。重点需要突破认知

模型和类脑智能算法,即如何在统一图谱空间内,利用类脑算法和情报图谱技术实现多模态情报信息及其关系间的组配,完成挖掘信息与源数据间的智能提取。

情报智能决策,指利用人工智能的推理与决策能力,提供并优化多模态情报决策结果。在情报图谱和类脑算法实时学习的基础上,利用深度确定性、策略梯度、各种深度决策网络,启动动态融合的地理空间情报感知,通过多维分布式深度学习方法,产生并优化多样化情报推荐策略。

图2是人工智能的情报增强架构,其中数据平台和情报图谱为后续的智能分析提供基础平台和模型,智能分析是架构的核心和“脑层”,新近提出的类脑理论,可作为增强型方法改善现有分析手段,智能决策层最终输出决策结果或分析策略。

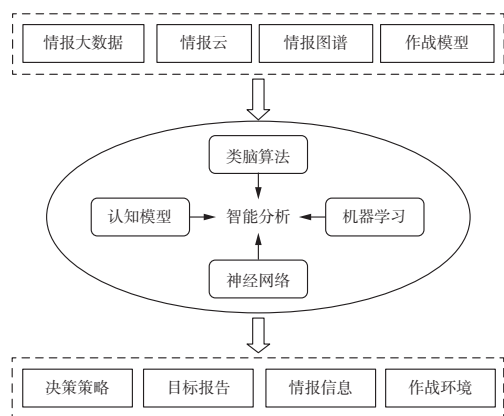


图2 人工智能情报分析架构

情报分析自动化是指在尽量少的人工干预情况下,利用智能硬件自动完成情报检索、情报分析和情报决策的整体流程,其可以解决海量原始数据和决策生成之间的失衡问题,可对各个单元和资源进行优化配置,提高情报挖掘的效率。情报分析自动化的过程主要是基于数据的规律,对数据进行加工处理、分析挖掘,而这些规律就是知识,包括有效数据的判别与筛选知识、数据结构的相关知识、多源数据的融合知识,信息甄别知识、相关性判断知识、计量分析知识,以及自然科学和社会科学等专业领域知识。自动化实现过程中,不管是采用机器学习的方式分析情报之间关系,还是人工构建情报知识库,都是为了让系统具有更好的自动化处理效果。自动化的程度与情报智能分析方法的进展密切相关,这需要梳理情报任务所面向行业的知识体系,将各类数据库整合为统一的情报图谱,并利用知识图谱技术实现行业情报的推理与应用。

情报人员需要增强推广联合化和融合式培养模式,规范军事情报培训规范,增加军种交流等措施。此外,

还应丰富情报人员的效能考核方式,一方面,设立专门的评估机构,如美国空军设立的“情报训练顾问委员会”,该委员会专门设立了教育与训练处,负责调查各统计空军情报部门的反馈意见,根据反馈明确情报训练的新内容,明确情报教育与情报需求间的一致性;另一方面建立教育培训与考核制度,如美国陆军情报中心与学校制定的教育培训与考核制度——“训后评估”,设立不同的学员评价标准和考核制度,致力于教学质量的提升。更重要的是设立培训效果认证制度,认证过程由专业的陆军各院校的权威专家组成,并且认证程序极为严格。美国军事情报训练的资格认证体系成为美军完善教学内容,提升教学质量的重要方面。

2 新 GEOINT 体系对陆战场作战支援能力提升

2.1 提升陆战场地理数据获取与集成式管理能力

地理空间数据是地理空间情报基础,是客观描述陆战场地物地貌、气象水文和时空分布的重要依据。目前,陆战场的地理空间数据可分为四级比例尺模式,分别是战略级(1:100万比例尺)、战役级(1:25万比例尺)、战术级(1:10万至1:1万比例尺)和城市级(≥ 1 万比例尺)。NGA传统的卫星影像很难满足城市级影像的实时更新,新的体制中,商业卫星、低轨小卫星的加入将有效提高大比例尺影像数据的获取能力,并且做到全天候、近实时、全球无缝的覆盖。这些大比例尺数据可有力支撑陆战场的战术级作战,分发给各保障部门作为生产通用态势图的基础,包括扫描的数字地图、高程数据、影像以及要素数据。

地理空间数据的管理需要依托企业级地理空间数据库,并利用基于大数据和云技术的地理空间情报集成平台,进而实现多军种、多层次和全域的地理空间数据分发服务,确保各类部队在遂行多种任务时可共享地理空间数据库。作战部署前,地理空间情报可根据战场环境特点完成数据库的大部分开发工作。作战部署准备阶段,作战部队获取多元地理空间数据,并装载到陆战场保障服务器中。作战部署后,可根据环境变化特点细粒度更新数据库或采集新的缺失数据(例如,卫星无法获取的有遮挡区域或地下设施),以便于制作地理空间产品。形成数据获取、数据使用、数据更新的应用流程。

2.2 提升陆战场环境分析与虚拟可视化能力

NGA认为,战场环境分析是智能情报分析重点解决和突破的环节,智能化情报分析与决策提出是地理空间情报对陆战场作战支援的高级形式^[13]。

情报图谱的优势在于对自然化语言描述的内容进行建模和描述,而作战环境分析考虑的地物、地貌和气象条件及其变化等要素非常适合产生情报图谱。例如,研究陆地战场环境空间特点,并分析其如何随作战态势发生变化时,通常地形与天气是环境中对作战影响最大的两个自然条件,因此在作战环境分析时应综合各种地形和气象因素,其中作战环境分析应考虑的天气因素包括气温、湿度、降水量、能见度、风速和云量,地形分析评估自然和人工地物的主要方面包括水文、地势、土壤成分、植被、障碍物和人工地物。这些自然化的语言要素模式,可充分利用情报图谱进行建模和描述,进而利用智能分析产生决策信息。

3A 增强中的自动化可有力支撑陆战场环境的可视化。战场环境可视化是对作战环境中自然要素分析的艺术化呈现,是辅助指挥决策的重要技术之一,影响到指挥员对地形、气候的理解和对态势的认知,包括环境对于敌我能力的影响。

自动化技术提供的环境可视化产品将更多地考虑人的理解和研判要素,其所表现的自然环境信息必须使指挥员和参谋易于解读,进而辅助他们更好地认识作战环境并实施决策。例如,针对美军的标准地理空间产品和专题地理空间产品,可按各自生产标准组成自动化流程,基于情报分析层提供的具体信息组织自动化生产,可按类别提供通用联合作战图、航空图、地形线划图和地理地势图等;另外,针对专题地理空间产品,采用自动化的制图综合流程,提供越野机动图、交通线图、水文分析图、植被分析图、土壤地质图、炮兵射程图、地势坡度色调图、地表物质图、建筑资源图、晕渲地貌图等。此外,还可结合 VR 技术自动化建立虚拟战场环境。

2.3 提升陆战场作战态势支援能力

地理空间情报态势支援指通过战场情报准备以提高指挥员对战场环境的认识,进而增加其对战场态势的理解。机器增强模式在增强地理空间情报的分析和可视化能力同时,将各种原始信息资料与协作分析的单元、流程和工具整合起来,构建基于情报大数据、情报云的态势支援体系,地理空间情报分析单元需要融合指挥员的决策需求和研判习惯,确定地理空间信息需求和作战决策对于专题地理空间产品的需求。指挥人员可以将智能化地理空间情报体系提供的信息依次吸收到他们的运行评价中,依据作战专业知识和战场的影响评估友军和敌军的能力,确定对作战的影响,最终从整个共享信息中提炼出通用作战图并实现态势理解,如图3所示。

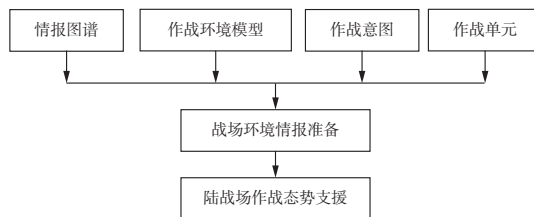


图3 地理空间情报陆战场态势支援流程

3 结 语

NGA 的运作成功是美军全球作战中对时空基准、战场环境、地理情报需求增长的必然,NGA 的技术体制对未来的测绘导航行业发展有很强的借鉴作用。随着人工智能、大数据等新兴科技发展和作战保障改革的深入,陆战场测绘导航部队的保障模式将从单一的生产保障型向生产和遂行保障型进行转变,研究 NGA 地理空间情报体系和未来发展趋势,从中发现地理空间情报保障与陆战场作战保障的可能结合点,对陆军的作战环境态势保障有很好的指导作用,并推进现有测绘导航保障模式的转变。陆战场作为军队实施地理空间情报保障的重要区域,如何融合人工智能、大数据等新兴技术、提高作战保障能力、推出满足作战和训练需要的地理空间情报服务与产品,是亟待解决的问题。

参考文献

- [1] 龚燃. 美国发布新版《商业地理空间情报战略》[J]. 卫星应用, 2019(2): 56-59
- [2] 郑宇文, 陈建光. 美国新版《商业地理空间情报战略》概要[J]. 国际太空, 2019(1): 52-55
- [3] Dan C, Susan G. The AIM Initiative: A Strategy for Augmenting Intelligence Using Machines[R/OL]. Director of National Intelligence. (2019-01-16) [2020-02-01]
- [4] 陈超. AIM-“利用机器增强情报”[J]. 竞争情报, 2019, 15(2): 1
- [5] 孙江. 美国地理空间情报的发展[J]. 外国军事学术, 2007, 41(6): 64-66
- [6] 周春平. 地理空间情报学[M]. 北京: 国防大学出版社, 2016
- [7] Timothy G. Mosaic Warfare and Multi-domain Battle[EB/OL]. Defense Advanced Research Projects Agency/(2018-09-05)/[2020-02-01]
- [8] 化柏林, 李广建. 智能情报分析系统的架构设计与关键技术研究[J]. 图书与情报, 2017(6): 74-83
- [9] 化柏林. 科技信息大数据在情报研究服务中的应用[J]. 图书情报工作, 2017, 61(16): 150-156
- [10] 肖恩·汉密尔顿, 迈克尔·克鲁泽. 信息时代美国空军情报的当务之急-大数据[J]. 军事文摘, 2019(7): 52-55
- [11] 漆桂林. 知识图谱研究进展[J]. 情报工程, 2017, 3(1): 4-25
- [12] 刘妍, 赵新国, 韦韬. 美国地理空间情报作战应用及启示[J]. 装备学院学报, 2013, 24(1): 128-131

第一作者简介: 路威, 博士, 副教授, 主要研究方向为测绘导航信息保障, 战场环境保障。

Collaborative Dynamic Update of Planning One Map Based on Attribute Constraints

by ZHANG Xiuqing

Abstract In this article, we introduced the dynamic update mode, process, method and implementation in detail, including data structure constraints, process establishment, front-end editing tools and background storage update tools, so that different professionals and different division of labor planning and database management personnel could cooperate with each other orderly, which could realize the automatic update of the "One Map" results, improve the efficiency of operations, and truly achieve a blueprint to the end.

Key words One Map, dynamic update, attribute constraint, collaborative update (Page: 1)

Evaluation of Land Resources Audit System of Outgoing Officials

by ZHOU Songshan

Abstract Under the background of ecological civilization system construction, land resources audit of outgoing officials has entered a comprehensive auditing stage from the pilot stage. At present, a complete set of auditing indicators, auditing standards and evaluation system for land resources audit of outgoing officials has not yet been formed in the practical work. As the most concerned content of government departments, land resource is also one of the key contents of outgoing audit. In this paper, based on the objectives, contents and research status of land resources audit of outgoing officials, we used analytic hierarchy process (AHP), expert investigation and measurement comparison to construct an evaluation index system for land resources audit of outgoing officials based on geographical conditions monitoring. This system includes one target layer, four subgoal layer and twenty three Index levels. Finally, we applied this system into validating land resources audit of outgoing officials in a county. Practical results show that the evaluation index system can serve the work of land resources audit of outgoing officials well, and provide assistant decision support for audit department.

Key words geographical conditions monitoring, leading official, natural resource assets, outgoing audit, index system (Page: 4)

Evaluation Method of the Urban Spatial Suitability and Its Application

by HE Lihua

Abstract Focusing on the influence factors of urban spatial suitability evaluation, we proposed the evaluation indexes from the constraint of resource and environment and the suitability of social and economic development foundation. Based on the fundamental geographical information data, geographical conditions census and monitoring data, land use change survey data and socio-economic statistics data, we clarified a specific method of index calculation, which could realize the division of development and utilization level. Taking the specific research area for example, we analyzed the application results of this method, and proposed several indications for further improvements.

Key words urban space, suitability, evaluation, classification (Page: 9)

Research on the Distribution Characteristics of Chengdu's Night Economy Based on Microblog Sign-in Data

by JIN Xin

Abstract Taking Chengdu as the research area, we used Python crawler tools to try to identify the spatio-temporal distribution rules and characteristics of night economy in Chengdu, which could provide a reference for the optimization of night economy development in Chengdu. The results show that Chengdu's night economy generally exhibits a four-level spatial pattern of "central aggregation, continuous expansion, and multi-point distribution" in space. The types of night economic places in hotspot areas of different levels are different, showing a characteristic of the highest activity on weekends and the lowest activity on weekdays. On the basis of this, we carried out a further comparative study of the spatio-temporal differences in the night consumption of local residents and tourists in Chengdu. It is found that the local residents participate in the night economy in a relatively concentrated area, mainly within the second ring road, and the active time is relatively short, mainly from 18:00 to 2:00. The areas where ecademic tourists participate in the night economy are more scattered, mainly distribute in the areas around schools, scenic spots and traffic station, and the active time is slightly later than local residents. Based on the above research results, we put forward some countermeasures and suggestions for the further development of night economy in Chengdu.

Key words microblog sign-in, night economy, spatial analysis, series analysis, Web crawler (Page: 13)

Design of Monitoring and Supervising Information System of Land Consolidation and Rehabilitation of Guangdong Province

by LI Lifan

Abstract Through analyzing the business requirements and policy requirements of the land consolidation and rehabilitation work of Guangdong Province, we designed the overall architecture and the functions of the system. This system not only realizes the full life cycle management of five kinds of land consolidation and rehabilitation projects, but also provides thematic analysis and auxiliary verification function based on one map of remote sensing monitoring of land and resources. In addition, considering that the system undertakes the land consolidation business of different departments in the province, this system designs and implements the cross-department user management, and realizes the cross-department data sharing by the advanced hardware and software technology.

Key words land consolidation and rehabilitation, monitor and supervise, system design (Page: 19)

Research on Challenges of US Geospatial Intelligence Technology and Support for Land Battle

by LU Wei

Abstract In this paper, we deeply analyzed the technological development of US geospatial intelligence system in future, and focused on the new key technologies and application patterns of intelligence acquisition, intelligence analysis and machines augmenting that proposed by National Geospatial-Intelligence Agency. Finally, combining with the characteristics of land battle geospatial intelligence supports, we researched the potential capability enhancement caused by new technology system.

Key words geospatial intelligence, mosaic warfare, intelligence graph, machines augmenting (Page: 23)

Discussion on Method for How to Determine the Boundary of Study Region

by DU Qingsong

Abstract In order to express scientifically the mapping in the research area, based on the commonly used mapping software ArcGIS10.5 and Google Earth Pro, we proposed a method for selecting the boundary of the study area accurately and quickly and expressing accurately in the cartography. Taking the distribution map of the Tarim Basin, the display of Qinghai Lake on Google Earth Pro, and the distribution map of DEM and Tianshan in Xinjiang for example, we described this method in detail, which could provide a method for the scientific researchers to accurately draw the study area in the practical work.

Key words study region, boundary, mapping, method (Page: 27)

Application of Combination Model in the Tunnel Structure Settlement Prediction

by GE Wen

Abstract Aiming at the shortcomings of the traditional combination model, such as single modeling criterion and the fixed weight, we introduced the stability related theory into construct a new optimal combination forecast model, and studied the judgment method of the superior combination model and the evaluation criterion of the prediction results. The core idea of this model is to give weights according to the consistency of the accuracy of the modeling and prediction stages of a single model. Then, we used the combination model, time series model and neural network model to predict the settlement of subway tunnel structure, and analyzed and compared the prediction results of each model. The results show that the combination model has higher prediction accuracy, and is an effective model for predicting the settlement of subway tunnel structure.

Key words stability, combination model, subway structure, settlement prediction (Page: 31)

Research on Dynamic Subsidence Characteristics of the Yushen Mining Area Based on SBAS-InSAR

by LI Xiaotao

Abstract In this paper, taking the mining subsidence monitoring of Yushen mining area as the research object, we used the small baseline set (SBAS-InSAR) technology and singular value decomposition algorithm to obtain the time series LOS deformation during the advancement of Jinjitan 106 working face, and extracted the actual surface subsidence. This study reveals the dynamic trend and deformation range of surface deformation with time and working face advancement from the space, and applies this scheme to remote sensing monitoring of large-scale time series deformation in mining areas, which can provide an effective technical method for inverting the mining conditions and surface movement parameters of the underground working face by the surface deformation information, and have a good reference value.

Key words D-InSAR, Yushen mining area, subsidence monitoring, Sentinel-1A image; time series analysis (Page: 35)

Research on Urban Isochronous Transportation Circle Based on Internet Big Data

by WANG Hui

Abstract Transportation system is one of the important areas of urban research. With the acceleration of urbanization, traffic pressure is increasing, and traffic congestion occurs from time to time. In response, the Ministry of Transport issued the "Three-year Action Plan (2018-2020)", focusing on promoting the construction of comprehensive transportation infrastructure, accelerating the construction of integrated transportation, and creating a "one-hour traffic circle". For the research of isochronous traffic circle, the traditional research method based on GIS spatial analysis is difficult to consider the actual situation and cannot really reflect the urban traffic situation. In this paper, we proposed a new research method supported by big data technology. Based on the isochronous traffic circle, we added real-time traffic data provided by Baidu Map, and taking Guangzhou as a research area, analyzed the traffic congestion current situation of Guangzhou city from multiple periods and dimensions, which had certain reference significance for the traffic development of Guangzhou City.

Key words isochronous traffic circle, GIS, Internet big data (Page: 39)

Application of PPK in sUAS Aerial Survey and Its Accuracy analysis

by LIU Jianpo

Abstract In this article, we explored the use of GNSS dynamic post-processing (PPK) technology to obtain geographic registration without using GCP. Then, we compared the results of geographic registration with precise positioning images based on GNSS real-time kinematics (RTK) technology with the checkpoints collected by ground GNSS-RTK technology. The results show that under the premise of camera calibration, the geographic registration results with precise positioning images obtained by relying solely on PPK technology can also achieve centimeter-level positioning accuracy. The conclusions of this study can help practitioners conduct aerial survey of sUAS.

Key words PPK, RTK, sUAS, Georeferencing, precision analysis (Page: 42)