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Research on Process Optimization and Project Management of Map Data Production Driven by AI Technology

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Abstract: With the rapid development of artificial intelligence (AI) technology in China, it has brought new ideas and tools for the upgrading of the geographic information industry. As an important carrier of geographic information services, map data production efficiency, accuracy, and scientific project management largely determine the quality of geographic information services. This paper systematically studies AI-driven process optimization by integrating core theories of project management and artificial intelligence technology. The results show that the integration of AI technology into the whole process of map data production can effectively shorten the production period, reduce project costs, improve data quality, and realize refined and intelligent management of map data production projects, providing practical references for the intelligent transformation of surveying and mapping geographic information enterprises.

Keywords: AI technology; Map data production; Process optimization; Project management; Intelligent production

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1. Introduction

1.1. Research background

In recent years, the application of artificial intelligence, deep learning, computer vision and other technologies in the geographic information field has been deepened. They have shown significant advantages in automatic extraction of map elements, intelligent data quality inspection, automatic scheduling of production processes, etc., providing technical possibilities for breaking the bottlenecks of traditional map data production and realizing process reengineering and project management upgrading. Against this background, exploring the path of AI-driven map data production process optimization and integrating project management theory to achieve full-process refined control has become an inevitable trend in the development of the surveying and mapping geographic information industry.

1.2. Research significance

Combined with actual map data production scenarios, the AI process optimization scheme proposed in this paper has strong implementability and operability, and can be directly applied to the production practice of surveying and mapping enterprises. By optimizing the production process and reducing manual repetitive labor, it can effectively improve the efficiency of map data production, shorten the project period, and reduce labor and time costs. At the same time, with the help of AI technology to realize automatic quality control and intelligent project scheduling, it improves the refinement level of project management, guarantees the quality of data results, helps surveying and mapping geographic information enterprises break through the bottlenecks of traditional production models, adapt to the trend of intelligent development, and enhance the core competitiveness of the industry.

2. Theoretical foundations

2.1. Theories related to map data production

Map data production is the process of generating geospatial data that meets application needs through a series of procedures, such as data collection, processing, quality inspection, and storage in accordance with established geographic information standards and specifications, which is the core business of the surveying and mapping geographic information industry. Its core procedures mainly include the following five links [1-3]:

(1) Data collection: Obtain original geospatial data, including image data, vector data, elevation data, etc., through remote sensing satellites, unmanned aerial vehicles, ground surveying and mapping, crowdsourced data collection, etc., which is the basic link of map data production.

(2) Data processing: Carry out correction, mosaicking, element extraction, editing, topology checking and other operations on the original collected data to convert the original data into standardized map vector data.

(3) Quality inspection: Verify the integrity, accuracy and consistency of the processed map data in accordance with industrial quality standards, correct data errors, and ensure that the data results meet delivery requirements.

(4) Data storage: Classify and organize the qualified map data after quality inspection in accordance with unified standards, and input them into the geographic information database to realize standardized data storage and management.

(5) Result delivery: Sort out data results, technical reports and other materials according to project requirements, deliver them to the client, and complete the project closing work.

Map data production is characterized by strong professionalism, high collaboration and close procedure relevance. Any problem in any link will affect the progress of subsequent procedures and the quality of final results, so a sound project management system is needed to achieve full-process control [4].

2.2. Core theories of project management

Project management is the process of using special knowledge, skills, tools and methods in project activities to enable the project to meet or exceed the set needs and expectations under the limitation of limited resources. The core elements of map data production project management include five aspects: schedule management, cost management, quality management, risk management and resource management [5–7].

(1) Schedule management: Formulate a project schedule, clarify the time nodes of each procedure, track

the project progress, adjust the lagging links in a timely manner, and ensure the on-time delivery of the project.

(2) Cost management: Calculate the labor, equipment, time and other costs of the project, formulate cost control objectives, optimize resource allocation, avoid unnecessary cost consumption, and maximize project benefits.

(3) Quality management: Establish a quality control system, clarify data quality standards, supervise the quality of the whole production process, and ensure that the data results meet industrial specifications and project requirements.

(4) Risk management: Identify potential risks in the project implementation process, such as technical risks, personnel risks, schedule delay risks, quality risks, etc., formulate risk response measures, and reduce the impact of risks.

(5) Resource management: Reasonably allocate production resources such as personnel, equipment and data, optimize task allocation, improve resource utilization efficiency, and ensure the orderly progress of each procedure.

The core goal of project management is to achieve a balance among project schedule, cost, and quality through scientific control, and improve the overall implementation effect of the project [8].

2.3. Applied technologies of artificial intelligence in map data production

Artificial intelligence is a technical science that simulates, extends and expands human intelligence. In map data production, the core applied technologies include deep learning, computer vision, natural language processing, intelligent scheduling algorithms, etc. The specific application scenarios are as follows [9]:

(1) Automatic map element extraction technology based on deep learning: Use deep learning models such as convolutional neural networks to interpret remote sensing images and unmanned aerial vehicle images intelligently, automatically identify map elements such as roads, buildings, water systems and vegetation, realize automatic extraction of vector data, replace traditional manual drawing, and greatly improve data processing efficiency.

(2) Data intelligent quality inspection technology driven by computer vision: Automatically check map data through computer vision algorithms, quickly identify problems such as missing drawing, wrong drawing, topology errors and attribute errors of data, generate quality inspection reports and error location, replace traditional manual spot-by-spot inspection, and improve the efficiency and accuracy of quality inspection.

(3) Intelligent task scheduling and progress prediction technology: Based on artificial intelligence algorithms, automatically assign production tasks according to the professional ability, workload and procedure priority of production personnel. At the same time, combined with historical project data, it can predict the progress time of each procedure, track the project progress in real time, warn of schedule delay risks in advance, and realize intelligent control of project progress.

(4) Automatic data processing technology: With the help of AI automation tools, realize automatic correction, mosaicking, and format conversion of original data, reduce manual intervention, simplify the data processing process, and improve the efficiency of the procedure connection.

The above AI technologies can effectively break the technical bottlenecks of traditional map data production and provide core technical support for process optimization and project management upgrading.

3. Analysis of pain points in the traditional map data production process and project management

3.1. Pain points in the traditional map data production process

(1) High manual dependence and low production efficiency: Data processing and quality inspection links are highly dependent on manual work. A large amount of manpower is required for large-scale tasks, with slow operation and prone to errors. Repeated quality inspection and modification significantly prolong the construction period.

(2) Poor process connection and low collaboration efficiency: Each link operates independently. Data transmission and task feedback rely on manual communication, which is prone to information lag and handover errors. The waiting time for procedures is long, and the overall coherence is poor.

(3) Poor stability of data quality: Quality depends on the professional level and sense of responsibility of personnel, with inconsistent standards. Problems such as missing drawing, wrong drawing and non-standard attributes are prone to occur. Manual quality inspection has blind areas, and quality consistency is difficult to guarantee [10].

3.2. Pain points in traditional map data production project management

(1) Difficult schedule control: Rely on manual tracking and regular reporting, unable to grasp the progress of each procedure and each personnel in real time. Lack of a scientific prediction mechanism, prone to lose at first and tighten at last, and delayed delivery.

(2) Imperfect quality management system: Focus on post-quality inspection, with late error discovery and high modification cost. Quality assessment is difficult to quantify, and early prediction and process control cannot be realized.

(3) Backward risk management and resource management: Risk identification relies on experience, making it difficult to predict in advance. Resource allocation lacks a scientific basis, with uneven tasks, coexistence of idle and overload, and low utilization efficiency [11].

4. Construction of an AI-driven map data production process optimization and project management model

4.1. Process optimization objectives

Focus on solving traditional pain points, follow industrial specifications and national geographic information standards, ensure the standardization and universality of data results, and realize the intelligent upgrading of production processes with the help of AI technology [12].

4.2. AI-driven map data production process optimization design

Construct a brand-new process of "automatic collection + intelligent processing + intelligent quality inspection + integrated management and control". The optimization points are as follows [13,14]:

(1) Optimization of data collection link: AI tools integrate multi-source data to realize automatic acquisition, classification and preprocessing, automatically complete correction, mosaicking and denoising, and improve the quality of original data.

(2) Optimization of data processing link: Adopt deep learning models to extract map elements automatically. AI tools complete topology checking and correction, with only a small amount of manual fine-tuning,

greatly reducing manual workload.

(3) Optimization of quality inspection link: Build an AI intelligent quality inspection system, conduct automatic verification in accordance with national standards, locate errors, generate quality inspection reports and modification suggestions, and automatically recheck after modification, improving the efficiency and accuracy of quality inspection.

(4) Optimization of data storage and delivery link: AI tools automatically classify, convert formats, standardize attributes, complete storage, and automatically generate technical reports and result lists, simplifying the closing work.

(5) Optimization of process collaboration: Build an AI integrated production management platform, connect data and task channels, realize automatic procedure connection and real-time information synchronization, break link barriers, and improve collaboration efficiency.

4.3. Construction of a map data production project management model integrated with AI

(1) AI-driven schedule management: The platform collects progress data in real time. AI algorithms compare the planned and actual progress, analyze deviations, warn of delays, automatically adjust nodes, and assist decision-making to ensure on-time delivery.

(2) AI refined cost management: AI algorithms count various costs in real time, compare with control objectives, and warn of overspending risks. Intelligently allocate manpower and equipment, reduce waste, and realize dynamic cost control and refined accounting.

(3) AI full-process quality management: Establish a dual system of "process control + intelligent quality inspection". AI supervises each link in real time, records quality data, quantifies assessment, and gives early warning, ensuring data quality from the source.

(4) AI intelligent risk management and resource management: AI algorithms automatically identify potential risks and generate evaluation reports and response plans. Automatically assign tasks according to personnel ability, workload and priority to realize optimal resource allocation.

5. Conclusion and prospect

5.1. Research conclusions

(1) The traditional map data production process is difficult to adapt to the intelligent development needs of the industry.

(2) AI technology has significant advantages in element extraction, intelligent quality inspection, task scheduling, progress prediction, etc., which can realize full-process automation and intelligence and break through traditional bottlenecks.

(3) The integrated model of "AI technology + process optimization + project management" can realize intelligent and refined management of schedule, cost, quality, risk and resources, effectively balance core project indicators, and improve implementation effects [15].

5.2. Research limitations

This paper has certain limitations: first, it focuses on the application of existing AI tools and algorithms, and does not carry out algorithm innovation research; second, it does not continuously track the long-term operation effect of the intelligent management model.

5.3. Future prospect

In the future, map data production will develop in the direction of full-process, unmanned, intelligent, and real-time. In the follow-up, the scope of cases can be expanded to adapt to different project types and scales; deepen AI integration and innovate high-precision and high-efficiency interpretation algorithms; combined with big data and cloud computing, build a cloud-integrated production and management platform to promote the comprehensive digital and intelligent transformation of the industry.

Disclosure statement

The author declares no conflict of interest.

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