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Analysis of GPS Technology in Surveying and Mapping Engineering Technology

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Abstract: With the rapid advancement of digital and information technology, global positioning system (GPS) technology has seen increasing utilization in surveying and mapping engineering, extending its application across land, ocean, and various other domains. By analyzing the technical means of GPS in surveying and mapping engineering, understanding the characteristics and key technologies in different application environments, and exploring the application process and key technical means, accurate control can be effectively realized. Based on this, this paper mainly analyzes the specific application of GPS technology in surveying and mapping engineering technology for reference.

Keywords: Surveying and mapping engineering technology; GPS technology

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1. Introduction

Technology can be combined with a variety of technical means to achieve accurate positioning analysis, based on satellite positioning and other technologies for processing, build a three-dimensional model, and achieve visual analysis. Reasonable application in surveying and mapping engineering can effectively improve comprehensive quality and efficiency. GPS technology has the advantages of convenient operation and high precision and is widely used in various fields. Reasonable application in surveying and mapping engineering can effectively improve the quality and efficiency of surveying and mapping, which is conducive to the intelligent development of surveying and mapping engineering.

2. Function of GPS technology in surveying and mapping engineering technology

GPS technology, also known as global positioning system, uses high-precision wireless navigation and other technologies for accurate positioning analysis. Global positioning system (GPS) technology covers a wide range, can achieve precise positioning, accurately locate people moving and driving vehicles, and mark time stamps based on actual conditions. Processing based on GPS technology can effectively improve accuracy by analyzing unit positioning, carrier phase positioning, and other technologies in positioning operations.

2.1. High-precision positioning

Reasonable application in surveying and mapping engineering can effectively achieve high-precision positioning. GPS technology has global characteristics, and its application in engineering surveys can provide a comprehensive and systematic coordinate system with relatively high positioning accuracy. In application, the actual situation of ground objects can be effectively analyzed by combining satellite receiving equipment for signal processing, measurement, and calculation analysis. In surveying and mapping, the ground datum points should be established based on the survey requirements, and the elevation and basic coordinates of different targets such as building structures, roads, and topography should be clearly defined. By establishing the datum through GPS technology, accurate positioning can be realized with high accuracy. In the process, it can be set by GPS technology, which is convenient for monitoring and construction management. In applying GPS technology, intelligent control can be carried out through coordinate systems and measurement work. The processing is based on a digital camera. Data processing and unmanned aerial vehicle (UAV) are comprehensively processed, and a geographic information management system is built based on the GIS registration book. With the support of intelligent technology, 5G, big data, cloud computing, and other technologies are combined for comprehensive processing, which effectively improves the efficiency of digital map production and application. Digital maps can realize three-dimensional visualization and display basic information on the map. They offer several advantages, including the ability to accommodate vast amounts of information, rapid update speeds, and high accuracy levels [1].

2.2. Topographic survey

Processing by GPS technology can effectively avoid the location of traditional field measurement, and using modern technology and dismantling by satellite signal lamp can obtain comprehensive and accurate information data and realize accurate positioning. With the support of GPS technology, it can cover the whole world, and can also carry out accurate measurements in special terrains such as mountains, waters, and deserts. At the same time, the equipment, technology, and calculation software can be determined according to the actual situation in the measurement, which can effectively meet the different functional requirements of different projects. Global analysis based on GPS technology can effectively obtain basic information and data, reduce measured data, effectively improve efficiency, and reduce hidden dangers.

2.3. Multi-application

Processing based on GPS technology can effectively improve measurement accuracy. In surveying and mapping, it's essential to verify site conditions, potentially through drilling and geophysical exploration, followed by meticulous basic processing. Subsequently, standardized surveying and mapping operations are conducted, unaffected by optical factors or similar variables, thereby significantly enhancing data accuracy. Topographic survey based on GPS technology can effectively realize the analysis, combined with traditional equipment such as total station for index analysis, and combined processing with modern technology, intelligent equipment, and unmanned aerial vehicles, to obtain high-precision information and effectively improve the comprehensive efficiency of surveying and mapping [2].

3. Surveying and mapping engineering technology GPS technology application field

3.1. Topographic mapping

The application of GPS technology should be broadened to meet the specific surveying and mapping

requirements of various areas efficiently, enabling the rapid acquisition of accurate data. By incorporating the dynamic differential method, the quality and efficiency of land surveys can be significantly enhanced. Through the integration of GPS and dynamic differential technologies, land ownership can be determined effectively. This approach facilitates the quick gathering of essential data, which is then processed and analyzed using computer systems and specialized software to generate maps or topographic representations.

3.2. Engineering deformation layer mapping analysis

Engineering deformation is mainly influenced by human factors, which leads to problems such as deformation and displacement of building structures. GPS technology offers a solution by enabling three-dimensional positioning, allowing us to understand the project's deformation state. Through GPS-based engineering deformation measurement, deformations in building structures, dams, and mines can be effectively analyzed. GPS technology provides accurate information and data, particularly in the analysis of mine deformations. By processing data with GPS technology, setting up monitoring points strategically, and dynamically analyzing data using GPS receivers, comprehensive and detailed information can be obtained, facilitating automatic detection [3].

3.3. Dot control

GPS technology can be applied in network control systems to obtain accurate geodetic data as traditional measurement methods are time-consuming. Therefore, GPS technology can effectively improve the measurement length and ensure the accuracy of the measurement. In dot control, observation points are set according to the actual situation, data are collected by laser receiving modules, sensors, and other equipment, and the collected information data are processed by the control module and finally displayed in the display module, thereby achieving intelligent measurement. Dot design is a crucial aspect of engineering surveys and processing by GPS technology can effectively improve the accuracy of measurement. The application of GPS technology in surveying and mapping offers flexibility, particularly in scenarios where line-of-sight processing is not feasible. However, meticulous attention to detail is essential during processing, especially considering that GPS technology based on wireless positioning can be susceptible to external factors throughout the operation. In the design phase, optimizing audit content and standards, addressing environmental conditions, and mitigating various factors' impacts are crucial steps to enhance data accuracy and reliability. In processing surveying and mapping data with GPS technology, it is imperative to minimize signal interference and ensure system stability.

3.4. Application of precision

GPS technology has been widely used in materials, equipment, and precision engineering. For instance, in tunnel penetration measurement, leveraging GPS technology enables effective understanding of fundamental information, ensuring that all numerical values align with design specifications and guaranteeing the tunnel excavation direction adheres to design requirements. During the design phase, GPS technology aids in analyzing and processing the positions of key connection points excavated at both ends, thereby ensuring the safety of tunnel excavation by accurately determining the position of the reference line.

3.5. Underwater topographic mapping

The depth of water and basic information are obtained through three-dimensional measurement and measurement analysis. This involves utilizing detection equipment and ultrasonic waves for processing, with additional correction from tide gauges. Combining these technologies enables the construction of a robust

surveying and mapping system, enhancing data accuracy. Within this system, signal processing capabilities ensure error control, supported by correction equipment, thereby upholding the quality and efficiency of surveying and mapping operations. For example, it is necessary to input the basic information and coordinate parameters of the surveying and mapping process before sailing. During actual measurements, this information is fed into receiving equipment for processing, facilitating coordinate transformation and the acquisition of fundamental parameters. The integrated navigation system and monitoring equipment are used to adjust the direction, while computers and big data technologies are leveraged to record, analyze, and efficiently store data.

3.6. Line construction survey

To meet the current needs of transportation and economic development and improve the comprehensive quality of line construction it's crucial to conduct scientific surveys aligned with urban planning and construction objectives. Leveraging GPS technology for processing, integrating urban line control networks, and engaging in static analysis using GPS receiving equipment within a time frame of 30 to 90 minutes ensures meticulous data collection and processing. This optimized approach aids in drawing precise map information and assessing ground conditions. Moreover, GPS technology facilitates the measurement of earthwork quantities, enabling accurate data analysis and providing invaluable insights for construction endeavors [4].

4. Application of GPS technology in surveying and mapping engineering

The application of GPS technology in surveying and mapping engineering is analyzed through a project. For areas less than 1 km^2, the project stipulates the establishment of 3 to 4 fourth-class online stores per township as per requirements. Within the project scope, the placement of first-level and second-level control points is strategically determined based on the prevailing conditions. Utilizing GPS technology, comprehensive mapping and site assessment are conducted, facilitating planning line segment analysis and engineering lofting procedures. Through the standardized application of GPS technology, comprehensive testing objectives are achieved, ensuring accuracy and efficiency throughout the project.

4.1. Determining the scheme of application

The effective use of GPS technology can significantly improve the quality of surveying and mapping efforts, meeting the needs of project construction and development. It is crucial to consider project specifics, mapping requirements, and real-world conditions when implementing GPS technology in surveying and mapping. By defining clear objectives, contents, and targets for mapping activities, a comprehensive and systematic planning approach can be developed, leading to improved mapping outcomes. Crafting a surveying and mapping strategy involves considering factors such as geographic positioning, mapping elements, and project intricacies. Before outlining mapping requirements, it is essential to process foundational data such as geographical features, geological formations, climate conditions, and structural details. Establishing detailed plans regarding timelines, content specifications, technical methodologies, data analysis approaches, and safety measures is essential for thorough project planning.

4.2. Selection of technical equipment

In surveying and mapping projects, it is essential to consider the practical context and employ a variety of intelligent equipment and technologies. The selection and use of equipment should be based on a thorough understanding of project needs and subjected to rigorous analysis. Common equipment includes GPS, GIS, total stations, and related tools. When choosing and combining equipment, factors such as overall performance,

functionality, technology, and cost-effectiveness should be carefully weighed. This analysis aids in identifying the best equipment setup, ultimately enhancing the quality of surveying and mapping outcomes.

4.3. Clearing the area of measurement

In engineering surveying and mapping using GPS technology, it's essential to define the specific area to be measured, including its size, boundaries, and key features. Once defined, appropriate equipment selection and parameter configuration should be carried out to ensure optimal signal transmission quality. During surveying operations, factors like geographical terrain, building structures, and vegetation cover must be carefully considered to assess their impact on GPS signal reception. Based on this assessment, measures can be taken to optimize signal reception, such as selecting open areas, minimizing obstructions from trees and buildings, and avoiding regions prone to ionospheric disturbances.

4.4. Determining the measurement marks

Processing data with GPS technology involves establishing comprehensive survey markers and defining survey positions to facilitate survey operations. Environmental variations are analyzed to adapt measurement representations to engineering characteristics, utilizing differential methods and ambiguity resolution to ensure measurement accuracy. First-level control is crucial in survey operations, requiring scientific project arrangement and coordinate determination, processed through GPS technology for precise measurement of each node. Careful control of horizontal and vertical differences is essential, ensuring they remain within 5 cm; deviations beyond this threshold necessitate layout resurveying for accurate orientation and information determination.

4.5. Control measurement

To ensure measurement accuracy, thorough preparations and equipment testing are imperative to verify compliance with performance standards. Evaluating influencing factors comprehensively and defining measurement time and scope help mitigate adverse effects. During measurement, establishing three-dimensional coordinates and processing data through the system is essential. While traditional engineering surveying relies on two-dimensional coordinate analysis, GPS-based three-dimensional analysis significantly enhances measurement precision. Integrating modern technology enables the creation of three-dimensional topographic maps, facilitating data integration and modularization. By processing satellite data, elevation, and other relevant information, Universal Transverse Mercator (UTM) projection based on the system can be achieved. Digital Elevation Model (DEM) format data can be utilized to create a three-dimensional model, enabling intuitive and stereoscopic visualization of the image structure. In the project, the topographic map is 1: 500, and the basic contour distance is 2.0 m, so framing should be done using a 40 ×50 cm rectangular grid. Additionally, utilizing UAV-based low-altitude aerial photography technology can enhance surveying accuracy. This involves conducting photo control surveys, processing field measurement data, and performing comprehensive analysis to ensure accuracy. Standardizing these processes helps minimize errors and avoids the need for costly rework. By employing dynamic analysis and leveraging advanced technologies like GPS, real-time kinematic (RTK), and China Navigation Satellite System (CNSS), precise and reliable measurements can be achieved. It's crucial to maintain detailed records throughout the testing process to verify compliance with design requirements and ensure the integrity of the surveying data [5].

5. Conclusion

Utilizing GPS technology in various fields and scenarios can effectively address measurement needs. With modern technological support, including big data, cloud computing, and 5G communication, GPS finds extensive applications across logistics, environmental protection, and agriculture. Task planning and design tailored to specific conditions enable precise data acquisition, facilitating engineering design. Effective utilization of GPS technology requires attention to basic management and control, defining surveying routes and equipment, and optimizing technical approaches to enhance surveying efficiency.

Disclosure statement

The author declares no conflict of interest.

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