Exploration of the Application of Surveying and Mapping Geographic Information Technology in Geological Surveying and Mapping Engineering

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Abstract: As technology progresses rapidly, China's geological surveying and mapping engineering projects are attaining greater completeness in their operational procedures, accompanied by an expansion in the variety of technical approaches utilized. The integration of cutting-edge methodologies, including Global Positioning System (GPS), Geographic Information System (GIS), and remote sensing, has transformed surveying and mapping processes. These advancements not only ensure superior quality but also address shortcomings in traditional geological engineering surveying and mapping. Specifically, the introduction of geographic information technology for surveying and mapping has emerged as a pivotal solution to traditional challenges, enhancing both work efficiency and the accuracy of results. This technology not only streamlines the surveying and mapping workflow but also bolsters data processing and analysis capabilities. By facilitating high-precision measurements and swift data processing, it captures real-time dynamic changes in the geological environment, providing crucial data for geological surveying and mapping projects. Furthermore, it facilitates data sharing and integration, advancing geological exploration in a scientific and systematic manner. This article delves into the application of geographic information technology in geological surveying and mapping engineering.

1. Introduction

During the execution of geological surveying and mapping projects, the choice and deployment of technological methods play a pivotal role in determining the precision of surveying and mapping outcomes, ultimately influencing geological exploration decisions and resource augmentation strategies [1]. However, geological surveying and mapping encounters unique external challenges, including complex and volatile terrains, rigorous climate conditions, and unpredictable geological formations, which render ensuring data accuracy a formidable task [2]. Amidst today's technological revolution, the advent of surveying and mapping geographic information technology has introduced fresh prospects for geological surveying and mapping. This technology incorporates cutting-edge advancements like remote sensing, GIS, GPS, and digital photogrammetry, enabling comprehensive, intricate, and precise geological environment assessments [3]. By incorporating these technologies into geological surveying and mapping projects, we can enhance the efficiency and precision of our work, alleviate operational complexities, enhance data quality, and thereby bolster geological exploration and resource augmentation efforts [4].

Traditional geological surveying and mapping methods often rely on manual measurement and calculation, which not only have a large workload and low efficiency, but are also easily affected by human and environmental factors, resulting in inaccurate surveying and mapping results [5]. By using advanced technologies such as remote sensing, GIS, and GPS, surveying and mapping geographic information technology can achieve rapid, accurate, and comprehensive surveying of the geological environment [6]. In geological surveying and mapping engineering, data sharing and integration are important links. Traditional surveying and mapping methods often lead to scattered data and difficulty in integrating and utilizing [7]. Surveying and mapping geographic information technology can achieve integration and sharing of multi-source data by adopting unified data standards and formats. This can not only improve the utilization and value of data, but also promote collaboration and communication between different departments. The ultimate goal of geological

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surveying and mapping engineering is to provide decision-making support and planning basis for geological exploration and resource growth [8]. Surveying and mapping geographic information technology can provide scientific and accurate data support for decision-making analysis and planning by conducting in-depth analysis and simulation of the geological environment.

As an emerging methodology in the field of surveying and mapping, geographic information technology has sparked fresh avenues for growth in geological surveying and mapping engineering, driven by its relentless evolution and innovation. Amidst the ongoing technological advancements and broadening of application scopes, this technology is poised to converge and evolve with cutting-edge technologies like the Internet of Things, cloud computing, and big data. This convergence will give birth to a more intelligent, automated, and consolidated surveying and mapping system, thereby enhancing the efficacy and standards of surveying and mapping operations. Consequently, it will foster sustained innovation and progress in geological surveying and mapping engineering. Consequently, it is imperative to intensify research and promote the application of geographic information technology in surveying and mapping, maximizing its benefits and contributions to geological surveying and mapping engineering.

2. Geoinformation Technology for Surveying and Mapping

2.1. Basic Characteristics

Surveying and mapping geographic information technology, a pivotal innovation in contemporary geological surveying, possesses distinctive attributes that have revolutionized the entire field [9]. Surveying and mapping geographic information technology integrates various advanced technologies such as remote sensing, GIS, GPS, digital photogrammetry, etc., making it have rich functions [10]. These functions not only cover the entire process of data acquisition, processing, analysis, and output, but can also be customized for growth and application according to specific needs. Therefore, surveying and mapping geographic information technology has a wide range of applications in various fields such as geological surveying, urban planning, environmental monitoring, and disaster warning. Traditional surveying methods are often susceptible to external environmental factors such as weather, terrain, and vegetation, resulting in inaccurate or inaccessible surveying data. Surveying and mapping geographic information technology, leveraging remote sensing, unmanned aerial vehicles (UAVs), and other modalities, can conduct surveying and mapping in complex and dynamic environments with minimal external interference. This characteristic renders GIT more reliable and efficient for applications in harsh environments.

Surveying and mapping geographic information technology can obtain more accurate data by using high-precision measurement equipment and technical means. For example, GPS technology can provide centimeter or even millimeter level positioning accuracy, making surveying results more accurate and reliable. At the same time, surveying and mapping geographic information technology can also process and analyze the obtained data, further improving the accuracy and reliability of the data. This enables geological surveying and mapping engineering to more accurately understand the characteristics and laws of the geological environment, providing more reliable data support for geological exploration and resource growth.

2.2. Common Types

Surveying and mapping geographic information technology covers various types, each with its unique characteristics and application scenarios. Photogrammetry technology is the process of capturing image information and collecting data information for specific spatial areas under the conditions of using photography technology. By synthesizing the obtained image information, photogrammetry technology can achieve transformation operations based on different measurement environment conditions. On the basis of information technology, digital surveying and mapping technology utilizes digital means to control the operation process of various surveying and mapping instruments and equipment, thereby constructing a multifunctional surveying and mapping technology system. This technology can efficiently and accurately process and analyze geographic

surveying and mapping data information, including multiple links such as data collection, data processing, and data display. For example, in mining geological surveying and mapping engineering, the application of network RTK technology is very common, which also belongs to information digital surveying and mapping technology. The RTK surveying and mapping operation flowchart is shown in Figure 1.

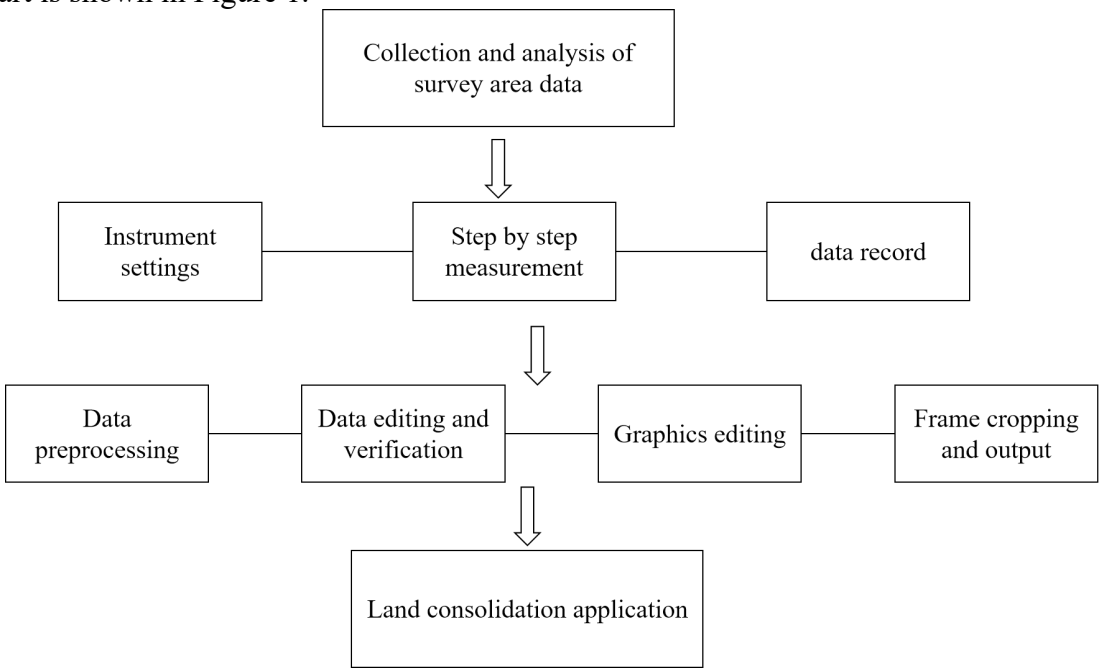

Figure 1 RTK surveying and mapping operation flowchart

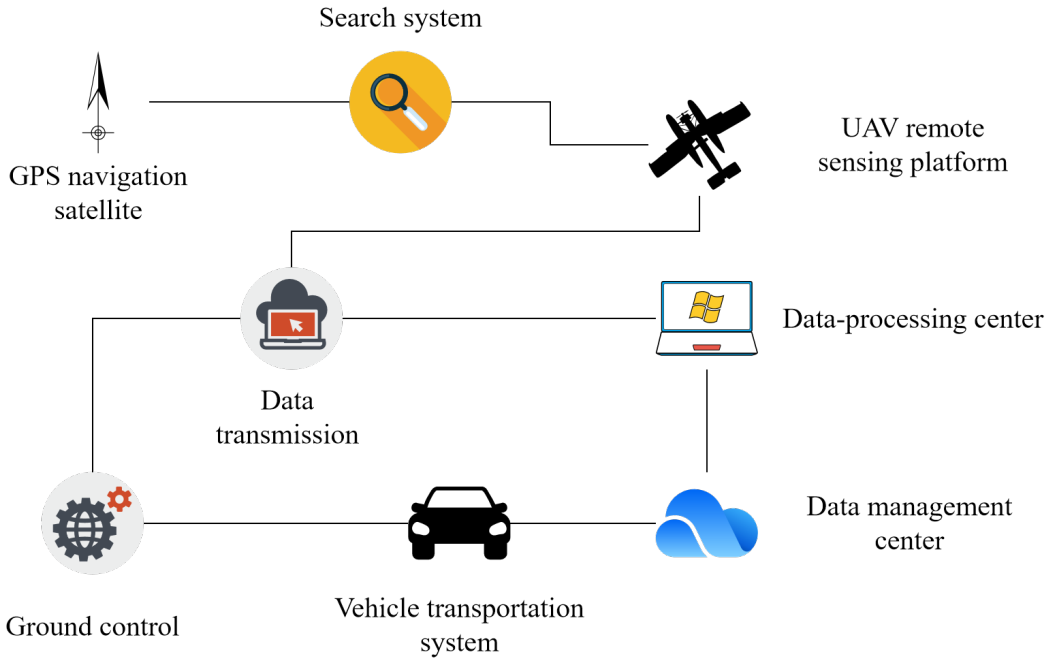

Figure 2 Geological mapping process of UAV

After completing the measurement and collection of data information, GIS technology can quickly and comprehensively transmit data information, and automatically organize and analyze the obtained data information. In addition, it can also run a 3D visualization technology system, providing convenient conditions for technical personnel and shortening the time for data information collection and processing. Remote sensing technology utilizes remote sensing platforms such as satellites and spacecraft to take aerial photographs of geological landforms and map the resulting images, thereby producing more accurate topographic maps. Remote sensing

technology has the characteristics of non-contact, wide coverage, and large data volume, which can obtain a large amount of surface information and provide rich data sources for geological surveying and mapping. The UAV technology developed based on remote sensing technology has been widely used in geological surveying and mapping engineering due to its fast and efficient characteristics. Figure 2 shows the geological mapping process based on UAV. By equipped with high-resolution cameras or LiDAR sensors, UAVs can obtain high-precision surface information, including terrain, buildings, vegetation, roads, etc. These data can be used to create digital maps, 3D models, terrain analysis, etc., providing basic support for practical applications.

3. The Application of Surveying and Mapping Geographic Information Technology in Geological Surveying and Mapping Engineering

3.1. Strengthening System Space Exploration

In geological exploration work, spatial system analysis plays a crucial role, and geographic information technology is an indispensable tool in this field. By conducting in-depth spatial analysis of the collected geological data, we can have a clearer understanding of the spatial distribution patterns and changing trends of geological information, providing solid scientific basis and decision support for geological exploration. Surveying and mapping geographic information technology, with its unique characteristics, has brought revolutionary changes to geological exploration work. Firstly, these technologies can achieve accurate mapping of complex geological environments. Whether it is rugged mountains, vast plains, or deep oceans, surveying and mapping geographic information technology can obtain high-resolution and high-precision geographic data through remote sensing, UAV and other means. These data not only contain terrain and geomorphological information, but also cover various aspects such as geological structure, lithological distribution, and mineral resources.

Secondly, surveying and mapping geographic information technology performs excellently in data processing and analysis. With the help of GIS technology, we can quickly and accurately process and analyze the geological data obtained. Through methods such as data visualization, spatial interpolation, and statistical analysis, we can reveal the spatial distribution patterns and changing trends of geological information. More importantly, surveying and mapping geographic information technology can also use spatial systems to further expand the scope of surveying and mapping operations. Traditional surveying and mapping methods are often limited by factors such as manpower and material resources, making it difficult to cover large and complex geological environments. With the help of remote sensing, UAV and other technologies, we can achieve rapid mapping and data collection of vast areas. Meanwhile, GIS technology can also integrate and share these data to form a unified and complete geological information system. This enables us to have a more comprehensive and in-depth understanding of geological information, providing more scientific and accurate decision-making support for geological exploration work.

3.2. Emphasize the Application of Virtual Reality (VR)

With the rapid growth of modern science and technology, surveying and mapping geographic information technology has also undergone innovation and upgrading, and has been widely applied in geological engineering surveying and mapping. The continuous improvement of the functionality of this technology not only improves the efficiency of surveying and data accuracy, but also greatly promotes the progress of geological exploration and planning work. Geographic information technology, through GIS software, can draw accurate geological maps, topographic maps, underground pipeline network maps, etc., providing important data support for geological exploration and planning. The integration of VR technology has brought revolutionary changes to this field. In practice, the processed surveying data information can be directly transmitted to the system and generate a three-dimensional model. This model can truly restore the general situation of geological engineering and the overall construction environment, so that engineers and technicians can intuitively understand the overall picture of the project. With the support of virtual

technology, geological engineering can be accurately simulated, and whether it is terrain, geological structure, or underground pipeline network, it can be clearly displayed.

The application of VR technology not only improves the accuracy of exploration and planning, but also enables effective prediction of possible emergency situations before project implementation. By simulating different construction scenarios and conditions, engineers can promptly identify potential risks and issues, and develop corresponding response measures. This not only reduces the risks of project implementation, but also improves the safety and efficiency of construction. In addition, VR technology can also provide a visual display platform for geological engineering. Through VR devices, users can experience the full picture and details of geological engineering firsthand, deepening their understanding and recognition of the project. This is of great significance for increasing public awareness and support for geological engineering.

4. Conclusions

In the current era of sustained economic growth, the rapid progress of technology and the widespread application of intelligent achievements have greatly promoted the growth of various industries. Especially in the field of geological engineering surveying and mapping, the application of surveying and mapping geographic information technology has become a trend. Combining advanced technology with traditional surveying and mapping technology not only greatly improves the speed and accuracy of detection, but also greatly improves the efficiency and quality of surveying and mapping work. The practical value of surveying and mapping geographic information technology cannot be ignored. It has many characteristics and advantages, which enable it to play a huge role in geological engineering surveying and mapping work. Compared with traditional surveying and mapping techniques, surveying and mapping geographic information technology has made significant progress in the accuracy of measurement data, the speed of measurement operations, and the convenience of measurement operations. More importantly, the close integration of surveying and mapping geographic information technology with computer network technology makes data processing and transmission more efficient and fast, reduces errors caused by human operations, and further improves the accuracy and reliability of measurement data. Meanwhile, through the application of 3D modeling and virtual reality technology, geological engineering surveying and mapping work has become more intuitive and vivid, providing engineers and technicians with more comprehensive information support, which helps to better grasp the overall picture and details of geological engineering.

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