

Research on the Application of Beidou Satellite System

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Abstract: With the continuous development and application of Beidou satellite (BDS), its application in various fields is becoming increasingly widespread. Industries such as agriculture, fisheries, transportation, power and communication, aerospace, mining, and tourism have also begun to explore how to use Beidou satellites to improve production efficiency, optimize resource allocation, and enhance service quality. The Beidou Navigation Satellite System (BDS), also known as COMPASS, is a global satellite navigation system independently developed by China. It is the third mature satellite navigation system after GPS and GLONASS. The Beidou Satellite Navigation System (BDS), along with GPS from the United States, GLONASS from Russia, and GALILEO from the European Union, are suppliers recognized by the United Nations Committee on Satellite Navigation. China's Beidou Satellite Navigation System (BDS) has been used in more than half of the countries and regions around the world, which is a satisfactory achievement in the field of space technology.

Keywords: Beidou satellite; Satellite system; Application areas

1. Location Fields of Beidou Satellite

The Beidou Satellite System is a satellite navigation system independently developed by China, with global coverage and high-precision positioning capabilities. Its application fields are very extensive, mainly including the following aspects:

1.1 Agriculture

1.1.1 Precision agriculture

The Beidou satellite system can provide precise positioning and data support for precision agriculture, helping farmers achieve agricultural production management such as precise fertilization, precise irrigation, and precise sowing. Through the Beidou satellite system, farmers can scientifically and reasonably carry out agricultural production based on factors such as soil conditions and crop demand, and improve crop yield and quality. In order to improve the precision control of agricultural production, the introduction of agricultural automatic navigation systems can enhance resource utilization and strengthen the effectiveness of agricultural machinery operations. For example, in the production process, it is possible to control production activity errors, avoid repetitive operations, accurately calculate the work area, and achieve high-precision positioning. Automatic navigation technology can effectively control routes, helping farmers achieve precise cultivation, sowing, fertilization, spraying, irrigation, etc. With the help of agricultural automatic navigation systems, it can improve sunlight and water use efficiency, enhance plant distribution uniformity, and ensure that plants enjoy the same nutrients. The introduction of automatic navigation technology in agricultural production has improved the precision and standardization of agricultural production, accelerating the pace of modernization in agricultural production.

1.1.2 Management of agricultural machinery operations

Traditional agricultural machinery operation management mainly relies on manual operation and experience judgment, which has problems such as low operation efficiency, excessive resource waste, and difficult management. After the introduction of the Beidou satellite system, agricultural machinery operation management can achieve real-time monitoring, precise positioning, intelligent scheduling and other functions, greatly improving operation efficiency and management level. Agricultural producers can accurately obtain location information, soil nutrient content, crop growth and other data of farmland plots through the Beidou satellite system, thereby achieving precise fertilization, precise irrigation, precise plant protection and other operational management, improving agricultural production efficiency and quality. The Beidou satellite system can provide accurate navigation and positioning services for agricultural machinery operations, helping farmers with tasks such as farming, fertilizing, and spraying pesticides. Farmers can accurately control the operating range and speed of agricultural machinery based on the land situation and operational needs, improving operational efficiency and quality.

1.2 Marine Fisheries

1.2.1 Fishing vessel positioning and monitoring

The Beidou satellite system can provide accurate positioning and monitoring services for fishing boats, helping fishermen to grasp the

real-time position, navigation route, and speed of fishing boats. Through the Beidou satellite system, the fishery administration department can monitor the activity range of fishing vessels, ensure their legal and compliant operations, and prevent illegal fishing and missing fishing vessels. The website of the fishing vessel position monitoring system has a rich graphical user interface, which enables enterprises and administrative departments at all levels to easily obtain dynamic information of fishing vessels. The system has a wide coverage, operates 24/7, and has high reliability.^[3]

1.2.2 Fishery resource survey

The Beidou satellite system can be combined with remote sensing technology to achieve monitoring and investigation of marine ecological environment and fishery resources. By using the Beidou satellite system to obtain data on ocean temperature, chlorophyll content, ocean tides, etc., it helps fishermen choose suitable fishing grounds and catch times, and improve fishing efficiency. In addition, the Beidou system provides effective technological means for various fishery authorities to strengthen the standardized management of fishing vessels, which can timely prevent fishing vessels from engaging in illegal fishing production during the off-season.

1.3 Logistics and transportation industry

The Beidou satellite system can provide real-time vehicle location tracking and road condition information for logistics transportation, and provide accurate navigation and positioning services for aviation, navigation, railway, highway and other transportation. It can achieve functions such as cargo tracking, vehicle scheduling, route planning, etc., improving logistics efficiency and transportation safety.

1.3.1 Vehicle monitoring and scheduling

The Beidou satellite system can monitor the real-time location information of vehicles, including their real-time position, driving trajectory, etc. Through the Beidou satellite system, vehicle management personnel can understand the location of vehicles at any time and achieve full monitoring of vehicles throughout the process; The Beidou satellite system can provide optimal route planning for vehicles, selecting the best route based on factors such as traffic and road conditions, reducing travel time and costs, and improving transportation efficiency; The Beidou satellite system can assist vehicle management personnel in vehicle scheduling and task allocation. Based on real-time vehicle location information and task requirements, it can reasonably arrange the order and route of vehicle departure, improve vehicle utilization and transportation efficiency; Logistics companies can manage and schedule vehicles through the Beidou satellite system, improve transportation efficiency, reduce transportation costs, and ensure the safe transportation of goods.

1.3.2 Road condition navigation

The Beidou satellite system can provide drivers with real-time road condition information and navigation services, helping them choose the best driving route, avoid congestion and accidents, and improve transportation efficiency. The Beidou satellite system can achieve vehicle safety monitoring and early warning functions, monitoring the vehicle's driving status, speed, dwell time and other information, timely detecting abnormal situations and conducting early warning processing, improving the safety and stability of vehicles; The Beidou satellite system can record the driving data and transportation information of vehicles, provide data support and analysis basis for vehicle management personnel, help optimize vehicle scheduling and management strategies, and improve transportation efficiency and service quality. The Beidou satellite system can also provide auxiliary navigation services such as road construction information and meteorological information to ensure the safe passage of vehicles.

1.4 Operation and maintenance of infrastructure such as electricity and communication

The Beidou satellite system can provide accurate positioning and monitoring services for the operation and maintenance of infrastructure such as power and communication, helping enterprises to discover and solve problems in a timely manner and ensuring the normal operation of infrastructure. The practical application of Beidou technology in power grid infrastructure projects mainly focuses on business scenarios, scope of application, equipment management, application management, cost management, and support guarantee. It constructs a demonstration sample of the integration of five Beidou innovative applications to achieve real-time on-site personnel status, intelligent on-site safety control, convenient on-site construction work, controllable on-site emergency management, and lean on-site environmental monitoring, providing practical support for the optimization, upgrading, and promotion of on-site personnel and equipment positioning products. Specifically, it is based on the Beidou navigation and positioning technology, using Beidou intelligent positioning equipment to monitor real-time dynamic information of personnel, vehicles, machinery, and vehicles on site. Combined with the management platform, it provides real-time comprehensive dynamic perception of infrastructure and operation sites, comprehensively improving the safety management level of work sites. Using the Beidou satellite as the central line, mechanical trajectory monitoring, environmental monitoring, and construction geological environment monitoring and warning position reporting functions are achieved through induction devices such as general terminals, vehicle mounted Beidou terminals, trajectory detection devices, Beidou safety helmets, and Beidou positioning cards. Combined with on-site data automation

collection and transmission, intelligent perception monitoring of key links, and human vehicle mechanical environment monitoring and management technologies, safety control of construction projects and maintenance operations on the line and site is completed.

1.4.1 Equipment monitoring and maintenance

The Beidou satellite system can achieve real-time monitoring and remote maintenance of infrastructure equipment such as power and communication. Through the Beidou satellite system, operation and maintenance personnel can obtain real-time information on equipment operation status, abnormal situations, etc., timely diagnose and repair faults, and improve the reliability and stability of equipment.

1.4.2 Inspection and safety

The Beidou satellite system can be used for inspection and safety monitoring of facilities such as power lines and communication towers. Operations personnel can use the Beidou satellite system to locate and monitor facilities, promptly detect damage, tilting, and other conditions, and ensure the safe operation of facilities.

1.5 Aerospace field

The Beidou satellite system can provide precise navigation and positioning services for the aerospace industry, ensuring the safe flight and operation of aircraft and spacecraft.

1.5.1 Aviation navigation

The Beidou satellite system can provide high-precision navigation and positioning services for aircraft, helping pilots accurately determine the position, heading, and speed of the aircraft, and improving flight safety and efficiency. The application of Beidou satellite system in the field of aviation navigation can cover various stages of aircraft takeoff, flight, landing, etc.

1.5.2 Space exploration and navigation

In the field of aerospace, the Beidou satellite system can provide precise navigation and positioning support for satellites and spacecraft, helping astronauts and spacecraft accurately control their orbits and attitudes, and achieve smooth execution of space missions.

1.6 Exploration of Mining Resources

The Beidou satellite system can provide accurate location information and geological data for mining resource exploration, helping mining enterprises to carry out resource exploration and development. The Beidou satellite system can provide accurate location information and navigation services for offshore oil field exploration, helping oil field enterprises efficiently develop and manage offshore oil field resources.

1.6.1 Precise positioning

The Beidou satellite system can provide high-precision positioning services for mining explorers, helping them accurately determine the location and scope of mining areas, and improving the efficiency and accuracy of mining exploration.

1.6.2 Geological exploration

By utilizing the positioning and navigation functions of the Beidou satellite system, mining exploration personnel can conduct geological surveys and explorations more conveniently, quickly obtain geological information, and find potential mineral resource points.

1.7 Tourism and guided tour services

The Beidou satellite system can provide accurate navigation and location information for tourism and navigation services, helping tourists better understand attractions and plan their itinerary.

1.7.1 Travel Navigation

The Beidou satellite system can provide accurate positioning and navigation services for tourists, helping them quickly find their destination in unfamiliar environments, plan the best travel routes, avoid getting lost and wasting time.

1.7.2 Scenic spot guide

Through the Beidou satellite system, tourists can obtain location information, introductions, and guided routes of various attractions, helping them better understand the history, culture, and characteristics of the attractions and enhance their travel experience.

2. The problems currently faced by Beidou satellite

2.1 Satellite lifespan issue

The lifespan of Beidou satellites is limited, and over time, the satellites may malfunction or fail, affecting the normal operation of the Beidou system.

2.2 Competitive pressure

The Beidou satellite system is facing competitive pressure from other satellite navigation systems (such as GPS, GLONASS, etc.) and needs to continuously improve its technological level and service quality to maintain its competitive advantage.

2.3 Security issue

Satellite navigation systems are susceptible to malicious interference or attacks, and the Beidou satellite system needs to strengthen security protection measures to ensure the safe and stable operation of the system.

2.4 Coverage issue

The Beidou satellite system currently mainly covers China and surrounding areas, and further expansion of coverage is needed to provide a wider range of services.

2.5 Technical upgrade issue

With the continuous development of technology, the Beidou satellite system needs to be constantly upgraded and updated to adapt to changes in user needs and improve system performance.

3. Outlook on the Stability, Accuracy, and Safety of Beidou Satellite

With the continuous advancement of technology and the continuous improvement of the system, the stability of the Beidou satellite system will be further enhanced. By strengthening the monitoring and maintenance of satellites, timely handling of satellite failures, and ensuring the stable operation of the system; The Beidou satellite system will continuously optimize satellite positioning algorithms to improve positioning accuracy and timeliness. Introduce new technologies and equipment, such as enhanced positioning technology, differential satellite navigation technology, etc., to further improve positioning accuracy; The Beidou satellite system will strengthen security measures to prevent malicious interference and attacks. Strengthen the encryption protection, identity authentication and other security mechanisms of the system to ensure the security of user data and communication.

4. Expectations for International Cooperation and Innovative Development of Beidou Satellite

I hope that the Beidou satellite system will actively engage in international cooperation, interconnect with other satellite navigation systems, and improve the coverage and service quality of the system. Promote the unification of international standards, advance the globalization of satellite navigation, continuously innovate and expand the application of satellite systems, actively explore new application scenarios and business models, promote the integration of satellite navigation technology with emerging technologies such as artificial intelligence and big data, and provide more possibilities for social and economic development. The future Beidou satellite system is expected to continue to develop in terms of technological innovation, application expansion, security assurance, and international cooperation, providing more convenient, safe, and reliable satellite navigation services for social and economic development and people's lives, and helping to build a digital and intelligent future society.

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