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ORIGINAL ARTICLE

A JTIDS/INS/DGPS navigation system with pseudorange differential information transmitted over Link-16: design and implementation

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Abstract As the battle environment becomes more complicated, the demand for higher accuracy and better anti-jam capacity of navigation has been increasing. The conventional JTIDS/INS/GPS integrated navigation cannot meet the demands of certain situations such as precision strike and formation flight. A new system that introduces the differential GPS into JTIDS/INS/GPS integration system is proposed to improve the navigation performance in the modern combined operations. In this system, the differential information of DGPS is transmitted through the communication data link of Link-16. As a result, the system resources are efficiently utilized and the controllability and anti-jam performance of the system are significantly enhanced. A hybrid slot allocation protocol (HSAP) that combines a static slot allocation algorithm and a dynamic slot allocation algorithm and the corresponding source-chosen mechanisms are proposed. The performance of the JTIDS/INS/GPS integration navigation using the differential GPS information from one or multiple base stations is studied and compared with that of the system without using the differential GPS information. Furthermore, the performance of the integration navigation using HSAP is compared with that of the system using static slot allocation algorithm. We show that navigation accuracy based on the differential GPS is improved, and using HSAP also leads to higher localization accuracy.

Keywords Link-16 · RTCM SC-104 · Pseudorange differential GPS · Integration navigation · HSAP

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Introduction

The joint tactical information distribution system (JTIDS) was first developed by the United States of America for its armed forces and later adopted by NATO. Integrating the capabilities of communication, navigation, and identification, JTIDS can well adapt to the current and future battle environments and it can be applied to electronic comprehensive systems for the battle of group (Altrichter 1992). When used under conditions of high dynamic flight such as precision strike, JTIDS cannot meet the requirements of high positioning accuracy in height, location information frequency, attitude information, and coverage of a large effective zone of more than 500 km radius. To enhance the system functionality, the integration of JTIDS with other navigation systems attracts increasing attention. For example, JTIDS/INS/GPS integrated navigation system (Alison and Phyllis 2003; Cong and Qin 2008; Widnall et al. 1982) has been extensively studied and applied. As the navigation and positioning technologies develop, navigation is applied to a variety of fields, and the requirements for positioning accuracy are constantly increasing in some situations such as formation flight and precision strike. The traditional JTIDS/INS/GPS integrated navigation system is unable to meet these requirements for high-accuracy localization.

Differential GPS (Elliott and Christopher 2006) can effectively improve the positioning accuracy of GPS, and therefore, introducing differential GPS into the integrated navigation systems serves as a good solution for improving the positioning accuracy. By using the differential techniques, all the errors caused by the satellite clock and ephemeris as well as most of the errors caused by the ionosphere delay and troposphere delay can be eliminated. As a result, differential GPS can significantly improve the