

Preface

Navigation system with high precision, high reliability, and strong autonomy will provide various moving objects and carriers with high-precision motion parameter information, which is the precondition to realize its accurate navigation and the basis to develop precise guidance technology. At present, navigation means commonly used in the aerospace field mainly include inertial navigation, satellite navigation and celestial navigation, which have respective advantages and disadvantages in application. Full autonomy, possibility to continuously provide complete motion parameters and high short-term high precision are the advantages of inertial navigation, and error accumulation with working time is its disadvantage; satellite navigation is able to provide all-time and all-weather high-precision position and velocity information with error not accumulating with time, but it is difficult to directly provide attitude information and is easily disturbed; celestial navigation is able to provide attitude and position information with error not accumulating with time, but it is restricted by weather condition and has low position precision. Therefore, a single navigation means is hard to meet the requirements of long-time and high-precision navigation of long-range missiles, naval vessels, long-range bombers and HALE UAV. The inertial navigation system (INS)/celestial navigation system (CNS)/global navigation satellite system (GNSS) integrated navigation system able to make full use of the feature of complementary advantages among each navigation subsystem to greatly improve the precision and reliability of navigation system has become an effective means to realize precise positioning and navigation and has always been the research focus and hotspot of the navigation technology.

This monograph consists of 11 chapters. Chapter 1 primarily introduces the history and current situation of INS/CNS/GNSS integrated navigation. Chapter 2 introduces the operating principles and analysis of error characteristics of inertial, satellite, and celestial navigation systems. Chapter 3 mainly introduces some advanced filtering methods such as unscented Kalman filter, unscented particle filter, and predictive filter commonly used in a navigation system. Chapter 4 mainly introduces gyro error modeling, test and compensation, calibration methods for strapdown inertial measurement unit, and high-dynamic strapdown inertial navigation system algorithm, etc. Chapter 5 primarily introduces the star map preprocessing method for star sensor on which celestial navigation is based, quick and efficient star map

identification method and celestial navigation method based on star sensor, etc. Chapters 6–9 are the key contents of this book. Among them, Chap. 6 introduces the principle and modeling method of INS/GNSS integrated navigation system and high-precision INS/GNSS integrated navigation method; Chap. 7 introduces the principle and modeling method of INS/CNS integrated navigation system, new INS/CNS integrated navigation method of guided missile and lunar vehicle, and INS/CNS integrated attitude method of satellite; Chap. 8 introduces the basic principle, composite mode, and modeling method for INS/CNS/GNSS integrated navigation system and INS/CNS/GNSS integrated navigation method based on federal UKF and information distribution factor of federal filtering optimization. Chapter 9 introduces PWCS observable analysis theory and method, and the method of using improved observable analysis theory to improve real-time performance of INS/CNS, INS/GNSS and INS/CNS/GNSS integrated navigation systems. Chapter 10 mainly introduces the principle, composition, realization, and experiment of semi-physical simulation system for INS/CNS/GNSS integrated navigation. The last chapter forecasts the future development trend of INS/CNS/GNSS integrated navigation technology.

This book is prepared by referring to the latest research achievements in integrated navigation technology field at home and abroad on the basis of research achievements made by the research team of the author for more than a decade on completion of a dozen relevant scientific research tasks. This book strives for systematic contents, novel viewpoints, and theory linked with practice, but deficiencies are inevitable since it involves multiple academic forelands and relative original contents and expertise owned by the author is limited, so criticism of various experts and readers are expected. This book may be regarded as a textbook or teaching reference book of graduate students and senior undergraduates of relevant major in institutions of higher education, or referred by engineering and technical staff engaged in navigation and guidance technology researches.

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