Preface

Space objects generally refer to all in-orbit spacecrafts, rocket bodies, and space debris, etc. Unlike meteoroid from the natural world, all space objects are made by mankind. Nowadays, more and more space objects are produced due to the frequent space activities performed by human beings, resulting in a greater possibility of space collision. The Chinese government is continuously promoting and forcefully implementing relevant policies and measures for space environment protection and maintenance, just as other large and responsible spacefaring powers have been doing all the time.

However, the continuous increasement of space objects is inevitable, and all mitigation measures taken can only gear down the increase rate of the space object. Conjunction assessment and collision avoidance maneuvers are the topics and countermeasures which ought to be further studied and carried out for effective applications by spacefaring powers. As the conjunction assessment study is based on the space catalog data (including basic information, orbital information, and characteristic information of space object) obtained from space surveillance network, how to take good use of these data and how to do the data mining comprehensively are the key to the strengthening of the conjunction assessment capacity. Furthermore, every space object performs in-orbit operation in strict accordance with orbital dynamics, but the synthetic movement of most space objects is virtually disordered. How to pinpoint the inherent principles of such motions from huge amount of catalog data is a challenge to us.

The space object orbital data, as an important part of space catalog data, can comprehensively be applied to conjunction assessment, orbital anomaly and space event detection, orbital error analysis and precision optimization, space debris environmental and flow analysis. Through computation and analysis with reference to orbital data, we can obtain the spatial position and velocity information of the space object at current time and a period of time in expected future. Thus, the foundation can be built upon it to let us know more about the space object distribution, and a strong support can be given to the conjunction assessment and collision avoidance maneuvers of in-orbit spacecrafts. The space object catalog data accumulated on a long-term basis can provide us the historical changing process

of space object orbits. Analysis of such data can lead to some intrinsic principles behind the orbital data, for example, the spacecraft orbital maneuver events. The innovative researches on such principles will be conducive to the expansion of the depth and width of space situational analysis and improvement of the ability to acquire the orbital characteristics of space objects.

This book discussed the applications of orbital data of space objects in target conjunction assessment and space situational analysis as well as relevant theories and methodologies. There are totally 7 chapters. The origins, types, and application purposes of space object orbital data are introduced in Chap. 1, where the applications of space object orbital data in target conjunction assessments and space situational analyses are emphasized; an overview of the space object orbit prediction error is presented in Chap. 2, the propagation methods of orbit prediction error based on orbit models are given, and so are the propagation methods based on relative dynamic theories; an error analysis method based on historical orbital data is introduced in Chap. 3, the periodic characteristics of the orbit prediction error are presented, and the error fitting is done by bringing in the Poisson series; an introduction to the analytical and numerical methods commonly applied to the space object approaching analysis is unfolded in Chap. 4; derivations of several explicit expressions of the collision probability under circular and ordinary orbital conditions through analysis of approaching distance are presented in Chap. 5, so as to have the collision probability expressed as explicit functions of the approaching distance or approaching geometric relationship, and errors and application scopes of the explicit expressions are also analyzed; the sensitivity of collision probability, maximum collision probability, false dismissal probability and false alarm probability of conjunction assessment, and multi-factor considered general collision risk assessment method on the basis of collision probability explicit expressions are deeply studied in Chap. 6; orbital anomaly and space event detection methods based on historical orbital data and assessments on such methods are illustrated in Chap. 7. Hence, this book can be used as a reference book for engineers and technical staffs specialized in spacecraft dynamics, spacecraft observation and control, space surveillance, space situational awareness, space debris research, and other related fields. It can also be used as a supporting course material for postgraduate students in relevant majors.

It should be honestly pointed out that this book is far from complete and perfect. For author's limited knowledge, there must be some small typos or even theoretical imperfects in this book. If the readers have any comment or suggestion about this book, we are really grateful for your direct contacting with us through chenl@nudt.edu.cn. Your help will be highly appreciated.

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