

Edited by  
Vincenzo Pesce, Andrea Colagrossi,  
and Stefano Silvestrini

# Modern Spacecraft Guidance, Navigation, and Control

From System Modeling to AI and  
Innovative Applications



# Spacecraft Navigation And Guidance

**Michael Brown**



## **Spacecraft Navigation And Guidance:**

Spacecraft Navigation and Guidance Maxwell Noton, 2012-12-06 The analysis and computational techniques associated with the navigation and guidance of spacecraft are now in a mature state of development. However, the documentation has remained dispersed throughout conference papers, journals, company and contract reports, making it difficult to get a true comprehensive picture of the subject. This text brings together the body of literature with suitable attention to the necessary underlying mathematics and computational techniques. It covers in detail the necessary orbital mechanics, orbit determination with emphasis on the SRIF algorithm, gravity assist manoeuvres and guidance both ground based and autonomous. Attention is paid to all phases of a space mission including launch and re entry and whether culminating in an earth satellite or a deep space mission to planets or primitive bodies. Software associated with the text is available free to the reader by means of the Internet server of the publisher. Spacecraft Navigation and Guidance is an invaluable aid for all those working within

astronautics, aeronautics and control engineering in general. **Fundamentals of Aerospace Navigation and Guidance** Pierre T. Kabamba, Anouck R. Girard, 2014-08-29 This text covers fundamentals used in the navigation and guidance of modern aerospace vehicles in both atmospheric and space flight. It can be used as a textbook supporting a graduate level course on aerospace navigation and guidance, a guide for self study or a resource for practicing engineers and researchers. It begins with an introduction that discusses why navigation and guidance ought to be considered together and delineates the class of systems of interest in navigation and guidance. The book then presents the necessary fundamentals in deterministic and stochastic systems theory and applies them to navigation. Next, the book treats optimization and optimal control for application in optimal guidance. In the final chapter, the book introduces problems where two competing controls exercise authority over a system, leading to differential games. **Fundamentals of Aerospace Navigation and Guidance** features examples illustrating concepts and homework problems at the end of all chapters. **Control, Guidance and Navigation of**

**Spacecraft** NASA-University Conference on the Science and Technology of Space Exploration, Chicago, 1962, 1986

Modern Spacecraft Guidance, Navigation, and Control Vincenzo Pesce, Andrea Colagrossi, Stefano Silvestrini, 2022-11-13 **Modern Spacecraft Guidance Navigation and Control** From System Modeling to AI and Innovative Applications provides a comprehensive foundation of theory and applications of spacecraft GNC from fundamentals to advanced concepts including modern AI based architectures with focus on hardware and software practical applications. Divided into four parts, this book begins with an introduction to spacecraft GNC before discussing the basic tools for GNC applications. These include an overview of the main reference systems and planetary models, a description of the space environment, an introduction to orbital and attitude dynamics and a survey on spacecraft sensors and actuators with details of their modeling principles. Part 2 covers guidance navigation and control including both on board and ground based methods. It also discusses classical and novel control techniques, failure detection, isolation and recovery, FDIR methodologies, GNC verification, validation and on

board implementation The final part 3 discusses AI and modern applications featuring different applicative scenarios with particular attention on artificial intelligence and the possible benefits when applied to spacecraft GNC In this part GNC for small satellites and CubeSats is also discussed Modern Spacecraft Guidance Navigation and Control From System Modeling to AI and Innovative Applications is a valuable resource for aerospace engineers GNC AOCS engineers avionic developers and AIV AIT technicians Provides an overview of classical and modern GNC techniques covering practical system modeling aspects and applicative cases Presents the most important artificial intelligence algorithms applied to present and future spacecraft GNC Describes classical and advanced techniques for GNC hardware and software verification and validation and GNC failure detection isolation and recovery FDIR

**Guidance, Navigation, and Control for Spacecraft Rendezvous and Docking: Theory and Methods** Yongchun Xie, Changqing Chen, Tao Liu, Min Wang, 2021-02-16 This book focuses on the theory and design methods for guidance navigation and control GNC in the context of spacecraft rendezvous and docking RVD The position and attitude dynamics and kinematics equations for RVD are presented systematically in accordance with several different coordinate systems including elliptical orbital frame and recommendations are supplied on which of these equations to use in different phases of RVD The book subsequently explains the basic principles and relative navigation algorithms of RVD sensors such as GNSS radar and camera type RVD sensors It also provides guidance algorithms and schemes for different phases of RVD including the latest research advances in rapid RVD In turn the book presents a detailed introduction to intelligent adaptive control and proposes corresponding theoretical approaches to thruster configuration and control allocation for RVD Emphasis is placed on the design method of active and passive trajectory protection in different phases of RVD and on the safety design of the RVD mission as a whole For purposes of verification the Shenzhou spacecraft s in orbit flight mission is introduced as well All issues addressed are described and explained from basic principles to detailed engineering methods and examples providing aerospace engineers and students both a basic understanding of and numerous practical engineering methods for GNC system design in RVD

Spacecraft Guidance, Navigation and Control Systems European Space Agency, 1994

Guidance and Control Technology of Spacecraft on Elliptical Orbit Fucheng Liu, Shan Lu, Yue Sun, 2018-08-14 This book introduces readers to the navigation guidance and control technologies involved in single spacecraft double spacecraft and multiple spacecraft tasks in elliptical orbits It comprehensively covers the key technologies of guidance navigation and control GNC system design for spacecraft in elliptical orbits including the orbit design formation configuration design and maintenance autonomous navigation technology and relative navigation technology as well as autonomous rendezvous technology The methods that this book introduces are very close to actual practical engineering applications and presented in an accessible style The book can serve as reference teaching material for senior undergraduates and postgraduates with space navigation related majors while also providing essential information and guidance for research personnel and engineering technical personnel engaged in the development of GNC systems for

spacecraft *Guidance, Navigation, and Control for Spacecraft Rendezvous and Docking: Theory and Methods* Yongchun Xie, Changqing Chen, Tao Liu, Min Wang, 2021 This book focuses on the theory of and design methods for guidance navigation and control GNC in the context of spacecraft rendezvous and docking RVD The position and attitude dynamics and kinematics equations for RVD are presented systematically and in accordance with several different coordinate systems including elliptical orbital frame and recommendations are supplied on which of these equations to use in different phases of RVD The book subsequently explains the basic principles and relative navigation algorithms of RVD sensors such as GNSS radar and camera type RVD sensors It also provides guidance algorithms and schemes for different phases of RVD including the latest research advances in rapid RVD In turn the book presents a detailed introduction to intelligent adaptive control and proposes corresponding theoretical approaches to thruster configuration and control allocation for RVD Emphasis is placed on the design method of active and passive trajectory protection in different phases of RVD and on the safety design of the RVD mission as a whole For purposes of verification the Shenzhou spacecraft s in orbit flight mission is presented as well All issues addressed are described and explained from basic principles to detailed engineering methods and examples providing aerospace engineers and students both a basic understanding of and numerous practical engineering methods for GNC system design in RVD Spacecraft Dynamics and Control Yongchun Xie, Yongjun Lei, Jianxin Guo, Bin

Meng, 2021-07-13 This book presents up to date concepts and design methods relating to space dynamics and control including spacecraft attitude control orbit control and guidance navigation and control GNC summarizing the research advances in control theory and methods and engineering practice from Beijing Institute of Control Engineering over the years The control schemes and systems based on these achievements have been successfully applied to remote sensing satellites communication satellites navigation satellites new technology test satellites Shenzhou manned spacecraft Tianzhou freight spacecraft Tiangong 1 2 space laboratories Chang e lunar explorers and many other missions Further the research serves as a guide for follow up engineering developments in manned lunar engineering deep space exploration and on orbit service missions **Control, Guidance, and Navigation of Spacecraft** ,1962 **NASA Technical Note** ,1968 **NASA**

**Thesaurus** ,1988 **Scientific and Technical Aerospace Reports** ,1992 **Position, Navigation, and Timing Technologies in the 21st Century** Y. Jade Morton, Frank van Diggelen, James J. Spilker, Jr., Bradford W. Parkinson, Sherman Lo, Grace Gao, 2021-01-13 Covers the latest developments in PNT technologies including integrated satellite navigation sensor systems and civil applications Featuring sixty four chapters that are divided into six parts this two volume work provides comprehensive coverage of the state of the art in satellite based position navigation and timing PNT technologies and civilian applications It also examines alternative navigation technologies based on other signals of opportunity and sensors and offers a comprehensive treatment on integrated PNT systems for consumer and commercial applications Volume 1 of Position Navigation and Timing Technologies in the 21st Century Integrated Satellite Navigation Sensor Systems and

Civil Applications contains three parts and focuses on the satellite navigation systems technologies and engineering and scientific applications. It starts with a historical perspective of GPS development and other related PNT development. Current global and regional navigation satellite systems GNSS and RNSS, their inter operability, signal quality monitoring, satellite orbit and time synchronization and ground and satellite based augmentation systems are examined. Recent progresses in satellite navigation receiver technologies and challenges for operations in multipath rich urban environment in handling spoofing and interference and in ensuring PNT integrity are addressed. A section on satellite navigation for engineering and scientific applications finishes off the volume. Volume 2 of Position Navigation and Timing Technologies in the 21st Century Integrated Satellite Navigation Sensor Systems and Civil Applications consists of three parts and addresses PNT using alternative signals and sensors and integrated PNT technologies for consumer and commercial applications. It looks at PNT using various radio signals of opportunity, atomic clock, optical laser, magnetic field, celestial, MEMS and inertial sensors as well as the concept of navigation from Low Earth Orbiting LEO satellites. GNSS INS integration, neuroscience of navigation and animal navigation are also covered. The volume finishes off with a collection of work on contemporary PNT applications such as survey and mobile mapping, precision agriculture, wearable systems, automated driving, train control, commercial unmanned aircraft systems, aviation and navigation in the unique Arctic environment. In addition, this text serves as a complete reference and handbook for professionals and students interested in the broad range of PNT subjects. Includes chapters that focus on the latest developments in GNSS and other navigation sensors, techniques and applications. Illustrates interconnecting relationships between various types of technologies in order to assure more protected, tough and accurate PNT. Position Navigation and Timing Technologies in the 21st Century Integrated Satellite Navigation Sensor Systems and Civil Applications will appeal to all industry professionals, researchers and academics involved with the science, engineering and applications of position navigation and timing technologies. [pnt21book.com](http://pnt21book.com)

**Navigation and Guidance Analysis of a Mars Probe Launched from a Manned Flyby Spacecraft** Thomas B. Murtagh, 1968

**Proceedings of the 44th Annual American Astronautical Society Guidance, Navigation, and Control Conference, 2022** Matt Sandnas, David B. Spencer, 2024-03-30

This conference attracts GN/C specialists from across the globe. The 2022 Conference was the 44th Annual GN/C conference with more than 230 attendees from six different countries with 44 companies and 28 universities represented. The conference presented more than 100 presentations and 16 posters across 18 topics. This year the planning committee wanted to continue a focus on networking and collaboration hoping to inspire innovation through the intersection of diverse ideas. These proceedings present the relevant topics of the day while keeping our more popular and well attended sessions as cornerstones from year to year. Several new topics including Autonomous Control of Multiple Vehicles and Results and Experiences from OSIRIS-REx were directly influenced by advancements in our industry. In the end, the 44th Annual GN/C conference became a timely reflection of the current state of the GN/C in the space industry. The annual American

Astronautical Society Rocky Mountain Guidance Navigation and Control GN C Conference began 1977 as an informal exchange of ideas and reports of achievements among guidance and control specialists local to the Colorado area Bud Gates Don Parsons and Bob Culp organized the first conference and began the annual series of meetings the following winter In March 1978 the First Annual Rocky Mountain Guidance and Control Conference met at Keystone Colorado It met there for eighteen years moving to Breckenridge in 1996 where it has been for over 25 years      **Advanced Trajectory**

**Optimization, Guidance and Control Strategies for Aerospace Vehicles** Runqi Chai,Kaiyuan Chen,Lingguo Cui,Senchun Chai,Gokhan Inalhan,Antonios Tsourdos,2023-09-27 This book focuses on the design and application of advanced trajectory optimization and guidance and control G C techniques for aerospace vehicles Part I of the book focuses on the introduction of constrained aerospace vehicle trajectory optimization problems with particular emphasis on the design of high fidelity trajectory optimization methods heuristic optimization based strategies and fast convexification based algorithms In Part II various optimization theory artificial intelligence AI based methods are constructed and presented including dynamic programming based methods model predictive control based methods and deep neural network based algorithms Key aspects of the application of these approaches such as their main advantages and inherent challenges are detailed and discussed Some practical implementation considerations are then summarized together with a number of future research topics The comprehensive and systematic treatment of practical issues in aerospace trajectory optimization and guidance and control problems is one of the main features of the book which is particularly suitable for readers interested in learning practical solutions in aerospace trajectory optimization and guidance and control The book is useful to researchers engineers and graduate students in the fields of G C systems engineering optimization applied optimal control theory etc      **Frontiers in**

**Robotics and AI editor's picks 2024** ,2025-03-12 For the third year in a row we are very happy to offer our readership an ebook of 11 articles that have achieved widespread acceptance within our core audience and beyond This time it concerns articles published in 2024 These papers are among the large number that attained significant interest last year but we selected just 11 which we consider to be the best These articles have already made an impact in the form of original research or comprehensive reviews As the Field Chief Editor I would like to stand alongside our journal staff to honor all authors who contributed very high level papers to the journal last year and are contributing to our success We also thank the editors and reviewers of these papers and of all papers this past year for their invaluable contribution      *NASA Scientific and Technical Reports* United States. National Aeronautics and Space Administration Scientific and Technical Information Division,1970

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