

JPL DEEP SPACE COMMUNICATIONS AND NAVIGATION SERIES

RADIOMETRIC TRACKING TECHNIQUES FOR DEEP SPACE NAVIGATION



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Radiometric Tracking Techniques For Deep Space Navigation

Dave Doody



Radiometric Tracking Techniques For Deep Space Navigation:

Radiometric Tracking Techniques for Deep-Space Navigation Catherine L. Thornton, James S. Border, 2003-02-05
Radiometric Tracking Techniques for Deep Space Navigation focuses on a broad array of technologies and concepts developed over the last four decades to support radio navigation on interplanetary spacecraft In addition to an overview of Earth based radio navigation techniques the book includes a simplified conceptual presentation of each radiometric measurement type its information content and the expected measurement accuracy The methods described for both acquiring and calibrating radiometric measurements also provide a robust system to support guidance and navigation for future robotic space exploration Radiometric Tracking Techniques for Deep-Space Navigation Catherine L. Thornton, James S. Border, United States. National Aeronautics and Space Administration, Jet Propulsion Laboratory (U.S.), 2000 *Radiometric Tracking Techniques for Deep-Space Navigation* Catherine L. Thornton, James S. Border, 2005-02-18 Radiometric Tracking Techniques for Deep Space Navigation focuses on a broad array of technologies and concepts developed over the last four decades to support radio navigation on interplanetary spacecraft In addition to an overview of Earth based radio navigation techniques the book includes a simplified conceptual presentation of each radiometric measurement type its information content and the expected measurement accuracy The methods described for both acquiring and calibrating radiometric measurements also provide a robust system to support guidance and navigation for future robotic space exploration Radio Science Techniques for Deep Space Exploration Sami W. Asmar, 2022-03-23 Explore the development and state of the art in deep space exploration using radio science techniques In Radio Science Techniques for Deep Space Exploration accomplished NASA JPL researcher and manager Sami Asmar delivers a multi disciplinary exploration of the science technology engineering mission operations and signal processing relevant to deep space radio science The book discusses basic principles before moving on to more advanced topics that include a wide variety of graphical illustrations and useful references to publications by experts in their respective fields Complete explanations of changes in the characteristics of electromagnetic waves and the instrumentation and technology used in scientific experiments are examined Radio Science Techniques for Deep Space Exploration offers answers to the question of how to explore the solar system with radio links and better understand the interior structures atmospheres rings and surfaces of other planets The author also includes Thorough introductions to radio science techniques and systems needed to investigate planetary atmospheres rings and surfaces Comprehensive explorations of planetary gravity and interior structures as well as relativistic and solar studies Practical discussions of instrumentation technologies and future directions in radio science techniques Perfect for students and professors of physics astronomy planetary science aerospace engineering and communications engineering Radio Science Techniques for Deep Space Exploration will also earn a place in the libraries of engineers and scientists in the aerospace industry **Spacecraft Optical Navigation** William M. Owen,

Jr.,2024-10-11 UNIQUE RESOURCE EXPLORING HOW SPACECRAFT IMAGERY PROVIDES PROFESSIONALS WITH ACCURATE ESTIMATES OF SPACECRAFT TRAJECTORY WITH REAL WORLD EXAMPLES AND DETAILED ILLUSTRATIONS

Spacecraft Optical Navigation provides detailed information on the planning and analysis of spacecraft imagery to help determine the trajectory of a spacecraft The author an experienced engineer within the field addresses the entirety of celestial targets and explains how a spacecraft captures their imagery Aimed at professionals within spacecraft navigation this book provides an extensive introduction and explains the history of optical navigation reviewing a range of optical methods and presents real world examples throughout With the use of mathematics this book discusses everything from the orbits sizes and shapes of the bodies being imaged to the location and properties of salient features on their surfaces Specific sample topics covered in Spacecraft Optical Navigation include History of various past spacecraft including Mariner and Viking Voyager Galileo NEAR Shoemaker and Cassini and flight hardware star catalogs and stereophotoclinometry Cameras covering the gnomonic projection and deviations from it creation of a digital picture picture flattening and readout smears Modeling optical navigation observables covering apparent directions to an object star and limbs or terminators and orientation of cameras Obtaining optical navigation observables covering centerfinding for stars and resolved and unresolved bodies and using opnav data in orbit determination Spacecraft Optical Navigation is an ideal resource for engineers working in spacecraft navigation and optical navigation to update their knowledge of the technology and use it in their day to day The text will also benefit researchers working with spacecraft particularly in navigation and professors and lecturers teaching graduate aerospace courses

CubeSat Antenna Design Nacer Chahat,2021-01-07 Presents an overview of CubeSat antennas designed at the Jet Propulsion Laboratory JPL CubeSats nanosatellites built to standard dimensions of 10cm x 10 cm x cm are making space based Earth science observation and interplanetary space science affordable accessible and rapidly deployable for institutions such as universities and smaller space agencies around the world CubeSat Antenna Design is an up to date overview of CubeSat antennas designed at NASA s Jet Propulsion Laboratory JPL covering the systems engineering knowledge required to design these antennas from a radio frequency and mechanical perspective This authoritative volume features contributions by leading experts in the field providing insights on mission critical design requirements for state of the art CubeSat antennas and discussing their development capabilities and applications The text begins with a brief introduction to CubeSats followed by a detailed survey of low gain medium gain and high gain antennas Subsequent chapters cover topics including the telecommunication subsystem of Mars Cube One MarCO the enabling technology of Radar in a CubeSat RainCube the development of a one meter mesh reflector for telecommunication at X and Ka band for deep space missions and the design of multiple metasurface antennas Written to help antenna engineers to enable new CubeSat NASA missions this volume Describes the selection of high gain CubeSat antennas to address specific mission requirements and constraints for instruments or telecommunication Helps readers learn how to develop antennas for

future CubeSat missions Provides key information on the effect of space environment on antennas to inform design steps Covers patch and patch array antennas deployable reflectarray antennas deployable mesh reflector inflatable antennas and metasurface antennas CubeSat Antenna Design is an important resource for antenna microwave engineers aerospace systems engineers and advanced graduate and postdoctoral students wanting to learn how to design and fabricate their own antennas to address clear mission requirements

Spaceborne Antennas for Planetary Exploration William A. Imbriale, 2006-08-08 JPL spacecraft antennas from the first Explorer satellite in 1958 to current R D Spaceborne Antennas for Planetary Exploration covers the development of Jet Propulsion Laboratory JPL spacecraft antennas beginning with the first Explorer satellite in 1958 through current research and development activities aimed at future missions Readers follow the evolution of all the new designs and technological innovations that were developed to meet the growing demands of deep space exploration The book focuses on the radio frequency design and performance of antennas but covers environmental and mechanical considerations as well There is additionally a thorough treatment of all the analytical and measurement techniques used in design and performance assessment Each chapter is written by one or more leading experts in the field of antenna technology The presentation of the history and technology of spaceborne antennas is aided by several features Photographs and drawings of JPL spacecraft Illustrations to help readers visualize concepts and designs Tables highlighting and comparing the performance of the antennas Bibliographies at the end of each chapter leading to a variety of primary and secondary source material This book complements Large Antennas of the Deep Space Network Wiley 2002 which surveys the ground antennas covered in support of spacecraft Together these two books completely cover all JPL antenna technology in keeping with the JPL Deep Space Communications and Navigation Series mission to capture and present the many innovations in deep space telecommunications over the past decades This book is a fascinating and informative read for all individuals working in or interested in deep space telecommunications

Deep Space Optical Communications Hamid Hemmati, 2006-06-05 A quarter century of research into deep space and near Earth optical communications This book captures a quarter century of research and development in deep space optical communications from the Jet Propulsion Laboratory JPL Additionally it presents findings from other optical communications research groups from around the world for a full perspective Readers are brought up to date with the latest developments in optical communications technology as well as the state of the art in component and subsystem technologies fundamental limitations and approaches to develop and fully exploit new technologies The book explores the unique requirements and technologies for deep space optical communications including Technology overview link and system design drivers Atmospheric transmission propagation and reception issues Flight and ground terminal architecture and subsystems Future prospects and applications including navigational tracking and light science This is the first book to specifically address deep space optical communications With an increasing demand for data from planetary spacecraft and other sources it is essential reading for all optical

communications telecommunications and system engineers as well as technical managers in the aerospace industry It is also recommended for graduate students interested in deep space communications **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 *Proceedings of the 27th Conference of Spacecraft TT&C Technology in China* Rongjun Shen, Weiping Qian, 2014-10-06 This book collects selected papers from the

27th Conference of Spacecraft TT C Technology in China held in Guangzhou on November 9 12 2014 The book features state of the art studies on spacecraft TT C in China with the theme of Wider Space for TT C To meet requirements of new space endeavors especially China s deep space programs China s spacecraft TT C systems shall go farther measure more accurately and control better with higher efficacy Researchers and engineers in the field of aerospace engineering and communication engineering can benefit from the book

China Satellite Navigation Conference (CSNC) 2012 Proceedings Jiadong Sun, Jingnan Liu, Yuanxi Yang, Shiwei Fan, 2012-04-02 Proceedings of the 3rd China Satellite Navigation Conference CSNC2012 presents selected research papers from CSNC2012 held on 15 19 May in Guangzhou China These papers discuss the technologies and applications of the Global Navigation Satellite System GNSS and the latest progress made in the China BeiDou system especially They are divided into 9 topics to match the corresponding sessions in CSNC2012 which broadly covered key topics in GNSS Readers can learn about the BeiDou system and keep abreast of the latest advances in GNSS techniques and applications SUN Jiadong is the Chief Designer of the Compass BeiDou system and the Academician of Chinese Academy of Sciences LIU Jingnan is a professor at Wuhan University and the Academician of Chinese Academy of Engineering YANG Yuanxi is a professor at China National Administration of GNSS and Applications and the Academician of Chinese Academy of Sciences FAN Shiwei is a researcher on satellite navigation

Autonomous Software-Defined Radio Receivers for Deep Space Applications Jon Hamkins, Marvin K. Simon, 2006-10-13 This book introduces the reader to the concept of an autonomous software defined radio SDR receiver Each distinct aspect of the design of the receiver is treated in a separate chapter written by one or more leading innovators in the field Chapters begin with a problem statement and then offer a full mathematical derivation of an appropriate solution a decision metric or loop structure as appropriate and performance results

Antenna Arraying Techniques in the Deep Space Network David H. Rogstad, Alexander Mileant, Timothy T. Pham, 2003 An introduction to antenna Arraying in the Deep Space network Antenna arraying is the combining of the output from several antennas in order to improve the signal to noise ratio SNR of the received signal Now implemented at the Goldstone Complex and other Deep Space Network DSN overseas facilities antenna arraying provides flexible use of multiple antennas to increase data rates and has enabled NASA s DSN to extend the missions of some spacecraft beyond their planned lifetimes Antenna Arraying Techniques in the Deep Space Network introduces the development and use of antenna arraying as it is implemented in the DSN Drawing on the work of scientists at JPL this timely volume summarizes the development of antenna arraying and its historical background describes key concepts and techniques analyzes and compares several methods of arraying discusses several correlation techniques used for obtaining the combined weights presents the results of several arraying experiments and suggests directions for future work An important contribution to the scientific literature Antenna Arraying Techniques in the Deep Space Network Was commissioned by the JPL Deep Space Communications and Navigation Systems DESCANSO Center of Excellence Highlights

many NASA funded technical contributions pertaining to deep space communications systems Is a part of the prestigious JPL Deep Space Communications and Navigation Series The Deep Space Communications and Navigation Series is authored by scientists and engineers with extensive experience in astronautics communications and related fields It lays the foundation for innovation in the areas of deep space navigation and communications by disseminating state of the art knowledge in key technologies

Deep Space Communications Jim Taylor, 2016-08-16 DEEP SPACE COMMUNICATIONS A COLLECTION OF SOME OF THE JET PROPULSION LABORATORY S SPACE MISSIONS SELECTED TO REPRESENT THE PLANETARY COMMUNICATIONS DESIGNS FOR A PROGRESSION OF VARIOUS TYPES OF MISSIONS The text uses a case study approach to show the communications link performance resulting from the planetary communications design developed by the Jet Propulsion Laboratory JPL This is accomplished through the description of the design and performance of six representative planetary missions These six cases illustrate progression through time of the communications system s capabilities and performance from 1970s technology to the most recent missions The six missions discussed in this book span the Voyager for fly bys in the 1970s Galileo for orbiters in the 1980s Deep Space 1 for the 1990s Mars Reconnaissance Orbiter MRO for planetary orbiters Mars Exploration Rover MER for planetary rovers in the 2000s and the MSL rover in the 2010s Deep Space Communications Provides an overview of the Deep Space Network and its capabilities Examines case studies to illustrate the progression of system design and performance from mission to mission and provides a broad overview of the mission systems described Discusses actual flight mission telecommunications performance of each system Deep Space Communications serves as a reference for scientists and engineers interested in communications systems for deep space telecommunications link analysis and design control

Research and Technology Objectives and Plans Summary (RTOPS) , 1985

Formulation for Observed and Computed Values of Deep Space Network Data Types for Navigation Theodore D. Moyer, 2003-01-31 A valuable reference for students and professionals in the field of deep space navigation Drawing on fundamental principles and practices developed during decades of deep space exploration at the California Institute of Technology s Jet Propulsion Laboratory JPL this book documents the formation of program Regres of JPL s Orbit Determination Program ODP Program Regres calculates the computed values of observed quantities e g Doppler and range observables obtained at the tracking stations of the Deep Space Network and also calculates media corrections for the computed values of the observable and partial derivatives of the computed values of the observables with respect to the solve for parameter vector q The ODP or any other program which uses its formulation can be used to navigate a spacecraft anywhere in the solar system A publication of the JPL Deep Space Communications and Navigation System Center of Excellence DESCANSO Formulation for Observed and Computed Values of Deep Space Network Data Types for Navigation is an invaluable resource for graduate students of celestial mechanics or astrodynamics because it features the expertise of today s top scientists places the entire program Regres formulation in an easy to access resource describes technology which

will be used in the next generation of navigation software currently under development The Deep Space Communications and Navigation Series is authored by scientists and engineers with extensive experience in astronautics communications and related fields It lays the foundation for innovation in the areas of deep space navigation and communications by conveying state of the art knowledge in key technologies

Advances in the Astronautical Sciences Volume 148 American Astronautical Society Contributors, Francesco Vicario, 2013-07-22 Advances in the Astronautical Sciences Series Volume 148 is a collection of scientific papers that were presented at the American Astronautical Society American Institute of Aeronautics and Astronautics Spaceflight Mechanics Meeting held February 10-14 2013 in Kauai Hawaii

Deep Space Craft Dave Doody, 2010-04-03 Deep Space Craft opens the door to interplanetary flight It looks at this world from the vantage point of real operations on a specific mission and follows a natural trail from the day to day working of this particular spacecraft through the functioning of all spacecraft to the collaboration of the various disciplines to produce the results for which a spacecraft is designed These results are of course mostly of a scientific nature although a small number of interplanetary missions are also flown primarily to test and prove new engineering techniques The author shows how in order to make sense of all the scientific data coming back to Earth the need for experiments and instrumentation arises and follows the design and construction of the instruments through to their placement and testing on a spacecraft prior to launch Examples are given of the interaction between an instrument's science team and the mission's flight team to plan and specify observations gather and analyze data in flight and finally present the results and discoveries to the scientific community This highly focused insider's guide to interplanetary space exploration uses many examples of previous and current endeavors It will enable the reader to research almost any topic related to spacecraft and to seek the latest scientific findings the newest emerging technologies or the current status of a favorite flight In order to provide easy paths from the general to the specific the text constantly refers to the Appendices Within the main text the intent is general familiarization and categorization of spacecraft and instruments at a high level to provide a mental framework to place in context and understand any spacecraft and any instrument encountered in the reader's experience Appendix A gives illustrated descriptions of many interplanetary spacecraft some earth orbiters and ground facilities to reinforce the classification framework Appendix B contains illustrated detailed descriptions of a dozen scientific instruments including some ground breaking engineering appliances that have either already been in operation or are poised for flight Each instrument's range of sensitivity in wavelengths of light etc and its physical principles of operation is described Appendix C has a few annotated illustrations to clarify the nomenclature of regions and structures in the solar system and the planets ring systems and places the solar system in context with the local interstellar environment

A Window on the Future of Geodesy Fernando Sansò, 2006-06-09 Every four years the International Association of Geodesy meets at the IUGG General Assembly and this has always been an important event for IAG to make the point on where are we going as geodesists both in terms of scientific production as well as in terms of

organization The proceedings of IAG at the Sapporo 2003 General Assembly are the mirror of our scientific achievements and as Geodesy is a living entity like any other science we could say it is a way to see the picture of what we consider our field of applications as well as of theoretical speculations Let us examine this aspect in terms of what are the object of our research the methods we use the general scientific results we can produce Our object here I would like to use a pseudo Helmert definition the object of Geodesy is knowing the surfaces of the earth the geometric surface by positioning and e m surveying and the physical surface i e the gravity field by land marine or satellite gravimetry and their time variations This object is naturally interlaced with other physical properties of the earth both through deep processes affecting its surface and through the gravity field at all different scales from the global to the regional and local where most engineering applications take place

Practical Astrodynamics Alessandro de Iaco Veris, 2017-11-28 This modern textbook guides the reader through the theory and practice of the motion and attitude control of space vehicles It first presents the fundamental principles of spaceflight mechanics and then addresses more complex concepts and applications of perturbation theory orbit determination and refinement space propulsion orbital maneuvers interplanetary trajectories gyroscope dynamics attitude control and rocket performance Many algorithms used in the modern practice of trajectory computation are also provided The numerical treatment of the equations of motion the related methods and the tables needed to use them receive particular emphasis A large collection of bibliographical references including books articles and items from the gray literature is provided at the end of each chapter and attention is drawn to many internet resources available to the reader The book will be of particular value to undergraduate and graduate students in aerospace engineering

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