Orbit Determination Of Lro At The Moon Nasa

Orbital Flight Handbook: Mission sequencing problems
Technical Report - Jet Propulsion Laboratory, California Institute of Technology
Orbit Determination Analysis Utilizing Radiometric and Laser Ranging Measurements for GPS Orbit
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Development of an illumination simulation software for the Moon's surface
Lunar Orbiter II
Astrodynamics: Orbit determination, space navigation, celestial mechanics
One Hundred Years Of General Relativity: From Genesis And Empirical Foundations To Gravitational Waves, Cosmology And Quantum Gravity - Volume 1
Crustal Dynamics Data Information System
To a Rocky Moon
REFAG 2014
A Study of the Accuracy of Estimating the Orbital Elements of a Lunar Satellite by Using Range and Range-rate Measurements
44th Congress of the International Astronautical Federation
SPACE FLIGHT HANDBOOKS. VOLUME 1- ORBITAL FLIGHT HANDBOOK, PART 3 - REQUIREMENTS
New View of the Moon 2
Prelaunch Analysis of High Eccentricity Orbits

Solid Earth (SE)
The Science of Time 2016
Statistical Orbit Determination
Advances in Spacecraft Systems and Orbit Determination
Method for Determination of the Accuracy of Closed Distant Stationary Orbits Determined from Range Rate
Proceedings of the 44th Annual American Astronautical Society Guidance, Navigation, and Control Conference, 2022
Lunar Reconnaissance Orbiter Mission
Planetary Remote Sensing and Mapping
Lunar Orbiter IV
Techniques for the Determination of Mass Properties of Earth-to-orbit Transportation Systems
Orbital Flight Handbook

ROLAND SANTANA

Orbital Flight Handbook: Mission sequencing problems Springer
A first order orbital mechanics analysis was conducted to examine the possibility of utilizing the Space Shuttle Orbiter to perform payload delivery missions to lunar orbit. In the analysis, the earth orbit of departure was constrained to be that of Space Station Freedom. Furthermore, no enhancements of the Orbiter's thermal protection system were assumed. Therefore, earth orbit insertion maneuvers were constrained to be all propulsive. Only minimal constraints were placed on the lunar orbits and no consideration was given to possible landing sites for lunar surface payloads. The various phases and maneuvers of the mission are discussed for both a conventional (Apollo type) and an unconventional mission profile. The velocity impulses needed, and the propellant masses required are presented for all of the mission maneuvers. Maximum payload capabilities were determined for both of the mission profiles examined. In addition, other issues relating to the feasibility of such lunar shuttle missions are discussed. The results of the analysis indicate that the Shuttle Orbiter would be a poor vehicle for payload delivery missions to lunar orbit. Haynes, Davy A. Langley Research Center RTOP 594-81-12-11...
Technical Report - Jet Propulsion Laboratory, California Institute of Technology John Wiley & Sons
The Lunar Reconnaissance Orbiter (LRO) was successfully launched on June 18, 2009 and joined an international eet of satellites (Japan’s SELENE/Kaguya, China’s Chang’E, and India’s Chandrayaan-1) that have recently orbited the Moon for scienti c exploration p- poses. LRO is the rst step to ful ll the US national space goal to return humans to the Moon’s surface, which is a primary objective of NASA’s Exploration Systems Mission - rectorate (ESMD). TheinitialLROmissionphasehasaone-yeardurationfullyfundedunder ESMD support. LRO is expected to have an extended phase of operations for at least two additional years to undertake further lunar science measurements that are

directly linked to objectives outlined in the National Academy of Science's report on the Scienti c Context for Exploration of the Moon (SCEM). All data from LRO will be deposited in the Planetary Data System (PDS) archive so as to be usable for both exploration and science by the widest possible community. A NASA Announcement of Opportunity (AO) solicited proposals for LRO instruments with associated exploration measurement investigations. A rigorous evaluation process - volving scienti c peer review, in combination with technical, cost and management risk assessments, recommended six instruments for LRO development and deployment. The competitively selected instruments are: Cosmic Ray Telescope for the Effects of Rad- tion (CRaTER), Diviner Lunar Radiometer Experiment (DLRE), Lyman-Alpha Mapping Project (LAMP), Lunar Exploration Neutron Detector (LEND), Lunar Orbiter Laser - timeter (LOLA), and Lunar Reconnaissance Orbiter Camera (LROC).

Orbit Determination Analysis Utilizing Radiometric and Laser Ranging Measurements for GPS Orbit Springer

The early 21st century marks a new era in space exploration. The National Aeronautics and Space Administration (NASA) of the United States, The European Space Agency (ESA), as well as space agencies of Japan, China, India, and other countries have sent their probes to the Moon, Mars, and other planets in the solar system. Planetary Remote Sensing and Mapping introduces original research and new developments in the areas of planetary remote sensing, photogrammetry, mapping, GIS, and planetary science resulting from the recent space exploration missions. Topics covered include: Reference systems of planetary bodies Planetary exploration missions and sensors Geometric information extraction from planetary remote sensing data Feature information extraction from planetary remote sensing data Planetary remote sensing data fusion Planetary data management and presentation Planetary Remote Sensing and Mapping will serve scientists and professionals working in the planetary remote sensing and mapping areas, as well as planetary probe designers, engineers, and planetary geologists and geophysicists. It also provides useful reading material for university teachers and students in the broader areas of remote sensing, photogrammetry, cartography, GIS, and geodesy.

Statistical Orbit Determination Springer Nature

The uses of time in astronomy - from pointing telescopes, coordinating and processing observations, predicting ephemerides, cultures, religious practices, history, businesses, determining Earth orientation, analyzing time-series data and in many other ways - represent a broad sample of how time is used throughout human society and in space. Time and its reciprocal, frequency, is the most accurately measurable quantity and often an important path to the frontiers of science. But the future of timekeeping is changing with the development of optical frequency standards and the resulting challenges of distributing time at ever higher precision, with the possibility of timescales based on pulsars, and with the inclusion of higher-order relativistic effects. The definition of the second will likely be changed before the end of this decade, and its realization will increase in accuracy; the definition of the day is no longer obvious. The variability of the Earth's

rotation presents challenges of understanding and prediction. In this symposium speakers took a closer look at time in astronomy, other sciences, cultures, and business as a defining element of modern civilization. The symposium aimed to set the stage for future timekeeping standards, infrastructure, and engineering best practices for astronomers and the broader society. At the same time the program was cognizant of the rich history from Harrison's chronometer to today's atomic clocks and pulsar observations. The theoreticians and engineers of time were brought together with the educators and historians of science, enriching the understanding of time among both experts and the public.

Determination of Precise Satellite Orbits and Geodetic Parameters using Satellite Laser Ranging Springer

The aim of this two-volume title is to give a comprehensive review of one hundred years of development of general relativity and its scientific influences. This unique title provides a broad introduction and review to the fascinating and profound subject of general relativity, its historical development, its important theoretical consequences, gravitational wave detection and applications to astrophysics and cosmology. The series focuses on five aspects of the theory: The first three topics are covered in Volume 1 and the remaining two are covered in Volume 2. While this is a two-volume title, it is designed so that each volume can be a standalone reference volume for the related topic.

Effect of Gravitational-model Selection on Accuracy of Lunar Orbit Determination from Short Data Arcs CRC Press

"Advances in Spacecraft Systems and Orbit Determinations", discusses the development of new technologies and the limitations of the present technology, used for interplanetary missions. Various experts have contributed to develop the bridge between present limitations and technology growth to overcome the limitations. Key features of this book inform us about the orbit determination techniques based on a smooth research based on astrophysics. The book also provides a detailed overview on Spacecraft Systems including reliability of low-cost AOCS, sliding mode controlling and a new view on attitude controller design based on sliding mode, with thrusters. It also provides a technological roadmap for HVAC optimization. The book also gives an excellent overview of resolving the difficulties for interplanetary missions with the comparison of present technologies and new advancements. Overall, this will be very much interesting book to explore the roadmap of technological growth in spacecraft systems.

Gravity, Geoid and Height Systems CRC Press

This report investigates a scanning optical system to provide attitude and trajectory of unmanned spacecraft during orbit about Mars.

Planetary Geodesy and Remote Sensing Createspace Independent Publishing Platform

The contribution of Satellite Laser Ranging (SLR) to the definition of the origin of the reference frame (geocenter coordinates), the global scale, and low degree coefficients of the Earth's gravity field is essential due to the remarkable orbit stability of geodetic satellites and the accuracy of laser observations at a level of a few millimeters. Considering

these aspects, SLR has an exceptional potential in establishing global networks and deriving geodetic parameters of the supreme quality. SLR faces today the highest requirements of the Global Geodetic Observing System (GGOS) yielding 1 mm of long-term station coordinate and 0.1 mm/y of station velocity stability. The goal of this work is to assess the contribution of the latest models and corrections to the SLR-derived parameters, to enhance the quality and reliability of the SLR-derived products, and to propose a new approach of orbit parameterization for low orbiting geodetic satellites. The impact of orbit perturbations is studied in detail, including perturbing forces of gravitational origin (Earth's gravity field, ocean and atmosphere tides) and perturbing forces of non-gravitational origin (atmospheric drag, the Yarkovsky effect, albedo and Earth's infrared radiation pressure). A multi-satellite combined solution is obtained using SLR observations to LAGEOS-1, LAGEOS-2, Starlette, Stella, and AJISAI. The quality of the SLR-derived parameters from the combined solution is compared with external solutions. The Earth rotation parameters are compared to the IERS-08-C04 series and the GNSS-derived series, whereas the time variable Earth's gravity field coefficients are compared to the CHAMP and GRACE-derived results.

Feasibility Analysis of Cislunar Flight Using the Shuttle Orbiter

Astronomical Institute, University of Bern, Switzerland

This book series is composed of peer-reviewed proceedings of selected symposia organized by the International Association of Geodesy. It deals primarily with topics related to Geodesy as applied to the Earth Sciences : terrestrial reference frame, Earth gravity field, Geodynamics and Earth rotation, Positioning and engineering applications.

Proceedings of the ION National Space Meeting on Space Navigation, Theory and Practice in the Post Apollo Era

Walter de Gruyter GmbH & Co KG

Zusammenfassung: 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 ins 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

AAS Science and Technology Series World Scientific

The German Aerospace Center (DLR) is developing a new, holistic optical navigation system for all stages of spacecraft planetary approach and landing procedures. The central feature of this new navigation system is its landmark-based navigation. Commonly, craters are used as landmarks, as they exhibit very characteristic shapes and they are stable over the long term with respect to shape, structure and positioning. However, the flawless perception of these surface features by computers is a non-trivial task. A possibility of generating realistic surface images of celestial bodies with a significant number of craters and with well-known local illumination conditions is essential for the development of new navigation algorithms, as well as a technique for estimating the local illumination direction on these images. To date, no software exists to generate artificial renderings of realistically illuminated planetary surfaces while determining the local solar illumination direction. Having said this, a surface illumination simulation software for solid planetary surfaces with a significant number of craters has been developed within a master's thesis at the Merseburg University of Applied Sciences and the German Aerospace Center (DLR), whereas all work has been done in the context of the Moon. This software, the Moon Surface Illumination Simulation Framework (MSISF), is the first software known to produce realistic renderings of the entire Moon's surface from virtually every viewpoint, while simultaneously generating machine-readable information regarding the exactly known parameters for the environmental conditions, such as the local solar illumination angle for every pixel of a rendering showing a point on the Moon's surface. To produce its renderings, the MSISF maintains a global digital elevation model of the Moon, using the latest data sets from the ongoing NASA Lunar Reconnaissance Orbiter mission. The MSISF has also demonstrated its ability to not only produce single renderings, but also whole series of renderings corresponding to a virtual flight trajectory or landing on the Moon. The MSISF can also be modified for the rendering of other celestial bodies. This book shows how these renderings will be produced and how they will be suitable for the development and testing of new optical navigation algorithms; it is based upon the examination version of the original master's thesis.

Joint Determination of Orbits of Spacecraft and Moons of Mars by Optical Sighting of the Moons BoD – Books on Demand

When human exploration of the lunar surface began in 1969, it marked not only an unprecedented technological achievement but also the culmination of scientific efforts to understand lunar geology. Memoirs of the Apollo astronauts have preserved the exploratory aspects of these missions; now a geologist who was an active participant in the lunar program offers a detailed historical view of those events--including the pre-Apollo era--from a heretofore untold scientific perspective. It was the responsibility of the scientific team of which Don Wilhelms was a member to assemble an overall picture of the Moon's structure and history in order to recommend where on the lunar

surface fieldwork should be conducted and samples collected. His book relates the site-selection process in detail, and draws in concomitant events concerning mission operations to show how they affected the course of the scientific program. While discussing all six landings in detail, it tells the behind-the-scenes story of telescopic and spacecraft investigations before, during, and after the manned landings. Intended for anyone interested the space program, the history of science, or the application of geology to planetology, To a Rocky Moon will leave all readers with a better idea of what the Moon is really like. In so expertly summarizing this earlier phase of exploration, it stands as an authoritative touchstone for those involved in the next.

Determination of Orbit of a Spacecraft with Respect to an Object in a Known Circular Orbit Springer

Much has happened in the world in the 17 years since the first New Views of the Moon was published as volume 60 of the Mineralogical Society of America in 2006. An exciting new era of lunar exploration has begun, including the promise of resuming human lunar exploration, exploring the lunar Poles, and missions to many other high-priority science targets. It is fitting, therefore, to now summarize the current state of knowledge to the degree possible at a time when advancements in knowledge of the Moon are proceeding at a breakneck pace. Therefore, during this period of unprecedented lunar exploration activity, and as we continue to rebound from a global pandemic, we now happily announce this New Views of the Moon 2 volume summarizing the advances in lunar science and exploration since 2006. The Steering Committee is eternally grateful to all contributors and especially the chapter leads, and to Professor Makiko Ohtake (University of Aizu, Japan) and Dr. David Blewett (Johns Hopkins University Applied Physics Laboratory, U.S.A.) for organizing the New Views of the Moon 2 Electronic Annex. We deeply appreciate the hard work and dedication of everyone involved in the production of this volume, especially Rachel Russell and Ian Swainson at the Mineralogical Society of America. This volume helps to frame our knowledge and expectations for an exciting future of lunar science and exploration and the new discoveries to be made. Having humans return to the Moon now seems more likely than it ever has since the last humans left the Moon on 14 December 1972.

A Simplified Technique for Determining Deviation in the Lunar Transfer Orbit Ephemeris World Scientific

While navigation systems for the determination of the orbit of the Global Position System (GPS) have proven to be very effective, the current issues involve lowering the error in the GPS satellite ephemerides below their current level. In this document, the results of an orbit determination covariance assessment are provided. The analysis is intended to be the baseline orbit determination study comparing the benefits of adding laser ranging measurements from various numbers of ground stations. Results are shown for two starting longitude assumptions of the satellite location and for nine initial covariance cases for the GPS satellite state vector. Welch, Bryan W. Glenn Research Center NASA/TM-2007-214679, E-15815 WBS 439432.07.04.03.01 GLOBAL POSITIONING SYSTEM; LASER RANGING; ORBIT DETERMINATION; RADIOMETERS; COVARIANCE; EPHEMERIDES; STATE

VECTORS; KALMAN FILTERS; LONGITUDE; SPACE NAVIGATION

Radiation Pressure Forces, the Anomalous Acceleration, and Center of Mass Motion for the Topex/Poseidon Spacecraft Elsevier

Statistical Orbit Determination presents fundmentals of orbit determination--from weighted least squares approaches (Gauss) to today's high-speed computer algorithms that provide accuracy within a few centimeters. Numerous examples and problems are provided to enhance readers' understanding of the material. Covers such topics as coordinate and time systems, square root filters, process noise techniques, and the use of fictitious parameters for absorbing un-modeled and incorrectly modeled forces acting on a satellite. Examples and exercises serve to illustrate the principles throughout each chapter.

Low-Energy Lunar Trajectory Design Createspace Independent Publishing Platform

Based on years of research conducted at the NASA Jet Propulsion Laboratory, Low-Energy Lunar Trajectory Design provides high-level information to mission managers and detailed information to mission designers about low-energy transfers between Earth and the moon. The book answers high-level questions about the availability and performance of such transfers in any given month and year. Low-energy lunar transfers are compared with various other types of transfers, and placed within the context of historical missions. Using this book, designers may reconstruct any transfer described therein, as well as design similar transfers with particular design parameters. An Appendix, “Locating the Lagrange Points,” and a useful list of terms and constants completes this technical reference. Surveys thousands of possible trajectories that may be used to transfer spacecraft between Earth and the moon, including transfers to lunar libration orbits, low lunar orbits, and the lunar surface Provides information about the methods, models, and tools used to design low-energy lunar transfers Includes discussion about the variations of these transfers from one month to the next, and the important operational aspects of implementing a low-energy lunar transfer Additional discussions address navigation, station-keeping, and spacecraft systems issues

On the Accuracy of an Elliptical Orbit Determination Academic Press

Advances in Geosciences is the result of a concerted effort to bring together the latest results and planning activities related to earth and space science in Asia and the international arena. The volume editors are all leading scientists in their research fields covering six sections: Atmospheric Science (AS), Hydrological Science (HS), Ocean Science (OS), Solid Earth (SE), Solar Terrestrial (ST) and Planetary Science (PS). The main purpose is to highlight the scientific issues essential to the study of earthquakes, tsunamis, atmospheric dust storms, climate change, drought, flood, typhoons, monsoons, space weather, and planetary exploration.

Development of an illumination simulation software for the Moon's surface

Shortly after launch of the TOPEX/POSEIDON (T/P) spacecraft (s/c), the Precision Orbit Determination (POD) Team at NASA's Goddard Space Flight Center (GSFC) and the Center for Space Research at the University of Texas, discovered residual along-track accelerations, which were unexpected. Here, we describe the analysis of

radiation pressure forces acting on the T/P s/c for the purpose of understanding and providing an explanation for the anomalous accelerations. The radiation forces acting on the T/P solar army, which experiences warping due to temperature gradients between the front and back surfaces, are analyzed and the resulting along-track accelerations are determined. Characteristics similar to those of the anomalous acceleration are seen. This analysis led to the development of a new radiation form model, which includes solar array warping and a solar array deployment deflection of as large as 2 deg. As a result of this new model estimates of the empirical along-track acceleration are reduced in magnitude when compared to the GSFC tuned macromodel and are less dependent upon beta(prime), the location of the Sun relative to the orbit plane. If these results we believed to reflect the actual orientation of the T/P solar array then motion of the solar array must influence the location of the s/c center of mass. Preliminary estimates indicate that the center of mass can vary by as much as 3 cm in the radial component of the s/c's position due to rotation of the deflected, warped solar array panel .The altimeter measurements rely upon accurate knowledge of the center of mass location relative to the s/c frame of reference. Any radial motion of the center of mass directly affects the altimeter measurements. Kubitschek, Daniel G. and Born, George H. Jet Propulsion Laboratory

Lunar Orbiter II

This volume includes a selection of papers presented at the IAG international symposium "Gravity, Geoid and Height Systems 2012" (GGHS2012), which was organized by IAG Commission 2 “Gravity Field” with the assistance of the International Gravity Field Service (IGFS) and GGOS Theme 1 “Unified Global Height System”. The book summarizes the latest results on gravimetry and gravity networks, global gravity field modeling and applications, future gravity field missions. It provides a detailed compilation on advances in precise local and regional high-resolution geoid modeling, the establishment and unification of vertical reference systems, contributions to gravity field and mass transport modeling as well as articles on the gravity field of planetary bodies.

Astrodynamics: Orbit determination, space navigation, celestial mechanics

Although lunar exploration began in the 1960s, the moon and other planets have many long-standing, unanswered questions about planetary environments, origin, formation and evolution, magnetization of crustal rocks, internal structure, and possible life. However, with the recent development of planetary geodesy and remote sensing with higher spatial

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