

SPACE MISSION ANALYSIS AND DESIGN

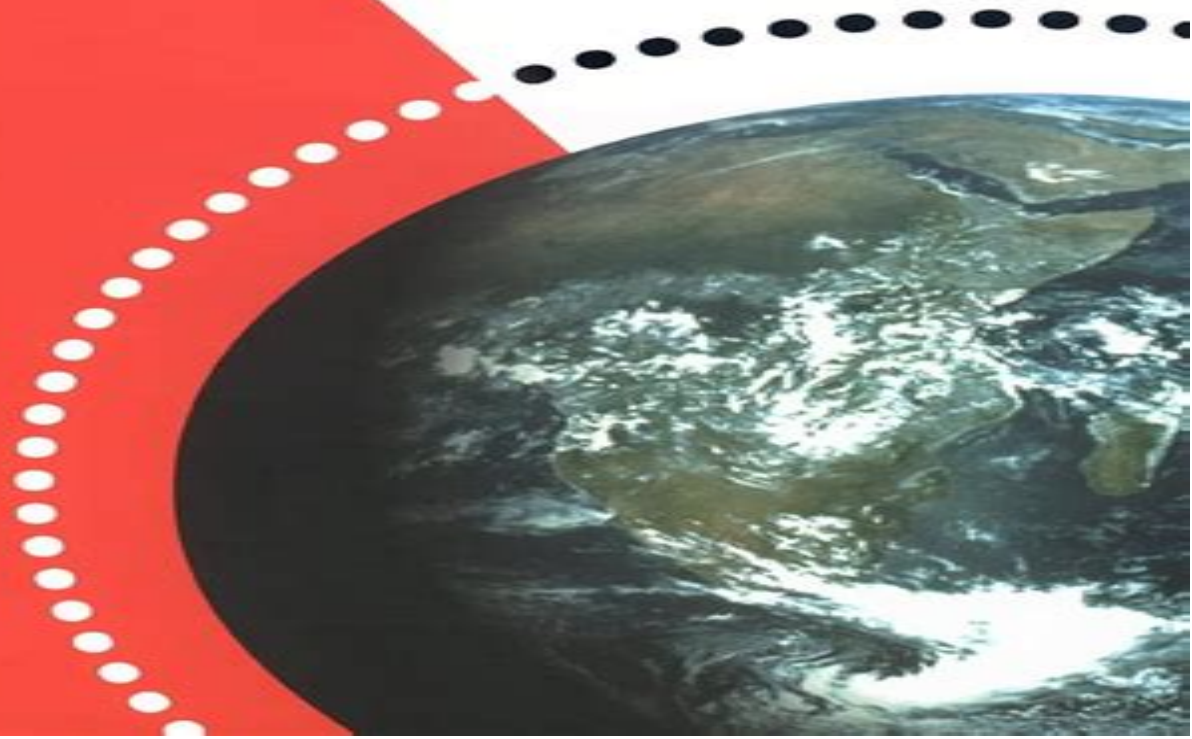
Third Edition

James R. Wertz
and **Wiley J. Larson**
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Space Mission Analysis And Design Third Edition

Yi-Tong Ma



Space Mission Analysis And Design Third Edition:

SMAD III Wiley J. Larson, James Richard Wertz, Brian D'Souza, 2005 *Fundamentals of Astrodynamics and Applications* D.A. Vallado, 2001-06-30 *Fundamentals of Astrodynamics and Applications* is rapidly becoming the standard astrodynamics reference for those involved in the business of spaceflight What sets this book apart is that nearly all of the theoretical mathematics is followed by discussions of practical applications implemented in tested software routines For example the book includes a compendium of algorithms that allow students and professionals to determine orbits with high precision using a PC Without a doubt when an astrodynamics problem arises in the future it will become standard practice for engineers to keep this volume close at hand and look it up in Vallado While the first edition was an exceptionally useful and popular book throughout the community there are a number of reasons why the second edition will be even more so There are many reworked examples and derivations Newly introduced topics include ground illumination calculations Moon rise and set and a listing of relevant Internet sites There is an improved and expanded discussion of coordinate systems orbit determination and differential correction Perhaps most important is that all of the software routines described in the book are now available for free in FORTRAN PASCAL and C This makes the second edition an even more valuable text and superb reference *Space Mission Analysis and Design* James Richard Wertz, Wiley J. Larson, 1991 This textbook for advanced undergraduate or introductory graduate courses or reference for those working in space technology allows readers with a general knowledge of physics math and basic engineering to begin with a blank sheet of paper and design a space mission to meet a set of broad often poorly defined objectives defining the mission in sufficient detail to identify principal drivers and make a preliminary assessment of overall performance size cost and risk Annotation copyrighted by Book News Inc Portland OR *Space Mission Engineering* James Richard Wertz, David F. Everett, Jeffery John Puschell, 2011 This book is a completely rewritten updated and expanded follow on to the 3rd edition of Space mission analysis and design

Photovoltaic Systems Engineering, Third Edition Roger A. Messenger, Amir Abtahi, 2010-02-26 The U S Department of Energy now estimates a factor of 14 increase in grid connected systems between 2009 and 2017 depending upon various factors such as incentives for renewables and availability and price of conventional fuels With this fact in mind Photovoltaic Systems Engineering Third Edition presents a comprehensive engineering basis for photovoltaic PV system design so engineers can understand the what why and how associated with the electrical mechanical economic and aesthetic aspects of PV system design Building on the popularity of the first two editions esteemed authors Roger Messenger and Jerry Ventre explore the significant growth and new ideas in the PV industry They integrate their experience in system design and installation gained since publication of the last edition Intellectual tools to help engineers and students to understand new technologies and ideas in this rapidly evolving field The book educates about the design of PV systems so that when engineering judgment is needed the engineer can make intelligent decisions based on a clear understanding of the

parameters involved This goal differentiates this textbook from the many design and installation manuals that train the reader how to make design decisions but not why The authors explain why a PV design is executed a certain way and how the design process is actually implemented In exploring these ideas this cutting edge book presents An updated background of energy production and consumption Mathematical background for understanding energy supply and demand A summary of the solar spectrum how to locate the sun and how to optimize the capture of its energy Analysis of the components used in PV systems Also useful for students the text is full of additional practical considerations added to the theoretical background associated with mechanical and structural design A modified top down approach organizes the material to quickly cover the building blocks of the PV system The focus is on adjusting the parameters of PV systems to optimize performance The last two chapters present the physical basis of PV cell operation and optimization Presenting new problems based upon contemporary technology this book covers a wide range of topics including chemistry circuit analysis electronics solid state device theory and economics this book will become a relied upon addition to any engineer s library

Orbital Mechanics and Astrodynamics Gerald R. Hintz, 2023-01-11 Now in an updated second edition this classroom tested textbook covers fundamental and advanced topics in orbital mechanics and astrodynamics designed to introduce readers to the basic dynamics of space flight The book explains concepts and engineering tools a student or practicing engineer can apply to mission design and navigation of space missions Through highlighting basic analytic and computer based methods for designing interplanetary and orbital trajectories the text provides excellent insight into astronautical techniques and tools The second edition includes new material on the observational basics of orbit determination information about precision calculations for data used in flight such as Mars 2020 with the Ingenuity Helicopter and improvements in mission design procedures including the automated design of gravity assist trajectories *Orbital Mechanics and Astrodynamics Techniques and Tools for Space Missions* is ideal for students in astronautical or aerospace engineering and related fields as well as engineers and researchers in space industrial and governmental research and development facilities as well as researchers in astronautics

Fundamentals of Space Medicine Gilles Clément, 2007-08-09 This readable text presents findings from the life science experiments conducted during and after space missions It provides an insight into the space medical community and the real challenges that face the flight surgeon and life science investigator

Space Psychology and Psychiatry Nick Kanas, Dietrich Manzey, 2003 This text deals with psychological psychiatric and psychosocial issues that affect people who live and work in space Rather than focusng on anecdotal reports and ground based simulation studies it emphasizes the findings from psychological research conducted during actual space missions readable text has previously been found only in scientific journal articles Topics that are discussed include behavioral adaptation to space human performance and cognitive effects crewmember interactions psychiatric responses psychological counter measures related to habitability factors work design selection training and in flight monitoring and support and the impact of expeditionary missions to Mars and beyond

universities medical students and residents in psychiatry and aerospace medicine human factors workers in space and aviation professions individuals involved with isolated environments on Earth for example the Antarctic submarines aerospace workers in businesses and space agencies such as NASA and ESA and anyone who is interested in learning the facts about the human side of long duration space missions Fundamentals of Electric Propulsion Dan M. Goebel, Ira Katz, 2008-12-22 Throughout most of the twentieth century electric propulsion was considered the technology of the future Now the future has arrived This important new book explains the fundamentals of electric propulsion for spacecraft and describes in detail the physics and characteristics of the two major electric thrusters in use today ion and Hall thrusters The authors provide an introduction to plasma physics in order to allow readers to understand the models and derivations used in determining electric thruster performance They then go on to present detailed explanations of Thruster principles Ion thruster plasma generators and accelerator grids Hollow cathodes Hall thrusters Ion and Hall thruster plumes Flight ion and Hall thrusters Based largely on research and development performed at the Jet Propulsion Laboratory JPL and complemented with scores of tables figures homework problems and references Fundamentals of Electric Propulsion Ion and Hall Thrusters is an indispensable textbook for advanced undergraduate and graduate students who are preparing to enter the aerospace industry It also serves as an equally valuable resource for professional engineers already at work in the field Overview Subramaniam Ganesan, 2010-11-29 Automotive systems engineering addresses the system throughout its life cycle including requirement specification design implementation verification and validation of systems modeling simulation testing manufacturing operation and maintenance This book is the first in a series of four volumes on this subject and features 15 papers published between 2004 2010 that emphasize the importance of systems concepts in the automotive area and stress the use of advanced tools and approaches Topics covered include Technology transfer Six Sigma deployment Systems engineering capability in automotive systems In addition to 11 SAE technical papers this volume also includes two invited papers Systems Engineering Definitions by editor Subramaniam Ganesan and Systems Engineering for Military Ground Vehicles by M Mazzara and R Iyer **The Logic of Microspace** Rick Fleeter, 2000 Changing the focus of the multibillion dollar global aerospace business toward smaller lower cost spacecraft is not happening solely due to technical managerial financial or market motivations Rick Fleeter s second book on the small low cost space programmes which are the fastest growing segment of aerospace activity gives the reader a keen understanding of the full spectrum of factors driving this profound change The text then goes beyond engineering technologies and management techniques to envision the tantalizing prospects microspace has in store for the industry its present markets and those of the future *SysML Distilled* Lenny Delligatti, 2014 SysML Distilled is a go to reference for everyone who wants to start creating accurate and useful system models with SysML Drawing on his pioneering experience creating models for Lockheed Martin and NASA Lenny Delligatti illuminates SysML s core components and shows how to use them even under tight deadlines and other constraints The

reader needn't know all of SysML to create effective models SysML Distilled quickly teaches what does need to be known and helps deepen the reader's knowledge incrementally as the need arises **Systems Engineering** Boris Cogan, 2012-03-16

The book Systems Engineering Practice and Theory is a collection of articles written by developers and researchers from all around the globe Mostly they present methodologies for separate Systems Engineering processes others consider issues of adjacent knowledge areas and sub areas that significantly contribute to systems development operation and maintenance Case studies include aircraft spacecrafts and space systems development post analysis of data collected during operation of large systems etc Important issues related to bottlenecks of Systems Engineering such as complexity reliability and safety of different kinds of systems creation operation and maintenance of services system human communication and management tasks done during system projects are addressed in the collection This book is for people who are interested in the modern state of the Systems Engineering knowledge area and for systems engineers involved in different activities of the area Some articles may be a valuable source for university lecturers and students most of case studies can be directly used in Systems Engineering courses as illustrative materials Development of an illumination simulation software for the Moon's surface

René Schwarz, 2016-12-27 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 *Space and Defense Policy* Damon Coletta, Frances T. Pilch, 2009-10-16 This edited volume introduces the reader to the role of space in military and defense strategy and outlines some of the major foreign and domestic actors in the space arena as well as constraints of law and treaties on activities in space It also addresses science and technology as they relate to space policy The book addresses three main questions How does the realm of space fit into strategic thinking about national security How does policy regarding space develop and what considerations both in the United States and abroad figure prominently in calculations about space policy How do different states nations actors regard the role of space in their national security calculations and how do these policies impact each other This book fills a niche in the space policy field providing insights into space and strategy from international experts from the military academic and scientific communities A unique feature of the book is the chapter on science and technology which utilizes the latest information available concerning space utilization and exploration

Essential Spaceflight Dynamics and Magnetospherics V. Rauschenbakh, M. Y. Ovchinnikov, Susan M.P. McKenna-Lawlor, 2006-04-11 *Essential Spaceflight Dynamics and Magnetospherics* describes in the first instance some of the key aspects of celestial mechanics and spaceflight dynamics It begins with classical two and three body problems illustrative of the aesthetic aspects of applying analytical methods of investigation to celestial mechanics Then osculating orbital elements are introduced as well as analysis techniques sufficient to evaluate the influence of various disturbing forces on spacecraft Next a theory of manoeuvres is outlined and the methodology of making interplanetary trajectory corrections Ideas involving various approaches to orbital element determinations using measured data are also considered The forces applied to a spacecraft can result in the development of torques that influence attitude motion and the effects of the most important of these are described in terms of equilibrium positions periodic motions steady state and transient motions Also considered is the problem of attitude control of a spacecraft using active and or passive methods of orientation and stabilization In addition a more advanced treatment of the development of attitude control systems is provided

Handbook of Space Technology Wilfried Ley, Klaus Wittmann, Willi Hallmann, 2009-03-18 Twenty years since the first edition was published in the German language and just over fifty years since the launch of the Earth's first ever artificial satellite Sputnik 1 this third edition of the *Handbook of Space Technology* presents in fully integrated colour a detailed insight into the fascinating world of space for the first time in the English language Authored by over 70 leading experts from universities research institutions and the space industry this comprehensive handbook describes the processes and methodologies behind the development construction operation and utilization of space systems presenting the profound changes that have occurred in recent years in the engineering materials processes and even politics associated with space technologies and utilization The individual chapters are self contained enabling the reader to gain a quick and reliable

overview of a selected field an extensive reference and keyword list helps those who wish to deepen their understanding of individual topics Featuring superb full colour illustrations and photography throughout this interdisciplinary reference contains practical hands on engineering and planning information that will be invaluable to those on a career path within space technology or simply for those of us who d like to know more about this fascinating industry Main section headings include Introduction historical overview space missions Fundamentals orbital mechanics aerothermodynamics reentry space debris Launch Vehicles staged technologies propulsion systems launch infrastructure Space Vehicle Subsystems structure energy supply thermal controls attitude control communication Aspects of Human Flight man in space life support systems rendezvous and docking Mission Operations satellite operation control center ground station network Utilization of Space Earth observation communication navigation space astronomy material sciences space medicine robotics Configuration and Design of a Space Vehicle mission concept system concept environmental simulation system design Galileo satellites Management of Space Missions project management quality management cost management space law *Space Infrastructures: From Risk to Resilience Governance* Unal Tatar,Jean Muylaert,2020-04-15 Space critical infrastructures represent an interdependent system of systems consisting of workforce environment facilities and multidirectional interactions These are essential for the maintenance of vital societal functions such as health safety security mobility and the economic and social well being of people and their destruction or disruption would have a significant impact on society as a whole In all 79 nations and government consortia currently operate satellites with 11 countries operating 22 launch sites Despite creating new challenges this multi actor environment offers opportunities for international cooperation but making the most of these opportunities requires a holistic approach to space critical infrastructure away from strictly defined space technologies and towards understanding the resilience of complex systems and how they are intertwined in reality This book presents papers from the NATO Advanced Research Workshop ARW entitled Critical Space Infrastructure From Vulnerabilities and Threats to Resilience held in Norfolk Virginia USA from 21 22 May 2019 The ARW brought together representatives from academia industry and international organizations in an effort to deepen scientific and technological understanding of space critical infrastructures and explore the implications for national and international space security and resilience It examined space as a critical infrastructure from a multidisciplinary perspective in accordance with NATO s Strategic Concept The 29 chapters in the book are divided into six sections covering space infrastructure governance cybersecurity risk resiliency and complexity emerging technologies such as block chain artificial intelligence and quantum computing application domains and national approaches and applications **Remote Sensing** Boris Escalante,2012-06-13 This dual conception of remote sensing brought us to the idea of preparing two different books in addition to the first book which displays recent advances in remote sensing applications this book is devoted to new techniques for data processing sensors and platforms We do not intend this book to cover all aspects of remote sensing techniques and platforms since it

would be an impossible task for a single volume Instead we have collected a number of high quality original and representative contributions in those areas *Flight mechanics and flight control for a multibody aircraft* Köthe, Alexander, 2019-06-26 Aircraft operating as so called High Altitude Platform Systems HAPS have been considered as a complementary technology to satellites since several years These aircraft can be used for similar communication and monitoring tasks while operating at a fraction of the cost Such concepts have been successfully tested Those include the AeroVironment Helios and the Airbus Zephyr with an endurance of nearly 624 hours 26 days All these HAPS aircraft have a high aspect ratio wing using lightweight construction In gusty atmosphere this results in high bending moments and high structural loads which can lead to overloads Aircraft crashes for example from Google s Solara 50 or Facebook s Aquila give proof of that fact Especially in the troposphere where the active weather takes place gust loads occur which can lead to the destruction of the structure The Airbus Zephyr the only HAPS aircraft without flight accidents provides only a very small payload Thus it does not fully comply with the requirements for future HAPS aircraft To overcome the shortcomings of such single wing aircraft so called multibody aircraft are considered to be an alternative The concept assumes multiple aircraft connected to each other at their wingtips It goes back to the German engineer Dr Vogt In the United States shortly after the end of World War II he experimented with the coupling of manned aircraft This resulted in a high aspect ratio wing for the aircraft formation The range of the formation could be increased correspondingly The engineer Geoffrey S Sommer took up Vogt s idea and patented an aircraft configuration consisting of several unmanned aerial vehicles coupled at their wingtips However the patent does not provide any insight into the flight performance the flight mechanical modeling or the control of such an aircraft Single publications exist that deal with the performance of coupled aircraft A profound complete analysis however is missing so far This is where the present work starts For the first time a flying vehicle based on the concept of the multibody aircraft will be analyzed in terms of flight mechanics and flight control In a performance analysis the aircraft concept is analyzed in detail and the benefits in terms of bending moments and flight performance are clearly highlighted Limits for operation in flight are shown considering aerodynamic optimal points The joints at the wingtips allow a roll and pitch motion of the individual aircraft This results in additional degrees of freedom for the design through the implementation of different relative pitch and bank angles For example using individual pitch angles for individual aircraft further decreases the induced drag and increases flight performance Because the lift is distributed symmetrically but not homogenously along the wingspan a lateral trim of the individual aircraft in formation flight becomes necessary The thesis presents a new method to implement this trim by moving the battery mass along half the wingspan which avoids additional parasite drag Further a complete flight dynamics model is provided and analyzed for aircraft that are mechanically connected at their wingtips To study this model in detail a hypothetical torsional and bending spring between the aircraft is introduced If the spring constants are very high the flight dynamics model has properties similar to those of an elastic

aircraft Rigid body and formation eigenmotions can be clearly distinguished If the spring constants are reduced towards zero which represents the case of the multibody aircraft classical flight mechanics eigenmotions and modes resulting from the additional degrees of freedom are coupled This affects the eigenstructure of the aircraft Hence normal motions with respect to the inertial space as known from a rigid aircraft cannot be observed anymore The plant also reveals unstable behavior Using the non linear flight dynamics model flight controllers are designed to stabilize the plant and provide the aircraft with an eigenstructure similar to conventional aircraft Different controller design methods are used The flight controller shall further maintain a determined shape of the flight formation it shall control flight bank and pitch angles and it shall suppress disturbances Flight control theories in the time domain Eigenstructure assignment and in the frequency domain H_∞ loop shaping are considered The resulting inner control loops yield a multibody aircraft behavior that is similar to the one of a rigid aircraft For the outer control loops classical autopilot concepts are applied Overall the flight trajectory of the multibody aircraft above ground is controlled and thus an actual operation as HAPS is possible In the last step the flight controller is successfully validated in non linear simulations with complete flight dynamics

Flugzeuge in der Form von sogenannten H henplattformen engl High Altitude Platform Systems HAPS werden seit einigen Jahren als kosteng nstige Erg nzung zu teuren Satelliten betrachtet Diese Flugzeuge k nnen f r hnliche Kommunikations und bewachungsaufgaben eingesetzt werden Zu den gegenw rtigen Konzepten solcher Flugger te die bereits erfolgreich im Flugversuch eingesetzt wurden z hlen der Helios von AeroVironment und der Airbus Zephyr der eine Flugdauer von fast 624 Stunden 26 Tagen erreicht hat Alle diese HAPS Flugzeuge besitzen einen Fl gel langer Streckung der in Leichtbauweise konstruiert ist Hieraus resultieren in b iger Atmosph re hohe Biegemomente und starke strukturelle Belastungen die zu berbelastungen f hren k nnen Flugunf lle beispielsweise von Googles Solara 50 oder Facebooks Aquila belegen dies Insbesondere in der Troposph re in der das aktive Wetter stattfindet treten B enlasten auf die die Struktur zerst ren k nnen Der Airbus Zephyr der bisher als einziges HAPS Flugzeug frei von Flugunf llen ist besitzt nur eine sehr geringe Nutzlast Daher kann er die Anforderungen an zuk nftige HAPS Flugzeuge nicht vollst ndig erf llen Um die Schwachstellen solcher Ein Fl gel Konzepte zu berwinden wird in dieser Arbeit ein alternatives Flugzeugkonzept betrachtet das als Mehrk rperflugzeug bezeichnet wird Das Konzept geht von mehreren an den Fl gelspitzen miteinander verbundenen Flugzeugen aus und beruht auf Ideen des deutschen Ingenieurs Dr Vogt Dieser hatte in den USA kurz nach Ende des Zweiten Weltkrieges bemannte Flugzeuge aneinanderkoppeln lassen Hierdurch ergab sich ein Flugzeugverbund mit einem Fl gel langer Streckung Damit konnte die Reichweite des Verbundes gesteigert werden Geoffrey S Sommer griff die Idee von Vogt auf und lies sich eine Flugzeugkonfiguration patentieren die aus mehreren unbemannten Flugzeugen besteht die an den Enden der Tragfl chen miteinander gekoppelt sind Die Patentschrift gibt jedoch keinen Einblick in die Flugleistungen die flugmechanische Modellierung oder die Regelung eines solchen Flugger tes Vereinzelt existieren Ver ffentlichungen die sich mit den Flugleistungen von gekoppelten Luftfahrzeugen

beschäftigen Eine tiefgreifende vollständige flugmechanische Analyse fehlt jedoch bisher Hier setzt die vorliegende Arbeit an Ein Fluggerät basierend auf dem Konzept des Mehrkörperfluges wird erstmalig hinsichtlich der Flugmechanik und Flugregelung untersucht In einer Flugleistungsbetrachtung wird das Flugzeugkonzept genau analysiert und die Vorteile hinsichtlich der Biegemomente und der Flugleistungen klar herausgestellt Die Grenzen des Einsatzes im Flugbetrieb werden mithilfe aerodynamischer Optimalpunkte aufgezeigt Über die Lager an den Flügelspitzen die eine relative Roll und Nickbewegung der Flugzeuge untereinander ermöglichen ergeben sich durch die Einstellung unterschiedlicher Längslage und Höhenwinkel zur tatsächlichen Freiheitsgerade im Entwurf Die Verwendung unterschiedlicher Nicklagewinkel der einzelnen Flugzeuge reduziert beispielsweise den induzierten Widerstand weiter und steigert die Flugleistung Durch die symmetrische entlang der Spannweite jedoch nicht homogene Auftriebsverteilung ist auch eine laterale Trimmung der einzelnen Flugzeuge in der Formation notwendig Hier stellt die Arbeit eine neuartige Möglichkeit vor um diese Trimmung ohne zusätzlichen parasitären Widerstand mittels Verschiebung der Batteriemasse entlang der Halbspannweite umzusetzen Weiterhin wird ein vollständiges flugdynamisches Modell für mechanisch miteinander verbundene Luftfahrzeuge aufgestellt und analysiert Für diese Analyse wird eine hypothetische Torsions- und Biegefeder zwischen den Flugzeugen modelliert Sind die Federsteifigkeiten hinreichend hoch besitzt das flugdynamische Modell Eigenschaften die einem elastischen Flugzeug entsprechen Starrkörper- und elastische Eigenbewegungsformen sind in diesem Fall klar separiert Bei immer weiterer Reduzierung bis auf eine Federsteifigkeit von Null kommt es zu Kopplungen zwischen den klassischen flugmechanischen Eigenbewegungsformen und den Moden aus den zusätzlichen Freiheitsgraden Dies stellt den Auslegungsfall für das Mehrkörperflugzeug dar Hierbei verändert sich die Eigenstruktur engl. eigenstructure des Flugzeugs und normale bei einem starren Flugzeug beobachtbare Bewegungen gegenüber dem inertialen Raum sind nicht mehr erkennbar Zusätzlich zeigt die Strecke instabiles Verhalten Basierend auf dem nichtlinearen flugdynamischen Modell werden mit verschiedenen Methoden Regler entworfen die die Regelstrecke stabilisieren und dem Flugzeug eine Streckenstruktur zuweisen die derjenigen klassischer Flugzeuge ähnelt Zudem soll durch die Regler eine vorgegebene Form des Flugzeugverbundes beibehalten werden die Fahrt der Längs- und Rolllagewinkel sollen geregelt und Störungen unterdrückt werden Als Auslegungsverfahren werden Theorien der Zustandsregelungen im Zeitbereich Eigenstrukturvorgabe und Frequenzbereich H_∞ loop shaping verwendet Hierdurch wird durch die inneren Regelschleifen ein Verhalten des Mehrkörperflugzeugs erzielt das dem eines starren Flugzeugs entspricht Für die äußeren Regelschleifen werden anschließend klassische Konzepte von Autopiloten verwendet Im Ergebnis ist eine Regelung des Flugweges über Grund des Mehrkörperflugzeugs und somit ein tatsächlicher Betrieb als HAPS möglich Die Funktionalität des Reglers wird abschließend in nichtlinearen Simulationen mit vollständiger Flugdynamik verifiziert

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