

Dynamics modeling and attitude control of a flexible space system with active stabilizers

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Abstract Attitude control of rigid-flexible multi-body systems by active stabilizers is studied in this paper. During slewing maneuvers, flexible members like solar panels may be excited to vibrate. These vibrations, in turn, produce oscillatory disturbing forces on other subsystems and consequently produce error in the spacecraft motion. Also, to develop a proper model-based controller for such complicated system, the system dynamic model is derived. However, due to practical limitations and real-time control implementation, the system dynamic model should be structured such that low computations burden will be imposed on the model-based controller. In this paper, in contrast to many accumulating dynamic modeling approach, a precise compact dynamic model for an active stabilized spacecraft (ASS) system with flexible members is derived. Toward this goal, the total system is virtually partitioned into two rigid and flexible portions. Moreover, the obtained model of these complicated systems

is vigorously verified using ANSYS and ADAMS programs. Finally, based on the derived dynamics and a proper virtual damping parameter, an attitude control algorithm is then developed. The suggested controller structure takes the advantage of utilizing the piezoelectric smart materials to dissipate the vibration of solar panels. The obtained results reveal the merits and effectiveness of the proposed suggested modeling and control methods for reliable attitude maneuvering of the system. In addition, it will be shown that the undesired vibrations of the flexible solar panels result in disturbing forces on the ASS system which can be significantly eliminated by the proposed attitude control algorithm.

Keywords Rigid-flexible multi-body systems · Reaction wheel · Piezoelectric patch · Attitude control

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List of symbols

B_f	Virtual damping matrix of flexible member
C	Vector of quadratic nonlinear terms of velocity
H	Positive definition mass matrix of system
J_c	Jacobian matrix for the spacecraft
J_f	Jacobian matrix of the floating frame of each flexible body
K	Stiffness matrix of flexible member
$K_p, \tilde{K}_d$	Gain matrix of controller for system in task space
K_{PZ}	Capacitances of the piezoelectric patches

Dynamics Modeling And Attitude Control Of A Flexible Space

Xiaolong Qi



Dynamics Modeling And Attitude Control Of A Flexible Space:

Business Intelligence and Information Technology Aboul Ella Hassanien, Dequan Zheng, Zhijie Zhao, Zhipeng Fan, 2024-08-29 This book constitutes the refereed proceedings of the 2023 International Conference on Business Intelligence and Information Technology BIIT 2023 held in Harbin China during December 16 17 2023 BIIT 2023 is organized by the School of Computer and Information Engineering Harbin University of Commerce and supported by Scientific Research Group in Egypt SRGE Egypt The papers cover current research in electronic commerce technology and application business intelligence and decision making digital economy accounting informatization intelligent information processing image processing and multimedia technology signal detection and processing communication engineering and technology information security automatic control technique data mining software development and design blockchain technology big data technology and artificial intelligence technology *Scientific and Technical Aerospace Reports* ,1992 **Technology for Large Space Systems** ,1987 *Dynamics and Control of Structures in Space III* Colin L. Kirk, 1996 These conference proceedings discuss such topics as space robotics solar energy concentrators orbital dynamics and space navigation thermally induced dynamics orbital rendezvous docking and impact multibody systems and robust control *Proceedings of the ... American Control Conference* ,1988 *NASA SP.* ,1962 **Journal of Dynamic Systems, Measurement, and Control** ,2007 *Rigid-Flexible Coupling Dynamics and Control of Flexible Spacecraft with Time-Varying Parameters* Jie Wang, Dong-Xu Li, 2021-09-15 This book presents the dynamic modeling and attitude control of flexible spacecraft with time varying parameters The dynamic characteristics vibration control methods and attitude stabilization methods for spacecraft are systematically studied in respects of the theoretical modeling numerical simulation and the ground experiment Three active control theories in complex mode space are presented for flexible space structures Optimal slew strategies based on variable amplitudes input shaping methods and coupling control methods are proposed for stabilization of flexible spacecraft The research provides an important way to solve the problem of high precision attitude control of flexible spacecraft with time varying parameters This book is appropriate for the researchers who focus on the multi body dynamics attitude and vibration control of flexible spacecraft **Dynamics and Control of Large Structures** Leonard Meirovitch, 1991 **Robust Controller Design Using Normalized Coprime Factor Plant Descriptions** Duncan C. McFarlane, Keith Glover, 1990 *NEC Research & Development* ,1993 *International Aerospace Abstracts* ,1999 **Modeling and Simulation, Volume 12, [part 4]** William G. Vogt, Marlin H. Mickle, 1981 **Space Station Systems** ,1990 **UTIAS Report** University of Toronto. Institute for Aerospace Studies, 1976 **Modeling and Simulation** William G. Vogt, 1981 *Large Space Structures & Systems in the Space Station Era* ,1990 **NASA/DOD Controls-Structures Interaction Technology 1989** ,1989 **Space Station Systems: A Bibliography with Indexes (supplement 3)** ,1987 *Government Reports Annual Index* ,1994

The book delves into Dynamics Modeling And Attitude Control Of A Flexible Space. Dynamics Modeling And Attitude Control Of A Flexible Space is a crucial topic that must be grasped by everyone, from students and scholars to the general public. This book will furnish comprehensive and in-depth insights into Dynamics Modeling And Attitude Control Of A Flexible Space, encompassing both the fundamentals and more intricate discussions.

1. This book is structured into several chapters, namely:
 - Chapter 1: Introduction to Dynamics Modeling And Attitude Control Of A Flexible Space
 - Chapter 2: Essential Elements of Dynamics Modeling And Attitude Control Of A Flexible Space
 - Chapter 3: Dynamics Modeling And Attitude Control Of A Flexible Space in Everyday Life
 - Chapter 4: Dynamics Modeling And Attitude Control Of A Flexible Space in Specific Contexts
 - Chapter 5: Conclusion
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 3. In chapter 2, the author will delve into the foundational concepts of Dynamics Modeling And Attitude Control Of A Flexible Space. This chapter will elucidate the essential principles that need to be understood to grasp Dynamics Modeling And Attitude Control Of A Flexible Space in its entirety.
 4. In chapter 3, this book will examine the practical applications of Dynamics Modeling And Attitude Control Of A Flexible Space in daily life. The third chapter will showcase real-world examples of how Dynamics Modeling And Attitude Control Of A Flexible Space can be effectively utilized in everyday scenarios.
 5. In chapter 4, the author will scrutinize the relevance of Dynamics Modeling And Attitude Control Of A Flexible Space in specific contexts. This chapter will explore how Dynamics Modeling And Attitude Control Of A Flexible Space is applied in specialized fields, such as education, business, and technology.
 6. In chapter 5, this book will draw a conclusion about Dynamics Modeling And Attitude Control Of A Flexible Space. This chapter will summarize the key points that have been discussed throughout the book.
- The book is crafted in an easy-to-understand language and is complemented by engaging illustrations. It is highly recommended for anyone seeking to gain a comprehensive understanding of Dynamics Modeling And Attitude Control Of A Flexible Space.

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