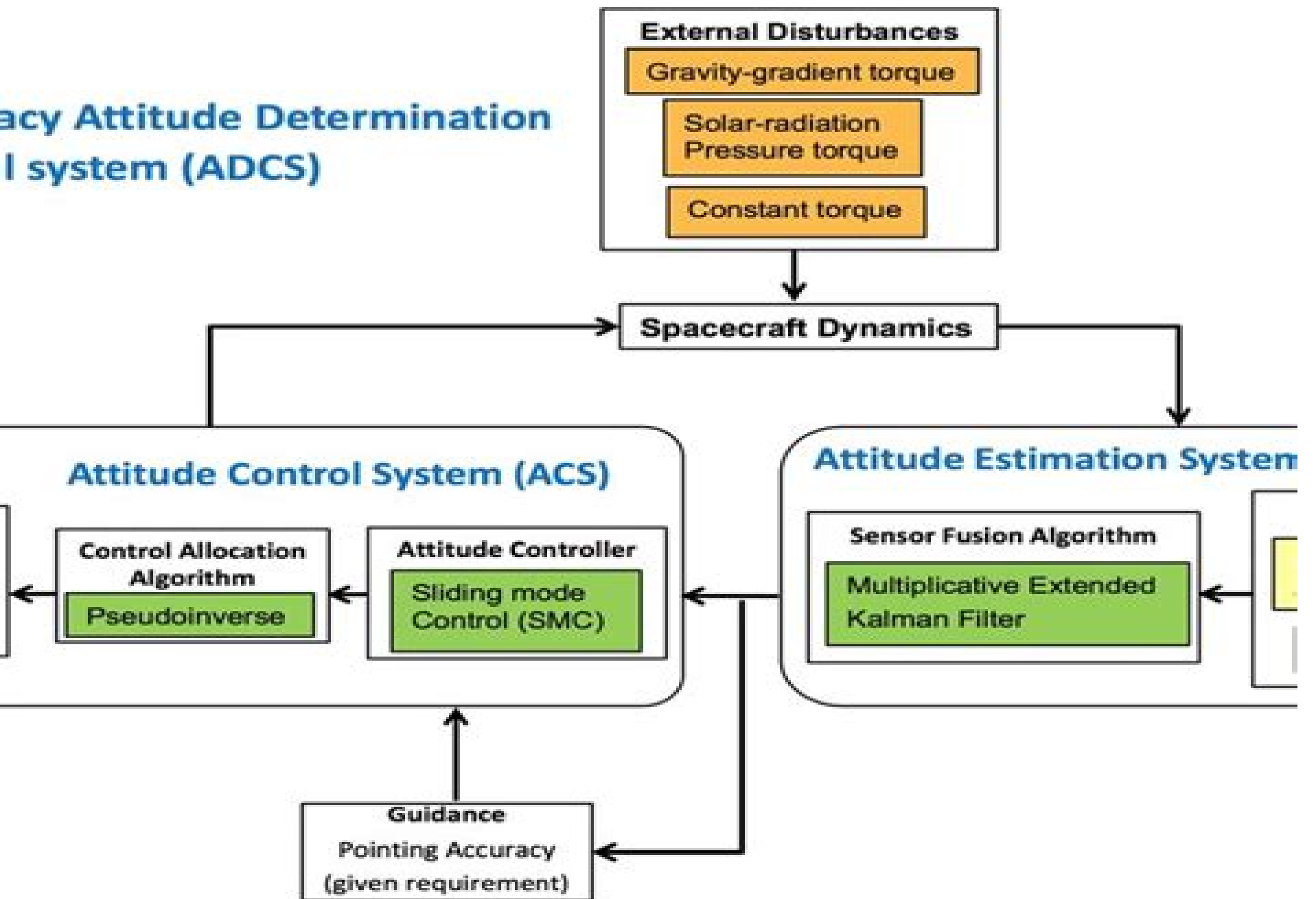


Attitude Determination and Control System (ADCS)



Attitude Determination And Control System Design For The

Yaguang Yang



Attitude Determination And Control System Design For The:

ADCS - Spacecraft Attitude Determination and Control Michael Paluszczek, 2023-04-27 ADCS Spacecraft Attitude Determination and Control provides a complete introduction to spacecraft control. The book covers all elements of attitude control system design including kinematics, dynamics, orbits, disturbances, actuators, sensors, and mission operations. Essential hardware details are provided for star cameras, reaction wheels, sun sensors, and other key components. The book explores how to design a control system for a spacecraft, control theory, and actuator and sensor details. Examples are drawn from the author's 40 years of industrial experience with spacecraft such as GGS, GPS, IIR, Mars Observer, and commercial communications satellites, and includes historical background and real-life examples. Features critical details on hardware and the space environment. Combines theory and ready-to-implement practical algorithms. Includes MATLAB code for all examples. Provides plots and figures generated with the included code. **Spacecraft Modeling, Attitude Determination, and Control** Yaguang Yang, 2019-02-06 This book discusses all spacecraft attitude control related topics: spacecraft including attitude measurements, actuator, and disturbance torques; modeling spacecraft attitude determination and estimation; and spacecraft attitude controls. Unlike other books addressing these topics, this book focuses on quaternion-based methods because of its many merits. The book lays a brief but necessary background on rotation sequence representations and frequently used reference frames that form the foundation of spacecraft attitude description. It then discusses the fundamentals of attitude determination using vector measurements, various efficient, including very recently developed attitude determination algorithms, and the instruments and methods of popular vector measurements. With available attitude measurements, attitude control designs for inertial point and nadir pointing are presented in terms of required torques, which are independent of actuators in use. Given the required control torques, some actuators are not able to generate the accurate control torques; therefore, spacecraft attitude control design methods with achievable torques for these actuators, for example, magnetic torque bars and control moment gyros, are provided. Some rigorous controllability results are provided. The book also includes attitude control in some special maneuvers such as orbital raising, docking, and rendezvous that are normally not discussed in similar books. Almost all design methods are based on state-space modern control approaches such as linear, quadratic, optimal, control, robust, pole assignment, control, model predictive control, and gain scheduling control. Applications of these methods to spacecraft attitude control problems are provided. Appendices are provided for readers who are not familiar with these topics. *An Attitude Determination and Control System for the Cornell Nanosatellite* Jonathan R. Schoenberg, 2003 *Spacecraft Modeling, Attitude Determination, and Control* Yaguang Yang, 2025-06-25 This book discusses spacecraft attitude control related topics: spacecraft modeling, spacecraft attitude determination and estimation, and spacecraft attitude controls. Unlike other books addressing these topics, this book focuses on quaternion-based methods because of their many merits. It provides a brief but necessary background on rotation sequence representations and

frequently used reference frames that form the foundation of spacecraft attitude description. It then discusses the fundamentals of attitude determination using vector measurements, various efficient methods including very recently developed attitude determination algorithms, and the instruments and methods of popular vector measurements. With available attitude measurements, attitude control designs for inertial point and nadir pointing are presented in terms of required torques which are independent of actuators in use. Given the required control torques, some actuators are not able to generate the accurate control torques; therefore, spacecraft attitude control design methods with achievable torques for these actuators, for example, magnetic torque bars and control moment gyros, are provided. Some rigorous controllability results are provided. The book also includes attitude control in some special maneuvers and systems such as orbital raising, docking, and rendezvous, and multi-body space systems that are normally not discussed in similar books. All design methods are based on state-space modern control approaches such as linear quadratic optimal control, robust pole assignment control, model predictive control, and gain scheduling control. Applications of these methods to spacecraft attitude control problems are provided. Appendices are provided for readers who are not familiar with these topics.

Development and Analysis of a Small Satellite

Attitude Determination and Control System Testbed Corey Whitcomb Crowell, Massachusetts Institute of Technology, Department of Aeronautics and Astronautics, 2011. Attitude Determination and Control Systems (ADCS) are critical to the operation of satellites that require attitude knowledge and/or attitude control to achieve mission success. Furthermore, ADCS systems only operate as designed in the reduced friction microgravity environment of space. Simulating these characteristics of space in a laboratory environment in order to test individual ADCS components and integrated ADCS systems is an important but challenging step in verifying and validating a satellite's ADCS design. The purpose of this thesis is to design and develop an ADCS testbed capable of simulating the reduced friction microgravity environment of space within the Massachusetts Institute of Technology's Space Systems Laboratory. The ADCS testbed is based on a tabletop-style three-degree-of-freedom rotational air bearing which uses four reaction wheels for attitude control and a series of sensors for attitude determination. The testbed includes all the equipment necessary to allow for closed-loop testing of individual ADCS components and integrated ADCS systems in the simulated inertial environment of space. In addition to the physical ADCS testbed, a MATLAB/Simulink-based model of the ADCS testbed is developed to predict the performance of hardware components and software algorithms before the components and algorithms are integrated into the ADCS testbed. The final objective of this thesis is to validate the operation of the ADCS testbed and simulation to prepare the tool for use by satellite design teams.

Attitude Determination and Control System Design and Implementation for a 6U CubeSat Proximity Operations Mission Francisco J. Franquiz, 2015. The purpose of this work is to discuss the attitude determination and control system (ADCS) design process and implementation for a 12 kg 6U 36.6 cm x 23.9 cm x 27.97 cm CubeSat class nano satellite. The design is based on the requirements and capabilities of the Application for Resident Space Object Proximity Analysis and

IMaging ARAPAIMA proximity operations mission The satellite is equipped with a cold gas propulsion system capable of exerting 2.5 mN m torques in both directions about each body axis The attitude sensors include an angular rate gyro and star tracker STR supplemented by the payload optical array cameras The dynamic simulation of the satellite includes extensive environmental models and analyses that show how the satellite attitude is affected by aerodynamic drag solar radiation pressure gravity gradient torques and residual magnetic moments A mechanical propellant slosh model and a reaction torque analysis of the deployable solar panel hinges approximate the internal dynamics of the satellite A trade study is presented to justify the use of a reaction control thruster actuated system over the more traditional reaction wheel configuration Both actuation systems are modeled to hardware specifications and their propellant and energy requirements are examined alongside pointing performance Two methods of accounting for sensor noise and sampling rates are presented The first is an extended Kalman filter based on the nonlinear model of a rate gyro coupled with quaternion attitude kinematics The second presents a gyro less angular rate observer capable of extrapolating STR measurements to the desired frequency An additional method uses images from the payload cameras to perform camera frame centering maneuvers and to address the possibility of bias in the controller reference signal Four different controllers are described to reflect the chronological progression of the ADCS design The first controller designed to perform long angle maneuvers and target tracking utilizes fixed gain eigenaxis control The same controller is then augmented with a parallel proportional integral derivative PID type control law using scheduled gains This configuration is designed to switch between eigenaxis and PID control during imaging procedures to take advantage of the integral control introduced by the PID algorithm To reduce system complexity a modified eigenaxis control law which incorporates scheduled integral control but does not require a switch to PID control is introduced A discrete time equivalent of the modified eigenaxis control law is also developed Additionally a brief description of a detumbling control law is presented Each of the four control laws is paired and tested with the different feedback and estimation methods discussed An extensive showcase of numerical simulation results outlines the pointing performance of each system configuration and evaluates their capabilities of meeting a 1 arcmin pointing requirement A comparison of the different properties and performance of each control system configuration precedes the selection of the discrete modified eigenaxis control law as the best alternative

Scientific and Technical Aerospace Reports, 1970 *Literature Survey of Communication Satellite Systems and Technology*, 1976 **An Introductory Guide to EC Competition Law and Practice** Valentine Korah, 1994 **AIAA Space Programs and Technologies Conference and Exhibit: 93-4201 - 93-4259**, 1993 **Attitude Stabilization for CubeSat** Mohammed Chessab Mahdi, 2018-11-14

This book explores CubeSat technology and develops a nonlinear mathematical model of a spacecraft with the assumption that the satellite is a rigid body It places emphasis on the CubeSat subsystem orbit dynamics and perturbations the satellite attitude dynamic and modeling and components of attitude determination and the control subsystem The book focuses on the attitude stabilization

methods of spacecraft and presents gravity gradient stabilization aerodynamic stabilization and permanent magnets stabilization as passive stabilization methods and spin stabilization and three axis stabilization as active stabilization methods It also discusses the need to develop a control system design and describes the design of three controller configurations namely the Proportional Integral Derivative Controller PID the Linear Quadratic Regulator LQR and the Fuzzy Logic Controller FLC and how they can be used to design the attitude control of CubeSat three axis stabilization Furthermore it presents the design of a suitable attitude stabilization system by combining gravity gradient stabilization with magnetic torquing and the design of magnetic coils which can be added in order to improve the accuracy of attitude stabilization The book then investigates simulates and compares possible controller configurations that can be used to control the currents of magnetic coils when magnetic coils behave as the actuator of the system

Bibliography of Scientific and Industrial Reports,1971 **Government Reports Index** ,1973 Government Reports Annual Index ,1994 International Aerospace Abstracts ,1998 *A Collection of the 22nd AIAA International Communications Satellite Systems Conference and Exhibit Technical Papers* ,2004 **Aerospace and Aeronautical Meteorology** ,1983 1996 IEEE Aerospace Applications Conference ,1996 Guidance and Control 1985 Robert D. Culp,Edward J. Bauman,Charles A. Cullian,1985 Science Abstracts ,1964

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