

Determination & Attitude Control Systems (DACS)

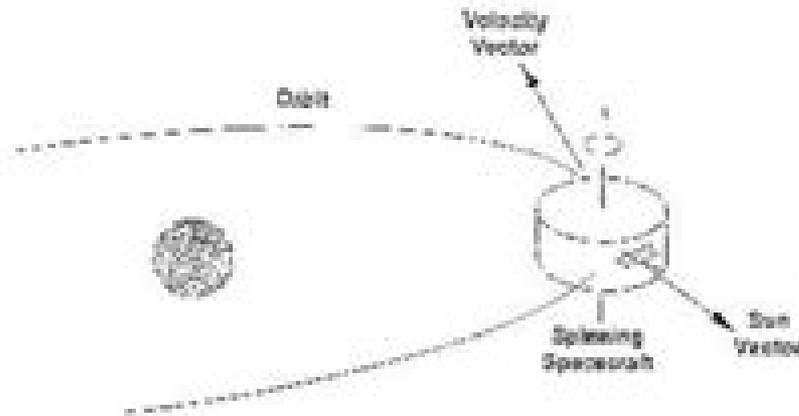
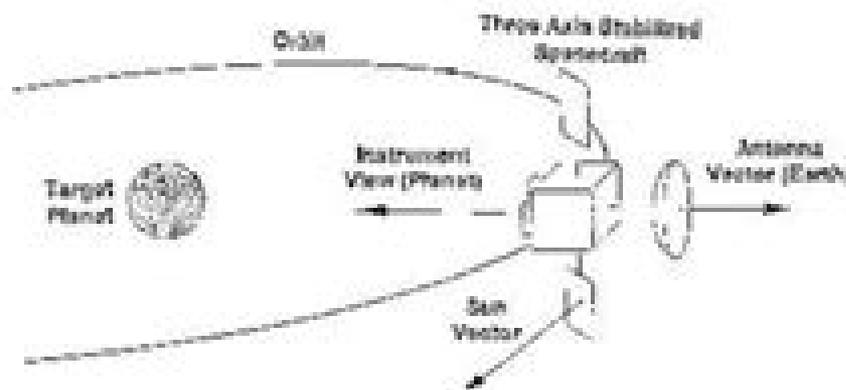


Fig. 3.2 Spinning spacecraft.

- Spinning Spacecraft provide simple pointing control along single axis (low accuracy)



- Three axis stability provides high accuracy pointing control in any direction

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ADCS - Spacecraft Attitude Determination and Control Michael Paluszek,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 spaced 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.

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 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

Spacecraft Attitude Determination and Control James R. Wertz, 1978-12-31 Roger D Werking Head Attitude Determination and Control Section National Aeronautics and Space Administration Goddard Space Flight Center Extensive work has been done for many years in the areas of attitude determination attitude prediction and attitude control During this time it has been difficult to obtain reference material that provided a comprehensive overview of attitude support activities This lack of reference material has made it difficult for those not intimately involved in attitude functions to become acquainted with the ideas and activities which are essential to understanding the various aspects of spacecraft attitude support As a result I felt the need for a document which could be used by a variety of persons to obtain an understanding of the work which has been done in support of spacecraft attitude objectives It is believed that this book prepared by the Computer Sciences Corporation under the able direction of Dr James Wertz provides this type of reference This book can serve as a reference for individuals involved in mission planning attitude determination and attitude dynamics an introductory textbook for students and professionals starting in this field an information source for experimenters or others involved in spacecraft related work who need information on spacecraft orientation and how it is determined but who have neither the time nor the resources to pursue the varied literature on this subject and a tool for encouraging those who could expand this discipline to do so because much remains to be done to satisfy future needs

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 micro gravity 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 micro gravity

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

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