

Design of Closed Loop Electro Mechanical Actuation System

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ABSTRACT: An Actuator is basically a position servo-control system used in industries and vehicles. A rotary electro-mechanical actuation system is an angular positioning system used in aerospace applications such as control of rudder and ailerons of aero planes and control of control surfaces, jet vanes, etc. This position loop system is to steer the vehicle to move in required direction. A servo controller is a driver to accurately control the position of the actuation system by getting the command signals from the on-board computer of the vehicle. It involves a class of DSP controller optimized for digital motor motion control and power conversion applications. In this thesis, Closed loop Rotary Electro Mechanical Actuating system is designed for the derived specifications by using the CAD software UNIGRAPHICS, and simulated the design with the help of FEA software ANSYS and MATLAB.

KEYWORDS: Actuator, ANSYS, CAD, DSP controller, UNIGRAPHICS.

1. INTRODUCTION

This document covers the description, design, inputs and specifications of the Actuation System for aerodynamic control of an Aero-vehicle. The document also describes the actuator specifications, mechanical components, BLDC motor, position sensor and the control system including simulation.

1.1 Actuator

An actuator is a mechanism that converts energy into motion. It can also be used to apply a force. An actuator typically is a mechanical device that takes energy, usually created by air, electricity, or liquid, and converts that into some kind of motion. That motion can be anything from blocking to clamping to ejecting. Actuators are typically used in manufacturing or industrial applications and may be used in things like motors, pumps, switches, and valves. The most common type of actuator is powered by air — the pneumatic cylinder, also known as the air cylinder. Air cylinders are air-tight cylinders, typically made from metal, that use the energy of compressed air to move a piston. Air cylinders are most commonly used in manufacturing and assembly processes. Grippers, which are used in robotics, use actuators driven by compressed air to work much like human fingers. Actuators can also be powered by electricity or hydraulics. Much like there are air cylinders, there are also electric cylinders and hydraulic cylinders where the cylinder converts electricity or hydraulics into motion. Hydraulic cylinders are often used in certain types of vehicles.

Many actuators have more than one type of power source. Solenoid valves, for example, can be powered by air and electricity. Electricity powers the solenoid, and the solenoid, powered by air actuates the valve. Alternatively, the solenoid can be powered by hydraulics and electricity. Actuators can create a linear motion, rotary motion, or oscillatory motion. That is, they can create motion in one direction, in a circular motion, or in opposite directions at regular intervals. Hydraulic and air cylinders can be classified as single acting, meaning that the energy source causes movement in one direction and a spring is used for the other direction. Alternatively, these cylinders can be double acting cylinders, meaning the energy is used in two directions. While actuators are typically discussed in terms of mechanical implements, muscles are sometimes given as an example of an actuator. Energy (e.g., created by eating carbohydrates) is converted by the muscle (i.e., the actuator) into motion (e.g., kicking a ball).

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Baoyan Duan, Shuxin Zhang



Design Of Closed Loop Electro Mechanical Actuation System:

Electromechanical Systems and Devices Sergey Edward Lyshevski, 2008-03-26 Students entering today's engineering fields will find an increased emphasis on practical analysis design and control. They must be able to translate their advanced programming abilities and sound theoretical backgrounds into superior problem solving skills. Electromechanical Systems and Devices facilitates the creation of critical problem solving. The Proceedings of the 2021 Asia-Pacific International Symposium on Aerospace Technology (APISAT 2021), Volume 2 Sangchul Lee, Cheolheui Han, Jeong-Yeol Choi, Seungkeun Kim, Jeong Ho Kim, 2022-09-29 This proceeding comprises peer reviewed papers of the 2021 Asia Pacific International Symposium on Aerospace Technology APISAT 2021 held from 15-17 November 2021 in Jeju South Korea. This book deals with various themes on computational fluid dynamics, wind tunnel testing, flow visualization, UAV design, flight simulation, satellite attitude control, aeroelasticity and control, combustion analysis, fuel injection, cooling systems, spacecraft propulsion and so forth. So this book can be very helpful not only for the researchers of universities and academic institutes but also for the industry engineers who are interested in the current and future advanced topics in aerospace technology. **Micro Electro Mechanical System Design** James J. Allen, 2005-07-08 It is challenging at best to find a resource that provides the breadth of information necessary to develop a successful micro electro mechanical system. MEMS design. Micro Electro Mechanical System Design is that resource. It is a comprehensive single source guide that explains the design process by illustrating the full range of issues involved, how they are interrelated, and how they can be quickly and accurately addressed. The materials are presented in logical order relative to the manner a MEMS designer needs to apply them. For example, in order for a project to be completed correctly on time and within budget, the following diverse yet correlated issues must be attended to during the initial stages of design and development: Understanding the fabrication technologies that are available; Recognizing the relevant physics involved for micron scale devices; Considering implementation issues applicable to computer aided design; Focusing on the engineering details and the subsequent evaluation testing; Maintaining an eye for detail regarding both reliability and packaging. These issues are fully addressed in this book along with questions and problems at the end of each chapter that promote review and further contemplation of each topic. In addition, the appendices offer information that complement each stage of project design and development. **Electromechanical Systems** Cornelius T. Leondes, 2000-08-08 Volume Four of the Mechatronic Systems Techniques and Applications series focusing specifically on electromechanical systems. Dielectric Elastomers as Electromechanical Transducers Federico Carpi, Danilo De Rossi, Roy Kornbluh, Ronald Edward Pelrine, Peter Sommer-Larsen, 2011-09-06 Dielectric Elastomers as Electromechanical Transducers provides a comprehensive and updated insight into dielectric elastomers, one of the most promising classes of polymer based smart materials and technologies. This technology can be used in a very broad range of applications from robotics and automation to the biomedical field. The need for improved transducer performance has resulted in considerable

efforts towards the development of devices relying on materials with intrinsic transduction properties. These materials, often termed as smart or intelligent, include improved piezoelectrics and magnetostrictive or shape memory materials. Emerging electromechanical transduction technologies based on so-called ElectroActive Polymers (EAP) have gained considerable attention. EAP offer the potential for performance exceeding other smart materials while retaining the cost and versatility inherent to polymer materials. Within the EAP family, dielectric elastomers are of particular interest as they show good overall performance, simplicity of structure, and robustness. Dielectric elastomer transducers are rapidly emerging as high performance pseudo-muscular actuators useful for different kinds of tasks. Further, in addition to actuation, dielectric elastomers have also been shown to offer unique possibilities for improved generator and sensing devices. Dielectric elastomer transduction is enabling an enormous range of new applications that were precluded to any other EAP or smart material technology until recently. This book provides a comprehensive and updated insight into dielectric elastomer transduction, covering all its fundamental aspects. The book deals with transduction principles, basic materials properties, design of efficient device architectures, material and device modelling, along with applications. Concise and comprehensive treatment for practitioners and academics. Guides the reader through the latest developments in electroactive polymer-based technology. Designed for ease of use, with sections on fundamentals, materials, devices, models, and applications.

Advances in Applied Nonlinear Dynamics, Vibration, and Control - 2024 Xingjian Jing, Dixiong Yang, Hu Ding, Jiqiang Wang, 2025-04-30

This book aims to provide readers with the latest exciting advancements in applied and interdisciplinary engineering science and technologies, particularly in nonlinear dynamics, vibration analysis, and control. Control systems theory and methods, robotics, and their various engineering applications developed in recent years. The chapters contributed by active scholars in these fields cover advanced systems theory and methods, innovative technologies, benchmark experimental validations, and active engineering practices. Readers will benefit from this cutting-edge collection of applied nonlinear dynamics and control, as well as various stimulating engineering theories, methods, and technologies, finding inspiration for their ongoing R D work. This book is intended for graduate students, research staff, and scholars in academics and also provides useful hand-up guidance for professionals and engineers in practical engineering missions.

Smarte Strukturen und Systeme Martin Wiedemann, 2016-10-24

Im Fokus steht das interdisziplinäre Themenfeld der aktiven intelligenten und adaptiven, kurzen smarten Strukturen und Systeme. Neben den klassischen Anwendungen der aktiven Schwingungs-Schall- und Gestaltkontrolle werden zahlreiche weitere Anwendungen, wie z.B. Structural Health Monitoring (SHM) oder Energy Harvesting, adressiert.

Electromechanical Coupling Theory, Methodology and Applications for High-Performance Microwave Equipment Baoyan Duan, Shuxin Zhang, 2022-12-01

Electromechanical Coupling Theory, Methodology and Applications for High-Performance Microwave Equipment. Electromechanical Coupling Theory, Methodology and Applications for High-Performance Microwave Equipment is an authoritative and up-to-date guide to the structural, mechanical, and electrical

aspects of electromechanical coupling Addressing control electromagnetism and structural engineering this comprehensive reference covers the electromechanical coupling of high performance microwave electronic equipment MEE such as antennas radar large radio telescopes and telecommunication and navigation equipment The book is divided into four main sections beginning with an introduction to electromechanical coupling EMC theory and a detailed description of the multi field coupling model MFCM and the influence mechanism IM of nonlinear factors of antenna servo feeder systems on performance Subsequent sections discuss MFCM and IM based design methodology EMC based measurement and testing computer software for coupling analysis and design of electronic equipment and various engineering applications of EMC theory and the IM of typical electronic equipment In addition the book Discusses information and data transfer in electromagnetic fields mechanical and structural deformation fields and temperature fields Explains how high performance microwave electronic equipment differs from traditional mechanical equipment Addresses EMC based and general design vector based optimization of electronic equipment design Describes applications such as a gun guided radar system for warships and a large diameter antenna for moon exploration Includes evaluation criteria to validate MFCM IM design theory and methodology Electromechanical Coupling Theory Methodology and Applications for High Performance Microwave Equipment is essential reading for circuit designers microwave engineers researchers working with high frequency microwave engineering and engineers working with integrated circuits in radar communications IoT antenna engineering and remote sensing

Electro-Mechanical Actuators for the More Electric Aircraft Mirko Mazzoleni, Gianpietro Di Rito, Fabio Previdi, 2021-01-19 This book presents recent results on fault diagnosis and condition monitoring of airborne electromechanical actuators illustrating both algorithmic and hardware design solutions to enhance the reliability of onboard more electric aircraft The book begins with an introduction to the current trends in the development of electrically powered actuation systems for aerospace applications Practical examples are proposed to help present approaches to reliability availability maintainability and safety analysis of airborne equipment The terminology and main strategies for fault diagnosis and condition monitoring are then reviewed The core of the book focuses on the presentation of relevant case studies of fault diagnosis and monitoring design for airborne electromechanical actuators using different techniques The last part of the book is devoted to a summary of lessons learned and practical suggestions for the design of fault diagnosis solutions of complex airborne systems The book is written with the idea of providing practical guidelines on the development of fault diagnosis and monitoring algorithms for airborne electromechanical actuators It will be of interest to practitioners in aerospace mechanical electronic reliability and systems engineering as well as researchers and postgraduates interested in dynamical systems automatic control and safety critical systems Advances in Industrial Control reports and encourages the transfer of technology in control engineering The rapid development of control technology has an impact on all areas of the control discipline The series offers an opportunity for researchers to present an extended exposition of new work in all

aspects of industrial control **NASA Scientific and Technical Reports** United States. National Aeronautics and Space Administration Scientific and Technical Information Division, 1967 Entwicklung, Herstellung und Charakterisierung piezoelektrischer Mikrospiegel Shanshan Gu-Stoppel, 2016-02-26

Im Mittelpunkt der Arbeit stand die Entwicklung piezoelektrisch angetriebener Mikrospiegel. Dabei handelt es sich um miniaturisierte optische Bauteile zur Ablenkung von Laserstrahlen mit denen sich z. B. Bildprojektionen realisieren lassen. Die Arbeit umfasst die Design- und Technologieentwicklung derartiger Mikrospiegel sowie die Entwicklung von Sensoren zur Spiegelpositionserfassung. Zudem bildet die eingehende Charakterisierung einen weiteren Schwerpunkt dieser Arbeit. Insgesamt wurden 30 verschiedene 1D-Spiegel, elf verschiedene 2D-Spiegel sowie drei unterschiedliche Sensor-Typen entworfen, hergestellt und untersucht. Für die resonanten 1D-Spiegel stellen die erreichbaren Scanwinkel und Resonanzfrequenzen die charakteristischen Größen dar. Die hier hervorgegangenen 1D-Spiegel erreichen sehr große Scanwinkel von 106° und hohe Resonanzfrequenzen von 69 kHz. Bei den 2D-Spiegeln sind die Kombinationen verschiedener Spiegelbewegungsmoden für die Realisierung unterschiedlicher Laserstrahl-Trajektorien von großer Bedeutung. Dabei wurden zwei Designkonzepte für die 2D-Spiegel realisiert: Die sogenannten Quadpod-Designs und die kardanisch aufgehängten Spiegel. Die Quadpod-Spiegel realisieren zwei senkrechte Torsionsmoden, die nahestehende Eigenfrequenzen aufweisen. Somit lassen sich kreisförmige und rechteckige Ausleuchtungen durch die resultierenden Lissajous-Figuren erzeugen. Zusätzlich sind derartige Spiegel auch für Translationsbewegungen geeignet. An einem Spiegeltyp mit 7 mm Spiegeldurchmesser wurden translatorische Amplituden von bis zu 1600 µm nachgewiesen, welche zu den höchsten vertikalen Amplituden von Spiegeln gehören. Die kardanisch aufgehängten 2D-Spiegel erlauben quasi statisch und resonant angetriebene Torsionsbewegungen und somit die Realisierung eines kompletten integrierten Raster-scanners. Die resonanten 1D- und 2D-Spiegel erfordern die Regelung zum Adressieren projizierter Punkte. Dafür wurden unterschiedliche Messprinzipien untersucht. Die kapazitiven und piezoelektrischen PZT-Sensoren zeigen die besten Signalqualitäten für die Positionserfassung dynamischer Bewegungen und können Messauflösung von mehr als 12 Bit erreichen. Statische Positionen des Spiegels lassen sich dagegen gut mit metallischen DMS erfassen. Auch wenn noch viele Herausforderungen und Aufgaben zu bewältigen sind, veranschaulichen die Ergebnisse der Arbeit das Potential piezoelektrischer Spiegel in der nahen Zukunft in kommerziellen Produkten. Eingang zu finden *Air Corps News Letter*, 1965

Engineering Haptic Devices Christian Hatzfeld, Thorsten A. Kern, 2014-09-15 In this greatly reworked second edition of *Engineering Haptic Devices* the psychophysics content has been thoroughly revised and updated. Chapters on haptic interaction, system structures and design methodology were rewritten from scratch to include further basic principles and recent findings. New chapters on the evaluation of haptic systems and the design of three exemplary haptic systems from science and industry have been added. This book was written for students and engineers that are faced with the development of a task-specific haptic system. It is a reference book for the basics of haptic interaction and existing haptic systems and

methods as well as an excellent source of information for technical questions arising in the design process of systems and components Divided into two parts part 1 contains typical application areas of haptic systems and a thorough analysis of haptics as an interaction modality The role of the user in the design of haptic systems is discussed and relevant design and development stages are outlined Part II presents all relevant problems in the design of haptic systems including general system and control structures kinematic structures actuator principles and sensors for force and kinematic measures Further chapters examine interfaces and software development for virtual reality simulations

Silicon Sensors and Actuators Benedetto Vigna, Paolo Ferrari, Flavio Francesco Villa, Ernesto Lasalandra, Sarah Zerbini, 2022-04-12 This book thoroughly reviews the present knowledge on silicon micromechanical transducers and addresses emerging and future technology challenges Readers will acquire a solid theoretical and practical background that will allow them to analyze the key performance aspects of devices critically judge a fabrication process and then conceive and design new ones for future applications Envisioning a future complex versatile microsystem the authors take inspiration from Richard Feynman's visionary talk There is Plenty of Room at the Bottom to propose that the time has come to see silicon sensors as part of a Feynman Roadmap instead of the More than Moore technology roadmap The sharing of the author's industrially proven track record of development design and manufacturing along with their visionary approach to the technology will allow readers to jump ahead in their understanding of the core of the topic in a very effective way Students researchers engineers and technologists involved in silicon based sensor and actuator research and development will find a wealth of useful and groundbreaking information in this book

Proceedings of 2021 Chinese Intelligent Systems Conference Yingmin Jia, Weicun Zhang, Yongling Fu, Zhiyuan Yu, Song Zheng, 2021-10-07 This book presents the proceedings of the 17th Chinese Intelligent Systems Conference held in Fuzhou China on Oct 16 17 2021 It focuses on new theoretical results and techniques in the field of intelligent systems and control This is achieved by providing in depth study on a number of major topics such as Multi Agent Systems Complex Networks Intelligent Robots Complex System Theory and Swarm Behavior Event Triggered Control and Data Driven Control Robust and Adaptive Control Big Data and Brain Science Process Control Intelligent Sensor and Detection Technology Deep learning and Learning Control Guidance Navigation and Control of Flight Vehicles and so on The book is particularly suited for readers who are interested in learning intelligent system and control and artificial intelligence The book can benefit researchers engineers and graduate students

Advanced Control Design with Application to Electromechanical Systems Magdi S. Mahmoud, 2018-04-12 Advanced Control Design with Application to Electromechanical Systems represents the continuing effort in the pursuit of analytic theory and rigorous design for robust control methods The book provides an overview of the feedback control systems and their associated definitions with discussions on finite dimension vector spaces mappings and convex analysis In addition a comprehensive treatment of continuous control system design is presented along with an introduction to control design topics pertaining to discrete time

systems Other sections introduces linear H1 and H2 theory dissipativity analysis and synthesis and a wide spectrum of models pertaining to electromechanical systems Finally the book examines the theory and mathematical analysis of multiagent systems Researchers on robust control theory and electromechanical systems and graduate students working on robust control will benefit greatly from this book Introduces a coherent and unified framework for studying robust control theory Provides the control theoretic background required to read and contribute to the research literature Presents the main ideas and demonstrations of the major results of robust control theory Includes MATLAB codes to implement during research

Fundamentals of Electric Aircraft Pascal Thalin,Ravi Rajamani,Jean-Charles Mare,Sven Taubert,2018-12-18 Fundamentals of Electric Aircraft was developed to explain what the electric aircraft stands for by offering an objective view of what can be expected from the giant strides in innovative architectures and technologies enabling aircraft electrification Through tangible case studies a deep insight is provided into this paradigm shift cutting across various aircraft segments from General Aviation to Large Aircraft Addressing design constraints and timelines foreseen to reach acceptable performance and maturity levels Fundamentals of Electric Aircraft puts forward a general view of the progress made to date and what to expect in the years to come Drawing from the expertise of four industry veterans Pascal Thalin editor Ravi Rajamani Jean Charles Mare and Sven Taubert contributors it addresses futuristic approaches but does not depart too far from the operational down to earth realities of everyday business Fundamentals of Electric Aircraft also offers analyses on how performance enhancements and fuel burn savings may bring more value for money as long as new electric technologies deliver on their promises *Proceedings of National Laser Symposium* ,2000

Scientific and Technical Aerospace Reports ,1995

Mechatronics William Bolton,2003 The integration of electronic engineering electrical engineering computer technology and control engineering mechatronics forms a crucial part in the design manufacture and maintenance of a wide range of engineering products and processes This book provides a clear and comprehensive introduction to the application of electronic control systems in mechanical and electrical engineering It gives a framework of knowledge that allows engineers and technicians to develop an interdisciplinary understanding and integrated approach to engineering Key features of the third edition provides the mix of skills in mechanical engineering electronics and computing which are required for students to be able to comprehend and design mechatronics systems enables students to operate and communicate across a range of engineering disciplines more discussion of microcontrollers and programming increased use of models for mechatronics systems numerous examples and case studies end of chapter problems with answers at the back of the book Mechatronics is essential reading for students studying mechatronics at higher diploma and undergraduate level Bill Bolton was formally Consultant to the Further Education Unit and Head of Research and Development and Monitoring at BTEC He is the author of many engineering textbooks

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