Drive Servo System (Part 1)

BY JOSE ALBERTO LUZARDO, PhD

Spindle motor

Disk

VCM actuator

Read /Write head

Hard Disk Drive Servo Systems

Da-Wei Gu,Petko H. Petkov,Mihail M Konstantinov

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Hard Disk Drive Servo Systems Ben M. Chen,Tong Heng Lee,Kemao Peng,Venkatakrishnan Venkataramanan,2006-06-09 The series Advances in Industrial Control aims to report and encourage technology transfer in control engineering The rapid development of control technology has an impact on all areas of the control discipline New theory new controllers actuators sensors new industrial processes computer methods new applications new philosophies new challenges Much of this development work resides in industrial reports feasibility study papers and the reports of advanced collaborative projects The series offers an opportunity for researchers to present an extended exposition of such new work in all aspects of industrial control for wider and rapid dissemination Hard disk drive systems are ubiquitous in today s computer systems and the technology is still evolving There is a review of hard disk drive technology and construction in the early pages of this monograph that looks at the characteristics of the disks and there it can be read that bit density continues to increase at an amazing rate spindle speed the move to faster and faster spindle speeds continue form factors the trend is downward to smaller and smaller drives performance factors are improving redundant arrays of inexpensive disks becoming increasingly common and is now seen in consumer desktop machines reliability is improving slowly it is very hard to improve the reliability of a product when it is changing rapidly and finally interfaces continue to create new and improved standards to match the increase in performance of the hard disks themselves   Hard Disk Drive Servo Systems Ben M. Chen,Tong Heng Lee,2014-01-15   **Hard Disk Drive Servo Systems** Ben M. Chen,Tong Heng Lee,Kemao Peng,Venkatakrishnan Venkataramanan,2009-10-12 The series Advances in Industrial Control aims to report and encourage technology transfer in control engineering The rapid development of control technology has an impact on all areas of the control discipline New theory new controllers actuators sensors new industrial processes computer methods new applications new philosophies new challenges Much of this development work resides in industrial reports feasibility study papers and the reports of advanced collaborative projects The series offers an opportunity for researchers to present an extended exposition of such new work in all aspects of industrial control for wider and rapid dissemination Hard disk drive systems are ubiquitous in today s computer systems and the technology is still evolving There is a review of hard disk drive technology and construction in the early pages of this monograph that looks at the characteristics of the disks and there it can be read that bit density continues to increase at an amazing rate spindle speed the move to faster and faster spindle speeds continue form factors the trend is downward to smaller and smaller drives performance factors are improving redundant arrays of inexpensive disks becoming increasingly common and is now seen in consumer desktop machines reliability is improving slowly it is very hard to improve the reliability of a product when it is changing rapidly and finally interfaces continue to create new and improved standards to match the increase in performance of the hard disks themselves   *Hard Disk Drive Servo Systems* Ben M. Chen,Tong Heng Lee,Venkatakrishnan Venkataramanan,2013-04-17 The series Advances in Industrial Contral aims to report and

encourage technology transfer in control engineering The rapid development of control technology has an impact on all areas of the control discipline New theory new controllers actuators sensors new industrial processes computer methods new applications new philosophies new challenges Much of this development work resides in industrial reports feasibility study papers and the reports of advanced collaborative projects The series offers an opportunity for researchers to present an extended exposition of such new work in all aspects of industrial control for wider and rapid dissemination From time to time a particular practical control problem emerges as a challenge to the design capabilities of the control community One example has been the activated sludge process in wastewater systems where the process is highly nonlinear and measurements are few A second example is the hard disk drive servo system These widely used systems are critical to the operation of modem computing devices They are nonlinear and demand a high precision control system for the operations of track seeking and track following There are also alternative actuation systems available to achieve these objectives In this Advances in Industrial Control monograph B M Chen T H Lee and V **Control Design and Implementation of Hard Disk Drive Servos** Jianbin Nie,2011 In this dissertation the design of servo control algorithms is investigated to produce high density and cost effective hard disk drives HDDs In order to sustain the continuing increase of HDD data storage density dual stage actuator servo systems using a secondary micro actuator have been developed to improve the precision of read write head positioning control by increasing their servo bandwidth In this dissertation the modeling and control design of dual stage track following servos are considered Specifically two track following control algorithms for dual stage HDDs are developed The designed controllers were implemented and evaluated on a disk drive with a PZT actuated suspension based dual stage servo system Usually the feedback position error signal PES in HDDs is sampled on some specified servo sectors with an equidistant sampling interval which implies that HDD servo systems with a regular sampling rate can be modeled as linear time invariant LTI systems However sampling intervals for HDD servo systems are not always equidistant and sometimes an irregular sampling rate due to missing PES sampling data is unavoidable With the natural periodicity of HDDs which is related to the disk rotation those HDD servo systems with missing PES samples can be modeled as linear periodically time varying LPTV systems For the control synthesis of HDD servos with irregular sampling rates an explicit optimal H_infinity control synthesis algorithm for general LPTV systems is first obtained by solving discrete Riccati equations Then the optimal H_infinity track following control for irregular sampling rate servos is synthesized Simulation and experiment studies which have been carried out on a set of actual single stage hard disk drives demonstrate that the proposed control synthesis technique is able to handle irregular sampling rates and can be used to conveniently design a track following servo that achieves the robust performance of a desired error rejection function for disturbance attenuation Moreover experiment results show that compared to the currently used methodology for irregular sampling rates the proposed control algorithm has significantly improved the servo performance In addition the feedback signal in HDD servos

is generated from the servo patterns that must be pre recorded using servo track writing process before the HDD can be used Thus the quality of the servo track writing process is also crucial to the accuracy of positioning read write head Recently self servo track writing has been developed in order to improve the quality of the written servo patterns and reduce the cost of servo track writing process This dissertation considers two novel controller synthesis methodologies employing a feedforward control structure for performing concentric self servo track writing in hard disk drives Simulation results confirm that the two proposed control synthesis methodologies prevent error propagation from the previously written tracks and significantly improve servo track writing performance *Advanced Control Designs for Hard Disk Drive Servo Systems* Ruifeng Chen,2001 **Advanced Nonlinear Control Technologies for Hard Disk Drive Servo Systems** V. Venkatakrishnan,2003 <u>Two Degree of Freedom Control for Disk Drive Servo Systems</u> Li I,2000 **Nonlinear Control and Its Applications to Hard Disk Drive Servo Systems** Venkatakrishnan Venkataramanan,2001 **Hard Disk Drive** Abdullah Al Mamun,GuoXiao Guo,Chao Bi,2017-12-19 The hard disk drive is one of the finest examples of the precision control of mechatronics with tolerances less than one micrometer achieved while operating at high speed Increasing demand for higher data density as well as disturbance prone operating environments continue to test designers mettle Explore the challenges presented by modern hard disk drives and learn how to overcome them with Hard Disk Drive Mechatronics and Control Beginning with an overview of hard disk drive history components operating principles and industry trends the authors thoroughly examine the design and manufacturing challenges They start with the head positioning servomechanism followed by the design of the actuator servo controller the critical aspects of spindle motor control and finally the servo track writer a critical technology in hard disk drive manufacturing By comparing various design approaches for both single and dual stage servomechanisms the book shows the relative pros and cons of each approach Numerous examples and figures clarify and illustrate the discussion Exploring practical issues such as models for plants noise reduction disturbances and common problems with spindle motors Hard Disk Drive Mechatronics and Control avoids heavy theory in favor of providing hands on insight into real issues facing designers every day **High-Speed Precision Motion Control** Takashi Yamaguchi,Mitsuo Hirata,Justin Chee Khiang Pang,2017-07-12 Edited by Takashi Yamaguchi Mitsuo Hirate and Chee Khiang Pang with contributions from pioneers known for their ground breaking work High Speed Precision Motion Control discusses high precision and fast servo controls in hard disk drives HDDs The chapter authors describe the control technologies they ve developed most of which have already been successfully applied to mass production of HDDs As the proposed methodologies have been verified on commercial HDDs at the very least these advanced control technologies can also be readily applied to precision motion control of other mechatronic systems e g scanners micro positioners photocopiers atomic force microscopes AFMs etc Each self contained chapter progresses from concept to technique and presents application examples in automotive aerospace aeronautical and manufacturing engineering The control technologies are categorized into high speed servo

control precision control and environment friendly control making it easy to find an appropriate control technology according to their domain of application The book also makes MATLAB SIMULINK codes for benchmark problems available for download The control technologies described range from fundamental classical control theories to advanced topics such as multi rate control The content contains a healthy balance between materials from the contributor s research works and that in the wider literature The resulting resource empowers engineers and managers with the knowledge and know how to make important decisions and policies   Modeling and Control of Vibration in Mechanical Systems Chunling Du,Lihua Xie,2018-09-03 From the ox carts and pottery wheels the spacecrafts and disk drives efficiency and quality has always been dependent on the engineer s ability to anticipate and control the effects of vibration And while progress in negating the noise wear and inefficiency caused by vibration has been made more is needed Modeling and Control of Vibration in Mechanical Systems answers the essential needs of practitioners in systems and control with the most comprehensive resource available on the subject Written as a reference for those working in high precision systems this uniquely accessible volume Differentiates between kinds of vibration and their various characteristics and effects Offers a close up look at mechanical actuation systems that are achieving remarkably high precision positioning performance Includes techniques for rejecting vibrations of different frequency ranges Covers the theoretical developments and principles of control design with detail elaborate enough that readers will be able to apply the techniques with the help of MATLAB Details a wealth of practical working examples as well as a number of simulation and experimental results with comprehensive evaluations The modern world s ever growing spectra of sophisticated engineering systems such as hard disk drives aeronautic systems and manufacturing systems have little tolerance for unanticipated vibration of even the slightest magnitude Accordingly vibration control continues to draw intensive focus from top control engineers and modelers This resource demonstrates the remarkable results of that focus to date and most importantly gives today s researchers the technology that they need to build upon into the future Chunling Du is currently researching modeling and advanced servo control of hard disk drives at the Data Storage Institute in Singapore Lihua Xie is the Director of the Centre for Intelligent Machines and a professor at Nanyang Technological University in Singapore   **Official Gazette of the United States Patent and Trademark Office** United States. Patent and Trademark Office,2000   **Official Gazette of the United States Patent and Trademark Office** ,2000   *Robust Control Design with MATLAB®* Da-Wei Gu,Petko H. Petkov,Mihail M Konstantinov,2006-03-30 Shows readers how to exploit the capabilities of the MATLAB Robust Control and Control Systems Toolboxes to the fullest using practical robust control examples   Advances in Information Storage Systems Bharat Bhushan,1998 This volume covers friction induced vibration the influence of actuator bearing grease composition wear measurements for proximity recording heads characteristics of a suspension assembly design and analysis of the HDD Servo System reluctance torque reduction etc It is organized into three parts Mechanics and Tribology for Data Storage Systems Dynamics and Controls for

Data Storage Systems and Electric Motors for Data Storage Systems **Advances In Information Storage Systems, Vol 8** Bharat Bhushan,1998-09-21 This volume covers friction induced vibration the influence of actuator bearing grease composition wear measurements for proximity recording heads characteristics of a suspension assembly design and analysis of the HDD Servo System reluctance torque reduction etc It is organized into three parts Mechanics and Tribology for Data Storage Systems Dynamics and Controls for Data Storage Systems and Electric Motors for Data Storage Systems

Mathematical Methods for Robust and Nonlinear Control Matthew C. Turner,Declan G. Bates,2007-10-23 The underlying theory on which much modern robust and nonlinear control is based can be difficult to grasp This volume is a collection of lecture notes presented by experts in advanced control engineering The book is designed to provide a better grounding in the theory underlying several important areas of control It is hoped the book will help the reader to apply otherwise abstruse ideas of nonlinear control in a variety of real systems *Systems, Automation and Control* Nabil Derbel,Faouzi Derbel,Olfa Kanoun,2017-12-04 The fifth volume of the Series Advances in Systems Signals and Devices is dedicated to fields related to Systems Automation and Control The scope of this issue encompasses all aspects of the research development and applications of the science and technology in these fields Topics of this issue concern system design system identification biological and economical models control modern control theory nonlinear observers control and application of chaos adaptive non adaptive backstepping control techniques advances in linear control theory systems optimization multivariable control large scale and infinite dimension systems nonlinear control distributed control predictive control geometric control adaptive control optimal and stochastic control robust control neural control fuzzy control intelligent control systems diagnostics fault tolerant control robotics and mechatronics navigation robotics and human machine interaction hierarchical and man machine systems etc Authors are encouraged to submit novel contributions which include results of research or experimental work discussing new developments in the field of systems automation and control The series can be also addressed for editing special issues for novel developments in specific fields The aim of this volume is to promote an international scientific progress in the fields of systems automation and control It provides at the same time an opportunity to be informed about interesting results that have been reported during the international SSD conferences High Performance Control Teng-Tiow Tay,Iven Mareels,John B. Moore,2012-12-06 The engineering objective of high performance control using the tools of optimal control theory robust control theory and adaptive control theory is more achiev able now than ever before and the need has never been greater Of course when we use the term high peiformance control we are thinking of achieving this in the real world with all its complexity uncertainty and variability Since we do not expect to always achieve our desires a more complete title for this book could be Towards High Performance Control To illustrate our task consider as an example a disk drive tracking system for a portable computer The better the controller performance in the presence of eccen tricity uncertainties and external disturbances such as vibrations when operated in a moving vehicle the

more tracks can be used on the disk and the more memory it has Many systems today are control system limited and the quest is for high performance in the real world

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Table of Contents Hard Disk Drive Servo Systems

1. Understanding the eBook Hard Disk Drive Servo Systems
    - The Rise of Digital Reading Hard Disk Drive Servo Systems
    - Advantages of eBooks Over Traditional Books
2. Identifying Hard Disk Drive Servo Systems
    - Exploring Different Genres
    - Considering Fiction vs. Non-Fiction
    - Determining Your Reading Goals
3. Choosing the Right eBook Platform
    - Popular eBook Platforms
    - Features to Look for in an Hard Disk Drive Servo Systems
    - User-Friendly Interface
4. Exploring eBook Recommendations from Hard Disk Drive Servo Systems

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