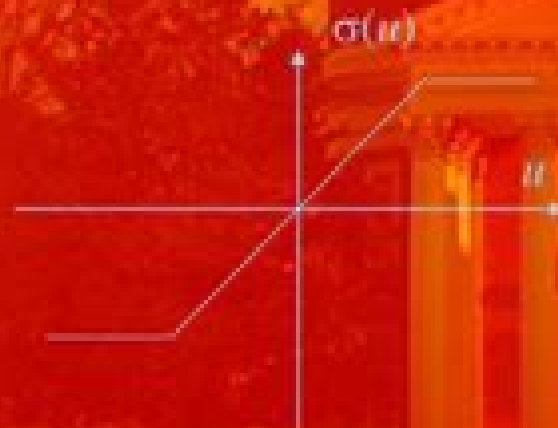


# Control Systems with Actuator Saturation

$$\dot{x} = Ax + B\sigma(u) + Ew$$



## Control Problems:

- Stabilization (large domain of attraction, fast convergence rate)
- Disturbance rejection (bounded energy disturbances, persistent disturbances, fixed frequency disturbances)
- Robustness to plant and actuator uncertainties

## Analysis Problems (for a given control design):

- Estimation of the size of domain of attraction, convergence rate
- Estimation of disturbance rejection capability
- Estimation of tolerance to plant and actuator uncertainties

# Control Systems With Actuator Saturation Analysis And Design

**Caisheng Wei,Zeyang Yin,Xia  
Wu,Zheng Wang,Xin Ning**



## **Control Systems With Actuator Saturation Analysis And Design:**

Control Systems with Actuator Saturation Tingshu Hu,Zongli Lin,2012-12-06 Saturation nonlinearities are ubiquitous in engineering systems In control systems every physical actuator or sensor is subject to saturation owing to its maximum and minimum limits A digital filter is subject to saturation if it is implemented in a finite word length format Saturation nonlinearities are also purposely introduced into engineering systems such as control systems and neural network systems Regardless of how saturation arises the analysis and design of a system that contains saturation nonlinearities is an important problem Not only is this problem theoretically challenging but it is also practically imperative This book intends to study control systems with actuator saturation in a systematic way It will also present some related results on systems with state saturation or sensor saturation Roughly speaking there are two strategies for dealing with actuator saturation The first strategy is to neglect the saturation in the first stage of the control design process and then to add some problem specific schemes to deal with the adverse effects caused by saturation These schemes known as anti windup schemes are typically introduced using ad hoc modifications and extensive simulations The basic idea behind these schemes is to introduce additional feedbacks in such a way that the actuator stays properly within its limits Most of these schemes lead to improved performance but poorly understood stability properties

*Control Systems with Saturating Inputs* Maria Letizia Corradini,Andrea Cristofaro,Fabio Giannoni,Giuseppe Orlando,2012-01-26 Saturation nonlinearities are ubiquitous in engineering systems every physical actuator or sensor is subject to saturation owing to its maximum and minimum limits Input saturation is an operating condition that is well known to the control community for its side effects which cause conventional controllers to lose their closed loop performance as well as control authority in stabilization Therefore the practical application of control theory cannot avoid taking into account saturation nonlinearities in actuators explicitly dealing with constraints in control design

**Actuator Saturation Control** Vikram Kapila,Karolos Grigoriadis,2002-02-20 Compiling the most significant advances from nearly a decade of research this reference compares and evaluates a wide variety of techniques for the design analysis and implementation of control methodologies for systems with actuator saturation The book presents efficient computational algorithms and new control paradigms for application in the

**Advanced Strategies in Control Systems with Input and Output Constraints** Sophie Tarbouriech,Germain Garcia,Adolf H. Glatfelter,2007-07-13 Physical safety and technological constraints suggest that control actuators can neither provide unlimited amplitude signals nor unlimited speed of reaction The techniques described in this book are useful for industrial applications in aeronautical or space domains and in the context of biological systems Such methods are well suited for the development of tools that help engineers to solve analysis and synthesis problems of control systems with input and output constraints

Stability and Stabilization of Linear Systems with Saturating Actuators Sophie Tarbouriech,Germain Garcia,João Manoel Gomes da Silva Jr.,Isabelle Queinnec,2011-08-13 This monograph details basic

concepts and tools fundamental for the analysis and synthesis of linear systems subject to actuator saturation and developments in recent research The authors use a state space approach and focus on stability analysis and the synthesis of stabilizing control laws in both local and global contexts Different methods of modeling the saturation and behavior of the nonlinear closed loop system are given special attention Various kinds of Lyapunov functions are considered to present different stability conditions Results arising from uncertain systems and treating performance in the presence of saturation are given The text proposes methods and algorithms based on the use of linear programming and linear matrix inequalities for computing estimates of the basin of attraction and for designing control systems accounting for the control bounds and the possibility of saturation They can be easily implemented with mathematical software packages **Journal of Guidance, Control, and Dynamics** ,2007 **Advances in State Estimation, Diagnosis and Control of Complex Systems** Ye Wang,2020-07-30 This book presents theoretical and practical findings on the state estimation diagnosis and control of complex systems especially in the mathematical form of descriptor systems The research is fully motivated by real world applications i e Barcelona s water distribution network which require control systems capable of taking into account their specific features and the limits of operations in the presence of uncertainties stemming from modeling errors and component malfunctions Accordingly the book first introduces a complete set based framework for explicitly describing the effects of uncertainties in the descriptor systems discussed In turn this set based framework is used for state estimation and diagnosis The book also presents a number of application results on economic model predictive control from actual water distribution networks and smart grids Moreover the book introduces a fault tolerant control strategy based on virtual actuators and sensors for such systems in the descriptor form *Fault Detection, Supervision and Safety of Technical Processes 2003 (SAFEPROCESS 2003)* Marcel Staroswiecki,Eva Wu,2004-02-27 A three volume work bringing together papers presented at SAFEPROCESS 2003 including four plenary papers on statistical physical model based and logical model based approaches to fault detection and diagnosis as well as 178 regular papers *Science in China* ,2007 *The Journal of the Astronautical Sciences* ,2005 *Journal of Dynamic Systems, Measurement, and Control* ,2007 **Fundamentals and Aerospace Applications of Prescribed Performance Control** Caisheng Wei,Zeyang Yin,Xia Wu,Zheng Wang,Xin Ning,2025 Zusammenfassung This book systematically presents the state of the art in prescribed performance control theory in terms of incomplete state information actuator saturation and faults constrained communication bandwidth and task time window as well as collision avoidance and more It provides a thorough presentation of fundamental structure controller design and analysis as well as simulation studies of aerospace applications The book aims to offer a valuable guide for researchers and aerospace engineers to address the theoretical and technical difficulties in different aerospace craft applications ranging from spacecraft attitude and orbital control to space robotic operations Meanwhile it can also work as a professional reference book for senior undergraduate students and postgraduate students in fields such as automation and aerospace

engineering     **IEEE Transactions on Circuits and Systems** ,2006     **Analysis of Actuator Saturation in Feedback Control Systems** Daniel Walter Bodtke,1998     Proceedings of the ... American Control Conference ,2005     **Stability and Performance of Control Systems with Actuator Saturation** Yuanlong Li,Zongli Lin,2017-11-28 This monograph investigates the stability and performance of control systems subject to actuator saturation It presents new results obtained by both improving the treatment of the saturation function and constructing new Lyapunov functions In particular two improved treatments of the saturation function are described that exploit the intricate structural properties of its traditional convex hull representation The authors apply these treatments to the estimation of the domain of attraction and the finite gain L2 performance by using the quadratic Lyapunov function and the composite quadratic Lyapunov function Additionally an algebraic computation method is given for the exact determination of the maximal contractively invariant ellipsoid a level set of a quadratic Lyapunov function The authors conclude with a look at some of the problems that can be solved by the methods developed and described throughout the book Numerous step by step descriptions examples and simulations are provided to illustrate the effectiveness of their results Stability and Performance of Control Systems with Actuator Saturation will be an invaluable reference for graduate students researchers and practitioners in control engineering and applied mathematics     **Integrated Tools for Control-system Analysis** Aaron J. Ostroff,1989     **Control Theory and Advanced Technology** ,1992     **Proceedings, IEEE Control Systems Society ... Symposium on Computer-Aided Control System Design (CACSD).** ,2004     *Reference Tracking in Feedback Control with Saturating Actuators* Yongsoon Eun,2003

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