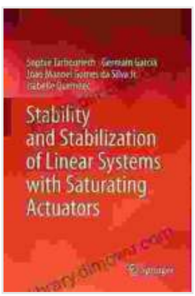
Stability and Stabilization of Linear Systems with Saturating Actuators

In the realm of engineering, controlling systems with saturation is a ubiquitous challenge. Saturation occurs when an actuator is physically constrained, limiting its output to a specific range. This nonlinear behavior can significantly impact the stability and performance of a system, making control design a complex and intricate task.



Stability and Stabilization of Linear Systems with Saturating Actuators by Sophie Tarbouriech

5 out of 5

Language	: English
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Text-to-Speech	: Enabled
Screen Reader	: Supported
Enhanced typesetting	: Enabled
Print length	: 453 pages

Understanding Saturation

Saturation arises when the input to an actuator exceeds its saturation limits. This limitation can be caused by physical constraints, such as the maximum power or torque that an actuator can generate, or by inherent design limitations. Saturation introduces nonlinearity into the system, making it difficult to predict and control its behavior.

Stability Analysis

Stability analysis is crucial in understanding the behavior of systems with saturation. The primary goal is to determine whether a system is stable or unstable under the influence of saturation. Various stability criteria have been developed to assess the stability of such systems, including the circle criterion, the Popov criterion, and the Kharitonov theorem.

Stabilization Techniques

Once the stability of a system with saturation has been determined, the next step is to implement stabilization techniques to ensure desired performance. Common stabilization approaches include:

- **Anti-windup:** This technique prevents the integrator in a feedback loop from saturating by limiting its output.
- **State-feedback:** By using feedback from the system states, state-feedback controllers can compensate for the effects of saturation.
- **Optimal control:** Optimal control techniques can be applied to find the best control law that minimizes a performance index while considering saturation constraints.

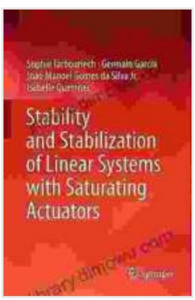
Real-World Applications

Systems with saturating actuators are prevalent in various engineering applications, including:

- **Robotics:** Actuators in robotic systems often encounter saturation limits due to joint angle constraints or motor power limitations.
- **Aerospace:** Control systems in aircraft and spacecraft must handle saturation in actuators due to aerodynamic forces and actuator limitations.

- **Automotive:** Throttle and brake actuators in vehicles are subject to saturation, affecting vehicle dynamics and safety.

Stability and Stabilization of Linear Systems with Saturating Actuators is a comprehensive guidebook that delves into the intricacies of controlling systems with saturation. By understanding the challenges posed by saturation, engineers can effectively design and implement stabilization techniques to ensure the desired performance and stability of their systems. This book is an invaluable resource for researchers, engineers, and students in the fields of control theory, system analysis, and engineering design.



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