FESTO

A short Introduction to Sliding Mode Control

Robust Control for Nonlinear Systems

Dr. Rainer Nitsche[1]

[1]Dept. Robotics
System Design Group

Control Methods in Robotics, August 2021

Sliding Mode Objectives

FESTO

Objecitves of this class of nonlinear control?

- Robustness versus uncertainties / perturbations
- Finite time convergence towards the control objectives

Sliding Mode Objectives

FESTO

Objecitves of this class of nonlinear control?

- Robustness versus uncertainties / perturbations
- Finite time convergence towards the control objectives

Features for this class of control?

- Discontinuous control law
- For standard sliding mode (first order): chattering effect, robustness
- For higher order sliding mode: accuracy, finite time convergence, robustness

Sliding Mode Objectives

FESTO

Objecitves of this class of nonlinear control?

- Robustness versus uncertainties / perturbations
- Finite time convergence towards the control objectives

Features for this class of control?

- Discontinuous control law
- For standard sliding mode (first order): chattering effect, robustness
- For higher order sliding mode: accuracy, finite time convergence, robustness

Remark

Sliding mode as a phenomenon may appear in a dynamic system governed by ordinary differential equation with *discontinuous right hand side*

Some Remarks on SMC

FESTO

This is a text in second frame. For the sake of showing an example.

- Good youtube video from Ali Nasir: ▸ Link

Some Remarks on SMC

FESTO

This is a text in second frame. For the sake of showing an example.

- Good youtube video from Ali Nasir: ▸ Link
- Text visible on slide 2

Some Remarks on SMC

FESTO

This is a text in second frame. For the sake of showing an example.

- Good youtube video from Ali Nasir: ▸ Link
- Text visible on slide 2
- Text visible on slide 3

Some Remarks on SMC

FESTO

This is a text in second frame. For the sake of showing an example.

- Good youtube video from Ali Nasir: ▸ Link
- Text visible on slide 2

- Text visible on slide 4

A motivating Example for SMC

FESTO

Example

Sliding mode of the system [1]:

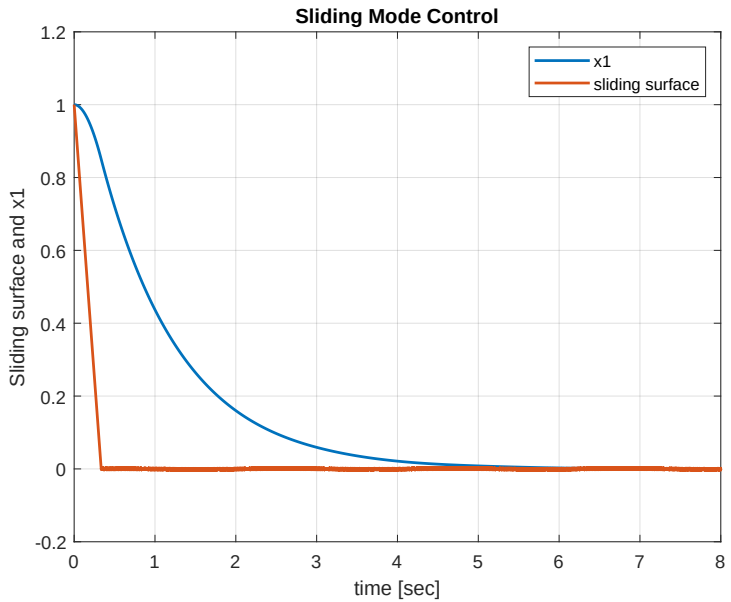
$$\ddot{x} = \sin(3t) + u \tag{1}$$

with sliding surface

$$s = c\dot{x} + x \tag{2}$$

with control law

$$u = -M\,\mathrm{sgn}(s) \tag{3}$$



Simulation results for $M = 3$ and $c = 1\,\mathrm{s}^{-1}$

If the system is in sliding mode, *i. e.* $s = 0$, the dynamics is $s = \dot{x} + x = 0$ and therefore independend of system parameters or disturbance $\rightsquigarrow$ robust !

Sample frame title

FESTO

In this slide, some important text will be highlighted because it's important. Please, don't abuse it.

Remark

Sample text

Important theorem

Sample text in red box

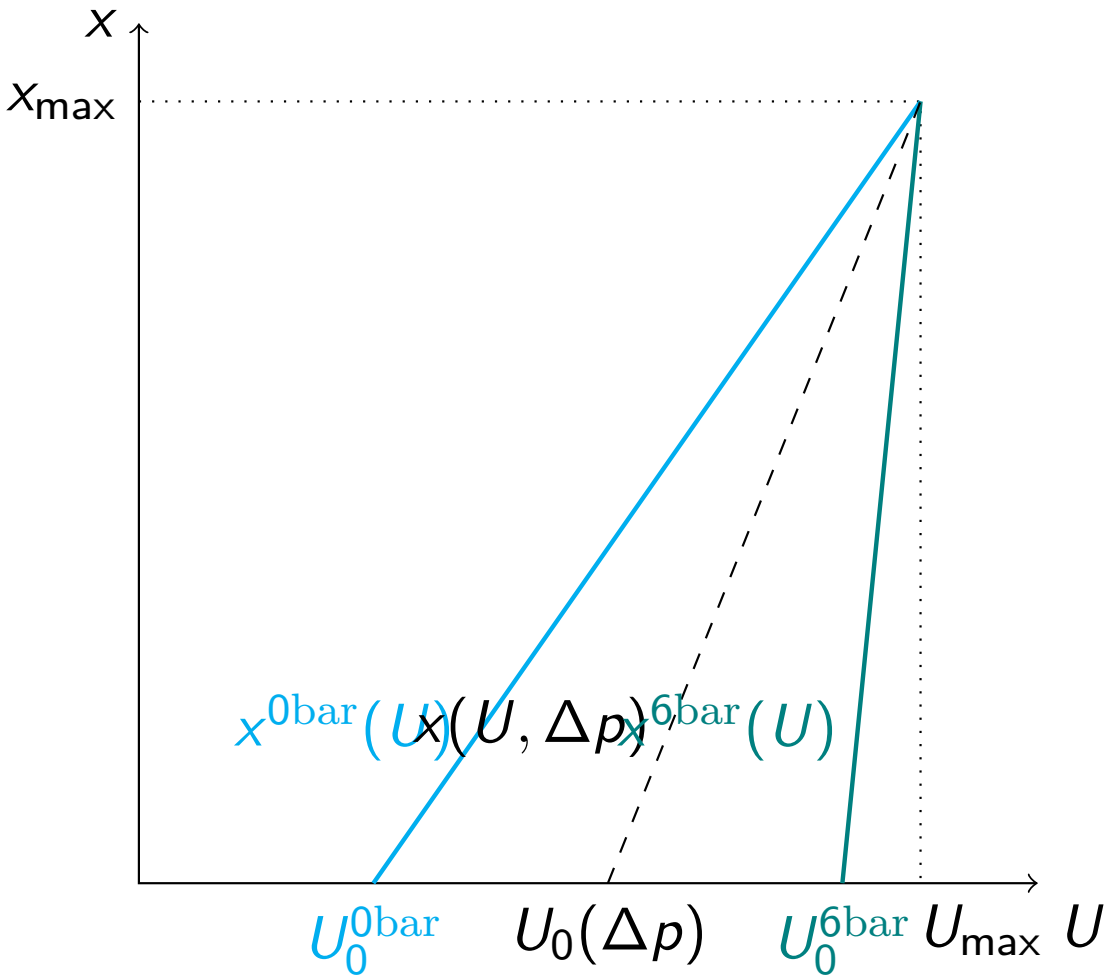
Examples

Sample text in green box. The title of the block is "Examples".

TikZ Test

FESTO

Hello world



References

FESTO

[1] Vadim I. Utkin et al. *Road map for sliding mode control design*. 6330 Cham, Switzerland: Springer, 2020. ISBN: 978-3030417086. DOI: 10.1007/978-3-030-41709-3.