Lehrstuhl Steuerung, Regelung und Systemdynamik

Master thesis

Programming

Modeling and control of an inverted flexible pendulum system with chaotic behavior

Conditions

Duration:	6 Months
Requirements:	Programming skills in Matlab and SIMULINK, strong interest in DSP-based programming and control (dSPACE)
Language:	German or English
Target groups:	Master students

Content

Chaos encountered in nonlinear physical and engineering problems often leads to an undesirable effect due to the nature of the irregular and unpredictable behavior. Problems and challenges arise are due to the complexity of nonlinear dynamical behaviors such as structural nonlinearities and couplings or unpredictable motions. The irregular and unpredictable time evolution of many nonlinear systems is called chaos. The main characteristic of chaos is that the system does not repeat its past behavior. The unique characteristic of chaotic systems is the sensitive dependence on the initial conditions. The inverted pendulum is commonly applied in practical exercise tasks in the study of control theory and system dynamics because it can be easily controlled by simple controllers such as PID or state control. Meanwhile, flexible inverted pendulum system is a popular and common example of a flexible link system.

The flexible pendulum fixed on a cart with tip mass has been studied in previous researches by focusing on system dynamics and multiple equilibria. The chaotic vibrations are developed by varying the frequency, amplitude, and related control parameters. In this work, the dynamical behavior of a nonlinear elastic mechanical system is considered, namely an inverted flexible pendulum precisely excited at the base by a motor-driven cart. The system shows chaotic jumping phenomena between three equilibria. Chaotic motion of the flexible pendulum tip in combination with a specific range of parameters has been identified. An existing control approach including filtering and actuation model has to be revised and improved. Furthermore, an existing discrete quantitative modeling approach has to be checked and revised through experiments.

The steps of this project are as follows:

- Analysis and investigation of the existing model and parameters
- Understanding and analyzing the existing control approach and programs
- Identification of chaotic motion of the flexible pendulum tip in combination with a specific range of parameters
- Revise of the existing control approach
- Improvement of the existing actuation model through experimental modeling
- Complete and detailed documentation/presentation of the research results

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