Elastic Modelling of Robots

Credits: 4 Semester 3 (ECN) Compulsory: No

Format	Lectures 20 h	Examples 12h	Private study 68 h

Lecturer: S. Briot, S. Caro

Objectives:

This course presents techniques for obtaining the elastostatic and elastodynamic models of robots.

Contents:

The following topics are treated:

- Overview of the different methods for the elastic modelling of robots
- Static modelling of serial robots with elastic joints
- Identification of the elastic parameters of serial robots: optimal measurement poses, application to advanced industrial operations.
- Static modelling of any robot with both elastic joints and elastic links
- Dynamic modelling of robots with flexible joints: the inverse and direct dynamic problems, computation of natural modes and frequencies.
- Dynamic modelling of flexible serial and tree structure robots: the inverse and direct dynamic problems, computation of natural modes and frequencies.
- Dynamic modelling of flexible parallel robots: the inverse and direct dynamic problems, computation of natural modes and frequencies.

Practical Work: Exercises will be set, involving modelling and simulation of robots. Advanced technical papers from recent international conferences will be analysed and reviewed.

Abilities: After completing this course, the students will be able to:

- Understand the fundamentals of the mathematical models of flexible robots and their applications in robot design, control and simulation
- Identify the elastic parameters of a serial robot with flexible joints
- Use of the best methods to develop the required models of a given structure,
- Apply the given techniques to other systems such as mobile robots or passenger cars.
- Use the convenient numerical schemes for numerical integration.
- Use modelling, optimization, and signal processing tool boxes software packages (Matlab, Adams).

Assessment: 30% continuous assessments, 70% from end of semester examination.

Recommended texts:

- Pashkevich, A., Chablat, D., and Wenger, W., "Stiffness analysis of overconstrained parallel manipulators,Mechanism and Machine Theory, Volume 44, Issue 5, May 2009, Pages 966-982
- W. Khalil, E. Dombre, *Modelling, identification and control of robots*, Hermes Penton, London, 2002.
- Klimchik, A., Pashkevich, A., Caro, S., and Chablat, D., 2012, "Stiffness Matrix of Manipulators with Passive Joints: Computational Aspects", IEEE Transactions On Robotics, Vol. 28(4), pp. 955-958.
- S. Briot and W. Khalil, *Dynamics of Parallel Robots*, Springer.
- Klimchik, A., Pashkevich, A., Wu, Y., Caro, S., and Furet, B., 2012, "Design of calibration experiments for identification of manipulator elastostatic parameters", Journal of Mechanics Engineering and Automation, Vol. 2(9), pp. 531-542, Print ISSN: 2159-5275; Online ISSN: 2159-5283, USA.
- S. Caro and S. Briot, lecture notes on "Elastic Modelling of Robots"

Further readings:

will be provided during the course