Optimal kinematic design of robots

Credits: 4 Semester 3 (ECN) Compulsory: No

Format	Lectures 20 h	Examples 12 h	Private study (68) h

Lectures: Ph. Wenger

Objectives : This course presents advance tools and methodologies for the kinematic design of new robots. Both serial and parallel kinematic architectures will be treated. The students will learn how to manage a general kinematic design problem in robotics.

Contents:
The course contains the following items:

- Formalization of relevant criteria for the performance evaluation of robots (accessibility, feasibility of trajectories, dexterity, cuspidality…),
- Methods for the calculation of robot workspace and of the maximal regions of feasible trajectories, taking into account joint limits and obstacles,
- Classification of cuspidal robots (non-singular posture changing robots) and geometric conditions for a robot to be cuspidal/noncuspidal
- Optimal design and placement of serial-type robots in cluttered environments,
- Methods for designing parallel kinematic robots (architecture design, geometric design, coping with singularities and operation modes),
- Application examples in typical industrial cases,
- Application examples for the design of innovative robots.

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

- Set an optimal design problem in robotics, taking into account multi-objective criteria,
- Evaluate the kinematic performances of serial and parallel robots,
- Know how to design a cuspidal or a non-cuspidal robot
- Find the best suitable robot for a given task
- Find the best placement of the robot's base,
- Design parallel kinematic robots with given mobility and motion type.

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

Practical Work: Exercises will be set, which will involve the optimal kinematic design of typical robotic manipulators (serial and parallel). Simulation and verification using Robotic-CAD systems.

Recommended texts:

- J. Angeles, *Fundamentals of Robotic Mechanical Systems,* Springer-Verlag, New York, 2002,
- P. Wenger : "Performance Analysis of Robots", in *Robot Manipulators: Modeling, Performance Analysis and Control,* E.Dombre, W.Khalil (ed.), ISTE, London, 2006.

Further readings:

- J.P. Merlet, *Parallel Robots,* Second Edition, Springer, 2006.