Humanoid Robots

Credits: 4 Semester 3 (ECN) Compulsory: No

Format	Lectures 20 h	Examples 12 h	Private study: 68 h

Lectures: C. Chevallereau (ECN), Y. Aoustin (ECN)

Contents: This course presents the fundamentals of control of humanoids for locomotion and manipulation. The students will learn the most common solutions used for stable motion synthesis and control.

The course contains the following items:

- biped locomotion: kinematics and dynamics, modelling of the contact with the ground
- motion synthesis for bipeds : optimization method, simplified models
- passive robots: properties, stability analysis (Poincaré map), extension
- control methods for postural stabilization, walking, and running : ZMP, on line adaptation, stability analysis, foot placement
- humanoid: whole motion control (redundancy)
- manipulation and grasping
- under-actuated hand

Practical Work: Exercises will be set, which will involve modelling biped, definition of optimal motion, simulation of passive robots, experiments on under-actuated hand.

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

define the walking robot stability considering the static and dynamic condition,
define a control law for a walking robot,
analyse the stability of a control strategy,
synthesize and implement the motion of simple walking robot,
define a control law for a manipulation task

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

Recommended texts:

- C. Chevallereau, G. Bessonnet, G. Abba et Y. Aoustin *Bipedal Robots*, ISTE Wiley, CAM Control Systems, Robotics and Manufacturing Series,
- E. R. Westervelt, J. W. Grizzle, C. Chevallereau, J-H Choi, *Feedback Control of Dynamic Bipedal Robot Locomotion, and Benjamin Morris*, Taylor & Francis/CRC Press, 2007.
- M. Vukobratovic, B. Borovac, D. Surla, D. Stokic, *Biped Locomotion: Dynamics, Stability, Control and Application*, Springer-Verlag , 1990.
- Marc Raibert , *Legged Robots That Balance*, MIT Press, 2000

Further readings:

will be provided during the course