ITMO University

Simulation of Robotic Systems

Course Workload		Assessment form (examination/ graded test/ ungraded test)
ECTS	Hours	
3	108	Exam

Modern robotic and mechatronic systems are complex in terms of all domains: mechanics, sensors, actuation, control, etc. To study the behavior and performance of an existing robotic system or a proposed one, we use models to focus on the essential features, keeping a reasonable tradeoff between realism and simplicity. Building a model is called modeling, and using that model to study a system's behavior and performance is called simulation. This module discusses modern technics of creating and using models to study the behavior and performance of robotic systems. The module consists of lecture and practice parts. The lectures mostly give theoretical inputs on modeling such as screw theory & Lie groups to describe motion, bond-graphs to describe the interconnection of different physical systems, control strategies to steer the systems, and optimization procedures for mechanics and control. The practice part focuses on simulation skills in MuJoCo.

Course structure:

1. Fundamentals and principles of simulation modelling of robotic systems

1.1. Analytical and simulation types of modelling: what is needed for what?
1.2. Analytical modelling of one-dimensional systems: derivation of the equation of motion
1.3. Basics of simulation modelling in MuJoCo
1.4. Modelling dynamical systems in bond-graphs

2. Modelling and control of electric motors in robotic systems

2.1. Overview of management strategies: by position, power and dynamic interaction
2.2. Feedback linearisation
2.3. Energy aware management

3. Analytical and simulation modelling of solid and elastic bodies articulated in mechanisms

3.1. Description of motion of absolutely solid bodies: rotation matrix for orientation description

3.2. Description of motion of absolutely rigid bodies: homogeneous transformation matrix for describing motion
3.3. Description of the motion of absolutely solid bodies: spatial kinematics
3.4. Description of the motion of absolutely solid bodies: spatial dynamics
3.5. Description of motion of elastic bodies and joints: kinematics and dynamics