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 robotic systems' simulation

1.1. Simulation vs modeling: what is the difference and why do we need them?
1.2. Modeling of one-dimensional systems: derivation of motion equation
1.3. Fundamentals of simulation in MATLAB Simscape
1.4. Modeling of dynamic systems in bond graphs

2. Motors' modeling and control in robotic systems

2.1. Control strategies: position, force, and interaction
2.2. Feedback linearization
2.3. Energy aware control

3. Modeling and simulation of rigid and elastic bodies in mechanisms

3.1. Motion of rigid bodies: rotation matrix
3.2. Motion of rigid bodies: homogeneous transformation matrix
3.3. Motion of rigid bodies: spatial kinematics
3.4. Motion of rigid bodies: spatial dynamics
3.5. Motion of elastic bodies and joints: kinematics and dynamics