ITMO University

Challenges and Approaches of Modern Robotics

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

The course is designed as an intro to the challenges and methodologies aligned with the research interests and expertise of the faculty in the Master's program "Robotics and AI." Course Goals: 1. Expand Knowledge of Modern Approaches: Dive into modeling, robot design, motion planning and control, data processing, and navigation, leveraging techniques such as deep learning, reinforcement learning, and large language and multimodal models. 2. Understand Practical Challenges: Explore real-world issues in collaborative and wearable robotics, energy-efficient locomotion, adaptive manipulation, and autonomous navigation in dynamic environments, with project examples from ITMO University in manufacturing, logistics, and environmental monitoring. 3. Enhance Research Opportunities: Facilitate informed choices of dissertation topics and advisors, and develop skills in crafting project proposals.

Course structure:

1. Dive-in into modern robotics

1.1. Robotics and AI: goals, objectives, format, key courses of the master's program
1.2. Introduction to the structure and goals of the course
1.3. Trends in robotics and AI

2. Modern methodological basis of robotics

2.1. Computational and generative design of robots
2.2. Robot sensor data processing and computer vision for object detection and surface inspection
2.3. Visual odometry and SLAM based on deep learning, semantic mapping and navigation
2.4. Planning robot motion in dynamic environments
2.5. Modern approaches to the design of control systems, including optimal, adaptive, robust and sensorless control
2.6. Learning sensory-motor skills and control policies through reinforcement learning and large language and multimodal models

3. Preparing for project work

3.1. Best practices for preparing project assignments