Course name:

Autonomous Mobile Robots

Course location:

Theoretical part (1 week): Partner Institution
Practical part (2 weeks): Johannes Kepler University Linz (Linz, Austria, Europe)

Requirements:

Literature:
R. Siegwart, I. Nourbakhsh, D. Scaramuzza, Autonomous Mobile Robots (2nd Edition)

Software:
Maple, Matlab/Simulink

Description of the course:

In this course the students will learn the basics of modelling, simulation and control of robotic systems. The course will be divided into two parts. Both parts will be taught by staff of the Institute for Robotics which is located at the Johannes Kepler University Linz.

The first part, focusing on theoretical issues, will last for one week and will take place at the Partner Institution. The students will get an understanding of the theoretical fundamentals of robotic topics, as for example structure of robots, sensors and actors, kinematics, dynamics, trajectory planning and robot control.

Shorty after the theoretical input, there is a two-week lab course at the Johannes Kepler University in Linz. During these two weeks the main focus lies on the practical implementation of the theoretical issues, which were presented during the course at the partner Institution and prepared as homework for the lab courses. The modelling and programming of real robots in combination with an intelligent controller design are the key aspects of this lab session. Students will work together in groups of two to three in order to solve the issues with the support of the Institute's scientists. Maple and Matlab/Simulink are used to derive the equations of motion, to simulate the received dynamics and to design intelligent controllers. The results are verified using the laboratory robots based on the Lego Mindstorm System. Beside the classes in the lab, students will also get an understanding of several robotic systems that are available at the Institute.

Contents of the Course:	**Hours**
Theoretical Part: ***1. Introduction to Autonomous Mobile Robots*** ***2. Locomotion*** 2.1. Legged Mobile Robots 2.2. Wheeled Mobile Robots ***3. Mobile Robot Kinematics*** 3.1. Kinematic Models and Constraints 3.2. Mobile Robot Maneuverability 3.3. Mobile Robot Workspace 3.4. Motion Control (Kinematic Control) ***4. Perception*** 4.1. Sensors for Mobile Robots 4.2. Fundamentals of Computer Vision 4.3. Fundamentals of Image Processing 4.4. Feature Extraciton 4.5. Place Recognition 4.7. Feature Extraction Based on Range Data (Laser, Ultrasonic) ***5. Mobile Robot Localization*** 5.1. The Challenge of Localization 5.2. Map Representation 5.3. Probabilistic Map-Based Localization 5.4. Autonomous Map Building ***6. Planning and Navigation*** 6.1. Path Planning 6.2. Obstacle avoidance	40 (CLASS)

Practical Part:
In the practical part, the theoretical topics are implemented on a real system. The real system, an autonomous mobile robot, is built by the students. The basic elements are Lego Mindstorms.
 	
The following exercises are worked out:
• Construction of a mobile robot
    o Exploration of different configurations for the mobile robot
    o Special consideration of wheel arrangements
• Modelling of the robot
    o Derivation of the equations of motion of the designed robot
    o Kinematical model for odometry
    o Implementation of a simulation model for offline controller evaluation
• Programming of the robot
    o Introduction to the Lego NXT programming system
    o Introduction to the NXT Matlab/Simulink interface and the Simulink External Mode
    o Handling of the Lego Mindstorm sensor and actuator systems
• Controller design for the robot
    o Low-level control of steering and driving systems
    o Trajectory control of the robot
• Localization of the robot
    o Simple localization on a map using the Mindstorms perception sensors
• Path planning for the robot
    o Combination of trajectory control and localization systems
	80 (LABS)