Università degli Studi di L'Aquila - Dipartimento di Ingegneria e Scienze dell'Informazione e Matematica

Course catalogue

Page compiled on 19/08/2019

Programme of Course "Robotica Industriale"

- Code: I0375
- Type of course unit: Elective (Laurea Magistrale in Ingegneria Informatica e Automatica curriculum Informatica), Compulsory (Laurea in Ingegneria dell'Informazione curriculum Automatica)
- Level of course unit: Postgraduate Degrees, Undergraduate Degrees
- Semester: 1

Number of ects credits: (Laurea in Ingegneria dell'Informazione) 9 (workload 225 hours), (Laurea Magistrale in Ingegneria Informatica e Automatica) 9 (workload 225 hours)

Teachers: Carlo Cecati (carlo.cecati@univaq.it), Costanzo Manes

1	**Course objectives**	The goal of this course is to introduce students to modeling, simulation and control techniques of industrial robots. On successful completion of this module, the students should be able to derive and implement kinematic and dynamic models of mechanical manipulators, to set-up trajectory planners, and to design control schemes. More in general, the learning outcome of this course is the enhancing of the student's abilities in modeling, control design, and simulation through their application to the exciting field of industrial robots.
2	**Course content and learning outcomes (dublin descriptors)**	Topics of the module include: • Definition of industrial robots and of its subsystems (hardware e software). Classification of robots on the basis of their geometries and mechanical structures. • Robot kinematics: Coordinate transformations between reference systems; rotation operators; orientation representations: orthonormal matrices, Euler Angles, axis and angle. Rigid body kinematics; linear and angular velocities; angular acceleration. Robot kinematics: prismatic and revolute joints; kinematic descriptions of chains of rigid bodies; the Denavit-Hartenberg notation; the inverse kinematics problem, closed form solutions; differential kinematics; algebraic and geometric Jacobians. Numerical methods for the computation of the inverse kinematics; kinematic singularities; kinematic redundancy. Kinematic simulation. Trajectory planning. • Robot statics: the principle of virtual works; force and moments transformations; compliance matrix and its inverse (stiffness). • Robot dynamics: Lagrange formulation; computation of the kinetic and potential energies for an open chain manipulator; the dynamic model of a robot and its properties; the Newton-Euler formulation and an efficient method for the computation of the inverse dynamics. • Robot control: control architectures for industrial robots; PD and local PID control laws, PD with gravity compensation; model based controllers for trajectory tracking: pre-computed and computed torque. • Elements of Matlab programming for the simulation of dynamic systems and graphical representation of objects. Elements of robot programming. On successful completion of this module, the student should : • The students will have knowledge and understanding of the methods of kinematic and dynamic modeling of robots, of trajectory planning and control design. Moreover, they will have knowledge of how the basic instructions of a robot programing language work. • At the end of the module the student will be able to apply the learned modeling methods to specific robots, and to implement simulation programs. • The students will be able to evaluate and choose the appropriate robot structure and control strategy for specific industrial tasks • The student will be able to discuss and explain to both technical and non-technical people the feasibility of the use of robots in specific industrial tasks, and to illustrate advantages and disadvantages. • The students will have the capacity of reading and understanding advanced texts on robotics

3	**Course prerequisites**	The students must know the basic notions of calculus and mechanics. Students should preferably have also some basic notions of systems dynamics and control.
4	**Teaching methodsand language**	Lectures and exercises. **Language**: Italian **Reference textbooks** • Costanzo Manes, ***Handouts***. *http://ing.univaq.it/manes/Didattica_Robotica_Industriale/Materiale_Didattico_Robotica.html* • B. Siciliano, L. Sciavicco, L. Villani, G. Oriolo,, ***Introduction to Robotics: Mechanics and Control***. Springer Verlag. 2009. • J.J. Craig, ***Introduction to Robotics: Mechanics and Control***. Prentice Hall. 2004.
5	**Assessment methods**	An oral exam. Discretionary report on chosen subject.