UNIVERSITÀ DEGLI STUDI DI PALERMO

DEPARTMENT	Ingegneria
ACADEMIC YEAR	2019/2020
MASTER'S DEGREE (MSC)	COMPUTER ENGINEERING
SUBJECT	ROBOTICS
TYPE OF EDUCATIONAL ACTIVITY	B
AMBIT	50369-Ingegneria informatica
CODE	06292
SCIENTIFIC SECTOR(S)	ING-INF/05
HEAD PROFESSOR(S)	CHELLA ANTONIO Professore Ordinario Univ. di PALERMO
OTHER PROFESSOR(S)	
CREDITS	12
INDIVIDUAL STUDY (Hrs)	216
COURSE ACTIVITY (Hrs)	84
PROPAEDEUTICAL SUBJECTS	
MUTUALIZATION	
YEAR	2
TERM (SEMESTER)	1° semester
ATTENDANCE	Not mandatory
EVALUATION	Out of 30
TEACHER OFFICE HOURS	**CHELLA ANTONIO** Monday 09:00 11:00 DICGIM, edificio 6, III piano

DOCENTE: Prof. ANTONIO CHELLA

PREREQUISITES	- Algorithms and data structures; - Operating systems; - C and Java Programming; - Automatic control systems; - Artificial Intelligence (suggested).
LEARNING OUTCOMES	Learning outcomes according to the Dublin descriptors: - Objective 1: Knowledge and understanding The student will acquire the theoretical knowledge necessary to solve the problems related to the design and implementation of autonomous robots and the methodologies to the robot performance analysis. The student will thus study the typical case studies of robot architectures and the principal topics of current research. Finally, the class will discuss ethical and societal aspects of autonomous robotics. The course will include lectures; class discussions of case studies; seminars and panels. - Objective 2: Applying knowledge and understanding The student will acquire the practical capabilities necessary to design and implement autonomous robots. He/she will be able to create robotic architectures, to identify the problems, to formulate algorithms, to implement and evaluate the performances of the proposed solutions. The course will include sessions in the robotics lab or autonomously, by employing the robot simulator and the robots NAO and PEPPER. - Objective 3: Making Judgments The student will acquire the necessary methodologies to implement and evaluate robot architectures not previously discussed in the case studies by integrating all the notions obtained during the course. He/she will be able to analyze problem data at disposal, even if limited and incomplete, and to propose robot design solutions tailored to the problem at hand. The student will be able to compare strengths and weaknesses of the proposed solutions and to evaluate the performance of the solutions also by ethical and societal aspects. The course will include analysis and discussion of case studies; lectures and group sessions; lectures on ethical, economic and social aspects of robotics; class discussions and presentations performed by students team concerning their projects and implementations; preparation of a written essay. - Objective 4: Communication skills The student will be able to work in a team and to communicate with competence and correctness of language the issues related to the design, implementation, and evaluation of autonomous robots. The course will include team sessions in the robotics lab on the design and implementation of autonomous robots; presentations and class discussions by the student's teams. - Objective 5: Learning skills The student will be able to autonomously learn and study specific difficult problems related to autonomous robotics by the literature of the field. The course will include seminars, panels and class discussion on the main research topics of autonomous robots
ASSESSMENT METHODS	Assessment methods will focus on the evaluation of learning outcomes of the course (see below) according to the Dublin descriptors. The final grade will be from 18/30 to 30/30 cum laude. - Assessment of Objective 1: Knowledge and understanding This objective will be assessed by an oral discussion concerning the theoretical topics of the syllabus. Objective 1 will count as 15% of the final grade. - Assessment of Objective 2: Applying knowledge and understanding This objective will be assessed by an oral discussion of the robot case studies analyzed by the student during team sessions in the lab. Objective 2 will count as 15% of the final grade. - Assessment of Objective 3: Making Judgments This objective will be assessed by a discussion of an essay, written at home and in the lab, by the student together with his/her student team. The article will concern the design and implementation of a robot performing assigned tasks. A live demo of the operating robot will have to be shown by the student team. In particular, Objective 3 will be assessed by discussing, in particular, the design and implementation choices performed by the student team. Objective 3 will count as 30% of the final grade. - Assessment of Objective 4: Communication skills This objective will be assessed by the oral discussions concerning Objectives 1,2,3 and the analysis of the written essay concerning Objective 3. Objective 4 will count as 10% of the final grade. - Assessment of Objective 5: Learning skills This objective will be assessed using the discussion of the essay described in Objective 3. In particular, Objective 5 will be evaluated by discussing, in particular, the theories and techniques autonomously learned by the student team and employed in the implementation of the robot. Objective 5 will count as 30% of the final grade.
EDUCATIONAL OBJECTIVES	Educational objectives are in agreement with the ACM/IEEE CS 2013 Body of Knowledge and they cover all or parts of the following Knowledge Units.

	Knowledge Area: Platform Based Development Knowledge Unit: Industrial Platforms Topics Covered: - Robotic software and its architecture Knowledge Area: Intelligent Systems Knowledge Unit: Robotics Topics Covered: - Overview: problems and progress: ° State-of-the-art robot systems, including their sensors and an overview of their sensor processing ° Robot control architectures, e.g., deliberative vs. reactive control and Braitenberg vehicles ° World modeling and world models ° Inherent uncertainty in sensing and in control - Configuration space and environmental maps - Interpreting uncertain sensor data - Localizing and mapping - Navigation and control - Motion planning Knowledge Area: Intelligent Systems Knowledge Unit: Advanced Representation and Reasoning Topics Covered: - Reasoning about action and change (e.g., situation and event calculus) - Planning: ° Partial and totally ordered planning ° Planning and execution including conditional planning and continuous planning ° Mobile agent/Multi-agent planning Knowledge Area: Intelligent Systems Knowledge Unit: Advanced Machine Learning Topics Covered: - Supervised learning: ° Learning neural networks ° Support vector machines (SVMs) - Unsupervised Learning and clustering: ° Self-organizing maps - Reinforcement learning: ° Exploration vs. exploitation trade-off ° Markov decision processes ° Value and policy iteration Knowledge Area: Information Assurance and Security Knowledge Unit: Foundational Concepts in Security Topics Covered: - Concept of trust and trustworthiness - Ethics (responsible disclosure)
TEACHING METHODS	The overall format of the course is: - Lectures - Lab sessions - Discussion classes
SUGGESTED BIBLIOGRAPHY	- Cangelosi, A. and Schlesinger (2015). Developmental Robotics. Cambridge, Mass., MIT Press. - Arkin, R. C. (1998). Behavior-based robotics. Cambridge, Mass., MIT Press. The book covers the following arguments in details: Behavior-based robotics; Subsumption architectures. Motor schemas. Behavioral coordination. - Thrun, S., Burgard, W. and Fox, D. (2005). Probabilistic Robotics. Cambridge, Mass., MIT Press. The book covers the following arguments in details: uncertain sensor data, probabilistic model of actuators, localization and mapping, SLAM. - Latombe, J.-C. (1991). Robot motion planning. Boston, Kluwer Academic Publishers. The book covers the following arguments in details: Configuration space. Motion planning.

SYLLABUS

Hrs	Frontal teaching
3	Overview: problems and progress
3	Robot software and architectures
3	Behavior-based robotics
6	Subsumption architectures. Motor schemas. Behavioral coordination
3	Sensors. Landmarks and triangulation
3	Locomotion. Kinematics of a mobile robot
3	Configuration space. Motion planning
3	Symbolic planning. STRIPS.
6	Neural networks for control: supervised, unsupervised, reinforcement learning
6	Artificial vision systems
3	Interpreting uncertain sensor data
3	Probabilistic model of actuators
3	Kalman filter

SYLLABUS

Hrs	Frontal teaching
3	Histogram filter
3	Particle filter
3	Ethical aspects of robotics
3	Trustworthy human-robot interactions

Hrs	Practice
3	Introduction to the NAO robot
3	Programming behaviors
3	Sensors and kinematics
3	Motion planning
3	Symbolic planning
3	Probabilistic model of sensors and actuators
3	Kalman filter
3	Histogram filter