1 UC *

Português *	Robótica Inteligente
English *	Intelligent Robotics

2 Team *

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*Research area(s) (related to the UC) **	*Robótica Inteligente, Sistemas Inteligentes, Aprendizagem Automática, Simulação*			
Projects in which you participated relevant to the UC	*FC Portugal, CAMBADA, EuRoC, GermiRRad, IntellWheels, LUL, Produtech-SIF, Produtech-PTI, XtremeCork, RETIOT, ACORD*			
Recent publications (relevant to the UC)	*Puente-Castro A., Rivero D., Pedrosa E., Pereira A., Lau N., Fernandez-Blanco E., Q-Learning based system for Path Planning with Unmanned Aerial Vehicles swarms in obstacle environments, (2024) Expert Systems with Applications, 235, art. no. 121240, DOI: 10.1016/j.eswa.2023.121240* *Kasaei M., Abreu M., Lau N., Pereira A., Reis L.P., Li Z. Learning hybrid locomotion skills—Learn to exploit residual actions and modulate model-based gait control. (2023) Frontiers in Robotics and AI, 10, art. no. 1004490 DOI: 10.3389/frobt.2023.1004490* *Abreu M., Kasaei M., Reis L.P., Lau N., FC Portugal: RoboCup 2022 3D Simulation League and Technical Challenge Champions, (2023) Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics), 13561 LNAI, pp. 313 - 324. DOI: 10.1007/978-3-031-28469-4_26* *Pedrosa E., Oliveira M., Lau N., Santos V., A general approach to hand-eye calibration through the optimization of atomic transformations, (2021) IEEE Transactions on Robotics, 37 (5), pp. 1619 - 1633, DOI: 10.1109/TRO.2021.3062306*			

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*Research area(s) (related to the UC) **	Inteligência Artificial, Sistemas Multi-Agente, Simulação			

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*Research area(s) (related to the UC) **	Robótica, Automação			

3 Syllabus *

Module[1]	Teacher	Topics
1 – Introduction	*Nuno Lau; Luis Paulo Reis; Armando Sousa*	• *Artificial Intelligence* • *Basic concepts of Robotics* • *Artificial Intelligence in Robotics* • *History, Evolution, and Current Trends in Intelligent Robotics*

2 – Architectures for Robotic Agents	*Nuno Lau*	• *Reactive, Deliberative, Hybrid* • *Belief, Desire and Intentions (BDI)* • *Cooperative Architectures*
3 – Perception and Sensorial Interpretation	*Nuno Lau*	• *Proximity sensors: Sonar or ultrasonic, infrared (IR), touch, light and feel sensors* • *Computer Vision: Cameras, Digital Image, Colour Models, Image Processing, Image Analysis* • *Odometry, Rotation and Compass Sensors* • *Sensor Fusion TechniquesD*
4 - Localization and Mapping	*Armando Sousa*	• *Creation, Representation and Updating of World States.* • *Markov and Gaussian Localization* • *Grid and Monte-Carlo Localization* • *Mapping: Occupancy Grid and SLAM* • *World Exploration*
5 - Mobile robots control: Locomotion and Action	*Armando Sousa*	• *Gears, Speed, Torque* • *Robot locomotion simulation*
6 - Robotic Learning	*Luis Paulo Reis*	• *Optimization methods* • *Reinforcement Learning*
7 - Navigation	*Nuno Lau*	• *Algorithms of navigation in known/unknown environments* • *Voronoi Diagrams* • *A* and D* Algorithms* • *Cellular Decomposition*
8 - Cooperative Robotics	*Luis Paulo Reis*	• *Introduction to the cooperation between robots for teamwork* • *Joint Intentions, TAEMS, Role-Based, Social Rules* • *Communication and Mutual Modeling* • *Locker-Room, Strategical Coordination, Partial Hierarchical* • *Swarm Robotics*
9 - Applications	*Nuno Lau; Luis Paulo Reis; Armando Sousa*	• *National and International Robotic Competitions: RoboCup, RoboOlympics, Fira Cup, DARPA Grand-Challenge, Portuguese Robotics Open, Autonomous driving, Micro-Mouse (Micro-Rato) and fire fighting Robots; European Robotics Challenges; Amazon Picking Challenge* • *Robotic simulators: Soccerserver 2D and 3D, RoboCup Rescue, Virtual Rescue, Ciber-Mouse, Gazebo, USARSim*

4 Objectives

At the end of the course, each student should be able to...

O1	*Acquire knowledge of current state and trends in intelligent robotics and practical knowledge from programming real/simulated robots; them;*
O2	*Demonstrate an understanding of main challenges of the discipline and be enabled to select appropriate techniques to solve*
O3	*Have a broad critical understanding of how Artificial Intelligence may be applied generally to intelligent and cooperative robotics;*
O4	*Appreciate the problems associated with programming and controlling simulated/real robotic platforms with different perception and action capabilities;*
O5	*Understand the challenges behind cooperative robotics and the construction of robotic teams that operate in dynamic, inaccessible, non-deterministic environments;*
O6	*Reference the sources used in their work in the context of intelligent robotics, being aware of the best projects/research works in this area around the world. Students must use accurately the standard referencing styles within the text of all written work for all sources used.*

5 Bibliography *

Num	Year	Type	Description
1	*2011*	*Book*	*"Introduction to Autonomous Mobile Robots" Roland Siegwart, Illah R. Nourbakhsh, Davide Scaramuzza, Edition: 2nd, MIT Press, 2011*
2	*2021*	*Book*	*"Artificial Intelligence: A Modern Approach", Stuart Russell, Peter Norvig, Edition: 4th, Pearson, 2021*
3	*2005*	*Book*	*"Probabilistic Robotics", Sebastian Thrun, Wolfram Burgard, Dieter Fox , MIT Press, Cambridge, Massachussets, London England, 2005*
4	*2017*	*Book*	*"Modern Robotics: Mechanics, Planning, and Control", Kevin M. Lynch, Frank C. Park. Cambridge University Press, Edition: 1st, 2017*
5	*2019*	*Book*	*"Robotics: Modelling, Planning and Control", Siciliano, Bruno, Lorenzo Sciavicco, Luigi Villani, and Giuseppe Oriolo. Springer, 2019.*