Lecturers

Name: Carlos Balaguer Bernaldo de Quiros
Academic Background: PhD in Robotics and Automation
Field of Specialization: Robotics
Employer: University Carlos III of Madrid (UC3M)
Previous Positions: Assistant and Associate Professor
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Name: Juan G Victores
Academic Background: PhD in Electrical Engineering, Electronics and Automation
Field of Specialization: Associate Professor @ UC3M, Researcher in Robotics and AI @ RoboticsLab (UC3M)
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Previous Positions: Assistant Professor, Teaching Assistant.
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Name: Bartek Łukawski
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Field of Specialization: Teaching and research staff in dpt. of Systems Engineering and Automation (UC3M)
Employer: Universidad Carlos III de Madrid, Leganés, Spain
Previous Positions: Research assistant at UC3M; software engineering intern at Canonical Robots (Madrid, Spain)
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Name: Alicia Mora Velasco
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Name: Adrián Prados Carrasco
Academic Background: Degree in Industrial Electronics and Automation Engineering / M.Sc. degree in Robotics and Automation
Field of Specialization: Researcher in robotics
Employer: Universidad carlos III de Madrid
Previous Positions: Work in Kibotics as a robotic teacher and environment designer.
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Name: Alberto Méndez García
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Previous Positions: Researcher on Medical Robotics at the University of Malaga
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Name: Luis Moreno
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Name: Raúl de Santos Rico
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Field of Specialization: Robotics Research Technician
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Name: Elisabeth Menéndez Salvador
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Previous Positions:
- Research Technician in the SHARON-CM-UC3M (Jan.2020 - Sep.2021).
- Research Technician in the BADGER European Project. (Jan.2017 - Sep.2020).
- Research Technician in the Robo-Spect European Project. (Oct.2015 - Dec.2016)
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Name: María José Herrero Villa
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Previous Positions: Before Nov 2004- Private Sector. Since Nov 2004, in UC3M Science Park different positions
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Previous positions: Ayudante Doctor
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Previous Positions: Ayudante Doctor
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http://roboticslab.uc3m.es/roboticslab/people/m-maroto-gomez

Name: Elena García Armada
Academic Background: Higher Industrial Engineer. Speciality: Electronics and Industrial Automation
Field of Specialization: Founder and CEO. Research Scientist
Employer: Marsi Bionics/ Consejo Superior de Investigaciones Científicas (CSIC)
Previous Positions: Phd Researcher at CSIC
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Name: Alberto Plaza Flores
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Field of Specialization: Chief R& D Officer

Employer: Marsi Bionics
Previous Positions: Electronics, Automation Engineer
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Course Description

Title: Beyond Asimov's Rules: Towards Intelligent Robotics
Fields of activity: Aerospace/Aeronautical Engineering , Automotive Engineering , Biological/Biotechnical/Gene Engineering , Biomedical Engineering , Chemical Engineering , Civil Engineering , Computational Sciences , Computer Engineering , Computer Science/Automatic Control/Informatics , Control Engineering/Systems engineering , Electrical/Electromechanical Engineering , Electronic/Electrotechnical Engineering , Industrial Engineering , Machine & Instrument engineering/Design , Mechanical Engineering , Mechatronics , Mining/Mineral Resources Engineering , Naval Architecture & Engineering , Physics/Physics Engineering , Telecommunications/Electronics
Examination type: Project work
Number of ECTS credits issued: 1
Learning Goals and Objective: The goal of the course is to obtain a general idea about what Intelligent Robots are. Participants will be able to work with robot simulators like Webots in domestic environments and they will also gain insight into the applications of robots in different industries

Syllabus

Name of activity	Introduction to Intelligent Robotics
Number of working hours	1.5h
Type of activity	Lecture
Lecturer	Carlos Balaguer Bernaldo de Quiros
Short summary of content	The objective of this lecture is to introduce the concept of intelligent robotics. The main topics are: - What is a robot? - What are Asimov's rules?

	- What is intelligence? - What are intelligent robots? - Main applications of intelligence robotics
Bibliography	- 2022 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), IEEE Explorer (https://ieeexplore.ieee.org/xpl/conhome/9981026/proceeding). - John J. Craig, Introduction to robotics: mechanics and control, Pearson, 4th edition, 2018.
Expected effect	The attendees will become familiar with the concepts of intelligent robotics and will be able to differentiate this type of robot from the rest. They will also learn the main applications of intelligent robots.

Name of activity	Introduction to Robot Simulation: Webots
Number of working hours	1h
Type of activity	Tutorial
Lecturer	Juan G Victores
Short summary of content	In this practical exercise, students will be working with a 3D open source robot simulator to integrate a robot in its environment. The simulator will allow students to create a scenario in which they can control the movement of a robot. The main goal of this exercise is to teach participants how to generate a simple robot environment using a Python script, and how to add obstacles to increase the complexity of their scenario.
Bibliography	- Collins, Jack, et Al, "A Review of Physics Simulators for Robotic Applications", IEEE Access, 2021. - Ivaldi, Serena, et Al, "Tools for simulating humanoid robot dynamics: a survey based on user feedback", 14th IEEE-RAS International Conference on Humanoid Robots (Humanoids 2014), 2014. - Wikipedia (electronic resource with edits by Jgvictores et Al), "Robotics simulator",

	https://en.wikipedia.org/wiki/Robotics_simulator, Access on 1 April 2023 at 15:49.
Expected effect	Provide students with a foundational understanding of the 3D open source robot simulator and its capabilities. It will provide students with a solid foundation for the subsequent examination.

Name of activity	Webots Project
Number of working hours	3h
Type of activity	Examination: Project Work
Lecturer	Juan G Victores, Bartek Lukawski
Short summary of content	Once students have a basic understanding of the simulator, they will begin working on the actual project. Participants will be divided into groups and tasked with creating a controller script that moves the robot from the origin to a goal. To do this, they will need to modify a selection of templates provided in Python, C++, and Matlab, to create the desired behavior for their robot. Students will work collaboratively to ensure their robot can navigate through the obstacles they have created and reach its destination. By the end of the project, participants will have gained valuable experience in programming, problem-solving, and teamwork.
Bibliography	-
Expected effect	- Learn how to use a Python script to generate a map for a 3D open source robotics simulator starting from a .csv (comma-separated values) file. - Create an environment in an open source robotics simulator and incorporate a robot. - Develop a robot controller program for the open source robot simulator that moves your robot from the origin to goal. - Experiment with changes in the environment and your robot controller.

Name of activity	Navigating Robotics Entrepreneurship
Number of working hours	2h
Type of activity	Group Seminar
Lecturer	Maria Jose Herrero Villa
Short summary of content	Participants will explore the application of entrepreneurship principles in the field of robotics through the award-winning board game e-Ship. They will navigate the uncertainties and challenges of starting a robotics venture, developing decision-making and strategic thinking skills. The lesson includes an introduction to entrepreneurship in robotics, an overview of e-Ship, gameplay session, debriefing, and a concluding discussion on the lessons learned. By engaging in experiential learning, participants will gain valuable insights into entrepreneurship in robotics and its real-world implications.
Bibliography	https://www.biosymfonix.com/Eship.html
Expected effect	This lesson aims to provide participants with a deeper understanding of the challenges and principles involved in starting a robotics venture. By exploring uncertainties in a hands-on, interactive setting, the lesson inspires participants and equips them with the motivation and knowledge to pursue entrepreneurial endeavors in the field of robotics.

Name of activity	Mobile Robots Lab
Number of working hours	1.5h
Type of activity	Laboratory Work
Lecturer	Ramon Barber, Alicia Mora Velasco, Adrián Prados Carrasco, Alberto Méndez García, Víctor Muñoz Sánchez
Short summary of content	- Introduction to mobile robotics and their importance in today's world - Understanding how robots perceive the world around them and navigate through it - Learning about the sensors that robots use to detect the

	environment - Understanding how robots process information and make decisions Live demonstrations of a mobile bimanipulator robot Opportunity to try out how artificial intelligence works
Bibliography	-
Expected effect	Students will gain knowledge and understanding of mobile robotics, including their perception abilities, navigation skills, and decision-making processes. They will also gain hands-on experience with a mobile bimanipulator robot and artificial intelligence, which will provide them with a deeper understanding of how these technologies work in practice.

Name of activity	Intelligent UAVs
Number of working hours	2h
Type of activity	Lecture
Lecturer	Luis Moreno
Short summary of content	UAVs (Unmanned Aerial Vehicles) technology has improved substantially over the last 20 years. Until recently the use of UAVs commercially has been strongly limited due to the absence of a specific set of norms to manage the air space where the UAVs are going to operate. The development of UTMs (Unmanned Traffic Management systems) and its coordination with the ATM (Air Traffic Management systems) will be done in the next years. But in parallel with the development of the UTM the UAVs, multirotors or fixed wings required the development of a different set of technologies (planning, communications, navigation, piloting...) and capabilities that will let the UAVs operate in a safe way in complex environments. Today, a wide part of the UAVs are manually or semi manually operated particularly small drones. The course objective is to introduce the different aspects related with the intelligence and autonomy of UAVs.
Bibliography	- A Review of Deep Learning Methods and Applications for Unmanned Aerial Vehicles, A. Carrio ,C. Sampedro, A. Rodriguez-Ramos, and P. Campoy, Journal of

	Sensors Open Access Volume 2017, https://doi.org/10.1155/2017/3296874 - ArduPilot-based adaptive autopilot: architecture and software-in-the-loop experiments, Simone Baldi, Danping Sun, Xin Xia, Guopeng Zhou, and Di Liu, IEEE Transactions on Aerospace and Electronic Systems · October 2022, DOI: 10.1109/TAES.2022.3162179. - A Hardware/Software Architecture for UAV Payload and Mission Control, Enric Pastor, Juan Lopez and Pablo Royo, - Survey of Advances in Guidance, Navigation, and Control of UnmannedRotorcraft Systems, Farid Kendoul, Journal of Field Robotics 29(2), 315–378 (2012) , DOI: 10.1002/rob.20414 - Autonomy Levels for Unmanned Systems (ALFUS) Framework, H. Huang 2007, NIST Special Publication 1011-II-1.0
Expected effect	This subject will provide students with a comprehensive understanding of the latest technologies used in UAVs, including functional architecture, piloting, navigation, guidance, and path planning. Students will also learn about multi UAV coordination and contingencies management. By studying these topics, students will gain knowledge on how to design, build, and operate autonomous UAVs safely in complex environments, which will be useful for those interested in pursuing a career in this field or wanting to gain knowledge on this emerging technology.

Name of activity	Humanoid Robots
Number of working hours	1.5h
Type of activity	Lecture
Lecturer	Santiago Martinez de la Casa
Short summary of content	The objective of this session is to make an introduction to basic concepts of robotics applied to humanoid robots. The main topic presented are: - Introduction to humanoid robots - Foundations of design and control of humanoid robots - Locomotion of humanoid robots

	- Manipulation in humanoid robots - Future trends
Bibliography	Kajita, S., Hirukawa, H., Harada, K., & Yokoi, K. (2014). Introduction to humanoid robotics (Vol. 101, p. 2014). Springer Berlin Heidelberg.
Expected effect	The attendees will be able to understand how a humanoid robot works and the foundations of its development.

Name of activity	Humanoid Robots Lab
Number of working hours	1.5h
Type of activity	Laboratory Work
Lecturer	Santiago Martinez de la Casa
Short summary of content	In this lab visit, students will be introduced to the world of humanoid robotics and will witness a demonstration of a manipulation task performed by a humanoid robot.
Bibliography	-
Expected effect	Students should understand the concept of humanoid robotics and its applications; understand how a manipulation task is performed by a humanoid robot and the challenges associated with humanoid robotics and its future prospects.

Name of activity	Intelligent Mobile Robots
Number of working hours	1.5h
Type of activity	Lecture
Lecturer	Ramon Barber Castaño
Short summary of content	The main topics involved in mobile robot navigation - Robot Perception - Robot Modeling - Robot Location - Robot Planning

	- Robot Navigation Participants will learn about sensors, modeling techniques, localization methods, planning algorithms, and how these components come together to enable robots to navigate and interact with their environment effectively. By the end of the session, participants will be equipped with the knowledge to design and develop intelligent mobile robot systems.
Bibliography	- R. Barber, J. Crespo, C. Gómez, A. C. Hernámdez, and M. Galli, 'Mobile Robot Navigation in Indoor Environments: Geometric, Topological, and Semantic Navigation', Applications of Mobile Robots. IntechOpen, Mar. 20, 2019. doi: 10.5772/intechopen.79842. - Crespo, J.; Castillo, J.C.; Mozos, O.M.; Barber, R. Semantic Information for Robot Navigation: A Survey. Appl. Sci. 2020, 10, 497. https://doi.org/10.3390/app10020497
Expected effect	The attendees will be able to understand the main topics involved in mobile robot environment modeling and navigation.

Name of activity	Company Visit: Marsi Bionics
Number of working hours	3.5h
Type of activity	Company Visit
Lecturer	Elena García Armada, Alberto Plaza Flores
Short summary of content	The aim of this visit is to get to know the work being done at Marsi Bionics through the devices developed in their facilities, exoskeletons created for gait rehabilitation. To achieve this goal, there will be a tour of the facilities and after that, one of the members of the Marsi Bionics team will explain the development of the exoskeletons: - Atlas Pediatric Exo: World's first pediatric exoskeleton. - Mak Active Knee: First robotic knee orthosis with adaptive stiffness. - Stelo: Project in development.

Bibliography	https://www.marsibionics.com/
Expected effect	To let the attendees know about Marsi Bionics work, the already developed devices and their next projects. To learn about the application of robotics to gait rehabilitation.

Name of activity	Visit Scientific Park UC3M
Number of working hours	1.5h
Type of activity	Field Work
Lecturer	Maria José Herrero Villa
Short summary of content	The objective of this session is to introduce the innovation ecosystem agents and dynamics in order to understand the way of bringing lab results to the market. To do so, the next topics will be presented: - What an innovation ecosystem is - To which extent it is important - The agents and dynamics: barriers and drivers - Building partnerships
Bibliography	- Europe's innovation ecosystem survey report. European Commission, Directorate-General for Research and Innovation, Kapfinger, K., Kurucki, N., Sevdalis, P., et al., Europe's innovation ecosystem survey report, Publications Office, 2021, https://data.europa.eu/doi/10.2777/387423 - Mark Lutz . Learning Python. 0'Reilly. 2013 Horizon EuropeEng agement Toolkit. Learning and teaching resources for educators and independent learners. https://unite4horizon.eu/wp-content/uploads/2023/01/UNITE4H-final-toolkit-separate-modules.pdf - Case Study Collection. https://unite4horizon.eu/cases/
Expected effect	The session aims to introduce participants to the innovation ecosystem and its role in bringing laboratory results to the market. In addition to discussing the concept of an innovation ecosystem and its importance, the session will also focus on

	robotics as a key area of innovation.

Name of activity	Intelligent Robotics for Healthcare
Number of working hours	1.5h
Type of activity	Lecture
Lecturer	Ignacio Montesino
Short summary of content	Application of robotic technologies to assist clinicians: serious games and robots for diagnosis and rehabilitation. The objective is to provide a realistic and updated view of the current capabilities of medical robotics in the clinical setting, especially in upper limb rehabilitation applications. Both non-contact, Serious Play-based, system-assisted rehabilitation techniques and those using intrinsically safe robots (cobots) to promote upper extremity mobilization will be covered. It will review sensor technologies, both external and wearable, used to monitor the patient's performance when interacting with a collaborative robot.
Bibliography	- Rehabilitation robotics, Robert Riener author. 2013. Hanover, Massachusetts : Now Publishers 2013 ISBN 1-60198-741-2; ISBN 1-60198-740-4 - Rehabilitation Robotics: Technology and Application, 2018. Roberto Colombo, Vittorio Sanguineti Saint Louis: Elsevier Science 2018 ISBN: 9780128119969 ISBN: 0128119969 - RehabWeek 2022: Home rehabweek.org
Expected effect	The attendee will be able to understand nowadays capabilities of medical robotics in the clinical setting and to distinguish videos of false applications published online and to discuss the expectations and future of robotic medical care.

Name of activity	Healthcare Robotics lab
Number of working hours	2h
Type of activity	Laboratory Work
Lecturer	Ignacio Montesino
Short summary of content	A visit to UC3M Assistive Robotics Lab to get to know the latest technologies being developed to help patients with neuromuscular pathologies. In this visit the students will interact with the following demos and procedures: Cobot physiotherapy: - Single arm and and double arm guided forces - Viscous resistive exercises - Virtual immersed robot therapy - Teleoperation VR Serious Games: - Gestures: arcade games controlled with hand gestures - VR-BBT: standard assessment of gross dexterity in patients - Fruits: reach testing and hand opening and closing training - Cloth-spin: fine motor dexterity Sensoring: - Pose detection for compensating motions - Force sensing in exercises
Bibliography	-
Expected effect	The attendees will have hands-on experience of what is possible in the field of robotic rehabilitation. They will see first hand the application of the concepts shown in class.

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Name of activity	Social Robotics lab
Number of working hours	2h
Type of activity	Laboratory Work
Lecturer	Enrique Fernández Rodicio, Marcos Maroto Gómez
Short summary of content	The objective of this session is to learn about how to build robots dedicated to social assistance and the design and programming of their principal software components. In this session, the students will address the following topics: - Designing and building social robots using state-of-the-art technology. - Learn the designing and programming methods used to obtain scalable and modular robotic architectures. - Autonomous social robots: decision-making. - Human-Robot interaction skills.
Bibliography	-
Expected effect	The attendees will be able to understand the principles of designing and building social robots and their software architectures. Besides, the students will learn about the potential of social robots in future society and the challenges it presents.

Pre-materials

Name	https://cyberbotics.com/
Topic/field	Webots (Cyberbotics)
Short description (optional)	Software necessary for the examination