COURSE SYLLABUS

SJK001 - Cyber-physical and Robotic Intelligent Systems

Academic year: 2024/2025

Degree: University Master's Degree in Intelligent Systems (2023 Programme of Study)

1. General information

Department: Department of Computer Languages and Systems
Area of knowledge: Computer Languages and Systems
Department: Department of Computer Science and Engineering
Area of knowledge: Computer Architecture and Technology
Department: Department of Computer Science and Engineering
Area of knowledge: Computer Science and Artificial Intelligence
Type: Compulsory
Semester: 1
Credits: 5
Language(s) of instruction: Please see the SIA
Main lecturer: Angel Pascual del Pobil Ferré
Please see the SIA for the list of lecturers who teach this subject.
Class schedule: See the guide of the web site

2. Introduction

This course covers the main techniques and principles of Robotic Intelligent Systems understood as Cyber-physical systems that behave in the real world. This intelligent behaviour includes goals such as adaptation to a complex environment, active perception to deal with a partially unknown environment, exploring for learning, etc.

3. Recommended background knowledge

Artificial Inteligence Foundations

4. Competences and learning outcomes

Generic and specific competences
CE03 - Integrate and manage a cyber-physical robotic system equipped with perception.

Learning outcomes
- Provide students with an overview of cyber-physical robotic systems: architecture, perception, planning, navigation and control.
- Be able to acquire the basic principles and practical skills necessary to design and implement a cyber-physical robotic system capable of exhibiting adequate and robust behaviour in a realistic environment.
- Be able to solve a real mobility problem of a robotic system in a semi-structured setting.

5. Contents

Cyber-physical systems, robotic systems, robotic intelligence, behavioural intelligence, sensory-motor coordination, biological inspiration, active perception, active learning, locomotion, manipulation, design principles for intelligent robotic systems. Mobile cyber-physical systems, perception, control and navigation architectures.

6. Units

1. Introduction to Cyber-physical and robotic systems

2. Introduction to robotic intelligence. Classical AI & The Hierarchical Paradigm

3. Biological foundations of intelligence

4. Behavior-based intelligence and the Reactive Paradigm

5. Active perception and learning

6. The Challenge of Manual Intelligence

7. Design principles of intelligent robotic systems

8. Mobile cyber-physical systems: perception, control and navigation architectures

7. Bibliography and additional resources

7.1. Basic bibliography

Stephen Marsland, Machine Learning. An Algorithmic Perspective 2nd edition, Chapman and Hall/CRC, 2014

Stuart J. Russell and Peter Norvig, Artificial Intelligence. A Modern Approach, Prentice Hall, Third Edition, New Jersey, 2010.

Rolf Pfeifer and Josh C. Bongard, How the Body Shapes the Way We Think. A New View of Intelligence, The MIT Press, 2006.

Robin R. Murphy, Introduction to AI Robotics, Second Edition, The MIT Press, 2019.

7.2. Additional bibliography

A.E. Eiben and J.E. Smith, Introduction to Evolutionary Computing, 2nd edition, Springer 2015.

Rolf Pfeifer and Christian Scheier, Understanding Intelligence, The MIT Press, 1999.

Brooks, R.A., Cambrian Intelligence - The Early History of the New AI, MIT Press, 1999.

Michael A. Arbib, The Handbook of Brain Theory & Neural Networks, The MIT Press, 2nd ed., 2003.

Ronald C. Arkin, Behavior-Based Robotics, The MIT Press, 1998.

George A. Bekey, Autonomous Robots - From Biological Inspiration to Implementation and Control, MIT Press, 2005

Cynthia L. Breazeal, Designing Sociable Robots, The MIT Press, 2004.

7.3. Websites

https://shanghailectures.org/

7.4. Other resources

8. Teaching methodology

Lectures, seminars, supervised assignments, autonomous assignments, laboratory work

9. Activity planning

Activities	Classroom hours	Non-classroom hours
Theory	20:00	0:00
Practice (laboratory)	10:00	0:00
Seminars	18:00	0:00
Assessment	2:00	0:00
Personal work	0:00	70:00
Exam preparation work	0:00	5:00
	50:00	**75:00**
Total hours (no. credits × 25).	125:00	

10. Learning assessment

10.1. Assessment type

Assessment type	Percentage of final mark
Continuous assessment	40
Projects	30
Reports and memoranda on practicals	20
Written exam (multiple choice, long answer and/or problems)	10
	100

10.2. Assessment criteria

To pass the course the student must submit all assigned work, and obtain a weighted average mark at the end of 50 out of 100. To qualify as presented, it is necessary to deliver at least one of the assignments. Students will have a second chance to pass every assignment in case of failure.

11. Other information

12. Specific software

13. Privacy and processing of personal data

Academic activities that involve the processing of data that can be linked to an identified or identifiable individual person shall be subject to the previsions set out in the General Data Protection Regulation EU 2016/679, of 27 April (GDPR) and the Spanish Organic Law 3/2018, of 5 December, on personal data protection and safeguarding digital rights (LOPDGDD) in addition to the specific legislation currently in force.

In general terms and in any of the physical and virtual teaching environments of the University, activities involving personal data processing, including recordings or online streaming, can only be carried out if they complywith current legislation, or resolutions and instructions that have been introduceddue to exceptional circumstances, and must be entered in the Official Record of Processing Activities (RPA) of the UJI.

Students shall not carry out any activities involving the use of resources not made available by the UJI, either on the Internet or online, which require them to provide their personal data or express consent. Only anonymous data may be used.

This anonymity must be ensured throughout all the phases of the processing. Only information that has been dissociated in such a way as to ensure that it cannot be linked to an identified or identifiable person will be complying with the regulations in force.

If, under circumstances of an exceptional nature that are duly justified by the person responsible for the activity, any data that can be linked to an identified or identifiable individual person were processed, the person responsible for the activity must enter it in the Official Record of Processing Activities (RPA) of the UJI and obtain authorisation from the General Secretary. Likewise, he or she shall draw up the information that is to be passed on to the users, apply the necessary security measures and provide the required information during auditing processes, while also taking any corrective steps, if advised to do so by these audits.

Office of the Vice-Rector for Studies and Lifelong Learning