Advanced industrial and service robotics

Academic Year: (2021 / 2022) **Review date: 30-06-2021**

Department assigned to the subject: Systems Engineering and Automation Department

Coordinating teacher: JARDON HUETE, ALBERTO

Type: Compulsory ECTS Credits : 3.0

Year : 1 Semester : 1

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Industrial robotics
Robot Operating Systems

OBJECTIVES

BASICS COMPETENCES

CB6 Possess and understand knowledge that provides a basis or opportunity to be original in the development and / or application of ideas, often in a research context

CB7 That students know how to apply the knowledge acquired and their ability to solve problems in new or unfamiliar environments within broader (or multidisciplinary) contexts related to their area of study

CB8 That students are able to integrate knowledge and face the complexity of making judgments based on information that, being incomplete or limited, includes reflections on social and ethical responsibilities linked to the application of their knowledge and judgments

CB9 That students know how to communicate their conclusions and the knowledge and ultimate reasons that sustain them to specialized and non-specialized audiences in a clear and unambiguous way

GENERALS COMPETENCES

CG1 Knowledge and understanding of the theoretical foundations of both industrial processes and services, and communications.

CG2 Ability to model, identify basic requirements and analyze various processes.

CG6 Capacity to adapt to changes in requirements associated with new products, new specifications and environments.

SPECIFIC COMPETENCES

CE1 Ability to design automatic process systems (production machinery, transport and storage systems and quality control) and the interconnection between their different modules (industrial protocols)

CE2 Ability to integrate and program the different industrial process control systems both from a hardware and software point of view

CE3 Ability to program and simulate robot control systems at high, intermediate and low levels

CE4 Ability to implement and simulate a system of intelligent and flexible control of processes and systems

LEARNING RESULTS

As a result of the learning, the student will be able to:

- Know the basics of automation of industrial systems and services (non-industrial): structure, industrial communications and systems control.
- Know the basics of collaborative robotics: structure, sensorization, control, programming, paths / outputs, multi- robot systems, industrial applications and services.
- Analyze and synthesize systems using advanced control: identification methods, fuzzy control, control with reference model, learning systems, control with neural networks, predictive control, etc.
- Use of simulation tools of production systems with continuous and discrete parts: lay-out, warehouses, transport, specific machines, delays, etc.
- Design an automated system of low and medium complexity with its cyber-physical components.

In fact thanks to this course:

The subject¿s goal is the acquisition of advanced new concepts of industrial robotics. The subject deals with the industrial robot from the integrated point of view, that is, not as an isolated machine but as a relevant part of a production system. In this way, the programming and control methods for the design of advanced applications are studied.
The student will acquire the necessary knowledge to understand the capabilities and limitations of various advanced applications with industrial robots, multi-robot systems and collaborative robots. The student will also learn to analyze and understand the resources necessary for the integration of robotic systems within an advanced production cell in the context of Industry 4.0.
Each part of the theoretical content of the subject is also developed in a practical way, analyzing the methods and concepts exposed through the study of robotic environments, review of programming methods and integration strategies of real industrial robots, and especially cobots.
At the end of the course, the student must have the ability to understand the technologies integrating the robotic applications that support the concept of Industry 4.0 for the functional design and the implementation of disruptive solutions.

DESCRIPTION OF CONTENTS: PROGRAMME

Common themes of the subjects:
- Automatization and control of processes, plants and factories
- Structures of industrial plants and services according to CI 4.0 model
- Systems engineering and process integration
- Process and plants simulation tools

Specific themes of this subject: Advanced industrial and service robotics:
1.- Introduction to Advanced Industrial Robotics
1.1 Review of the evolution of key technologies and their applications
1.2. Concept of collaborative robots or cobots.
2.- Sensorization of collaborative robots
2.1 Technologies and strategies for HRI
2.2 Advanced security concepts
2.3 Modes of interaction
3.- Control and programming of collaborative robots
3.1 Task control for advanced applications
3.2 Advanced methods of task control (force, vision)
3.3 Advanced programming of industrial robots
4.- Integration of advanced robots in the production and service processes
4.1 Applicable normative and regulations: AIR, collaborative robots
4.2 Ethical and legal issues of security, responsibility, privacy of the cobots.
4.3 Multi-robot systems

LEARNING ACTIVITIES AND METHODOLOGY

MD1 Teacher¿s lecture with support of computer and audiovisual media, in which the main concepts of the subject are developed, and the bibliography is provided to complement the students' learning.
MD2 Critical reading of texts recommended by the teacher of the subject: articles, reports, manuals and/or academic articles, either for further discussion in class, or to expand and consolidate the knowledge of the subject.
MD3 Resolution of practical cases, problems, lab session etc. raised by the teacher individually or in groups.
MD4 Exhibition and discussion in class of topics related to the content of the subject, as well as case studies.
MD5 Writing reports and memorandum individually or within a workgroup.

ASSESSMENT SYSTEM

Continuous evaluation (SE2):
Lab performance: 10%
Final work (in group): 50%
Final exam (SE3): 40%

% end-of-term-examination:	40
% of continuous assessment (assigments, laboratory, practicals…):	60

BASIC BIBLIOGRAPHY

- Editors: Bruno Siciliano Oussama Khatib. Springer Handbook of Robotics 2016, Springer. DOI.: 10.1007/978-3-319-32552-1. ISBN: 9783319325521 (online) 9783319325507 (print), 2016
- Mark W. Spong, Seth Hutchinson, M. Vidyasagar. Robot Modeling and Control., ISBN: 978-0-471-64990-8 , December 2005

ADDITIONAL BIBLIOGRAPHY

- Andreas Bauer. KUKA LBR IIWA, Kuka Roboter GmbH. , 2016.

- null Changeable Automation With The APAS family. , Robert Bosch GmbH. Stuttgart., 2015

- Davos-Klosters The World Economic Forum, Industrial Internet of Things: Unleashing the Potential of Connected Products and Services,, The World Economic Forum, January 2015
- European Comission. Digital Transformation Of European Industry And Enterprises. Report And Recommendations Of The Strategic Policy Forum on Digital Entrepreneurship., European Comission, 2015.

- Michael Rüßmann, Markus Lorenz, Philipp Gerbert, Manuela Waldner, Jan Justus, Pascal Engel, and Michael Harnisch Industry 4.0: The Future of Productivity and Growth in Manufacturing Industries, The Boston Consulting Group , 2015
- Michael, R. Markus, L. and et al. Industry 4.0: The Future of Productivity and Growth in Manufacturing Industries, Boston Consulting Group, 2015