| Teaching Guide | | | | |
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| Identifying Data | | | | 2022/23 |
| Subject (*) | Mobile Robotics | | Code | 770538020 |
| Study programme | Máster Universitario en Informática Industrial e Robótica | | | |
| Descriptors | | | | |
| Cycle | Period | Year | Type | Credits |
| Official Master's Degree | 2nd four-month period | First | Optional | 3 |
| Language | SpanishGalician | | | |
| Teaching method | Face-to-face | | | |
| Prerequisites | | | | |
| Department | Ciencias da Computación e Tecnoloxías da InformaciónEnxeñaría IndustrialEnxeñaría Naval e Industrial | | | |
| Coordinador | Bellas Bouza, Francisco Javier | E-mail | francisco.bellas@udc.es | |
| Lecturers | Bellas Bouza, Francisco Javier<br>Prieto Garcia, Abraham<br>Quintián Pardo, Héctor | E-mail | francisco.bellas@udc.es<br>abraham.prieto@udc.es<br>hector.quintian@udc.es | |
| Web | | | | |
| General description | The aim of the course is to provide a global vision of the problems to be dealt with and the existing solutions in the operation of mobile robots in industry, focusing on their autonomous operation. The course has a clearly practical focus, and the theoretical concepts will be worked on in a practical way through the programming of rolling robots, both real and simulated. | | | |

| Study programme competences / results | |
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| Code | Study programme competences / results |
| A1 | CE01 - Capacidad para aplicar técnicas de análisis de datos y técnicas inteligentes en robótica y/o informática industrial |
| A4 | CE04 - Capacidad para uso y desarrollo de código y librerías que permitan captar el entorno y actuar sobre él en sistemas robóticos y/o industriales |
| B2 | CB7 - Que los estudiantes sepan aplicar los conocimientos adquiridos y su capacidad de resolución de problemas en entornos nuevos o poco conocidos dentro de contextos más amplios (o multidisciplinares) relacionados con su área de estudio |
| B5 | CB10 - Que los estudiantes posean las habilidades de aprendizaje que les permitan continuar estudiando de un modo que habrá de ser en gran medida autodirigido o autónomo. |
| B9 | CG4 - Extraer, interpretar y procesar información, procedente de diferentes fuentes, para su empleo en el estudio y análisis |
| B10 | CG5 - Capacidad para proponer nuevas soluciones en proyectos, productos o servicios |
| B14 | CG9 - Aplicar conocimientos de ciencias y tecnologías avanzadas a la práctica profesional o investigadora |
| C1 | CT01 - Adquirir la terminología y nomenclatura científico-técnica para exponer argumentos y fundamentar conclusiones |
| C3 | CT03 - Aplicar una metodología que fomente el aprendizaje y el trabajo autónomo |

| Learning outcomes | | | |
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| Learning outcomes | Study programme competences / results | | |
| Ability to design, simulate and/or implement technological solutions involving the use of autonomous mobile robots in an industrial environment. | AC1<br>AC4 | BC2<br>BC5<br>BC9<br>BC10<br>BC14 | CC1<br>CC3 |
| Understanding the scope and limitations of current autonomous mobile robots in terms of their sensing and actuation capabilities. | AC1<br>AC4 | BC9<br>BC14 | CC1<br>CC3 |
| Understanding the fundamentals and main control techniques in autonomous robotics, and implement them practically on a mobile robot. | AC1<br>AC4 | BC9<br>BC14 | CC1<br>CC3 |

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| Understanding the particularities of using computer vision techniques in mobile robotics. | AC1<br>AC4 | BC9<br>BC14 | CC1<br>CC3 |
| Understanding the fundamentals of the main problems of mobile autonomous robotics: localization, mapping and path planning, as well as a practical implementation of some of the main existing techniques. | AC1<br>AC4 | BC9<br>BC14 | CC1<br>CC3 |

| Contents | |
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| **Topic** | **Sub-topic** |
| Introduction to mobile robotics | Locomotion:<br>- Motors<br>- Degrees of freedom<br>- Legs<br>- Wheels<br>- Other effectors |
| Perception in mobile robotics | - Types of sensors<br>- Sensors in mobile robotics<br>-- Contact<br>-- Distance<br>-- Computer vision<br>-- IMU<br>-- GPS<br><br>- Control architectures<br>-- Deliberative<br>-- Reactive<br>-- Hybrid<br>-- Communications |
| Movement control | - Position control system |
| Localization and mapping | - Navigation:<br>-- Topological<br>-- Metric<br>- Simultaneous localisation and mapping<br>-- Localisation (odometry, beacons)<br>-- Visual SLAM |
| Trajectory planning | - Graph search<br>- Wavefront-based planning |

| Planning | | | | |
|---|---|---|---|---|
| **Methodologies / tests** | **Competencies / Results** | **Teaching hours (in-person & virtual)** | **Student?s personal work hours** | **Total hours** |
| Guest lecture / keynote speech | B5 B9 C1 C3 | 10.5 | 4.5 | 15 |
| ICT practicals | B2 B5 B9 B10 B14 C1 C3 | 10 | 10 | 20 |
| Oral presentation | A1 A4 B9 B10 B14 | 0.5 | 6.5 | 7 |
| Supervised projects | A1 A4 B2 B10 B14 C1 C3 | 0 | 30 | 30 |
| Personalized attention | | 3 | 0 | 3 |
| **(*)The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.** | | | | |

| Methodologies | |
|---|---|
| **Methodologies** | **Description** |

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| Guest lecture / keynote speech | Oral presentation of the theoretical syllabus by the teachers of the course. |
| ICT practicals | Face-to-face sessions with the computer in which teachers will explain the use and programming of the mobile robotics techniques seen in theory, so that students acquire sufficient skills to use them autonomously. Real and/or simulated robots will be used. |
| Oral presentation | Theory paper(s) on a topic proposed by the teachers of the course, which must be presented in front of classmates and also handed in in writing. |
| Supervised projects | Carrying out work/projects outside the classroom in which different programmes related to the topics seen in practical classes will be implemented through ICT, using real or simulated robots selected by the subject teachers. These projects will be carried out autonomously by the students and their progress will be supervised by the lecturers. |

| Personalized attention | |
|---|---|
| **Methodologies** | **Description** |
| Supervised projects<br>ICT practicals | During the practical work through ICT, the student will be able to consult the teacher about all the doubts that may arise regarding the programming of the robots.<br><br>Tutored work: we recommend the use of personalised attention in these activities to resolve conceptual or procedural doubts that may arise during the resolution of practical problems. In addition, personalised attention will also focus on the student's explanation of the proposed solution.<br><br>Oral presentation: students will have to go to the teachers to resolve any doubts they may have about the preparation of the work to be presented, both in terms of the content and the presentation itself.<br><br>Students enrolled part-time will have an online personalised communication channel in all the methodologies. |

| Assessment | | | |
|---|---|---|---|
| **Methodologies** | **Competencies / Results** | **Description** | **Qualification** |
| Supervised projects | A1 A4 B2 B10 B14 C1 C3 | Several practical tasks will be proposed throughout the course focused on solving mobile robotics problems using real or simulated robots. These tasks will be developed autonomously by the student outside the classroom and must be defended in front of the lecturers. | 70 |
| Oral presentation | A1 A4 B9 B10 B14 | The oral presentation of the theoretical work/works, the written version of the same and the active participation in the presentations of the classmates have an important weight in the final grade of the course. | 30 |

| Assessment comments |
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| In order to obtain a pass in this subject, a minimum score of 50 must be passed by adding all the above methodologies, there being no minimum in any of them. If the student does not pass the subject in the ordinary exam, he/she will have to repeat the necessary activities of the methodology/s that were not passed in the extraordinary exam. As an example, if a student passed the Oral Presentation part but failed the Supervised Assignments, he/she will have to repeat the practical assignments necessary to achieve a pass, normally those that were not passed individually.<br>Assessment of the early sitting (December): students who opt for this sitting will have to repeat the tutored work and oral presentation methodologies. It is necessary to contact the lecturers at the beginning of the term in order to establish appropriate deadlines.<br>Students enrolled part-time, in the event of not being able to make the oral presentation with the rest of the students nor in person neither online, an alternative date must be arranged with the teachers. This modification must be requested to the teachers of the subject at the beginning of the course.<br>The fraudulent realisation of tests or activities, once verified, will directly imply the qualification of failing "0" in the subject in the corresponding call, thus invalidating any qualification obtained in all the assessment activities for the extraordinary call. |

| Sources of information | |
|---|---|
| Basic | - Kelly, Alonzo (2013). Mobile robotics: mathematics, models and methods. Cambridge University Press<br>- Nehmzow, Ulrich (2003). Mobile robotics a practical introduction. Springer<br>- ? Siegwart, Roland (2004). Introduction to autonomous mobile robots. MIT Press |
| Complementary | - Joseph, Lentin (2015). Learning robotics using Python : design, simulate, program, and prototype an interactive autonomous mobile robot from scratch with the help of Python, ROS, and Open-CV. Packt Publishing<br>- Robin R. Murphy (2000). Introduction to AI Robotics. A Bradford Book<br>- Lynch, Kevin (2017). Modern robotics : mechanics, planning, and control. Cambridge University Press |

| Recommendations |
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| Subjects that it is recommended to have taken before |
| Autonomous Robotics Applications/770538015<br>Machine Vision I/770538018<br>Introduction to Python for Engineers/770538011<br>Smart Robotics and Autonomous Systems/770538005 |
| Subjects that are recommended to be taken simultaneously |
| Introduction to Python for Engineers/770538011<br>Machine Learning I/770538016 |
| Subjects that continue the syllabus |
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| Other comments |
| The documents to be deliver in this subject:- Virtual format or digital support will be requested.- They'll be done on the Virtual Campus without printing them.In case they?re done in paper:- Don't use plastics.- Use double-sided printing.- Use recycled paper.- Avoid printing drafts. |