



## Teaching Guide

| Teaching Guide           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |        |                            |           |
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| Identifying Data         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |        |                            | 2020/21   |
| Subject (*)              | Machine Vision for Industrial Applications                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |        | Code                       | 730497239 |
| Study programme          | Mestrado Universitario en Enxeñaría Industrial (plan 2018)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |        |                            |           |
| Descriptors              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |        |                            |           |
| Cycle                    | Period                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Year   | Type                       | Credits   |
| Official Master's Degree | 2nd four-month period                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Second | Optional                   | 3         |
| Language                 | SpanishGalician                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |        |                            |           |
| Teaching method          | Hybrid                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |        |                            |           |
| Prerequisites            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |        |                            |           |
| Department               | Ciencias da Computación e Tecnoloxías da Información                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |        |                            |           |
| Coordinador              | Paz López, Alejandro                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | E-mail | alejandro.paz.lopez@udc.es |           |
| Lecturers                | Mallo Casdelo, Alma María                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | E-mail | alma.mallo@udc.es          |           |
|                          | Paz López, Alejandro                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |        | alejandro.paz.lopez@udc.es |           |
| Web                      | moodle.udc.es                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |        |                            |           |
| General description      | Esta asignatura ten como obxectivo formar aos estudantes nos conceptos e aspectos prácticos fundamentais da visión artificial (ou visión por computador) no ámbito industrial. A formación está enfocada a dotar aos alumnos dos conceptos introductorios necesarios que lles permitan identificar e analizar problemas potencialmente resolubles con técnicas de visión artificial, como poden ser a inspección ou control de calidade automatizadas de produtos. Ademais, o apartado práctico da asignatura permitirá que os alumnos poidan levar á práctica exemplos de aplicación dalgúns dos conceptos introducidos na parte teórica. |        |                            |           |
| Contingency plan         | 1. Modifications to the contents<br><br>2. Methodologies<br>*Teaching methodologies that are maintained<br><br>*Teaching methodologies that are modified<br><br>3. Mechanisms for personalized attention to students<br><br>4. Modifications in the evaluation<br><br>*Evaluation observations:<br><br>5. Modifications to the bibliography or webgraphy                                                                                                                                                                                                                                                                                   |        |                            |           |

## Study programme competences

| Code | Study programme competences                                                                                                                                                                                                                                                         |
|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| A8   | ETI8 - Ability to design and project automated production systems and advanced process control.                                                                                                                                                                                     |
| B1   | 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.                                                                                                           |
| B2   | 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.                                                                 |
| B3   | 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 the social and ethical responsibilities linked to the application of their knowledge and judgments. |
| B4   | CB9 - That the 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.                                                                           |
| B5   | CB10 - That students have the learning skills that allow them to continue studying in a way that will be largely self-directed or autonomous.                                                                                                                                       |



|     |                                                                                                                                                                                                                                                                 |
|-----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| B6  | G1 - Have adequate knowledge of the scientific and technological aspects in Industrial Engineering.                                                                                                                                                             |
| B13 | G8 - Apply the knowledge acquired and solve problems in new or unfamiliar environments within broader and multidisciplinary contexts.                                                                                                                           |
| B14 | G9 - Be 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. |
| B15 | G10 - Knowing how to communicate the conclusions -and the knowledge and ultimate reasons that sustain them- to specialized and non-specialized publics in a clear and unambiguous way.                                                                          |
| B16 | G11 - Possess the learning skills that allow to continue studying in a self-directed or autonomous way.                                                                                                                                                         |
| C1  | ABET (a) - An ability to apply knowledge of mathematics, science, and engineering.                                                                                                                                                                              |
| C3  | ABET (c) - An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.                       |
| C6  | ABET (f) - An understanding of professional and ethical responsibility.                                                                                                                                                                                         |
| C7  | ABET (g) - An ability to communicate effectively.                                                                                                                                                                                                               |
| C8  | ABET (h) - The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.                                                                                                          |
| C9  | ABET (i) - A recognition of the need for, and an ability to engage in life-long learning.                                                                                                                                                                       |
| C11 | ABET (k) - An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.                                                                                                                                           |

| Learning outcomes                                                                                                                     |  |                             |                                                                                                           |
|---------------------------------------------------------------------------------------------------------------------------------------|--|-----------------------------|-----------------------------------------------------------------------------------------------------------|
| Learning outcomes                                                                                                                     |  | Study programme competences |                                                                                                           |
| Coñecer os procedementos de adquisición de imaxes digitais e as súas particularidades na contorna industrial.                         |  |                             | BJ1<br>BJ3<br>BJ4<br>BJ5<br>BJ6<br>BJ13<br>BJ14<br>BJ15<br>BJ16<br>CJ1<br>CJ3<br>CJ6<br>CJ7<br>CJ8<br>CJ9 |
| Coñecer as principais técnicas de acondicionamento de imaxes e iniciarse no seu uso práctico.                                         |  | AJ8                         | BJ1<br>BJ2<br>BJ5<br>BJ16<br>CJ1<br>CJ9<br>CJ11                                                           |
| Coñecer as principais técnicas de procesado de imaxes digitais e iniciarse no seu uso práctico.                                       |  | AJ8                         | BJ1<br>BJ2<br>BJ5<br>BJ16<br>CJ1<br>CJ9<br>CJ11                                                           |
| Adquirir os coñecementos básicos sobre os procesos de análises de imaxe máis utilizados na industria e iniciarse no seu uso práctico. |  | AJ8                         | BJ1<br>BJ2<br>BJ5<br>BJ16<br>CJ1<br>CJ9<br>CJ11                                                           |

| Contents                                                                |                                                                                                                                                                                                                        |
|-------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Topic                                                                   | Sub-topic                                                                                                                                                                                                              |
| Introducción á visión artificial.                                       | <ul style="list-style-type: none"> <li>- Conceptos básicos.</li> <li>- Aplicacións de visión artificial na industria.</li> <li>- Adquisición e representación de imaxes.</li> <li>- Propiedades das imaxes.</li> </ul> |
| Compoñentes dun sistema de visión artificial para entornos industriais. | - Compoñentes dun sistema de visión artificial para entornos industriais.                                                                                                                                              |



|                                                                                  |                                                                                                                                                                                                        |
|----------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Deseño de sistemas de visión artificial para tarefas de inspección automatizada. | - Deseño de sistemas de visión artificial para tarefas de inspección automatizada.                                                                                                                     |
| Análise de imaxe.                                                                | - Introducción as técnicas comúns de análise de imaxe utilizadas en aplicacións de automatización industrial.<br>- Filtrado de imaxes.<br>- Binarización.<br>- Análise morfolóxico.<br>- Segmentación. |
| Outras ferramentas.                                                              | - Cámaras intelixentes.<br>- Deep Learning.                                                                                                                                                            |

| Planning                                                                                                                        |                                                     |                      |                               |             |
|---------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------|----------------------|-------------------------------|-------------|
| Methodologies / tests                                                                                                           | Competencies                                        | Ordinary class hours | Student?s personal work hours | Total hours |
| Guest lecture / keynote speech                                                                                                  | A8 B1 B2 B4 B5 B13<br>B15 B14 B16 B6 C3<br>C6 C8 C9 | 7                    | 15.5                          | 22.5        |
| ICT practicals                                                                                                                  | B1 B4 B13 B16 C1<br>C9 C11                          | 14                   | 33.5                          | 47.5        |
| Supervised projects                                                                                                             | B3 B13 B15 B16 B6<br>C1 C3 C7 C9 C11                | 1.5                  | 3.5                           | 5           |
| Personalized attention                                                                                                          |                                                     | 0                    | 0                             | 0           |
| (*)The information in the planning table is for guidance only and does not take into account the heterogeneity of the students. |                                                     |                      |                               |             |

| Methodologies                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|--------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Methodologies                  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Guest lecture / keynote speech | Actividade presencial na aula ou a través de TICs para a explicación oral do temario teórico fomentando a discusión e a participación dos alumnos.                                                                                                                                                                                                                                                                                                                                                                                                      |
| ICT practicals                 | Actividade presencial na aula ou a través de TICs para realización de prácticas nas que se aplicarán algunhas das técnicas e estratexias vistas en teoría. Os alumnos completarán as propostas de traballos planteadas polos profesores. Estas prácticas poderán estar relacionadas coa aplicación práctica de técnicas de procesamento de imaxes, o análise da solución adecuada a un problema industrial que pode resolverse con visión artificial, ou a selección e configuración de elementos hardware-software para un sistema de visión concreto. |
| Supervised projects            | Traballo/s de profundización práctica sobre algún tema de teoría proposto polos profesores da asignatura. Os alumnos realizarán un traballo de estudo e deseño dalgúns dos aspectos relevantes dunha solución de visión artificial para algún caso realista proposto polos profesores. O traballo será exposto e discutido diante dos compañeiros e entregado por escrito. O traballo será realizado polos alumnos de forma autónoma e o seu avance será tutorizado polos profesores.                                                                   |

| Personalized attention                |                                                                                                                                                                                                                                                                                                                                                                                                      |
|---------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Methodologies                         | Description                                                                                                                                                                                                                                                                                                                                                                                          |
| Supervised projects<br>ICT practicals | Prácticas a través de TIC: Para a realización das prácticas, o alumno poderá consultar co profesor todas as dúbidas que lle xurdan sobre a realización dos traballos.<br><br>Traballos tutelados: é recomendable o uso da atención personalizada nestas actividades para resolver dúbidas, para discutir e orientar o traballo co profesor, e para ter un seguimento do correcto avance do traballo. |

| Assessment    |              |             |               |
|---------------|--------------|-------------|---------------|
| Methodologies | Competencies | Description | Qualification |



|                     |                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                       |    |
|---------------------|--------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| Supervised projects | B3 B13 B15 B16 B6<br>C1 C3 C7 C9 C11 | Propoñeráse un traballo tutelado que deberá ser desenvolvido de forma autónoma polo alumno fóra das clases e que terá que ser presentado e defendido. É imprescindible obter unha cualificación mínima de 3 puntos sobre 10 nesta metodoloxía para superar a asignatura.                                                                                                                                                              | 50 |
| ICT practicals      | B1 B4 B13 B16 C1<br>C9 C11           | Propoñeráse un ou varios traballos prácticos de aplicación de técnicas concretas de visión artificial ao longo do curso que serán desenvolvidos polos alumnos e entregados para a súa avaliación. É imprescindible obter unha cualificación mínima de 3 sobre 10 nesta metodoloxía para superar a asignatura.<br><br>Poderase valorar positivamente a asistencia e participación activa nas clases ata un máximo de 1 punto sobre 10. | 50 |

## Assessment comments

## Sources of information

|                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|----------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Basic</b>         | <ul style="list-style-type: none"> <li>- Sandipan Dey (2018). Hands-On Image Processing with Python. Packt Publishing</li> <li>- Gonzalo Pajares, Arturo de la Escalera, Enrique Alegre (2016). Conceptos y métodos en visión por computador. Comité Español de Automática</li> <li>- Eusebio de la Fuente López, Félix Miguel Trespaderne (2012). Visión artificial industrial. Procesamiento de imágenes para inspección automática y robótica.. Universidad de Valladolid</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Complementary</b> | <ul style="list-style-type: none"> <li>- Richard Szeliski (2010). Computer Vision: Algorithms and Applications. Springer</li> </ul> <p>Libros accesibles de forma libre a través do proxecto CVONLINE (<a href="http://homepages.inf.ed.ac.uk/rbf/CVonline/SUPPORT/overview.htm">http://homepages.inf.ed.ac.uk/rbf/CVonline/SUPPORT/overview.htm</a>). Os libros están dispoñibles na seguinte páxina web: <a href="http://homepages.inf.ed.ac.uk/rbf/CVonline/books.htm">http://homepages.inf.ed.ac.uk/rbf/CVonline/books.htm</a> Richard Szeliski, "Computer Vision: Algorithms and Applications" - <a href="http://szeliski.org/Book/Dana%20Ballard%20and%20Chris%20Brown,%20Computer%20Vision">http://szeliski.org/Book/Dana Ballard and Chris Brown, "Computer Vision"</a> - <a href="http://homepages.inf.ed.ac.uk/rbf/BOOKS/BANDB/bandb.htm">http://homepages.inf.ed.ac.uk/rbf/BOOKS/BANDB/bandb.htm</a> Documentación da librería Scikit-Image <a href="https://scikit-image.org/Documentación%20da%20librería%20OpenCV">https://scikit-image.org/Documentación da librería OpenCV</a> <a href="https://docs.opencv.org/master/Versión%20borrador%20online%20gratuita%20do%20libro%20Computer%20Vision%3A%20Algorithms%20and%20Applications">https://docs.opencv.org/master/Versión borrador online gratuita do libro "Computer Vision: Algorithms and Applications":</a> <a href="http://szeliski.org/Book/Versión%20borrador%20online%20gratuita%20do%20libro%20Conceptos%20y%20métodos%20en%20visión%20por%20Computador">http://szeliski.org/Book/Versión borrador online gratuita do libro "Conceptos y métodos en visión por Computador":</a> <a href="https://intranet.ceautomatica.es/sites/default/files/upload/8/files/ConceptosyMetodosenVxC.pdf">https://intranet.ceautomatica.es/sites/default/files/upload/8/files/ConceptosyMetodosenVxC.pdf</a></p> |

## Recommendations

### Subjects that it is recommended to have taken before

### Subjects that are recommended to be taken simultaneously

### Subjects that continue the syllabus

## Other comments

A entrega dos traballos documentais que se realicen nesta materia: Solicitarase en formato virtual e/ou soporte informático. Realizarase a través de Moodle, en formato dixital sen necesidade de imprimilos. De se realizar en papel: Non se empregarán plásticos. Realizaranse impresións a dobre cara. &nbsp;Empregarase papel reciclado. Evitarase a impresión de borradores.

(\*)The teaching guide is the document in which the URV publishes the information about all its courses. It is a public document and cannot be modified. Only in exceptional cases can it be revised by the competent agent or duly revised so that it is in line with current legislation.