



Escola de Enxeñaría de Telecomunicación

(*)Páxina web

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www.teleco.uvigo.es

(*)Presentación

The School of Telecommunication Engineering (EET) is a higher education school of the University of Vigo that offers Bachelor's degrees, Master's degrees and Doctoral programs in the fields of Telecommunications Engineering.

Bachelor's Degree in Telecommunication Technologies Engineering (EUR-ACE®).

The main goal of the Bachelor's Degree in Telecommunication Technologies Engineering is to form professionals at the forefront of technological knowledge and professional competences in telecommunication engineering. This Bachelor has been recognized with the best quality seals, like the EUR-ACE's. **It has a bilingual option: up to 80% of the degree credits can be taken in English.**

http://teleco.uvigo.es/images/stories/documentos/gett/degree_telecom.pdf

www: <http://teleco.uvigo.es/index.php/es/estudios/gett>

Master in Telecommunication Engineering

The Master in Telecommunication Engineering is a Master's degree that qualifies to exercise the profession of Telecommunication Engineer, in virtue of the established in the Order CIN/355/2009 of 9 of February.

http://teleco.uvigo.es/images/stories/documentos/met/master_telecom_rev.pdf

www: <http://teleco.uvigo.es/index.php/es/estudios/mit>

Interuniversity Masters

The current academic offer includes interuniversity master's degrees that are closely related to the business sector:

Master in Cybersecurity: www: <https://www.munics.es/>

Master in Industrial Mathematics: www: <http://m2i.es>

International Master in Computer Vision: www: <https://www.imcv.eu/>

(*)Equipo directivo

MANAGEMENT TEAM

Directora: Rebeca Pilar Díaz Redondo (teleco.direccion@uvigo.gal)

Secretaría e Subdirección de Novas Titulacións: Pedro Rodríguez Hernández

(teleco.subdir.secretaria@uvigo.gal;teleco.subdir.novastitulacions@uvigo.gal)

Subdirección de Organización Académica: Pedro Comesaña Alfaro (teleco.subdir.academica@uvigo.gal)

Subdirección de Relaciones Internacionais e Subdirección de Infraestructuras: María Verónica Santalla del Río (teleco.subdir.internacional@uvigo.gal; teleco.subdir.infraestructuras@uvigo.gal)

Subdirección Difusión e Captación: Laura Docio Fernández (teleco.subdir.captacion@uvigo.gal)

Subdirección de Calidade: Ana María Cao Paz(teleco.subdir.calidade@uvigo.gal)

BACHELOR'S DEGREE IN TELECOMMUNICATION TECHNOLOGIES ENGINEERING

Generalcoordinator: Lucía Costas Pérez (teleco.grao@uvigo.gal)

<https://teleco.uvigo.es/es/documentos/acordos-es/comisions-academicas-es/miembros-de-la-comision-academica-del-gett/>

MASTER IN TELECOMMUNICATION ENGINEERING

Generalcoordinator: Manuel García Sánchez (teleco.master@uvigo.gal)

<https://teleco.uvigo.es/es/documentos/acordos-es/comisions-academicas-es/miembros-de-la-comision-academica-del-met/>

MASTER IN CYBERSECURITY

General coordinator: Ana Fernández Vilas (teleco.munics@uvigo.gal)

<https://teleco.uvigo.es/es/documentos/acordos-es/comisions-academicas-es/miembros-de-la-comision-academica-del-munics/>

MASTER IN INDUSTRIAL MATHEMATICS

Generalcoordinator: Elena Vázquez Cendón (USC)

UVigo coordinator: José Durany Castrillo (durany@dma.uvigo.es)

<http://www.m2i.es/?seccion=coordinacion>

INTERNATIONAL MASTER IN COMPUTER VISION

General coordinator: Xose Manuel Pardo López (USC)

UVigo coordinator: José Luis Alba Castro (jalba@gts.uvigo.es)

<https://www.imcv.eu/legal-notice/>

MASTER'S DEGREE IN QUANTUM INFORMATION SCIENCE AND TECHNOLOGIES (MQIST)

General coordinator: Javier Mas (USC)

Coordinador UVIGO: Manuel Fernández Veiga(teleco.mqist@uvigo.es)

<https://quantummastergalicia.es/info>

Máster Universitario en Visión por Computador

Subjects

Year 1st

Code	Name	Quadmester	Total Cr.
V05M185V01101	Fundamentals of image analysis and processing	1st	6
V05M185V01102	Image description and modeling	1st	6
V05M185V01103	Fundamentals of machine learning for computer vision	1st	6

V05M185V01104	Instrumentation and processing for machine vision	1st	6
V05M185V01105	Instrumentation and processing for biomedical applications	1st	6
V05M185V01201	Advanced image processing and analysis	2nd	6
V05M185V01202	Three-dimensional modeling and recognition	2nd	3
V05M185V01203	Visual recognition	2nd	6
V05M185V01204	Human action recognition	2nd	3
V05M185V01205	Advanced machine learning for computer vision	2nd	6
V05M185V01206	Photogrametrics and robot vision	2nd	6
V05M185V01207	Real time machine vision	2nd	3
V05M185V01208	Biomedical image analysis	2nd	6
V05M185V01209	Biometrics	2nd	3
V05M185V01210	External practices	2nd	3

IDENTIFYING DATA				
Fundamentals of image analysis and processing				
Subject	Fundamentals of image analysis and processing			
Code	V05M185V01101			
Study programme	Máster Universitario en Visión por Computador			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	1st	1st
Teaching language	English			
Department				
Coordinator				
Lecturers				
E-mail				
Web	http://guiadocente.udc.es/guia_docent/index.php?centre=614&ensenyament=614535&assignatura=614535001&any_academic=2020_21&idioma=eng&any_academic=2020_21			
General description	This course deals with the fundamental issues of image processing and analysis and is presented as the first part of another course that introduces more advanced topics. In addition to the study and application of fundamental techniques, practical applications of these techniques to solve real problems are studied. This subject provides the tools needed to apply the algorithms used in practical cases, as well as the basis for developing new algorithms and continuing with more advanced methods.			

Training and Learning Results
Code

Expected results from this subject	
Expected results from this subject	Training and Learning Results

Contents
Topic

Planning			
	Class hours	Hours outside the classroom	Total hours
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies
Description

Personalized assistance

Assessment		
Description	Qualification	Training and Learning Results

Other comments on the Evaluation

Sources of information
Basic Bibliography
Complementary Bibliography

Recommendations

IDENTIFYING DATA				
Image description and modeling				
Subject	Image description and modeling			
Code	V05M185V01102			
Study programme	Máster Universitario en Visión por Computador			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	1st	1st
Teaching language	English			
Department				
Coordinator	Fernández Álvarez, Antonio			
Lecturers	Fernández Álvarez, Antonio			
E-mail	antfdez@uvigo.gal			
Web	http://guiadocente.udc.es/guia_docent/index.php?centre=614&ensenyament=614535&assignatura=614535004&any_academic=2020_21&idioma=cast&any_academic=2020_21			
General description	The aim of this course is to become familiar with the fundamental characteristics of the digital image and its forms of representation, the description of visual content through local features of colour, shape and texture, and the practical application of these concepts to problems of image processing and analysis.			

Training and Learning Results

Code	
A1	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
A2	CB7 Students should be able to apply their acquired knowledge and problem-solving skills in new or unfamiliar environments within broader (or multidisciplinary) contexts related to their area of study
B1	Capacity for analysis and synthesis of knowledge
B3	Ability to develop computer vision systems depending on the existent needs and apply the most suitable technological tools
C1	To know and apply the concepts, methodologies and technologies of image processing
D1	To practice the profession with a clear awareness of its human, economic, legal and ethical dimensions and with a clear commitment to quality and continuous improvement
D2	Capacity for teamwork, organization and planning

Expected results from this subject

Expected results from this subject	Training and Learning Results
To know the fundamental characteristics of digital image and its forms of representation	A1 A2 B1 B3 C1 D1 D2
Description of visual content through local characteristics of colour, shape and texture	A1 A2 B1 B3 C1 D1 D2
To apply image modelling and representation techniques to image processing and analysis problems	A1 A2 B1 B3 C1 D1 D2

Contents

Topic	
Image representation and modeling	Space-frequency, orientation and phase, space-scale
Wavelets and filter banks	- Wavelets - Filter banks

Image coding and reconstruction	- Coding - Reconstruction
Image descriptors	- Colour - Shape - Texture
Applications	- Image modelling applications - Image description applications

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	10	20	30
Case studies	4	16	20
Laboratory practical	16	32	48
Project based learning	10	40	50
Objective questions exam	2	0	2

*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.

Methodologies

	Description
Lecturing	Participatory lessons with the aim of learning the theoretical content of the subject
Case studies	Elaboration and presentation of selected state-of-the-art methodologies related to the subject
Laboratory practical	Analysis and resolution of practical cases with the aim of strengthening the practical application of the theoretical content. Practice in computer classrooms, learning based on the resolution of practical cases, autonomous work and independent study of the students, and group work and cooperative learning.
Project based learning	Learning based on the resolution of practical cases, autonomous work and independent study of the students, and group work and cooperative learning.

Personalized assistance

Methodologies	Description
Case studies	Individualized advice during case studies
Laboratory practical	Resolution of doubts during laboratory practices
Project based learning	Individualized advice during research projects

Assessment

	Description	Qualification	Training and Learning Results			
Case studies	Elaboration and presentation of works on selected state-of-the-art methodologies	15	A1 A2	B1 B3	C1	D1 D2
Laboratory practical	Analysis and resolution of practical cases with the aim of strengthening the practical application of theoretical content	40	A1 A2	B1 B3	C1	D1 D2
Project based learning	Resolution of practical cases of application of the subject through autonomous work of the student, and using the techniques learned during the course	20	A1 A2	B1 B3	C1	D1 D2
Objective questions exam	Continuous self-evaluation tests during the course. Evaluation by examination at the end of the course as an alternative.	25	A1 A2	B1 B3	C1	D1 D2

Other comments on the Evaluation

The evaluation corresponding to the objective test may be passed by means of the tests scheduled during the course or by means of the final exam.

Sources of information

Basic Bibliography

Bovik, Alan, **The essential guide to image processing**, 1, Elsevier, 2009

Bovik, Alan, **Handbook of image and video processing**, 2, Elsevier, 2005

Mallat, Stephane, **A wavelet tour of signal processing: The sparse way**, 3, Elsevier, 2009

Nixon, Mark S.; Aguado, Alberto S., **Feature extraction and image processing for computer vision**, 3, Elsevier, 2012

Sonka, M.; Hlavac, V.; Boyle, R., **Image Processing, Analysis, and Machine Vision**, 3, Thomson Learning, 2009

Forsyth, David A.; Ponce, Jean, **Computer Vision: A Modern Approach**, 2, Pearson, 2012

Szeliski, Richard, **Computer Vision: Algorithms and Applications**, 1, Springer, 2010

Petrou, Maria; García-Sevilla, Pedro, **Image processing: Dealing with texture**, 1, Wiley, 2006

9. Mirmehdi, M.; Xie, X.; Suri, J., **Handbook of texture analysis**, 1, Imperial College Press, 2008

Complementary Bibliography

Recommendations

Subjects that are recommended to be taken simultaneously

Fundamentals of machine learning for computer vision/V05M185V01103

Fundamentals of image analysis and processing/V05M185V01101

IDENTIFYING DATA				
Fundamentos de aprendizaxe automática para visión por computador				
Subject	Fundamentos de aprendizaxe automática para visión por computador			
Code	V05M185V01103			
Study programme	Máster Universitario en Visión por computador			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	1	1c
Teaching language	Inglés			
Department				
Coordinator				
Lecturers				
E-mail				
Web	http://www.usc.gal/gl/centros/etse/materia.html?materia=144504			
General description	O obxectivo do curso é presentar ó alumnado algúns dos temas mais relevantes da aprendizaxe automática, facendo fincapé na teoría, exemplos prácticos e proxectos reais aplicados a visión por computador. Cada exercicio tratará de reforzar algún concepto explicado nas clases expositivas.			

Resultados de Formación e Aprendizaxe

Code	
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Resultados previstos na materia

Expected results from this subject	Training and Learning Results
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Contidos

Topic	
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Planificación

	Class hours	Hours outside the classroom	Total hours
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*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.

Metodoloxía docente

Description	
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Atención personalizada

Avaliación

Description	Qualification	Training and Learning Results
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Other comments on the Evaluation

Bibliografía. Fontes de información

Basic Bibliography

Complementary Bibliography

Recomendacións

IDENTIFYING DATA				
Instrumentation and processing for machine vision				
Subject	Instrumentation and processing for machine vision			
Code	V05M185V01104			
Study programme	Máster Universitario en Visión por Computador			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	1st	1st
Teaching language	English			
Department				
Coordinator				
Lecturers				
E-mail				
Web	http://www.usc.gal/gl/centros/etse/materia.html?materia=144506			
General description	(*)Comprende-lo principio de funcionamento dun sistema de visión artificial para distintos tipos de sensores e os seus respectivos campos de aplicación.			

Training and Learning Results

Code	
Expected results from this subject	
Expected results from this subject	Training and Learning Results

Contents

Topic	
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Planning

	Class hours	Hours outside the classroom	Total hours
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*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.

Methodologies

Description	
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Personalized assistance

Assessment

Description	Qualification	Training and Learning Results
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Other comments on the Evaluation

Sources of information

Basic Bibliography

Complementary Bibliography

Recommendations

IDENTIFYING DATA				
Instrumentation and processing for biomedical applications				
Subject	Instrumentation and processing for biomedical applications			
Code	V05M185V01105			
Study programme	Máster Universitario en Visión por Computador			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	1st	1st
Teaching language	English			
Department				
Coordinator				
Lecturers				
E-mail				
Web	http://guiadocente.udc.es/guia_docent/index.php?centre=614&ensenyament=614535&assignatura=614535012&any_academic=2020_21&idioma_assig=&idioma=cast&idioma=cat			
General description				
Training and Learning Results				
Code				
Expected results from this subject				
Expected results from this subject				Training and Learning Results
Contents				
Topic				
Planning				
	Class hours	Hours outside the classroom	Total hours	
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.				
Methodologies				
	Description			
Personalized assistance				
Assessment				
Description	Qualification	Training and Learning Results		
Other comments on the Evaluation				
Sources of information				
Basic Bibliography				
Complementary Bibliography				
Recommendations				

IDENTIFYING DATA				
Advanced image processing and analysis				
Subject	Advanced image processing and analysis			
Code	V05M185V01201			
Study programme	Máster Universitario en Visión por Computador			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	1st	2nd
Teaching language	English			
Department				
Coordinator				
Lecturers				
E-mail				
Web	http://guiadocente.udc.es/guia_docent/index.php?centre=614&ensenyament=614535&assignatura=614535002&any_academic=2020_21&any_academic=2020_21			
General description	This subject contains advanced topics in image processing and analysis and is presented as the second part of another subject where the fundamental topics are dealt with. It was designed to provide the essential foundation for students who will continue research in this area. In addition to advanced techniques in image processing and analysis, applications in this area to solve real-world problems will be studied. This course provides the necessary tools to apply the studied algorithms in practical cases as well as to develop new algorithms.			

Training and Learning Results	
Code	

Expected results from this subject	
Expected results from this subject	Training and Learning Results

Contents	
Topic	

Planning			
	Class hours	Hours outside the classroom	Total hours

*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.

Methodologies	
	Description

Personalized assistance	
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Assessment		
Description	Qualification	Training and Learning Results

Other comments on the Evaluation	
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Sources of information	
Basic Bibliography	
Complementary Bibliography	

Recommendations	
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IDENTIFYING DATA

Modelado e reconhecimento tridimensional

Subject	Modelado e recoñecemento tridimensional			
Code	V05M185V01202			
Study programme	Máster Universitario en Visión por computador			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	3	Optional	1	2c
Teaching language	Inglés			
Department				
Coordinator				
Lecturers				
E-mail				
Web	http://www.usc.gal/gl/centros/etse/materia.html?materia=144500			
General description	Ao acabar a materia o alumnado debe entender o desenvolvemento de aplicacións gráficas interactivas enfocadas no modelado poligonal, representación de imaxes volumétricas e ray- marching.			

Resultados de Formación e Aprendizaxe

Code

Resultados previstos na materia

Expected results from this subject	Training and
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Expected results from this subject	Training and Learning Results
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Contidos

Topic

Planificación	
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	Class hours	Hours outside the classroom	Total hours
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*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.

Metodoloxía docente

Description

Atención personalizada

Avaliación	
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Description	Qualification	Training and Learning Results
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Other comments on the Evaluation

Bibliografía. Fontes de información

Basic Bibliography

Complementary Bibliography

Recomendaciones

IDENTIFYING DATA				
Recoñecemento visual				
Subject	Recoñecemento visual			
Code	V05M185V01203			
Study programme	Máster Universitario en Visión por computador			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	1	2c
Teaching language	Inglés			
Department				
Coordinator				
Lecturers				
E-mail				
Web	http://www.usc.gal/es/centros/etse/materia.html?materia=144502			
General description	<p>As tarefas de recoñecemento visual van desde a detección de obxectos en imaxes e vídeos, a clasificación de obxectos e o recoñecemento de instancias, ata o recoñecemento de accións humanas. No curso realizaremos un estudo das primeiras tarefas, xa que o recoñecemento de accións é o tema principal da materia Recoñecemento de Acción Humanas.</p> <p>O obxectivo é que o alumnado adquira coñecementos e habilidades que lles permitan deseñar sistemas de detección de movemento de vídeo, segmentación e rastreamento baseados en movementos, clasificación e detección de obxectos en imaxes e vídeo, así como rastrexo visual de obxectos.</p>			
Resultados de Formación e Aprendizaxe				
Code				
Resultados previstos na materia				
Expected results from this subject				Training and Learning Results
Contidos				
Topic				
Planificación				
	Class hours	Hours outside the classroom	Total hours	
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.				
Metodoloxía docente				
	Description			
Atención personalizada				
Avaliación				
Description	Qualification	Training and Learning Results		
Other comments on the Evaluation				
Bibliografía. Fontes de información				
Basic Bibliography				
Complementary Bibliography				
Recomendacións				

IDENTIFYING DATA				
Recoñecemento de accións humanas				
Subject	Recoñecemento de accións humanas			
Code	V05M185V01204			
Study programme	Máster Universitario en Visión por computador			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	3	Optional	1	2c
Teaching language	Inglés			
Department				
Coordinator				
Lecturers				
E-mail				
Web	http://www.usc.gal/es/centros/etse/materia.html?materia=144503			
General description	(*)-- Conocimiento de técnicas de reconocimiento visual aplicadas al reconocimiento de personas, y partes del cuerpo. -Análisis y evaluación de aplicaciones de reconocimiento de acciones humanas -Desarrollo de herramientas basadas en tecnologías avanzadas de reconocimiento de acciones humanas			

Resultados de Formación e Aprendizaxe

Code

Resultados previstos na materia

Expected results from this subject	Training and Learning Results
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Contidos

Topic

Planificación

	Class hours	Hours outside the classroom	Total hours
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*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.

Metodoloxía docente

Description

Atención personalizada

Avaliación

Description	Qualification	Training and Learning Results
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Other comments on the Evaluation

Bibliografía. Fontes de información

Basic Bibliography

Complementary Bibliography

Recomendacións

IDENTIFYING DATA				
Advanced machine learning for computer vision				
Subject	Advanced machine learning for computer vision			
Code	V05M185V01205			
Study programme	Máster Universitario en Visión por Computador			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	1st	2nd
Teaching language	English			
Department				
Coordinator	Alba Castro, José Luis			
Lecturers	Alba Castro, José Luis			
E-mail	jalba@gts.uvigo.es			
Web	http://moovi.uvigo.gal			
General description	The objective of this subject is to know and apply advanced neural models, to know the techniques of the state of the art of deep learning, with end-to-end training approaches, and minimizing the use of tagged data, to solve computer vision applications using the methodologies covered in the subject.			

Training and Learning Results	
Code	
A1	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
A2	CB7 Students should be able to apply their acquired knowledge and problem-solving skills in new or unfamiliar environments within broader (or multidisciplinary) contexts related to their area of study
A5	CB10 Students should possess the learning skills to enable them to continue studying in a largely self-directed or autonomous manner.
B1	Capacity for analysis and synthesis of knowledge
B3	Ability to develop computer vision systems depending on the existent needs and apply the most suitable technological tools
B5	Ability to identify unsolved problems and provide innovative solutions
B6	Ability to identify theoretical results or new technologies with innovative potential and turn them into products and services useful to society
C2	To know and apply automatic learning and pattern recognition techniques applied to computer vision
D1	To practice the profession with a clear awareness of its human, economic, legal and ethical dimensions and with a clear commitment to quality and continuous improvement
D2	Capacity for teamwork, organization and planning

Expected results from this subject	
Expected results from this subject	Training and Learning Results
To know, apply and evaluate advanced neural models.	A1
	A2
	A5
	B1
	B3
	B5
	B6
	C2
	D1
	D2
To know deep learning techniques with end-to-end training approaches, and minimizing the use of labelled data.	A1
	A2
	A5
	B1
	B3
	B5
	B6
	C2
	D1

To solve computer vision applications using advanced machine learning methods

A1
A2
A5
B1
B3
B5
B6
C2
D1
D2

Contents

Topic

Multilayer perceptron and backpropagation
Convolutional neural networks and recurrent networks
Principles of deep learning
Self-supervised learning and autoencoders.
Advanced Neural models for computer vision.
Advanced paradigms of supervision
Selected subjects in machine learning for computer vision.
Advanced Applications in computer vision.

Planning

	Class hours	Hours outside the classroom	Total hours
Laboratory practical	16	32	48
Case studies	4	16	20
Project based learning	10	40	50
Lecturing	10	20	30
Objective questions exam	2	0	2

*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.

Methodologies

	Description
Laboratory practical	Analysis and resolution of practical cases with the objective of reinforce the practical application of the theoretical contents. Practices in computing labs, learning based in the resolution of practical cases, autonomous work and independent study of the students, and work in group and cooperative learning.
Case studies	Elaboration and presentation of works on selected and related state of the art methodologies.
Project based learning	Learning based on the resolution of practical cases, autonomous work and independent study of the students, and group work and cooperative learning.
Lecturing	Participatory lessons aimed at learning the theoretical contents of the subject

Personalized assistance

Methodologies	Description
Laboratory practical	Resolution of doubts during laboratory practices.
Case studies	Individualized advice during the case study.
Project based learning	Individualized advice during the realization of the projects

Assessment

	Description	Qualification	Training and Learning Results			
Laboratory practical	Analysis and resolution of practical cases with the objective of affirming the practical application of theoretical contents	40	A1 A2 A5 B6	B1 B3 B5 B6	C2	D1 D2
Case studies	Elaboration and presentation of works on selected state-of-the-art methodologies	15	A1 A2 A5	B1 B3 B5 B6	C2	D1 D2

Project based learning	Resolution of practical cases of application of the subject by means of autonomous work of the student, and using the techniques learned during the course	20	A1 A2 A5	B1 B3 B5 B6	C2	D1 D2
Objective questions exam	Tests for continuous assessment during the course. Evaluation by means of a final examination of the course as an alternative	25	A1 A2 A5	B1 B3 B5 B6	C2	D1 D2

Other comments on the Evaluation

The evaluation corresponding to the objective test can be passed by means of the programmed tests during the course or by means of a final exam.

Sources of information

Basic Bibliography

Complementary Bibliography

Ian Goodfellow, Yoshua Bengio, Aaron Courville., **Deep Learning.**, MIT Press., 2017

Artigos recentes en revistas e conferencias científicas relevantes: NIPS, ICML, IJCAI, AAAI, ECML, C,

Recommendations

Subjects that are recommended to be taken simultaneously

Visual recognition/V05M185V01203

Subjects that it is recommended to have taken before

Image description and modeling/V05M185V01102

Fundamentals of machine learning for computer vision/V05M185V01103

IDENTIFYING DATA				
Photogrametrics and robot vision				
Subject	Photogrametrics and robot vision			
Code	V05M185V01206			
Study programme	Máster Universitario en Visión por Computador			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Optional	1st	2nd
Teaching language	English			
Department				
Coordinator	Martínez Sánchez, Joaquín			
Lecturers	Martínez Sánchez, Joaquín			
E-mail	joaquin.martinez@uvigo.es			
Web	http://https://www.imcv.eu/			
General description	<p>In this subject students will learn to:</p> <ol style="list-style-type: none"> 1.- Accurately model an image acquisition system from a geometric point of view; 2.- Model the relative orientation between images and the acquisition and processing methodologies to obtain a local system 3D model 3.- Describe and obtain a three-dimensional model in a global reference system based on orientation tools 4.-Integrate heterogeneous sensors and multimodal vision-laser information aimed at mapping and navigating the environment. 			

Training and Learning Results	
Code	
A1	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
A4	CB9 Students should be able to communicate their findings - and the ultimate knowledge and reasons behind them - to specialist and non-specialist audiences in a clear and unambiguous manner
A5	CB10 Students should possess the learning skills to enable them to continue studying in a largely self-directed or autonomous manner.
C1	To know and apply the concepts, methodologies and technologies of image processing
C3	To know and apply the concepts, methodologies and technologies of image and video analysis
C5	To analyze and apply state-of-the-art methods in computer vision
C6	To know and apply the fundamentals of image acquisition and machine vision systems
C9	To know and apply the concepts, methodologies and technologies for the recognition of visual patterns in real scenes
D2	Capacity for teamwork, organization and planning

Expected results from this subject	
Expected results from this subject	Training and Learning Results
Know howto precisely modelling image acquisition systems from a geometrical point of view	A1 A4 A5 C6 C9 D2
Understand and apply the methodologies for image acquisition and processing oriented to obtain their relative orientation	A1 A4 A5 C1 C3 C5 C9 D2
Understand and apply orientation techniques aimed at obtaining georeferenced 3D models	A1 A4 A5 C1 C6 C9 D2

Understand and apply mapping and navigation techniques based on sensor fusion in a multimodal vision-laser system	A1 A4 A5 C1 C3 C6 C9 D2
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Contents

Topic	
Calibration of cameras. Geometrical transformations.	Geometrical properties of optical systems: Collinearity Condition. Geometrical resolution of a camera. Transformations in the plane: Similarity. Affinity. Projectivity. Polynomial transformations Calibration of a camera. Parameters. Errors. Iterative correction. Precision. Correction of perspective, rectification and metrology: Spatial image resection. Planar image rectification. Single view Measurement. Precision.
Relative and absolute orientation.	Coplanarity condition. Epipolar geometry and triangulation. Model Coordinate system . Quality Parameters and precision. Stereoscopic pairs. Absolute orientation. Global Reference Systems. Datum. Spatial Transformations. 7-Parameter Transformation.
Bundle Adjustment	Adjustment Models and self-calibration. Generation of orthoimages.
3D Point Clouds	Calculation and Collection 3D Processing
Robot Vision Applications	Motion estimation. Spatial image resection and Visual Odometry. Mapping.

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	10	20	30
Practices through ICT	25	40	65
Mentored work	0.5	20	20.5
Seminars	4	6	10
Objective questions exam	0.5	5	5.5
Problem and/or exercise solving	1	7.5	8.5
Report of practices, practicum and external practices	0.5	10	10.5

*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.

Methodologies

	Description
Lecturing	It will consist of the collaborative discussion of contents of the course of way. This includes discussion and solving problems and practical case studies in the classroom.
Practices through ICT	Methodology oriented to solving cases of study related with the thematic of the course using software of reference. Practices and exercises focused on the implementation of the algorithms explained in the participatory classes.
Mentored work	Specific hardware will be used in the laboratory in sessions of mandatory face-to-face attendance Taking into account proposed practical case studies, this method is oriented to solving and documenting a complete photogrammetric project, including the definition of: image acquisition methodologies in the field, supporting data collection for model georeferencing and the main photogrammetric products obtained through the photogrammetric process .
Seminars	The description of a concrete practical case related with the professional practice of photogrammetry.

Personalized assistance

Methodologies	Description
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Lecturing	For all the modalities of teaching, tutorial session meetings could be held by telematic means (email, videoconference, forums in FAITIC, ...) Under the modality of previous agreement.
Practices through ICT	In the mandatory lab sessions there will be a continuous assesment of the student performance. For all the modalities of teaching, tutorial session meetings could be held by telematic means (email, videoconference, forums in FAITIC, ...) Under the modality of previous agreement.
Mentored work	For all the modalities of teaching, tutorial session meetings could be held by telematic means (email, videoconference, forums in FAITIC, ...) Under the modality of previous agreement.

Assessment					
	Description	Qualification	Training and Learning Results		
Mentored work	The students will have to complete a case of study by means of the design of a methodology that include the steps seen in the course: 1.- Objectives, Requirements and Products analysis 2.- Definition of the image acquisition networks in the case study 3.- Image processing and analysis 4.- Obtaining key photogrammetric products	30	A1 A4 A5	C1 C3 C5 C6 C9	D2
Objective questions exam	The students will have to answer individually a test with questions about the contents of the course.	30	A1 A4 A5	C1 C3 C5 C6 C9	
Problem and/or exercise solving	The students will have to resolve of individual form and in small groups a group of cases and concrete practical exercises.	40	A1 A4 A5	C1 C3 C5 C6 C9	D2

Other comments on the Evaluation

For more information about the tests dates and schedule please visit the webpage of the programm: <https://www.imcv.eu/>

Sources of information

Basic Bibliography

Thomas Luhmann, **Close Range Photogrammetry**, Whittles Publishing, 2006

Richard Hartley, **Multiple view geometry in Computer Vision**, 2, Cambridge : Cambridge University Press, 2003

Karl Kraus, **Photogrammetry : geometry from images and laser scans**, 2, Berlin ; New York : Walter De Gruyter, cop., 2007

Complementary Bibliography

Wolfgang FörstnerBernhard P. Wrobel, **Photogrammetric Computer Vision**, Springer, 2016

Recommendations

Subjects that are recommended to be taken simultaneously

Instrumentation and processing for machine vision/V05M185V01104

Real time machine vision/V05M185V01207

Subjects that it is recommended to have taken before

Image description and modeling/V05M185V01102

Fundamentals of image analysis and processing/V05M185V01101

IDENTIFYING DATA				
Real time machine vision				
Subject	Real time machine vision			
Code	V05M185V01207			
Study programme	Máster Universitario en Visión por Computador			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	3	Optional	1st	2nd
Teaching language	English			
Department				
Coordinator	Martín Herrero, Julio			
Lecturers	Martín Herrero, Julio			
E-mail	julio@uvigo.es			
Web	http://imcv.eu			
General description	Workshop for getting acquainted with machine vision cameras and hardware, their configuration, fine tuning and how to work with them in real time.			

Training and Learning Results	
Code	
A5	CB10 Students should possess the learning skills to enable them to continue studying in a largely self-directed or autonomous manner.
B3	Ability to develop computer vision systems depending on the existent needs and apply the most suitable technological tools
C6	To know and apply the fundamentals of image acquisition and machine vision systems

Expected results from this subject	
Expected results from this subject	Training and Learning Results
The students will learn how to efficiently program real time acquisition and processing of images proper of machine vision applications.	A5 B3 C6

Contents	
Topic	
Real time programming for machine vision	.
PC-frame-grabber communication	.
Memory management	.
Structure and usage of a typical machine vision SDK	.
Low-level programming for high speed industrial processes	.

Planning			
	Class hours	Hours outside the classroom	Total hours
Workshops	75	0	75
Systematic observation	0.1	0	0.1
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies	
	Description
Workshops	Hands-on workshop working in pairs in the lab with a computer and machine vision hardware, using C and C++. On-site attendance is compulsory, except when any extraordinary circumstances may concur.

Personalized assistance	
Methodologies	Description
Workshops	Direct access to the teacher during the work at the lab.

Assessment					
	Description	Qualification	Training and Learning Results		
Systematic observation	The teacher will follow closely the performance and progress of the students during the workshop, with timely individual feedback.	100	A5	B3	C6

Other comments on the Evaluation

This is an optional experimental subject that requires in situ attendance of the students at the lab. Attendance to each of the four in situ sessions is compulsory. The classes' schedule is published before the enrolment period. Make sure that you will be able to attend the four sessions at UVigo before you enrol in this subject. If you are working, make sure that you get a commitment in writing from your employers allowing you to attend the four scheduled sessions at UVigo before you enrol. Otherwise, DO NOT ENROL, choose another optional subject that does not require in situ attendance. Job commitments are not a recognised cause for leave of absence. Porto students please note: UPorto's general 25% leave of absence DOES NOT APPLY at UVigo. The only recognised causes for leave of absence at UVigo are the usual force majeure causes: death, serious illness, law enforcement, and acts of God, and they must be officially sanctioned by UVigo's administrative services by means of suitable documentary proof. If a leave of absence is officially sanctioned by UVigo, the evaluation of the missed session will be arranged on a case-per-case basis with consideration of the particular circumstances of the case.

Sources of information

Basic Bibliography

Davies, **Machine Vision**, 3, Elsevier, 2005

Complementary Bibliography

Several, **Webinar series**, Basler, 2020

Recommendations

Other comments

Good working knowledge of C/C++ is essential. Note that this subject requires on-site attendance at the University of Vigo in the programmed dates and times.

IDENTIFYING DATA				
Análise de imaxes biomédicas				
Subject	Análise de imaxes biomédicas			
Code	V05M185V01208			
Study programme	Máster Universitario en Visión por computador			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Optional	1	2c
Teaching language	Inglés			
Department				
Coordinator				
Lecturers				
E-mail				
Web	http://www.usc.gal/gl/centros/etse/materia.html?materia=144510			
General description	<p>-Coñecemento de técnicas avanzadas específicas de procesado e análise de imaxe biomédica.</p> <p>-Análise de aplicacións de imaxe biomédica actuais, e capacidade de avaliación das solucións existentes, así como o desenvolvemento de novas solucións específicas.</p> <p>-Avaliación da adecuación das metodoloxías alicadas nun contexto multidisciplinar para contornas biomédicas.</p> <p>-Capacidade de redacción de documentación e informes de resultados científico-técnicos.</p>			
Resultados de Formación e Aprendizaxe				
Code				
Resultados previstos na materia				
Expected results from this subject	Training and Learning Results			
Contidos				
Topic				
Planificación				
	Class hours	Hours outside the classroom	Total hours	
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.				
Metodoloxía docente				
	Description			
Atención personalizada				
Avaliación				
Description	Qualification	Training and Learning Results		
Other comments on the Evaluation				
Bibliografía. Fontes de información				
Basic Bibliography				
Complementary Bibliography				
Recomendacións				

IDENTIFYING DATA				
Biometrics				
Subject	Biometrics			
Code	V05M185V01209			
Study programme	Máster Universitario en Visión por Computador			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	3	Optional	1st	2nd
Teaching language	English			
Department				
Coordinator				
Lecturers	Alba Castro, José Luis			
E-mail				
Web	http://moovi.uvigo.gal			
General description	This subject offers a general vision of the biometric identification techniques based on image and video. It delves into the most common ones: face, fingerprint and iris recognition.			

Training and Learning Results	
Code	
A3	CB8 Students should be able to integrate knowledge and deal with the complexity of making judgements based on incomplete or limited information, including reflections on the social and ethical responsibilities associated with applying their knowledge and judgements
B4	Capacity for critical analysis and rigorous evaluation of technologies and methodology
B7	Autonomous learning ability for specialization in one or more fields of study
C2	To know and apply automatic learning and pattern recognition techniques applied to computer vision
C4	To conceive, develop and evaluate complex computer vision systems
D1	To practice the profession with a clear awareness of its human, economic, legal and ethical dimensions and with a clear commitment to quality and continuous improvement
D4	Ability to understand the meaning and application of the gender perspective in the different areas of knowledge and in professional practice with the aim of achieving a more just and egalitarian society

Expected results from this subject	
Expected results from this subject	Training and Learning Results
The students will have comprised the common characteristics of the technicians of biometric identification, the evaluation metrics, the problems of practical implementation, the peculiarities of each biometric modality and the best way to combine them. Besides, they will have developed a critical analysis on the best working point for a concrete application, as well as an understanding of the peculiarities been due to demographic factors (sex, age, race, culture) in the design, development, evaluation and deployment of a solution of biometric identification.	A3 B4 B7 C2 C4 D1 D4

Contents	
Topic	
Basic principles of biometric identification	Identity versus biometric traits: Types of traits and biometric signatures. Variance intra-class and *nter-class of the biometric signatures. Influence of the sensors in the different signatures. Mathematical modelling of the biometric data: Extraction of characteristics. Compression. Representation versus Discrimination. Recognition, Identification, Verification and Authentication. Types of errors: TER, ERR, FAR, FRR.
Current biometric technologies	Physiological characteristics: fingerprints, iris, face, palm, retina, voice. Behavioural characteristics: signature (static and dynamic), keystrokes. Detection of alive sample. Pros and cons in the use of each biométric trait.
Facial recognition	Global technics (eigenfaces, fisherfaces) versus local technics (template matching, NCC, Elastic Bunch Graph Matching). The problem of the variation of illumination and pose. The problem of the detection and normalisation. Technicians of deep learning. Pros and cons.
Fingerprint recognition	Representation of minucias. Hausdorff distance. Gabor. filters. Tolerance to deformations. Types of sensors.

Iris recognition	Representation of the iris. Algorithm of Daugman. Algorithm of Wildes. Recognition at a distance. Pros and cons of iris recognition.
Multimodal recognition. Multibiometrics.	Combination of classifiers. Independent or correlated sources. Fusion of classifiers: intramodal, intermodal, algorithmic and scores-based. State of the art Systems using multimodal recognition and/or multibiometrics.

Planning

	Class hours	Hours outside the classroom	Total hours
Laboratory practical	12	0	12
Lecturing	7	20	27
Objective questions exam	1	0	1
Problem and/or exercise solving	1	0	1
Laboratory practice	0	40	40

*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.

Methodologies

	Description
Laboratory practical	Practices of the concepts showed in the masterclasses. They will be made with software accessible to all the students. Learning based in the resolution of practical cases and in small projects. The work will be in general autonomous and with independent study of the students. Some practices will be done in group and by means of cooperative learning. Intensive use of the virtual classroom will be implemented.
Lecturing	Participatory master classes where the contents are exposed and the pros and cons that different options would have to solve practical cases will be advanced, leaving some open questions so that the students work them and arrive to their own conclusions.

Personalized assistance

Methodologies	Description
Lecturing	During the master class the debate between the students will be forced and open questions will hang in the air.
Laboratory practical	During the face-to-face part of the practices of laboratory there will be a personalized attention to solve doubts and to help in the advances. During the asynchronous part an extensive use of the Learning Management Systems and the forums of debate will be implemented

Assessment

	Description	Qualification	Training and Learning Results
Objective questions exam	Test of short questions about the concepts studied with individual evaluation	15	A3 B4 C2 D1 D4
Problem and/or exercise solving	Examination of short problems on the concepts and practices carried out, with individual evaluation	15	A3 B4 C4
Laboratory practice	The laboratory practices will have a part that can be evaluated individually or in groups depending on the type of practice.	70	A3 B4 C2 D4 B7 C4

Other comments on the Evaluation

Sources of information

Basic Bibliography

Complementary Bibliography

Wayman, J.L., Jain, A.K., Maltoni, D., Maio, D. (Eds.), **Biometric systems. Technology, Design and Performance Evaluation**, 1, Springer, 2005

Anil Jain, Ruud Bolle y Sarta Pankanti (Eds.), **Biometrics. Personal Identification in Networked Society**, 1, Kluwer Academic Publishers, 2006

John Daugman, **How iris recognition works**, IEEE Transactions on Circuits and Systems for Video, 2004

Recommendations

Subjects that are recommended to be taken simultaneously

Advanced machine learning for computer vision/V05M185V01205

Advanced image processing and analysis/V05M185V01201

Subjects that it is recommended to have taken before

Image description and modeling/V05M185V01102

Fundamentals of machine learning for computer vision/V05M185V01103

Fundamentals of image analysis and processing/V05M185V01101

Other comments

Big part of the material of study is based in scientific articles that will be left to student's disposal in the LMS.

IDENTIFYING DATA				
Prácticas externas				
Subject	Prácticas externas			
Code	V05M185V01210			
Study programme	Máster Universitario en Visión por computador			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	3	Mandatory	1	2c
Teaching language	Castelán Galego Inglés Portugués			
Department				
Coordinator				
Lecturers	Alba Castro, José Luis			
E-mail				
Web	http://imcv.eu			
General description	<p>As prácticas externas deben proporcionar ao alumnado un contacto directo coa realidade laboral. Aínda que os créditos son limitados, faranse esforzos para integrar ao estudantado nos proxectos en curso, non só para aprender os fluxos e a dinámica do traballo en equipo no campo da visión informática, senón tamén para intentar contribuír nalguna parte do proxecto. coñecementos adquiridos no Máster ata a data.</p> <p>Este traballo debería levar ao alumnado a profundizar nunha temática relacionada co Máster en Visión por Computador, a interiorizar conceptos, métodos e técnicas na perspectiva de aprender a facer, permitindo desenvolver reflexión e síntese, e a realizar un traballo aplicado no contexto da área de especialización da visión por computador.</p>			

Resultados de Formación e Aprendizaxe

Code

Resultados previstos na materia

Expected results from this subject	Training and Learning Results
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Contidos

Topic

As prácticas acordaranse coas empresas e cos centros de investigación ofertantes (que xa asinen un convenio de colaboración), de tal maneira que se cumpra o requisito de que os proxectos nos que se integren axuden a completar a súa formación nalgunhas das materias obrigatorias ou *optativas cursadas e que lles permitan ter un contacto directo coa realidade do mercado	-Revisión da estado da arte; -Análise de posibles solucións; -Proposta / Desenvolvemento dunha solución; -Análise crítica da solución proposta / desenvolvida;
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Cada estudante terá un programa de traballo individual no campo dos docentes, definido polo tutor na institución anfitrío e validado pola tutor académico. Os pasos principais poden incluír un subconxunto dos seguintes, de acordo coas necesidades específicas do proxecto.

Ao final, o/a estudante fará un informe escrito do traballo realizado.

Planificación

	Class hours	Hours outside the classroom	Total hours
Prácticum, Practicas externas e clínicas	0	70	70
Informe de prácticas, prácticum e prácticas externas	0	5	5

*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.

Metodoloxía docente	
	Description
Prácticum, Practicas externas e clínicas	<p>Acordarase coas entidades ofertantes un plan de traballo que deberá ser aprobado pola CAM. Cada estudante terá *tutoría académica e tutor na empresa/centro de investigación que velarán polo correcto desenvolvemento da práctica.</p> <p>As tarefas principais do traballo inclúen a comprensión do problema, a formalización do problema, o estudo de metodoloxías apropiadas, o desenvolvemento e deseño dunha proposta / solución ao problema, unha avaliación e unha análise crítica dos resultados obtidos, e conclusións. Promoverase que as Prácticas Externas sirvan como adaptación do alumnado á nova contorna de traballo, ou como preámbulo para a realización do TFM, nese caso máis que proporcionar solucións buscaríase facer propostas a desenvolver no TFM.</p> <p>Plan de Continxencia para escenarios alternativos: Exporanse as prácticas contemplando a posibilidade de realización remota.</p>

Atención personalizada	
Methodologies	Description
Prácticum, Practicas externas e clínicas	Cada estudante tendrá un tutor académico y un tutor en la empresa/centro de investigación que velarán por el correcto desarrollo de la práctica.

Avaliación			
	Description	Qualification	Training and Learning Results
Informe de prácticas, prácticum e prácticas externas	Sistema de avaliación Informe do tutor na entidade externa (60%) Informe do tutor n académico (40%)	100	

Other comments on the Evaluation

Bibliografía. Fontes de información	
Basic Bibliography	
Complementary Bibliography	

Recomendacións