CIMET Course catalogue

Semester 2 - Course offer 2013-2015

COURSES AT UGR (30 ECTS)
Radiometry, sources and detectors (5 ECTS)
Optical Imaging and Processing (5 ECTS)
Advanced colorimetry (5 ECTS)
Human Vision and Computer Vision (5 ECTS)
Advanced Color Image Processing (5 ECTS)
Fundamentals of spectral science (5 ECTS)

COURSES AT UJM (30 ECTS)
Coding and compression of media data (delivered by GUC) (10 ECTS)
Pattern recognition (5 ECTS)
Computer vision (5 ECTS)
Human Vision and perception (3 ECTS)
Advanced Colorimetry (2 ECTS)
3D-4D Computer vision (5 ECTS)
CIMET Radiometry, Sources and Detectors

Course name: Radiometry, sources and detectors  
Course level: Master  
Course instructor(s): Antonio Pozo & Ana Carrasco Sanz (University of Granada-CSIC), and Mathieu Hebert (University Jean Monnet)

Education period (Dates): 2nd semester  
Language of instruction: English

Prerequisite(s): Module “Photonics and Optics Fundamentals” (1st semester)

Expected prior-knowledge: Basic geometrical optics.

Aim and learning outcomes:
This course develops an understanding of the measurement of electromagnetic radiation in spectral regions from ultraviolet to infrared. The course covers principles of radiometric, photometric and spectrophotometric instrumentation, including the study of light sources and physical detectors.

On completion of this course the student will be able to:
- Understand (i.e. to describe, analyse and reason about) how to use the methodology in quantifying electromagnetic radiation, from ultraviolet to infrared.
- Correctly use radiometric and photometric quantities and units.
- Understand (i.e. to describe, analyse and reason about) how to characterize light sources with different emission spectra.
- Understand (i.e. to describe, analyse and reason about) how to characterize photodetectors with different properties and responsivities.
- Demonstrate the use of mathematical tools to solve problems in radiometry and photometry.

Topics to be taught (may be modified):
- Fundamentals of radiometry: Radiometric quantities and important laws.
- Photometric quantities: Photometry versus radiometry, radiometric and photometric quantities.
- Sources: Thermal sources (blackbody and incandescent lamps), gas discharge, luminescent, laser, solid state (light emitting diodes).
- Photodetectors: Important features and types (thermal, photoemissive, photoconductive and photovoltaic detectors).
- Electronics reviews: detector electronics, detector interfacing.
- Matrix detectors.
- Radiometric, spectroradiometric and photometric instruments.
- Radiometric measurements of satellite observation and remote sensing.
- Radiometry of laser and coherent sources.

Practical Laboratory Sessions:
- Verification of photometry laws.
- Design and built a radiance meter.
- Photodetector calibration.
- Source calibration.

Teaching methods: Lectures, lab classes, and homework exercises.
Form(s) of Assessment: 60% for the exam(s) versus 40% for practical (seminar, exercices, project...)

External/internal examiner: --

Examination support: None

Literature and study materials: Handouts of the material covered in the lectures will be distributed.

Reference book:

Additional books:

Additional information:

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UGR CIMET Optical Imaging and Processing

Course name: Optical Imaging and Processing  
Course code: CIMET OIP  
Course level: Master  
ECTS Credits: 5.00

Course instructors: Javier Hernandez Andres & Juan Luis Nieves (University of Granada)

Education period (Dates): 2nd semester  
Language of instruction: English

Prerequisite(s): Module "Photonics and Optics Fundamentals" (1st semester)

Expected prior-knowledge: Image formation fundamentals and diffraction phenomenon, Fourier analysis and linear systems.

Aim and learning outcomes:
This course develops an understanding of the fundamentals of diffraction limited and aberrated limited imaging systems. The course covers advanced topics in diffraction, Fourier Optics and optical image processing. Different architectures for optical-based image manipulation will be given, including optical correlation, wavefront coding, recording and manipulation, spatial filtering techniques, optical pattern detection, recognition and extraction, and optical correlators used in inspection industry. This course provides also an opportunity to engage with practical and theoretical aspects of optical and digital holography.

On completion of this course the students will be able to:
- Understand how diffraction and aberrations influence optical image quality.
- Analyze how an optical image can be encoded, manipulated and processed using optical-based techniques, with emphasis on coherent image formation.
- Make appropriate use of Fourier techniques in optical image processing.

Topics to be taught (may be modified):
- Overview of optical imaging: domains of image science. Electromagnetic waves and rays.
- Diffraction-limited imaging. Image formation with coherent and incoherent illumination. Analysis of optical resolution.
- Frequency analysis of optical imaging systems. Frequency response for diffraction-limited optical systems: coherent and incoherent imaging. Optical transfer function (OTF), modulation transfer function (MTF) and phase transfer function (PTF): characterisation and measures.

Practical Laboratory Sessions:
- Simulating diffraction using MATLAB.
- Visualization of diffraction patterns using an optical processor.
- Optical Fourier filtering: practical implementation of a 4f-Fourier processor.
- Digital Fourier filtering: simulations with MATLAB.
- Measure of the modulation transfer function (MTF) of an imaging system.
- Making a transmission hologram.
- Making a reflection hologram.
- Recording of a digital hologram and numerical reconstruction.

Teaching methods: Lectures and lab classes, and homework exercises.
Form(s) of Assessment: Written exam (50%), Practical work (50%)

External/internal examiner: --

Examination support:

Literature and study materials: Handouts of the material covered in the lectures will be distributed.

Reference book:


Additional books:


Additional information:

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UGR CIMET Advanced Colorimetry

Course name: Advanced Colorimetry                      Course code: CIMET AC
Course level: Master                                     ECTS Credits: 5.00 at UGR
Course instructors: Rafael Huertas & Luis Gómez Robledo (University of Granada), Alain Trémeau (University of Saint-Etienne)

Education period (Dates): 2\textsuperscript{nd} semester   Language of instruction: English

Prerequisite(s): Module “Color Science” (1\textsuperscript{st} semester), Module “Human Vision and Computer Vision” (2\textsuperscript{nd} semester)

Expected prior-knowledge:

Aim and learning outcomes:

To supply an introduction color difference models and color appearance models, their evolution and present development. Also, basic knowledge on color reproduction methods and perceptual and physical evaluation of color images.

On completion of this course the students will be able to:

- Describe the color difference models.
- Describe the perceptual attributes of colour and the different systems for the representation of colour
- Demonstrate the use of colour measurement instruments and the interpretation of colour measurement data
- Demonstrate the computation of uniform colour space coordinates from reflectance measurements
- Describe the requirements for consistent colour reproduction across different media.
- Practical implementation of measurements of the appearance.
- Skills on methods of evaluation of the quality of color images.
- Basic methods of color reproduction on the industry.

Topics to be taught (may be modified):

- Weighted color difference equations. Color tolerance experiments. CIE94 and CIEDE2000 color-difference formulas.
- Effects of viewing conditions. Achromatic adaptation models. The structure of chromatic adaptation (CAT) models.
- The appearance attributes of colored materials viewed against a neutral grey background. The appearance attributes of colored areas within images. The influence of surrounding and background color on the appearance of a central color element.
- The structure of color appearance models: CIECAM97’s, CIECAM02. CAM implementation. CAM testing.
- S-CIELAB color-difference formulae. Image appearance models: iCAM
- Visual appearance(color + gloss, translucency and texture)
- Image quality Measurements. Rendering HDR Images
- Whiteness Measurements. Industrial Colorimetry.

Teaching methods: Lectures and lab classes, and homework exercises.
Form(s) of Assessment: Written exam (60%), practical work (40%)

External/internal examiner: --

Examination support:

Literature and study materials: Handouts of the material covered in the lectures will be distributed.

Reference book:


Additional books:


Additional information:

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UGR CIMET Human Vision and Computer Vision

Course name: Human Vision and Computer Vision  
Course code: CIMET HVCV  
Course level: Master  
ECTS Credits: 5.00

Course instructors: Juan Luis Nieves & Luis Gómez Robledo (University of Granada), Éric Dinet & Alain Trémeau (University of Saint-Étienne)  
Education period (Dates): 2nd semester (Dates to be determined)  
Exam period: --  
Language of instruction: English

Prerequisite(s): Module "Color Science" (1st semester)  
Expected prior-knowledge: Modules Photonics and Optics Fundamentals" (1st semester) and Radiometry, Sources and Detectors” (2nd semester)

Aim and learning outcomes:
The aim of the course is to provide a solid and integrated view of the visual processes with an emphasis on the physical aspects and on automatic processing of visual information. This more quantitative approach is complemented with notions of retinal and cortical organization and with the fundamentals on visual psychophysics. Although the course aims at a solid theoretical basis, practical issues and problem solving will be considered wherever appropriate and independent project development and research will be strongly encouraged.

On completion of this course the students will be able to:
• anatomically and functionally identify the main components of the human visual system.  
• apply visual optical to describe the imaging process in the eye.  
• identify the physical constraints imposed on the visual system and to relate them with the limitation on visual performance.  
• identify and to describe the main psychophysical aspects of human vision and to describe the basic psychophysical techniques.  
• describe and to apply basic image processing algorithms in the context of automatic vision problems

Topics to be taught (may be modified):
• Image quality. Image quality and psychophysical methods of assessing of the perceived quality of images.  
• Introduction to computer vision. Introduction to computer vision: what is computer vision? The Marr paradigm and scene reconstruction, Model-based vision. Other paradigms for image analysis: bottom-up, top-down, neural network, feedback. Pixels, lines, boundaries, regions, and object representations. "Low-level", "intermediate-level", and "high-level" vision.  
• Applications of computer vision. Image Processing Shape from X Shape from shading. Photometric stereo. Occluding contour detection. Motion Analysis. Motion detection and optical

**Practical Laboratory Sessions** (Some of these practical laboratory sessions will be held at Granada or at Saint Etienne following devices available):
- Colour measurement and illumination. Colour measurement and colour perception.
- Colour mixing and colour perception. Colour emotion.
- Optical illusions.
- Image processing, image quality evaluation and imaging system design (with ISET : Image Systems Evaluation Tools)
- Demos of stereo vision and measurement of stereo acuity (needs CRS card and goggles, for acuity a basic system with three vertical bars)
- Demos of apparent movement (needs CRS card)
- Cambridge Colour Test (needs CRS card)
- Measurement of CSF (needs CRS card and metropsis software)
- Calibration of monitors (and printers?)
- Anomaloscope

**Specialized seminars** (University of Granada):
- Sérgio Nascimento: Chromatic diversity perceived by the normal and colour deficient observer.
- Larry Maloney: Computational algorithms for colour constancy.
- Gavin Brelstaff: Mysterious aspects of color perception - beyond the trichromatic.

**Teaching methods**: Lectures and lab classes, and homework exercises.

**Form(s) of Assessment**: Written exam (60%), Practical work (40%)

**External/internal examiner**: --

**Examination support**: None

**Literature and study materials**: Handouts of the material covered in the lectures will be distributed.

**Basic textbook**:

**Additional books**:

**Additional information**:

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UGR CIMET Advanced Color Image Processing

**Course name:** Advanced Color Image Processing  
**Course code:** CIMET ACIP

**Course level:** Master  
**ECTS Credits:** 5.00

**Course instructors:** Timo Eckhard (Universidad de Granada).

**Education period (Dates):** 2nd semester  
**Language of instruction:** English

**Expected prior-knowledge:** Basic Image Processing. Linear Algebra. Matlab, Python, Java or C++/OpenCV knowledge.

**Aim and learning outcomes:**

This course is a graduate-level course of advanced digital image processing. It emphasizes on advanced principles of image acquisition and processing, with focus on scientific as well as technical applications. Topics that will be covered range from practical aspects of advanced image acquisition principles over different image information processing schemes to aspects of color image reproduction.

Programming assignments will use MATLAB and the MATLAB Image Processing Toolbox, though the use of other computer languages and/or software packages will be accepted. Additional seminars will be organized to introduce specific tools or applications to enlarge the covering of image processing and analysis.

**Topics to be taught (may be modified):**

- HDR image acquisition and data processing (radiance mapping and computational photography)
- Image compression (mechanisms and compression standards)
- Fuzzy logic applied to color and gray scale image processing
- Colorimetric camera calibration (high-fidelity color image measurements)
- Spectral image reproduction workflow (high-fidelity color image reproduction)
- Computational color constancy, color and texture descriptors
- Advance image segmentation schemes (region based, boundary based, hierarchical, model based, template based, graph based)

**Practical Laboratory Sessions:** implementation of image processing approaches taught in the lectures, introduction to KNIME (a Java-based graphical workbench for image processing/analysis workflows) do-it-yourself HDR image acquisition and processing.

**Teaching methods:** Lectures and lab classes, scientific article discussions, class exercises and homework assignments.

**Form(s) of Assessment:** final exam (70%), homework/lab reports (30%).

**External/internal examiner:** --

**Examination support:**

**Literature and study materials:**
Reference books:

- Fuzzy logic for beginners, by Masao Mukaidono, World scientific (2001)
- Color image processing and applications by Plataniotis, Venetsanopoulos, Anastasios, Springer (2000)
- High dynamic range imaging: acquisition, display, and image-based lighting by Reinhard et al., Morgan Kaufmann (2010)

Additional information:

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UGR CIMET Fundamentals of Spectral Science

**Course name:** Fundamentals of Spectral Science  
**Course code:** CIMET FSC  
**Course level:** Master  
**ECTS Credits:** 5.00

**Course instructors:** Javier Hernández-Andrés and Eva M. Valero (University of Granada)  
**Education period (Dates):** 2nd semester (Dates to be determined)  
**Exam period:** --  
**Language of instruction:** English

**Prerequisite(s):** Module "Fundamentals" (1st semester)  
**Expected prior-knowledge:** Matlab knowledge

**Aim and learning outcomes:**
The main aim of this course is to provide the basis of the multispectral approach of color imaging, i.e., imaging systems that use more than three acquisition channels. The contents include image capture procedures, spectral characterization of image capture devices, estimation of spectral functions from conventional image capture systems, evaluation of the accuracy or performance of multispectral images, and a basic description of some of the most relevant applications of multispectral images.

On completion of this course the students will be able to:
- Demonstrate an understanding of basic multispectral color science.
- Analyze, compare, develop and implement algorithms for spectral estimation from camera responses.
- Describe, analyze and reason about how multispectral acquisition devices work and how they can be optimized for a particular application.
- To know the state of the art of spectral color science and some of its most relevant fields of application.

**Topics to be taught (may be modified):**
- Spectral characterization of image acquisition systems: experimental determination of spectral response curves, influence of noise.
- Mathematical modelization of spectral functions: reflectances, illumination, color signals, etc. Linear and non-linear models: principal and independent component analysis.
- Spectral estimation from camera responses: models, algorithms, a priori necessary information, selection of data sets, use of color filters, filter selection, quality evaluation of the spectral signals obtained, influence of noise.
- Experimental spectral image acquisition systems.
- Applications of spectral imaging.

**Practical Laboratory Sessions:**  
Matlab laboratory topics in order to implement and master basic issues explained in the lectures.

**Teaching methods:** Lectures and lab classes, and homework exercises.

**Form(s) of Assessment:** 40% exam + 25% lab + 15% homeworks + 20% seminars

**External/Internal examiner:** --

**Examination support:** None
**Literature and study materials:** Lessons outlines (presentations), description and guides for exercises’ sessions. Handouts of the material covered in the lectures will be distributed.

**Basic textbook:**

**Additional books:**
Color image science: Exploiting Digital Media. MacDonald, Luo, 2002 (John Wiley and Sons)
http://books.google.es/books?id=lbexPr9lcjoC&dq=Multispectral+images+book&lr=&source=gbs_summary_s&cad=0


**Additional information:**
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**Home page:** [http://www.master-eramusmundus-color.eu/](http://www.master-eramusmundus-color.eu/)
UJM CIMET Coding and compression of media data

Course name: Coding and compression of media data          Course code: CIMET CC
Course level: Master                                          ECTS Credits: 10.00
Course instructors: Faouzi Alaya Cheikh (Gjovik University College)

Education period (Dates): 2nd semester          Language of instruction: English

Prerequisite(s)
IMT4991 Mathematics for Signal and Image Processing

On the basis of
Builds on some of the lectures in IMT4811 Image Processing and Analysis.

Expected learning outcomes
This course is a graduate-level introductory course to the fundamentals of coding and compression of media data. It focuses on the fundamental principles of coding and compression and discusses several of the existing audio, image and video compression standards. Students will gain theoretical as well as hands-on experience in media data compression techniques via regular lectures, exercises and a project work.

After completing the course, the students shall have good insight into digital media data coding and compression techniques and related standards

They will also have indepth practical knowledge about the JPEG encoder through the project work.

Topic(s)
- Motivation for media data compression
- Media data redundancy and compression
- Fundamental digital image representation and processing
- Sampling and quantization
- Entropy coding, run-length coding, variable-length coding
- Lossy and lossless compression techniques
- Transform-based coding
- Compression of audio, image, and video data
- File formats and standards
- JPEG, JPEG2000
- Motion estimation, motion compensation, motion compensated prediction
- H.261, H.263, MPEG-1, MPEG-2, MPEG-4, and MPEG-7
- Image quality

Teaching Methods
Lectures
Net Support Learning
Exercises
Project work

Teaching Methods (additional text)
The course will be offered both as an ordinary on campus course and as a flexible course to off-campus students. Lecture notes in PDF, Audio recordings of the lectures and other types of e-learning material will be offered through an Fronter. Communication between the teacher and the students, and among the students, will be facilitated via the Fronter.

**Form(s) of Assessment**

Written exam, 4 hours  
Evaluation of Project(s)

**Form(s) of Assessment (additional text)**

Written Exam, 4 hours (counts 60%)  
Evaluation of Project (counts 40%)

Each part must be individually approved of.

**Grading Scale**

Alphabetical Scale, A (best) – F (fail)

**External/internal examiner**

Internal examiner evaluates the written exam and the project reports.

**Re-sit examination**

Written exam: ordinary re-sit examination. There is no re-sit examination for projects.

**Examination support**

English dictionary

**Coursework Requirements**

Mandatory exercises reports. These will not be graded.

**Teaching Materials**


Additional material from the book authors: (http://www.cs.sfu.ca/mmbook/) and guest lectures on specific topics.
**UJM CIMET Pattern Recognition**

**Course name:** Pattern Recognition  
**Course code:** CIMET PR

**Course level:** Master  
**ECTS Credits:** 5.00

**Course instructors:** Elisa Fromont, Amaury Habrard, Marc Sebban (University Jean Monnet, Saint-Étienne)

**Education period (Dates):** 2\(^{nd}\) semester  
**Language of instruction:** English

**Expected prior-knowledge:** sufficient knowledge in statistics (DAA)

**Aim and learning outcomes:**

This course presents an advanced study (with both practical and theoretical aspects) of some supervised learning algorithms useful to tackle pattern recognition tasks in computer vision. It aims to deal with not only feature vectors (with SVM, decision trees and Neural Networks) but also with structured data represented in the form of strings (Hidden Markov models). Some data mining techniques are also presented to show how to discover valuable knowledge from images and videos.

**Topics to be taught (may be modified):**

- Introduction to pattern recognition and machine learning; (~10h)  
  - Statistical learning theory;  
  - Boosting theory

Non parametric methods (ex: KNN)

- Advanced decision trees. (~5h)

- Hidden Markov Models (Forward, backward and Viterbi algorithms, Expectation-Maximization algorithm), (~8h)

- Introduction to Neural Networks (~6h)

- Advanced Support Vector Machines, Kernel theory. (~20h)

- Basic Pattern Mining. (optional ~6h)

**Practical Laboratory Sessions (project):**

"From image description to image classification" (~15h of personal work)

**Teaching methods:** Lectures + lab sessions.

**Form(s) of Assessment:** written exam (60%), practical work (40%)

**External/internal examiner:** --

**Examination support:** None

**Literature and study materials:**

**Basic textbook:**

Pattern Recognition and Machine Learning, Christopher M. Bishop, Springer 2006.

Additional book:

Classification and Regression Trees, by Leo Breiman, Jerome Friedman, Charles J. Stone, R.A. Olshen, Chapman et al. 1998

(for data mining)


Additional information:

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CIMET Human Vision and Perception

Course name: Human Vision and Perception
Course code: CIMET HVP
Course level: Master
ECTS Credits: 3.00
Course instructor: Éric Dinet (University Jean Monnet, Saint-Étienne)
Education period (Dates): 2nd semester
Language of instruction: English

Expected prior-knowledge:

Aim and learning outcomes:
The aim of the course is to provide a solid and integrated view of the human visual system with an emphasis on visual perception. This approach is complemented with notions of visual optics, retinal and cortical organization and neural processing of visual information. Although the course aims at a solid theoretical basis, practical issues and problem solving will be considered wherever appropriate and independent project development and research will be strongly encouraged.

On completion of this course the students will be able:

- to anatomically and functionally identify the main components of the human visual system.
- to identify the physical constraints imposed on the visual system and to relate them with the limitation on visual performance.
- to identify and to describe the main psychophysical aspects of human vision
- to use and to implement the basic psychophysical techniques.

Course outline:

- **Introduction to visual perception**

- **The retina**

- **Colour perception**

- **The primary visual cortex**
  From retina to cortex. Basic organization of the cortex. Simple and complex cells. Maps and columns in the striate cortex.

- **Higher order visual areas**

- **The perception of space**

- **Attention and neglect**

Lab experiments: Demonstrations and experiments based on Virtual Lab tool

Teaching methods: Lectures and lab classes

Form(s) of assessment: Written exams and practical works

External/internal examiner:
**Examination:** Mid-term exam (25%), Practical works (25%), Final exam (50%)

**Literature and study materials:** Handouts of the material covered in the lectures will be distributed

**Reference book:**

**Additional books:**

**Additional information:**
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UJM CIMET Computer Vision

Course name: Computer vision
Course level: Master
Course code: CV
ECTS Credits: 5.00

Course instructors: Alain Trémeau

Education period (Dates): from February to June
Language of instruction: English

Expected prior-knowledge:
- Matrix algebra
- Fundamentals of image processing.
- Fundamentals of human vision and perception.

Aim and learning outcomes:
The challenge of computer vision is to develop a computer based system with the capabilities of the human eye-brain system. It is therefore primarily concerned with the problem of capturing and making sense of digital images. The field draws heavily on many subjects including digital image processing, artificial intelligence, computer graphics and psychology.

This course will explore some of the basic principles and techniques from these areas which are currently being used in the research and development of computer vision systems:

- to develop the students' understanding of the basic principles and techniques of image analysis and image understanding and of the current approaches to image formation and image modelling;
- to develop the students' skills to analyse and design a range of algorithms for image processing and computer vision;
- to develop the students' understanding of the fundamentals of 3D imaging techniques;
- to develop the students' skills to compare these techniques, to evaluate solutions to problems in computer vision, and to design the most appropriate one relative to image acquisition constraints, expected accuracy and expected processing time;
- to develop the students' skills to put into practice these techniques by acquiring and processing images.

Course outline:

1. Introduction to computer vision
   - Introduction to computer vision: what is computer vision? Examples and applications.
   - Notations and definitions: 3D Euclidean space, Cartesian coordinates frames and homogeneous coordinates
   - Image formation: Projective geometry, Camera models, Pinhole camera model

2. Recovering 3D from images
   - Visual cues, perception of objects and scenes. Shape from X.
   - The Marr paradigm and scene reconstruction, Model-based vision. Gestalt cues.
   - Other paradigms for image analysis: bottom-up, top-down, neural network, feedback.
   - Pixels, lines, boundaries, regions, and object representations. "Low-level", "intermediate-level", and "high-level" vision.
   - Object recognition model-based methods
   - Appearance-based methods. Invariant features
   - From scenes to objects, emergent features, scene categorization.
   - The importance of the context.

3. Recovering 3D from stereovision & Multiview
   - Introduction to Mutli-view Geometry, Stereovision,
   - Two view geometry: Epipolar geometry, 3D reconstruction ambiguities.
   - Computation of the Essential Matrix and Fundamental Matrix (linear methods, iterative methods, robust methods), Structure computation, Rectification methods.
   - Camera Geometry and Single View Geometry, Calibration and auto-calibration in Stereovision
• Depth from Triangulation, Two-View Geometry, N-View Geometry, Depth estimation and 3D reconstruction
• Primitive description from lines, edges, corners, interest points,
• Correlation methods, energy minimization methods
• Recovering camera and geometry up to ambiguity (affine approximation, Algebraic methods, Factorization methods)

4. **Recovering 3D from Motion**

• Introduction of Motion Field, Optical Flow. Motion Analysis. Motion detection.

**Lab experiments:**
- Camera calibration
- Two-View calibration and acquisition
- Two-View matching based on invariant features
- 3D Reconstruction from a Two-View setup
- Computation of RGB-D from Kinect camera
- Motion analysis based in Optical flow

**Teaching methods:**
Lectures and lab classes.

**Form(s) of Assessment:**
- Midterm exam
- Laboratory work report grading
- Final exam

**Examination:** Midterm exam (20%) – Final exam (30%) – Exercises and Laboratory work (50%)

**Literature and study materials:**

**Reference book:**

**Additional books:**
- Ma, Soatto, Kosecka and Sastry Gavin Brelstaff, *An invitation to 3D vision* edited by CRS4 - Pula (CA) Sardinia Italy.

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CIMET Advanced Colorimetry

**Course name:** Advanced Colorimetry
**Course code:** CIMET AC
**Course level:** Master
**ECTS Credits:** 5.00 at UGR and 2.00 at UJM

**Course instructors:** Rafael Huertas & Luis Gómez Robledo (University of Granada), Alain Trémeau (University of Saint-Etienne)

**Education period (Dates):** 2nd semester
**Language of instruction:** English

**Prerequisite(s):** Module “Color Science” (1st semester), Module “Human Vision and Computer Vision” (2nd semester)

**Expected prior-knowledge:**

**Aim and learning outcomes:**
To supply an introduction color difference models and color appearance models, their evolution and present development. Also, basic knowledge on color reproduction methods and perceptual and physical evaluation of color images.

On completion of this course the students will be able to:
- Describe the color difference models.
- Describe the perceptual attributes of colour and the different systems for the representation of colour
- Demonstrate the use of colour measurement instruments and the interpretation of colour measurement data
- Demonstrate the computation of uniform colour space coordinates from reflectance measurements
- Describe the requirements for consistent colour reproduction across different media.
- Practical implementation of measurements of the appearance.
- Skills on methods of evaluation of the quality of color images.
- Basic methods of color reproduction on the industry.

**Topics to be taught at UGR (may be modified):**
- Weighted color difference equations. Color tolerance experiments. CIE94 and CIEDE2000 color-difference formulas.
- Effects of viewing conditions. Achromatic adaptation models. The structure of chromatic adaptation (CAT) models.
- The appearance attributes of colored materials viewed against a neutral grey background. The appearance attributes of colored areas within images. The influence of surrounding and background color on the appearance of a central color element.
- The structure of color appearance models: CIECAM97’s, CIECAM02. CAM implementation. CAM testing.
- S-CIELAB color-difference formulae. Image appearance models: iCAM
- Visual appearance(color + gloss, translucency and texture)
- Image quality Measurements. Rendering HDR Images
- Whiteness Measurements. Industrial Colorimetry.

**Topics to be taught at UJM (may be modified):**
- The structure of color appearance models: CIECAM97’s, CIECAM02. CAM implementation. CAM testing.
- S-CIELAB color-difference formulae. Image appearance models: iCAM
• Visual appearance(color + gloss, translucency and texture)
• Management of the transfer of color information between image capture devices and image production devices. Device characterization, Gamut mapping algorithms, Device calibration. Concepts of device dependent and device independent methods of color specification.

Teaching methods: Lectures and lab classes, and homework exercises.

Form(s) of Assessment: Written exam (60%), practical work (40%)

External/internal examiner: --

Examination support:

Literature and study materials: Handouts of the material covered in the lectures will be distributed.

Reference book:


Additional books:


Additional information:

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Home page: http://www.master-erasmusmundus-color.eu/
CIMET 3D-4D Computer vision

Course name: 3D-4D Computer vision  
Course code: 3D-4D CV

Course level: Master  
ECTS Credits: 5.00

Course instructors: Corinne Fournier

Education period (Dates): from February to June  
Language of instruction: English

Expected prior-knowledge:
- Matrix algebra.
- Fundamentals of Image Processing.
- Fundamentals of Computer Vision.

Aim and learning outcomes:
- Learn fundamentals of 3D imaging techniques.
- Be able to compare these techniques and to choose the most appropriate one relative to image acquisition constraints, expected accuracy and expected processing time.
- Be able to put into practice four of these techniques, by acquiring and processing images: stereovision, structured light projection, shape from shading, time of flight.
- Learn the basics of tomographic reconstruction from projections.

Course outline:

1 3D Reconstruction from Multiview
   - Projective reconstructions
   - Affine reconstruction
   - Projective factorization
2 3D Reconstruction from Structured light projection
   - Calibration
   - Reconstruction
   - Image processing algorithms to unwrap the phase image
3 3D Reconstruction from motion analysis
   - Optical flow
   - 3D reconstruction from optical flow
4 Shape from Shading
   - Reflectance model
   - Minimization approaches
   - Propagation approaches
5 3D Reconstruction from Time-of-Flight
   - Principle
   - Cloud points processing
6 3D Reconstruction from Phase: Interferometry, Digital Holography
   - Recording
   - Reconstruction
7 Volumetric imaging from Multiple Projections: Tomography
   - Recording
   - Reconstruction

Lab experiments:
- Camera auto-calibration
- Shape from Shading
- Digital holography reconstruction
- Tomographic reconstruction
- Time of Flight cameras and 3D reconstruction
- 3D processing using Point Cloud Library
Teaching methods:
Lectures and lab classes.

Form(s) of Assessment: Form(s) of Assessment:
- Midterm exam
- Laboratory work report grading
- Final exam

Examination: Midterm exam (20%) – Final exam (30%) – Laboratory work (50%)

Literature and study materials:

Reference book:

Additional books:
- Ma, Soatto, Kosecka and Sastry Gavin Brelstaff, *An invitation to 3D vision* edited by CRS4 - Pula (CA) Sardinia Italy.

Additional information:
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