CIMET Human Vision and Computer Vision 2011-2012

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

Course instructors: Sérgio Nascimento & Juan Luis Nieves (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):

- Introduction to visual perception. Visual perception and the main components of the human visual system. The visual process: image formation, transduction, codification, retinal and cortical processing. Receptive fields, LGN and cortex processing. Basic numbers in human vision.
- Visual Optics. Optics of the eye, spherical and astigmatic ametropy, aberrations. Magnification. Accommodation. Contrast sensitivity.
- Photopic and scotopic vision. Photopic and scotopic vision: photopic, scotopic and mesopic vision. Spectral sensitivities and Purkinje Shift. Night myopia. Visual Fields, spatial and temporal summation. Perimetry.
- Colour perception. Fundamentals of colour perception: colour matching and the trichromacy, spectral sensitivities of photoreceptors. Hue cancellation and opponent colours. Colour constancy. Colour illusions. Acquired and inherited colour vision deficiencies.
- Spatial and temporal aspects of visual perception. Perception of objects and shapes. Perception of movement. Binocular vision and depth perception. Stereo acuity. Eye movements. Troxler phenomenon intensification.
- 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 flow structure from motion. Object recognition model-based methods. Appearance-based methods. Invariants.

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:
Foundations of vision, Brian A. Wandell, Sinauer Associates, 1995.

Eye, brain, and vision, David A. Hubel, W. H. Freeman & Co, 1988.

Color appearance models, Mark D. Fairchild, Addison-Wesley, 2005.

Principles of color technology, Roy S. Berns, Wiley-Interscience, 2000.

Sensation and Perception. E. Bruce Goldstein. 6th edition Wadsworth Publishing. ISBN: 0534639917, 2002

The image processing handbook, Fifth edition, John C. Russ, CRC Press, 2006.

Additional books:

Vision science: photons to phenomenology, Stephen E. Palmer, The MIT Press, 1999.

Visual space perception, Maurice Hershenson, The MIT Press, 1999.

The reproduction of colour, Robert W. G. Hunt, Voyageur Press, 2004.

Introduction to Visual Optics. Alan H. Tunnacliffe. Association of British Dispensing Opticians. ISBN 0-900099-28-1, 1993.

Computer Vision and Applications: A Guide for Students and Practitioners. Bernd Jahne. Academic Press, 2000.

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