COURSE MODULE – ADVANCE COLOUR IMAGE PROCESSING

COURSE CODE	COSI ACIP
COURSE LEVEL	Master
ECTS CREDITS	5
COURSE INSTRUCTOR/S	Miguel Angel Martínez Domingo; Eva Valero; +Several invited speakers that can vary each academic year.
EDUCATION PERIOD	SEMESTER 2
EXPECTED PRIOR-KNOWLEDGE	Color Science, Photonics and Optics Fundamentals, Image Processing and Analysis, Basics and Fundamentals with Matlab, Basics and Fundamentals on Statistics and Probability, Basic and Fundamentals on Mathematics for Data analysis, Signal and Image Processing. Basic skills in Matlab.
LANGUAGE OF INSTRUCTION	English

AIM

This course emphasizes advanced principles of image processing, with focusing in scientific as well as technical applications. We expect to cover topics such as advanced color image processing, fuzzy logic applied to image processing, High-Dynamic-Range imaging, image registration, multiscale representation of images, compression image standards, variational principles applied to the problem of labelling and image segmentation, and color constancy algorithms. 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. Lectures and lab classes, and up-to-date paper discussions and exercises as homework.

TEACHING ACTIVITIES

This course is based on flip-teaching, exchanges and discussions between students and instructors, lectures and practical session activities, as well as homework.

COURSE OUTLINE

(topic 1) Image compression.

(topic 2) HDR imaging.

(topic 3) Image registration: general framework and application to multispectral images

(*topic 4*) Variational techniques applied to the problem of color correction, image restoration and labelling

(*topic 5*) Fuzzy logic applied to image processing
(*topic 6*) Computational color constancy and color texture descriptors

PRACTICAL ACTIVITIES

Practical works (laboratory sessions and case studies) in order to implement concepts introduced in the lectures, to practice on real applications and to train students. Specific laboratory sessions include: HDR Imaging, Basic image registration with Matlab, Variational techniques, Fuzzy Logic for color images.

LEARNING OUTCOMES[1]

• *Knowledge* and *Comprehension* of the fundamentals, principles, applications, limits, relationships, of all concepts and topics covered by this course;
• *Application, Analysis, Synthesis* and *Evaluation* skills of the main concepts and topics covered by this course;
• Ability to apply/implement concepts and principles introduced in the lectures on practical tasks and on industrial study cases;
• Ability to self-learn, to understand some problems and to suggest/find solutions to solve these problems.
On completion of this course the students will be able to:

[1] The meaning of *keywords* in italic used to define Learning Outcomes are detailed in Annex.

• *Know the basic principles of image compression algorithms.* Build some parts of the compression code from scratch (like Huffman coding). Identify and describe the assets and limitation of the most common compression algorithms. Apply different kinds of algorithms to the same image and evaluate the quality of the final image.
• *Understand the principle of HDR imaging.* Describe some capture techniques and algorithms for computing the radiance map of an HDR capture. Use Debevec and Malik's algortihm to obtain and HDR imaging. Perform some basic tonemapping with Matlab.
• *Understand the main steps of the workflow of a typical image registration algorithm.* List some relevant control point extractors, feature descriptors, matching algorithms and optimization techniques for solving the registration problem (being aware of their applicability for basic cases and their limitations). Perform basic image transformations with Matlab, and perform basic image registration both with manual and automatic CP and feature extraction. Identify and list the inherent problems of registration applied to multispectral/hyperspecral images.
• *Understand the principles of variational calculus applied* to color correction, labellng and segmenting objects within a color image.
• *Understand what is a fuzzy system, and how fuzzy logic can be applied to grayscale and color image processing*. Perform some basic operations of fuzzy logic to particular instances of images for edge extraction or more complex image processing tasks.
• *Know the basic principles of color constancy and how it can be evaluated by psychophysical experiments*. Analyze the basic underlying ideas of two algorithms of color constancy: category correlation and surface matching. Describe relevant image texture descriptors within the context of image retrieval tasks. Perform basic feature descriptor building for color texture combining different spaces. Understand the theory behind advanced recent color texture descriptors.

FORM/S OF ASSESSMENT

Written exam (50%), Practical works (25%), Acquired skills (25%)

ASSESSMENT CRITERION

Written exam and Practical works

Excellent - outstanding performance	A
Very Good - above the average standard but with some errors	B
Good - generally sound work with a number of notable errors	C
Satisfactory - fair but with significant shortcomings	D
Sufficient - performance meets the minimum criteria	E
Fail - some more work required before the credit can be awarded	FX
Fail - considerable further work is required	F

Detail of criteria used to assess acquired skills :
• Activities and questionnaires giving evidence of knowing (5%)
• Activities and questionnaires giving evidence of comprehension/understanding (5%)
• Activities and questionnaires giving evidence of analysis (5%)
• Activities and questionnaires giving evidence of synthesis (5%)
• Activities and questionnaires giving evidence of evaluation (5%)

Excellent	A
Very Good - above the average standard	B
Good - generally sound well	C
Satisfactory - but with significant shortcomings	D
Sufficient - performance meets the minimum criteria	E
Fail - some more work required	FX
Fail - considerable further work is required	F

The evaluation of informal learning outcomes will be based on questionnaires and laboratory notebook (self-evaluation, learning diary).

LITERATURE AND STUDY MATERIALS

- The Essential Guide to Image Processing, Edited by Alan Bovik, Academic Press, (2009).
- Fuzzy Logic for beginners, Masao Mukaidono, World Press (2001)
- Color Image Processing and Applications, by Plataniotis et al. Springer-Verlag (2000)
- Still image and video compression with Matlab, K.S. Thyagarajan, John Wiley and Sons (2011)

- High Dynamic Range Imaging: acquisition, display and image lighting. Reinhard et al., Morgan Kaufmann (2010).
- Image Registration: Principles, tools and methods. A.A. Goshtasby, Springer (2012).

PDF versions of the slides and matlab codes for the class exercises will be distributed among the students to facilitate the learning process.

CONTACT DETAILS

Miguel Angel Martínez Domingo - Universidad de Granada (SPAIN)
E-mail: martinezm@ugr.es
Eva Valero Benito - Universidad de Granada (SPAIN)
E-mail: valerob@ugr.es
Office: n. 141, Edificio Mecenas, Departamento de Óptica, Facultad de Ciencias