Syllabus

Subject

Subject / Group	11302 - Image Processing and Applications / 1
Degree	Master's in Advanced Physics and Applied Mathematics
Credits	3
Period	2nd semester
Language of instruction	English

Professors

Lecturers	**Office hours for students**					
	Starting time	**Finishing time**	**Day**	**Start date**	**End date**	**Office / Building**
Bartomeu Coll Vicens tomeu.coll@uib.es	You need to book a date with the professor in order to attend a tutoring session.					
Ana Belén Petro Balaguer anabelen.petro@uib.es	12:30	13:30	Wednesday	02/09/2019	17/02/2020	D.111

Context

In the world of new technologies, digital images occupy a central place. Think of digital photography from camera commercial, medical images (X-rays, CT scan, magnetic resonance imaging, etc.), the images obtained from the video surveillance, satellite images that allow us to study on earth, etc.. On a formal level, an image is an application defined on the plane, such that each point (x, y) correspond to a value that makes what is known as gray level or intensity. In the color case, this value is in vector form (R,G,B) which means the Red, Green and Blue information of the image. A discrete or digital imaging comes from the continuous setting and it is defined as a finite sample of a set of small squares centered at the points (i, j). These squares (i, j) 's are called pixels and its associated value is the value of gray level or intensity.
This course will focus on mathematical models to study, between others, the following problems or topics:

to improve the contrast, to clean the image from the noise and disturbances suffered in the process of capture (denoising process), segmentation of the objects contained within the image and compression of the image in order to avoid problems in the transmission of the information.

The teachers:

B. Coll: Bartomeu Coll is full professor and head of the reserach group TAMI (Mathematical Processing and Analysis of Images). His interests focus on the restoration and digital image processing as well as the applications in the field of satellite images and digital photography.

A.B. Petro: Ana Belén Petro belongs to TAMI group. She is a doctor in mathematics from 2006 and her interests focus on the image restoration and appications mainly in the field of color image.

Requirements

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Essential

The specific requirements of the master

Recommended

The specific requirements of the master

Skills

Specific

* EMA5: Capacity to perform the various steps in the process of mathematical modeling in image processing courses: problem statement, experimentation / testing, mathematical modeling, simulation / program, discussion of results and refinement / model rethinking
* EMA6: Learn to determine in the field of digital images if the model of a given problem is well formulated and it is mathematically well-posed in a suitable functional framework.
* CE1 - Students must possess the learning skills that enable them to combine specialized knowledge in Astrophysics and Relativity, Geophysical Fluids, Materials Physics, Quantum Systems or Applied Mathematics, with the versatility that provides an open training curriculum..
* CE2 - Students must possess the ability to use and adapt mathematical models to describe physical phenomena of different nature
* CE3 - To acquire edge-line knowledge in the international scientific research context and demonstrate a full comprehension of theoretical and practical aspects, together with the scientific methodology.

Generic

* CG1: Systematic understanding of a field of study and mastery of skills and methods of research associated with that field.
* CB6 - Possess the knowledge and its understanding to provide the basis or opportunity to be original in developing and/or applying ideas, often within a research context
* CB7 - Students can apply the broader (or multidisciplinary) acquired knowledge and ability to solve problems in new or unfamiliar environments within contexts related to their field of study
* CB9 - Students can communicate their knowledge to specializaed and non-specialized audiences in a clear way and without ambiguities.
* CB10 - Students gain the learning skills that enable them to continue studying in a way that will be largely self-directed or autonomous

Basic

* You may consult the basic competencies students will have to achieve by the end of the Master's degree at the following address: http://estudis.uib.cat/master/comp_basiques/

Content

Range of topics

0. Introduction

Image formation, image representation

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1. Fourier transform and Sampling.
   The 2-D Discrete Fourier Transform

   Sampling. The Shanon theorem

   Filtering in the Frequency domain.
2. Local operators and PDE's
   Edge contourn detection: multiscale theory, classical approach (Canny), LSD model

   Denoising: heat equation, mean curvature motion, total variation

   From local operators to non-local: NL-means, NL-Bayer,
3. Segmentation
   K-means

   Mumford-Shah, Region growing, Region merging, etc.

   Graph-cuts
4. Compression
   Losless compression: png

   PG, DCT, JPEG, JPEG2000

Teaching methodology

In-class work activities (1.2 credits, 30 hours)

Modality	Name	Typ. Grp.	Description	Hours
Theory classes	Lectures	Large group (G)	In this activity, we will give the theoretical background of the subjects.	14
Practical classes	Practical classes	Medium group (M)	In this activity, the students will do the problems/activities proposed in each subject. In this activity, skills EMA5 and EMA6 will be evaluated.	10
Laboratory classes	Computer laboratory	Medium group (M)	In this activity, from IPOL and MatLab software, the students will do a set of practices. In this activity, skills EMA5 and EMA6 will be evaluated.	6

At the beginning of the semester a schedule of the subject will be made available to students through the UIBdigital platform. The schedule shall at least include the dates when the continuing assessment tests will be conducted and the hand-in dates for the assignments. In addition, the lecturer shall inform students as to whether the subject work plan will be carried out through the schedule or through another way included in the Aula Digital platform.

Distance education tasks (1.8 credits, 45 hours)

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Modality	Name	Description	Hours
Group or individual self-study	Individual self-study or group	In this activity, students will perform a work proposed at the beginning of the course. In this activity, skills CE3, EMA5, EMA6 and CG1 will be evaluated.	45

Specific risks and protective measures

The learning activities of this course do not entail specific health or safety risks for the students and therefore no special protective measures are needed.

Student learning assessment

Frau en elements d'avaluació

In accordance with article 33 of Regulation of academic studies, "regardless of the disciplinary procedure that may be followed against the offending student, the demonstrably fraudulent performance of any of the evaluation elements included in the teaching guides of the subjects will lead, at the discretion of the teacher, a undervaluation in the qualification that may involve the qualification of "suspense 0" in the annual evaluation of the subject".

Practical classes

Modality	Practical classes
Technique	Short-answer tests **(non-retrievable)**
Description	In this activity, the students will do the problems/activities proposed in each subject. In this activity, skills EMA5 and EMA6 will be evaluated.
Assessment criteria	

Final grade percentage: 25%

Computer laboratory

Modality	Laboratory classes
Technique	Papers and projects **(non-retrievable)**
Description	In this activity, from IPOL and MatLab software, the students will do a set of practices. In this activity, skills EMA5 and EMA6 will be evaluated.
Assessment criteria	

Final grade percentage: 25%

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Individual self-study or group

Modality	Group or individual self-study
Technique	Papers and projects **(retrievable)**
Description	In this activity, students will perform a work proposed at the beginning of the course. In this activity, skills CE3, EMA5, EMA6 and CG1 will be evaluated.

Assessment criteria

Final grade percentage: 50%

Resources, bibliography and additional documentation

The bibliography will follow during the course is based on some books on the subject in addition to scientific papers that will serve to the development of the course.

Basic bibliography

R.C. Gonzalez, R.E. Woods, S.L. Eddinds, Digital image processing using MatLab, 2on edition, ISBN 0982085400, 2009.

G. Aubert, P. Kornprobst, Mathematical Problems in Image Processing: Partial Differential Equations and the Calculus of Variations (Applied Mathematical Sciences), ISBN 0387322000, 2006.

Complementary bibliography

Research articles published in scientific journals and other resources.

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