

## 370549 - FOTOGRAF - Photography and Image Processing

Coordinating unit: 370 - FOOT - Terrassa School of Optics and Optometry  
Teaching unit: 731 - OO - Department of Optics and Optometry  
Academic year: 2019  
Degree: BACHELOR'S DEGREE IN OPTICS AND OPTOMETRY (Syllabus 2009). (Teaching unit Optional)  
ECTS credits: 6 Teaching languages: Catalan

### Teaching staff

Coordinator: Jaume Escofet Soteras (<http://futur.upc.edu/JaumeEscofetSoteras>)  
Others: María Sagrario Millán (<http://futur.upc.edu/MariaSagrarioMillanGarciaVarela>)

### Prior skills

Basic knowledge of Geometrical Optics

### Teaching methodology

Lectures by the professor, laboratory and field work, group work, exhibitions of student work.  
Use of specific software in class, in the computer room and in the proposed works.  
The two thematic parts of the subject (Photography and Image Processing) progress in parallel during the teaching period.

### Learning objectives of the subject

1. To know how pinhole camera works.
2. To know how digital camera works.
3. To make a pinhole camera.
4. To take pictures with a pinhole camera.
5. To know the developing process of the photographic paper in the laboratory.
6. To make photographic developing with paper in the laboratory.
7. To take pictures with the digital camera controlling the various settings of the shooting mode of the camera.
8. To measure the light in the scene by means of different exposimeters.
9. To know different techniques of photographic capture (Bracketing).
10. To perform panoramic and HDR photographs.
11. To know the basics of digital image and its contents of spatial, chromatic and temporal information.
12. To know the fundamental criteria of digital image processing based on the application: image improvement and analysis.
13. To understand the sequence of an image processing algorithm.
14. To know operations that improve the visualization of a digital image.
15. To know analysis operations that extract information and data from an image.
16. To know basic operations that compress, store, transmit and reproduce digital images, as well as their effects on the content of the image.
17. To know methodologies that operate in the spatial and frequency domain of an image.
18. To know the basics of morphologic operations.
19. To practice with different software applications (ImageJ and Photoshop).



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### Study load

Total learning time: 144h	Hours large group:	0h	0.00%
	Hours medium group:	42h	29.17%
	Hours small group:	18h	12.50%
	Guided activities:	0h	0.00%
	Self study:	84h	58.33%

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### Content

(ENG) -1. The photographic camera	Learning time: 8h Practical classes: 6h Self study : 2h
Description: 1. Types of cameras according to their lens: 1.1 Dioptric/catadioptric lens camera 1.1 Pinhole lens camera 2. Types of cameras according to their sensor: 2.1 Analogic camera 2.2 Digital 3. Elements of the camera: 3.1 The lens 3.2 The sensor 3.3 The exposure meter 3.4 The display	
(ENG) -3. The photographic image	Learning time: 4h Practical classes: 2h Self study : 2h
Description: 1. Focal and format 2. Camera kind 2.1 APS format and smart mobile phone format 2.2 Small format 2.2.1 The reflex camera 2.3 Medium Format 2.4 Large Format 3. Crop factor 4. Equivalent focal 5. Angular field 5.1 Wide angle lens 5.2 Normal lens 5.3 Telephoto lens 6. Image perspective 6.1 Perspective and focal 6.2 Deformations due to magnification	

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(ENG) -3. Image lighting	Learning time: 10h Practical classes: 3h Laboratory classes: 2h Self study : 5h
<p>Description:</p> <ol style="list-style-type: none"> <li>1. Exposure time t</li> <li>2. F-number f/#</li> <li>3. Sensor sensivity S</li> <li>4.The exposure</li> <li>5. The triangle t, f/#, S</li> <li>6. Image histogram</li> <li>7. Relationship L-N2 / t</li> <li>4. Noise and sensitivity</li> <li>7. Sensor sensitivity</li> <li>8. The exposure value (EV)</li> <li>9. Noise and sensitivity</li> <li>10. The gray card</li> <li>11. The exposure meter</li> <li>11.1 Light incident</li> <li>11.2 Light reflected</li> <li>12. White balance</li> </ol>	
(ENG) -4. Image sharpening	Learning time: 6h Practical classes: 2h Self study : 4h
<p>Description:</p> <ol style="list-style-type: none"> <li>1. The circle of tolerance</li> <li>2. Need for unsharp mask on a digital camera</li> <li>3. Depth of focus and field</li> <li>4. The hyperfocal distance</li> <li>5. Parameters that affect depth of field and focus.</li> <li>5. Relationship between depth of field and magnification</li> </ol>	

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(ENG) -5. The photographic system quality	Learning time: 7h Practical classes: 3h Laboratory classes: 1h Self study : 3h
Description: <ol style="list-style-type: none"> <li>1. Image resolution</li> <li>2. Measurement of image resolution</li> <li>3. Image contrast</li> <li>4. Measurement of image contrast</li> <li>5. The image sharpness</li> <li>6. Measurement of sharpness by means of MTF</li> <li>7. MTF measurement by the method of the slanted edge (SET)</li> <li>6. Quality parameters of photographic system</li> </ol>	
(ENG) -6. Digital imagin and image processing	Learning time: 6h Practical classes: 4h Laboratory classes: 2h
Description: <ol style="list-style-type: none"> <li>1. What is a digital image, what does it represent and what type of information it contains?</li> <li>2. What is image processing?</li> <li>3. Basic functions: Improvement and analysis of the image</li> <li>4. Processing levels of information: from "tweaks" to computer vision</li> <li>5. Scope of the fields of application of image processing</li> <li>6. Image processing algorithm: Sequence of operations. Preprocessing, segmentation, feature extraction, classification</li> <li>7. Representation of the image</li> <li>8. Relationship between the perception of the human visual system and the digital image</li> <li>9. Sampling, quantization and resolution of space information, intensity, color, time ...</li> <li>10. Ways to represent and work with a digital image</li> </ol>	
(ENG) -7. Image enhancement	Learning time: 6h Practical classes: 4h Laboratory classes: 2h
Description: <ol style="list-style-type: none"> <li>1. What does "improve" an image mean?</li> <li>2. Methods of image enhancement in space domain</li> <li>3. Histogram of an image</li> <li>4. Point operations based on the histogram</li> <li>5. Improvement of the contrast: Equalization and linear expansion of the histogram</li> <li>6. The noise, degradation of an image</li> <li>7. Random noise and deterministic noise (main types and description)</li> </ol>	

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<p>(ENG) -8. Filtering based on the environment of the neighbors</p>	<p>Learning time: 6h Practical classes: 4h Laboratory classes: 2h</p>
<p>Description:</p> <ol style="list-style-type: none"> <li>1. Convolution, filters, size and shape of the mask, kernel.</li> <li>2. Smoothing filters</li> <li>3. Filters to improve contours</li> <li>4. Filters to detect edges</li> </ol>	
<p>(ENG) -9. Spatial frequencies domain transformation</p>	<p>Learning time: 5h Practical classes: 4h Laboratory classes: 1h</p>
<p>Description:</p> <ol style="list-style-type: none"> <li>1. Meaning of the Fourier Transform of a digital image</li> <li>2. Distribution of information in the frequency domain</li> <li>3. Examples and cases to interpret according to the content of the image: size and orientation, contours, sharpness, frames or periodic elements, textures ...</li> </ol>	
<p>(ENG) -10. Filtering in the spatial frequency domain</p>	<p>Learning time: 4h Practical classes: 3h Laboratory classes: 1h</p>
<p>Description:</p> <ol style="list-style-type: none"> <li>1. Removing filters: Low-pass and High-pass</li> <li>2. Removing filters to suppress or highlight a periodic plot</li> <li>3. Smoothing operations, contrast modification, contour improvement and edge extraction in the frequency domain.</li> </ol>	
<p>(ENG) -11. Image morphology</p>	<p>Learning time: 5h Practical classes: 3h Laboratory classes: 2h</p>
<p>Description:</p> <ol style="list-style-type: none"> <li>1. Basic operations of morphology in binary images: erosion, dilation.</li> <li>2. "Opening" and "closing" operations</li> <li>3. Image enhancement operations, noise removing, edge extraction, etc. using images morphology operations.</li> </ol>	

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### Qualification system

Continous evaluation.

Final mark: NF

Mark corresponding to photography part: N1

$$N1=0.3 \cdot E1+0.6 \cdot T1+0.1 \cdot A1$$

E1: Theory exam; T1: Proposed works; A1: Assistance.

Mark corresponding to image processing part: N2

$$N2=0.4 \cdot E2+0.4 \cdot T1+0.2 \cdot A1$$

E2: Theory exam; T2: Practic individual test; A2: Assistance.

Nota final: NF

$$NF = 0,5 \cdot N1 + 0,5 \cdot N2$$

### Bibliography

Basic:

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Jacobson, R. E. [et al.]. Manual de fotografia: fotografia e imagen digital. 9ª ed. Barcelona: Omega, 2002. ISBN 8428212813.

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Langford, M.J. Tratado de fotografia: un texto avanzado para profesionales. Barcelona: Omega, 1976.

London, Barbara; Upton, John. Photography. 5th ed. New York: HarperCollins College Publishers, cop. 1994. ISBN 0673522237.

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Fiete, Robert D. Modeling the imaging chain of digital cameras [on line]. Bellingham, Wash.: SPIE Press, 2010 [Consultation: 29/01/2019]. Available on:

<[https://discovery.upc.edu/iii/encore/record/C\\_\\_Rb1510253\\_\\_SModeling%20the%20imaging%20chain%20of%20digital%20cameras%20Robert%20Fiete\\_\\_Orighresult\\_\\_U\\_\\_X2?lang=cat&suite=def](https://discovery.upc.edu/iii/encore/record/C__Rb1510253__SModeling%20the%20imaging%20chain%20of%20digital%20cameras%20Robert%20Fiete__Orighresult__U__X2?lang=cat&suite=def)>. ISBN 9780819483393.

Solomon, Chris; Breckon, Toby. Fundamentals of digital image processing: a practical approach with examples in Matlab. Chichester: Wiley-Blackwell, 2011. ISBN 9780470844724.

Dougherty, Edward R; Lotufo, Roberto A. Hands-on morphological image processing. Bellingham, Wash: SPIE Press, 2003. ISBN 9780819447203.

Others resources:

Image editor Photoshop

Image editor ImageJ

Image editor

Analogic cameras (Praktica, Zenith, Ricoh)

Set of elements for the development of negatives and paper

Photographic enlarger