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 exposure meters.
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).
## Study load

<table>
<thead>
<tr>
<th></th>
<th>Hours large group:</th>
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<th>Hours medium group:</th>
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<th>Hours small group:</th>
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<th>Guided activities:</th>
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<th>Self study:</th>
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<tbody>
<tr>
<td><strong>Total learning time:</strong></td>
<td>144h</td>
<td></td>
<td>0h</td>
<td>0.00%</td>
<td>42h</td>
<td>29.17%</td>
<td>18h</td>
<td>12.50%</td>
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## Content

<table>
<thead>
<tr>
<th>(ENG) - 1. The photographic camera</th>
<th>Learning time: 8h</th>
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<tbody>
<tr>
<td></td>
<td>Practical classes: 6h</td>
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<tr>
<td></td>
<td>Self study: 2h</td>
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**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

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<tr>
<th>(ENG) - 3. The photographic image</th>
<th>Learning time: 4h</th>
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<tr>
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<td>Practical classes: 2h</td>
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<tr>
<td></td>
<td>Self study: 2h</td>
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**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
### (ENG) - 3. Image lighting

**Description:**
1. Exposure time $t$
2. F-number $f/#$
3. Sensor sensitivity $S$
4. The exposure
5. The triangle $t$, $f/#$, $S$
6. Image histogram
7. Relationship $L-N^2/t$
8. Noise and sensitivity
9. Sensor sensitivity
10. The exposure value (EV)
11. Noise and sensitivity
12. The gray card
13. The exposure meter
14. Light incident
15. Light reflected
16. White balance

**Learning time:** 10h
- Practical classes: 3h
- Laboratory classes: 2h
- Self study: 5h

### (ENG) - 4. Image sharpening

**Description:**
1. The circle of tolerance
2. Need for unsharp mask on a digital camera
3. Depth of focus and field
4. The hyperfocal distance
5. Parameters that affect depth of field and focus.
6. Relationship between depth of field and magnification

**Learning time:** 6h
- Practical classes: 2h
- Self study: 4h
### 5. The photographic system quality

**Learning time:** 7h  
**Practical classes:** 3h  
**Laboratory classes:** 1h  
**Self study:** 3h

**Description:**
1. Image resolution  
2. Measurement of image resolution  
3. Image contrast  
4. Measurement of image contrast  
5. The image sharpness  
6. Measurement of sharpness by means of MTF  
7. MTF measurement by the method of the slanted edge (SET)  
8. Quality parameters of photographic system

### 6. Digital image and image processing

**Learning time:** 6h  
**Practical classes:** 4h  
**Laboratory classes:** 2h

**Description:**
1. What is a digital image, what does it represent and what type of information it contains?  
2. What is image processing?  
3. Basic functions: Improvement and analysis of the image  
4. Processing levels of information: from "tweaks" to computer vision  
5. Scope of the fields of application of image processing  
6. Image processing algorithm: Sequence of operations. Preprocessing, segmentation, feature extraction, classification  
7. Representation of the image  
8. Relationship between the perception of the human visual system and the digital image  
9. Sampling, quantization and resolution of space information, intensity, color, time ...  
10. Ways to represent and work with a digital image

### 7. Image enhancement

**Learning time:** 6h  
**Practical classes:** 4h  
**Laboratory classes:** 2h

**Description:**
1. What does "improve" an image mean?  
2. Methods of image enhancement in space domain  
3. Histogram of an image  
4. Point operations based on the histogram  
5. Improvement of the contrast: Equalization and linear expansion of the histogram  
6. The noise, degradation of an image  
7. Random noise and deterministic noise (main types and description)
<table>
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<th>Component</th>
<th>Learning time</th>
<th>Description</th>
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| **(ENG) -8. Filtering based on the environment of the neighbors** | **6h** | Practical classes: 4h
Laboratory classes: 2h |
| **Description:** |  | 1. Convolution, filters, size and shape of the mask, kernel.  
2. Smoothing filters  
3. Filters to improve contours  
4. Filters to detect edges |
| **(ENG) -9. Spatial frequencies domain transformation** | **5h** | Practical classes: 4h
Laboratory classes: 1h |
| **Description:** |  | 1. Meaning of the Fourier Transform of a digital image  
2. Distribution of information in the frequency domain  
3. Examples and cases to interpret according to the content of the image: size and orientation, contours, sharpness, frames or periodic elements, textures ... |
| **(ENG) -10. Filtering in the spatial frequency domain** | **4h** | Practical classes: 3h
Laboratory classes: 1h |
| **Description:** |  | 1. Removing filters: Low-pass and High-pass  
2. Removing filters to suppress or highlight a periodic plot  
3. Smoothing operations, contrast modification, contour improvement and edge extraction in the frequency domain. |
| **(ENG) -11. Image morphology** | **5h** | Practical classes: 3h
Laboratory classes: 2h |
| **Description:** |  | 1. Basic operations of morphology in binary images: erosion, dilation.  
2. "Opening" and "closing" operations  
3. Image enhancement operations, noise removing, edge extraction, etc. using images morphology operations. |
Continuous evaluation.
Final mark: NF
Mark corresponding to photography part: N1
\[ N1 = 0.3 \times E1 + 0.6 \times T1 + 0.1 \times A1 \]
Mark corresponding to image processing part: N2
\[ N2 = 0.4 \times E2 + 0.4 \times T2 + 0.2 \times A1 \]
Nota final: NF
NF = 0.5 \times N1 + 0.5 \times N2

Bibliography

Basic:

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

Others resources:

- Image editor Photoshop
- Image editor ImageJ
- Analogic cameras (Praktica, Zenith, Ricoh)
- Set of elements for the development of negatives and paper
- Photographic enlarger