310625 - Digital Image Processing

Coordinating unit: 310 - EPSEB - Barcelona School of Building Construction
Teaching unit: 751 - DECA - Department of Civil and Environmental Engineering
Academic year: 2018
Degree: BACHELOR'S DEGREE IN GEOPHYSICS AND GEOMATICS ENGINEERING (Syllabus 2016).
ECTS credits: 6
Teaching languages: Catalan

Teaching staff
Coordinator: ALBERT PRADES VALLS

Degree competences to which the subject contributes

Specific:
1. Capacity of spatial vision and knowledge of the graphic representation techniques, for traditional methods of metric and geometric geometry but also for applications of assisted design by a computer.
2. Capacity for the resolution of mathematical problems that can be set out in engineering. Aptitude to apply the knowledge about: linear algebra, geometry, differential geometry, differential and integral calculus, differential equations and in partial derivatives, numeric methods, numeric algorithm, statistics and optimization.
3. Knowledge, application and analysis of the processes of treatment of digital images and special information, proceeding from airborne and satellite sensors.
4. Knowledge, use and application of the treatment techniques. Analysis of special data. Study of models applied to the engineering and architecture.
5. Knowledge, use and application of instruments and appropriate photogrametric methods for the fulfillment of cartographic.
6. Basic knowledge about use and computer programming, operative systems, databases and software programs with application in the engineering.
7. (ENG) Planificació, projecte, direcció, execució i gestió de processos de mesura, sistemes d’informació, explotació d’imatges, posicionament i navegació; modelització, representació i visualització de la informació territorial en, sota i sobre la superfície terrestre.

Generic:
10. Use of teams and instrumental: Capacity to select the necessary resources to achieve the planned goals according to the quality requirements. Use of the teams, in adequate conditions, with professional efficiency and taking into account the limitations of the instruments and its context of use, in relation with the required precisions.

Transversal:
8. EFFICIENT ORAL AND WRITTEN COMMUNICATION - Level 1. Planning oral communication, answering questions properly and writing straightforward texts that are spelt correctly and are grammatically coherent.
9. TEAMWORK - Level 1. Working in a team and making positive contributions once the aims and group and individual responsibilities have been defined. Reaching joint decisions on the strategy to be followed.
10. EFFECTIVE USE OF INFORMATION RESOURCES - Level 1. Identifying information needs. Using collections, premises and services that are available for designing and executing simple searches that are suited to the topic.

Teaching methodology

The guided learning hours consist in, give theoretic classes (big group) where the professor does a brief exposition to introduce the general goals of learning related with the basic concepts of the subject. Afterwards and by practical exercises, the professor tries to motivate and involve the students to make them participate in its learning.
310625 - Digital Image Processing

Learning objectives of the subject

It is pretended that the student acquires the enough knowledge to operate with digital images in order to be able to, the subjects of superior courses related with the photogrametry and remote surveying.

Study load

<table>
<thead>
<tr>
<th>Total learning time: 150h</th>
<th>Hours large group:</th>
<th>24h</th>
<th>16.00%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hours medium group:</td>
<td>36h</td>
<td>24.00%</td>
</tr>
<tr>
<td></td>
<td>Self study:</td>
<td>90h</td>
<td>60.00%</td>
</tr>
</tbody>
</table>
310625 - Digital Image Processing

## Content

### Digital image

**Description:**
The subject starts with the basic topic of digital image:
- Introduction with the digital image.
- Sensors, formative image system, codification.
- Noise in the image: of lecture, termic, from different efficiency, etc.
- Vision systems: monoscopic and estereoscopic.

**Related activities:**
- Activity 1
- Activity 2

<table>
<thead>
<tr>
<th>Learning time: 30h</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theory classes: 6h</td>
</tr>
<tr>
<td>Practical classes: 6h</td>
</tr>
<tr>
<td>Laboratory classes: 0h</td>
</tr>
<tr>
<td>Self study : 18h</td>
</tr>
</tbody>
</table>

### Treatment of digital image

**Description:**
In this chapter is introduced the bases of image basic treatment.
1) Definition of histogram: Changes of histogram: linear, logarithmic, square root, equalization.
2) Screen in the image space: the product of convolution, filters based in the average.
3) The transformed of Fourier, theorem of sample, screen in the frequence space.
4) Image quality, compression of images

**Related activities:**
- Activity 3

<table>
<thead>
<tr>
<th>Learning time: 45h</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theory classes: 6h</td>
</tr>
<tr>
<td>Practical classes: 12h</td>
</tr>
<tr>
<td>Laboratory classes: 0h</td>
</tr>
<tr>
<td>Self study : 27h</td>
</tr>
</tbody>
</table>
### Image matching

**Learning time:** 45h  
Theory classes: 6h  
Practical classes: 12h  
Laboratory classes: 0h  
Self study: 27h

**Description:**  
For some photogrammetric applications are necessary some methods to automate processes. In this chapter are seen some methods to identify correspondences between two or more frames.  
1) Methods based in areas: correlation and minimum quadratic adjustment.  
2) Methods based in correspondences of characteristics: detection of points and characteristics of interest, correspondence between characteristics.  
3) Operators SIFT and SURF, definition of characteristics, correspondences in relation to these characteristics.  

**Related activities:**  
Activity 4

### Multispectral images

**Learning time:** 30h  
Theory classes: 6h  
Practical classes: 6h  
Laboratory classes: 0h  
Self study: 18h

**Description:**  
In this chapter will be seen some treatment methods of multispectral image:  
Transformation of principle components, tasseled-head, index of vegetation, quotient of bands.  

**Related activities:**  
Activity 5
### Planning of activities

| ACTIVITY 1 | **Hours:** 1h  
**Practical classes:** 1h |
|-------------|--------------------------------------------------|
| **Description:** | Basic use of the program that will be used in the practices of the subject  
**Support materials:** | The documentation will be in Atenea. The exercise will be done in the calculus center.  
**Descriptions of the assignments due and their relation to the assessment:** | The activity will take place during the first week and is not evaluated.  
**Specific objectives:** | At the end of the practice the student must be capable of using minimally the tools that will be used during the whole course. |

| ACTIVITY 2 | **Hours:** 3h 30m  
**Practical classes:** 2h  
**Laboratory classes:** 1h 30m |
|-------------|--------------------------------------------------|
| **Description:** | Will be solved a collection of basic introduction exercises to the digital images where the topics will be seen:  
· Spacial and spectral discretization: measurements of an image, digital levels, etc.  
· Basic statistics on an image: histogram, medium values, average, covariance matrix.  
· Changes of histogram: linears, square root, logarythmic, equation and estereocopic vision.  
**Support materials:** | The documentation will be in Atenea. The exercise will be done in the calculus center.  
**Descriptions of the assignments due and their relation to the assessment:** | The activity will take place between the second and the fouth week and is evaluated with a 10% of the final mark.  
**Specific objectives:** | At the end of the practice the student must be capable of doing improvements in the digital images using the changes of histogram and build with a stereoscopic even, a tridimensional image. |

| ACTIVITY 3 | **Hours:** 6h  
**Practical classes:** 3h  
**Laboratory classes:** 3h |
|-------------|--------------------------------------------------|
| **Description:** | Application of different filters to the images and check their deffects.  
**Support materials:** | The documentation will be in Atenea. The exercise will be done in the calculus center.  
**Descriptions of the assignments due and their relation to the assessment:** | The activity will take place during the fifth and seventh week and is evaluated with a 10% of the final mark. |
### Specific objectives:
About an image with some type of defect, the student must know which type of screen is the most adequate to correct it.

### MIDTERM EXAM
| Hours: 1h |
| Theory classes: 1h |

**Description:**
Written midterm exam evaluated

**Descriptions of the assignments due and their relation to the assessment:**
The activity will take place during the seventh or eighth week and is evaluated with a 20% of the final mark.

### ACTIVITY 4
| Hours: 5h |
| Practical classes: 3h |
| Laboratory classes: 2h |

**Description:**
Application of even methods to find correspondence between images.

**Support materials:**
The documentation will be in Atenea. The exercise will be done in the calculus center.

**Descriptions of the assignments due and their relation to the assessment:**
The activity will take place during the ninth and the eleventh week and is evaluated with a 10% of the final mark.

### ACTIVITY 5
| Hours: 5h |
| Practical classes: 3h |
| Laboratory classes: 2h |

**Description:**
Application of global transformations in a multispectral image.

**Support materials:**
The documentation will be in Atenea. The exercise will be done in the calculus center.

**Descriptions of the assignments due and their relation to the assessment:**
The activity will take place during the twelfth and the fourteenth week and is evaluated with a 10% of the final mark.

### FINAL EXAM
| Hours: 1h |
| Theory classes: 1h |

**Description:**
Written final exam evaluated

**Support materials:**
The activity will take place at the end of the course and is evaluated with a 40% of the final mark.
Qualification system

The final qualification is the addition of the following partial qualifications:

Final mark = 0.1 * activity 2 + 0.1 * activity 3 + 0.1 * activity 4 + 0.1 * activity 5 + 0.2 * midterm exam + 0.4 * final exam

Bibliography

Basic:

