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ACQUISITION, RECONSTRUCTION AND INVERSE PROBLEM

1. SYLLABUS INFORMATION

1.1. Course title
Acquisition, Reconstruction and Inverse Problem

1.2. University
Université de Bordeaux

1.3. Semester
2nd year, 1st semester

2. COURSE DETAILS

2.1. Course nature
Compulsory

2.2. ECTS Credit allotment
6

2.3. Recommendations
Basic knowledge in linear algebra and Fourier transform, C/C++ programming.

2.4. Faculty data
Prof. Pascal Desbarats - LaBRI - firstname.lastname@u-bordeaux.fr
Prof. Jean-François Giovanelli - IMS - firstname.lastname@u-bordeaux.fr

3. COMPETENCES AND LEARNING OUTCOMES

3.1. Course objectives

The goal of this course is to understand the principles of 2D/3D imaging, from physics and acquisition to image reconstruction, analysis, and visualization. It gives an overview of several imaging modalities and it is exemplified through a variety of application fields (medical, astrophysical, remote-sensing,…). The course deals with question such as: 2D/3D deconvolution, depth map reconstruction, Fourier synthesis, inverse Radon,… and resort to numerical optimization and variational techniques for criterion including penalties and constraints. The students will learn how to implement a processing chain from the physical acquisition of data to the visualisation and analysis of images. They will also understand the specificities of stereoscopic, volumetric and surfacic 3D images.

3.2. Course contents

1. Volumetric Imaging (voxel images)
   - From Radiography to CT scan
   - MRI and its different modalities
   - Nuclear medicine imaging (SPECT, PET)

2. Surfacic and Depth Imaging (point clouds, meshes, depth maps)
   - Laser scan
   - Stereo and depth camera
   - Mono camera

3. Linear solutions
   - Inverse filtering
   - Wiener filtering and Tikhonov penalty
   - Numerical results and examples of application

4. Convex and constrained approaches
   - Half-quadratic approaches and Legendre-Fenchel transform
   - Lagrangian and ADMM
   - Numerical results and examples of application

3.3. Course bibliography

- N. Barrie Smith and A. Smith, « Introduction to Medical Imaging: Physics, Engineering and Clinical Applications », Cambridge University Press, 2010

- T. Luhmann, S. Robson, S. Kyle, J. Boehm. « Close-Range Photogrammetry and 3D Imaging », De Gruyter Editions, 2014

- M. Bertero and P. Boccacci, "Introduction to Inverse Problems in Imaging", CRC Press, 2002

- J.-F. Giovannelli, and J. Idier, "Regularization and Bayesian Methods for Inverse Problems in Signal and Image Processing", ISTE Ltd and John Wiley & Sons Inc, February 2015.

4. TEACHING-AND-LEARNING METHODOLOGIES AND STUDENT WORKLOAD

4.1. List of training activities

Activity	Hours
Lectures	20
Practical work	8
Tutored computer lab	20
Exam	1,5

5. EVALUATION PROCEDURES AND WEIGHT OF COMPONENTS IN THE FINAL GRADE

Part 1:

- Lab assignments: 50%
- Exam: 50%

Part 2:

- Practical work: 33,3%
- Exam: 66,6%