Computational imaging

Component

École Nationale Supérieure d'Électrotechnique d'Électronique d'Informatique d'Hydraulique et des Télécommunications

In brief

> **Ametys Code:** M34HO9QB

> **Open to exchange students:** Yes

Presentation

Objectives

This course focuses on the design of numerical methods dedicated to solving inverse problems in imaging. Students will explore a wide range of tools used at each stage of this process: from modelling image formation processes to formalising inverse problems, including issues related to discretisation. Particular attention will be paid to the links between these different components and how they work together to design methods that are both robust and effective.

Description

The course consists of six lectures (with time devoted to exercises) and two tutorials. The course outline is as follows.

1 Physics of imaging

    1.1 A generic direct model

    1.2 Some physics concepts (diffraction, X-ray transform)

    1.3 Digitisation

2 From continuous to discrete

    2.1 General principle

    2.2 Efficient matrix-vector products (sparse/banded/Toeplitz/low-rank matrices)

    2.3 Discretisation errors

3 Ill-posed inverse problems

    3.1 Failure of direct inversions

    3.2 Generalised inverses

    3.3 Inversion stabilisation (filtering of singular systems)

4 Bayesian formulation of an inverse problem

    4.1 The parametric statistics perspective (MAP)

    4.2 Examples of observation likelihood

    4.3 Approximations of data attachments (l2-weighted, non-linear transformations, pre/post-processing)

5 Examples of regularisation functions

    5.1 Tikhonov

    5.2 Total variation

    5.3 Parsimony in a basis

Pre-requisites

Algebra, Analysis, Statistics, Introduction to inverse problems, Optimisation.