Doctoral Course

"Time-frequency analysis: basis and recent advances"

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Short Abstract: In this course, we will first recall basic notions on Fourier analysis and time-frequency analysis. The emphasis will then be put on recent developments, mainly reassigment techniques and synchrosqueezing. Finally, lab sessions will end the course.

Course Contents in brief:

- **Topic 1: From Fourier analysis to time-frequency analysis**

  Main Fourier techniques (Fourier transform, Fourier series (DFT),…), emphasis will be put on the relation between discrete and continuous formulation.

  Motivations for time-frequency analysis: short-time Fourier transform, wavelet transform (comparative discussion of these two types of time-frequency analysis, presentation of the main properties of wavelet transforms: vanishing moments, compact support,etc…)

  Discretization of time-frequency operators.

- **Topic 2: Recent developments of time-frequency techniques reassignment techniques and synchrosqueezing**

  Motivation: multicomponent signals are ubiquitous (audio-signal (musicology), echolocation calls, fetal ECG, PCG…), and are associated with specific time-frequency (TF) signatures, which is informative on the signal behavior.

  Retrieval of time-frequency signature using reassignment techniques: presentation of reassignment techniques both in the wavelet and short-time Fourier transform context.

  Extension of reassignment to synchrosqueezing technique, enabling not only determination of TF signatures of the components but also their reconstruction. Presentation of some recent developments (adaptation of synchrosuqeezing to strongly modulated signals). Practical implementation will also be discussed.

- **Topic 3: Lab hours**

  Analysis of different types of signals by means of time-frequency technique and synchrosqueezing.

The students will be given (or will bring) signals and then analyze them with the techniques discussed above.

Matlab routines will be given to assist them. The goal is to help them understand how to use these techniques in their research.

Total # of hours: 20 hours

References:

[1] Time-frequency/time-scale analysis, Patrick Flandrin, Academic press.
[2] Fourier analysis and applications: filtering, numerical computation, Wavelets, Claude Gasquet and Patrick Witomski, Springer.

CV of the Teacher

see attached CV

Room and Schedule

Room: *Aula Riunioni del Dipartimento di Ingegneria dell'Informazione, Via G. Caruso 16, Pisa – Ground Floor*

Schedule:

- 21 maggio 2018: 9:30 - 13:30

- 22 maggio 2018: 14:30 - 18:30

- 23 maggio 2018: 9:30 - 13:30

- 24 maggio 2018: 9:30 - 13:30

- 25 maggio 2018: 9:30 - 13:30