Module Description, available in: EN

Statistical Digital Signal Processing and Modeling

General Information

Number of ECTS Credits
3

Module code
TSM_StatDig

Valid for academic year
2021-22

Last modification
2020-12-24

Coordinator of the module
Guido Schuster (OST, guido.schuster@ost.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

	Lausanne			Lugano	Zurich		
Instruction					**X** E 100%		
Documentation					**X** E 100%		
Examination					**X** E 100%		

Module Category
TSM Technical scientific module

Lessons
2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

Understanding of the following concepts at the Bachelor of Science level

- Calculus
- Linear algebra
- Probability/Statistics
- Digital signal processing

Brief course description of module objectives and content

The goal of this module is to introduce the students to the powerful world of statistical digital signal processing. While at the bachelor level digital signal processing is most often taught with deterministic signals, in the real world most interesting signals are stochastic in nature. Hence in more advanced applications, such as prediction or noise removal, the theories presented in this module are essential.

The basic digital signal processing, linear algebra and probability theory necessary to understand the module are brushed-up at the beginning. Then stochastic processes are introduced which allows the proper formulation of the optimal filtering and spectral estimation problem later on. After an in-depth treatment of the optimal filtering and estimation problem, adaptive filters are introduced which are a popular choice for many advanced statistical digital signal processing problems.

Aims, content, methods

Learning objectives and acquired competencies

- The student becomes familiar with stochastic signals and systems
- The student understands and can apply the different methods for signal modeling
- The student has an in-depth understanding of Wiener filtering and knows how a discrete Kalman filter can be used to solve a stochastic filtering problem
- The student understands and can apply the different methods for spectrum estimation
- The student knows the most common adaptive filters and is able to select the proper one for the application at hand

Contents of module with emphasis on teaching content

The module starts with a review of basic digital signal processing, linear algebra and probability theory. It then introduces some concepts about stochastic processes, which are necessary to understand the following applications of statistical signal processing. Then the module discusses several different ways of signal modeling which can be used for parametric methods later on. Then one of the core topics is presented, which is the optimal linear mean square error estimation of a signal which is corrupted by additive noise. The module then presents a chapter about the very important topic of spectral estimation and finally concludes with the application of the learned theory for designing adaptive filters.
The available 14 weeks are organized as follows:
- 2 weeks: Background (review of digital signal processing and linear algebra)
- 3 weeks. Discrete-time random processes (including a review of probability)
- 2 weeks: Signal modeling
- 3 weeks: Wiener filtering (including the discrete Kalman Filter)
- 2 weeks: Spectrum estimation
- 2 weeks: Adaptive filtering

Teaching and learning methods

- A three hour session each week for 14 weeks
- The first hour is a homework review session where the homework is discussed. The homework is "paper and pencil" homework and small Matlab programming assignments
- The next two hours are lecture hours, where new theory is introduced

Literature

"Statistical Digital Signal Processing and Modeling" by Monson H. Hayes

Assessment

Certification requirements

Module does not use certification requirements

Basic principle for exams

As a rule, all the standard final exams for modules and also all resit exams are to be in written form

Standard final exam for a module and written resit exam

Kind of exam

written

Duration of exam

120 minutes

Aids permitted as specified below:

No aids permitted

Open book

Special case: Resit exam as oral exam

oral

30 minutes

No aids permitted