SGN-9906 Short graduate course *Signal Processing Based on Projection Method*

Teacher: Assoc. Prof. Masahiro Yukawa (Niigata University)

Dates: 20.8 – 24.8.2012 (2 credits)

Abstract

Adaptive filter is a fundamental tool to estimate —and keep tracking— time-varying unknown parameters in real time. The theory of adaptive filtering has its origin in the study of linear estimation, whose history goes back at least to the 17th century. The adaptive filter has many applications in a variety of areas such as communications, radar, sonar, acoustics, navigation, seismology, biomedical engineering, and financial engineering. Due to the recent diversification and advancement of adaptive filtering applications, a great deal of effort has been devoted to establish a more and more efficient algorithm and a promising analytic-framework.

Outline

The course will consist of three parts, each of which is described below.

Part 1 includes an introduction to adaptive filtering, classical approaches (least mean square, recursive least squares), advantages and disadvantages of each method, and a few basics of mathematics that we need in learning more sophisticated algorithms.

Part 2 starts with the normalized least mean square (NLMS) algorithm with emphasis on its geometric property. Also it introduces the affine projection algorithm (APA), an extension of NLMS, with our focus on its similarity to the method of projection onto convex sets (POCS), which is popular in image/signal processing. The similarity delivers a parallel projection algorithm which enjoys several nice properties.

Part 3 focuses on the similarity between the NLMS algorithm and the projected subgradient method (Polyak 1969) for minimizing a nonsmooth cost function under a convex constraint. The similarity allows us to build up a very general and promising framework to analyze various types of adaptive filtering algorithms including NLMS, APA, and the parallel projection algorithm.

Timetable

Monday 20.8.2012

[14:15-15:45 in TB222] Introduction to Projection Method

Tuesday 21.8.2012

[14:15-15:45 in TB222] Basics of Vector Space

Wednesday 22.8.2012

[14:15-15:45 in TB222] Orthogonal Projection Method

[15.45-16:15] Break

[16:15-17:00 in TC303] PRACTICAL SESSION: MATLAB Simulations

Thursday 23.8.2012

[14:15-15:45 in TB223] Convex Projection Method

Friday 24.8.2012

[12:15-13:45 in TB223] Fixed Point Theory of Nonexpansive Mapping (Part I)

[13:45-14:15] Break

[14:15-15:45 in TB223] Fixed Point Theory of Nonexpansive Mapping (Part II)

Requirements for passing the course

Attendance in the lectures (min. 75 %) and a Matlab assignment.