KING FAHD UNIVERSITY OF PETROLEUM AND MINERALS
ELECTRICAL ENGINEERING DEPARTMENT
First Semester (031)

EE 662 Adaptive Filtering and Applications [3-0-3]

- ## Introduction:

  Adaptive filters have found many uses in todays technology. In signal processing, applications include noise cancellation, deconvolution, and adaptive beamforming. In telecommunications, applications include channel equalization and echo canceling. In control systems, applications include inverse control and cancellation of plant disturbance. In acoustics, applications include active control of sound and vibration. Many of these subjects will be discussed.

- ## Objectives:

  Basic theory of adaptive filter design and implementation. Steepest descent, LMS algorithm, Mixed-Norm algorithms, RLS algorithm, nonlinear adaptive filters, and blind deconvolution. Analysis of performance and applications.

- **Prerequisites:** Consent of Instructor.

- **Instructor:** Dr. Azzedine Zerguine,
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- ## Course Outline:

- **Introduction, Review and Background** (2.5 weeks)
  - Review
  - Stochastic processes and power spectral density

- **Wiener filters** (1.5 weeks)
  - Derivation of the Wiener-Hopf equations
  - Principle of orthogonality
  - Problems and applications
  - Solving the Wiener-Hopf equations

- **Gradient-Based Adaptive Filters** (3.5 weeks)
  - Steepest descent
  - The LMS algorithm
  - Performance Analysis (Convergence, Transient Behaviour, Steady-State Behaviour, Tracking)
  - Variations on the LMS algorithm
  - The LMF algorithm
  - Mixed-Norm techniques
  - Examples and comparison of techniques
  - The LMS algorithm Using Lattice filters

- **The method of least squares** (2.0 weeks)
  - Linear least squares estimation; Windowing; Orthogonality
  - Properties of least squares estimators

- **Recursive least squares** (2.0 weeks)
  - Transversal filters (Exponentially weighted; Windowing; FTF algorithm)
  - Lattice filters (Order update recursions; Time update recursions)

- **Nonlinear adaptive filters** (1.5 weeks)
  - Blind deconvolution - decision directed feedback
  - Examples

- **Applications** (2.0 weeks)
  - Adaptive line enhancement
  - Adaptive spectrum estimation, frequency tracking
  - Adaptive interference cancellation

- **Textbook:** Simon Haykin, Adaptive Filter Theory,Fourth Edition, Prentice-Hall, 2002.

- **References:**

1. B. Farhang-Boroujeny, *Adaptive Filters: Theory and Applications*, John Wiley, NY, 1998.
2. M. H. Hayes, *Statistical Digital Signal Processing and Modeling*, John Wiley, NY, 1996.
3. O. Macchi, *Adaptive Processing: The LMS Approach with Applications in Transmission*, John Wiley, New York, NY, 1995.
4. V. Solo and X. Kong, *Adaptive Signal Processing Algorithms: Stability and Performance*, Prentice-Hall, Englewood Cliffs, NJ, 1995.
5. A. Benveniste, M. Metivier and P. Priouret, *Adaptive Algorithms and Stochastic Approximations*, Springer-Verlag, Berlin, 1990.
6. C. F. N. Cowan and P. M. Grant, *Adaptive Filters*, Prentice-Hall, Englewood Cliffs, NJ, 1985.
7. B. Widrow and S. Stearns, *Adaptive Signal Processing*, Prentice-Hall, Englewood Cliffs, NJ, 1985.
8. J. R. Treichler, C. R. Johnson and M. G. Larimore, *Theory and Design of Adaptive Filters*, Prentice-Hall, Englewood Cliffs, NJ, 2001.

- **Homework Assignments** will be issued about once every two weeks.

- **Grading Policy**
  - Homework 20 %
  - Major Exam 25 %
  - Project 25 %
  - Final Exam 30 %