Department of Electrical & Computer Engineering
University of California, Santa Barbara

ECE 245
Spring 2011
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H.O. #2

ECE 245 ADAPTIVE FILTER THEORY

TENTATIVE COURSE OUTLINE

OPTIMAL FILTERING

Wide-sense stationary signals
Wiener-Hopf equation
Noncausal Wiener filter
Causal Wiener filter
Mean-square-error (MSE) expressions

PERFORMANCE SURFACE

Natural, translated, and rotated coordinate systems
Normal form of the correlation matrix R
Interpretation of eigenvalues and eigenvectors
Stochastic normal equation
Stochastic orthogonality principle

STEEPEST DESCENT AND NEWTON'S METHOD

Gradient vector and Hessian matrix
Stability conditions for convergence
One-step convergence
Geometric ratio and time constants

GRADIENT ESTIMATION

Weight-misadjustment method
Perturbation P
Gradient noise model
Misadjustment M

LEAST-MEAN-SQUARE (LMS) ALGORITHM

- Convergence in the mean
- Convergence of the MSE
- Stability conditions on the step-size parameter μ
- Misadjustment expressions
- Modified LMS algorithms

METHOD OF LEAST SQUARES (LS)

- Nonrecursive (block) solution
- Windowing of the data
- Deterministic normal equation
- Deterministic orthogonality principle
- Minimum sum of squared errors
- Properties of LS estimates

RECURSIVE LEAST SQUARES (RLS)

- Exponential weighting λ
- Prewindowed data
- Matrix inversion lemma
- Weight and error recursions
- Initial conditions
- Convergence in the mean (bias)
- Convergence in the mean square
- Sliding window form

LINEAR PREDICTION

- Forward and backward prediction errors
- Augmented normal equation
- Levinson-Durbin recursion
- Reflection coefficients (time-invariant)
- Lattice realization
- Step-up and step-down recursions
- Correlation properties
- Joint-process estimation
- Burg formula

ADAPTIVE LATTICE FILTERS

Gradient methods
Least-squares approach
Augmented normal equation: prewindowed form
A priori and a posteriori estimation errors
Order updates
Gain vector, likelihood variable γ
Time updates
Joint-process estimation
Correlation properties

APPLICATIONS

Linear prediction
Adaptive noise canceling
System identification
Inverse modeling