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 $\mu$
- 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 $\lambda$
- 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 $\gamma$
Time updates
Joint-process estimation
Correlation properties

APPLICATIONS

Linear prediction
Adaptive noise canceling
System identification
Inverse modeling