GUJARAT TECHNOLOGICAL UNIVERSITY

ELECTRONICS & COMMUNICATION (WIRELESS COMMUNICATION SYSTEMS & NETWORKS) (27)

SMART ANTENNAS FOR WIRELESS COMMUNICATION

SUBJECT CODE: 2732702

ME Semester: III

Type of course: Major Elective-IV

Prerequisite: Signal processing, Fundamental knowledge of statistics

Rationale: This course treats adaptive signal processing algorithms for extracting relevant information from noisy signals. The emphasis is on recursive, model based estimation methods for time-varying systems

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
				Theory Marks		Practical Marks				
L	T	P	C	ESE (E)	PA (M)	ESE (V)		PA (I)		
						ESE	OEP	PA	RP	
4	0	2#	5	70	30	20	10	10	10	150

Content:

Sr. No.	Content	Total Hrs	% Weightage
1	**Discrete random processes:** Random variables, random processes, filtered random processes. Ensemble averages, correlation, covariance, power spectrum, cross power spectrum, Ergodicity, time averages, biased & unbiased estimators, consistent estimators.		
2	**Linear prediction:** Direct form linear prediction filtering, Normal equations for linear prediction filtering, Levinson algorithm, Linear prediction lattice filtering		
3	**Digital Wiener Filtering :** Wiener smoothing and prediction filters, Application of Wiener smoothing to noise cancelling, Application of Wiener prediction filters, Constrained, linear MMSE filtering, Minimum variance beam forming.		
4	**Least Mean Squares Adaptive Filter:** Fundamentals of adaptive systems, LMS adaptive algorithm, Properties of LMS adaptive filter, Least squares adaptive filters, frequency domain adaptive filters, Adaptive lattice filters, Godard algorithm		
5	**Normalizes Least Mean Square Filters (NLMS), Recursive Least :** Square based (RLS) based filters, RLS(Recursive least squares), Generalisations of LMS and RLS		

Reference Books:

1. Statistical and Adaptive Signal Processing: Spectral Estimation, Signal
2. Modeling, Adaptive Filtering and Array Processing, D. Manolakis, V. Ingle, S. Kogan, McGraw Hill, 1999.
3. Adaptive Signal Processing, B. Widrow, S. Stearns, Prentice-Hall
4. Fundamentals of Adaptive Filtering, Ali H. Sayed, John Wiley
5. Theory and Design of Adaptive Filters, J. Triechler, C. Johnson, M. Larimore Prentice-Hall
6. Adaptive Filtering: Algorithms and Practical Implementation, P. Diniz, Kluwer
7. Adaptive Filters: Structures, Algorithms and Applications, M. Honig, D. Messerschmitt, Kluwer
8. Adaptive Signal Processing, L. Sibul, Ed., IEEE Press

Course Outcomes:

After learning the course the students should be able to:

- Understand discrete random processes
- Design and apply optimal minimum mean square estimators and in particular linear estimators. To understand and compute their expected performance and verify it.
- Design, implement and apply Wiener filters (FIR, non-causal, causal) and evaluate their performance.
- Use a combination of theory and software implementations to solve adaptive signal problems.
- Analyze the accuracy and determine advantages and disadvantages of each method of adaptive systems
- Use the theoretical understanding to do troubleshooting, e.g., in cases the observed performance is not as expected.
- Report the solution and results from the application of the above filtering techniques to given problems.

List of Experiments:

1. Implementation of adaptive filters based on least mean squares (LMS) techniques
2. Implementation of adaptive filters based recursive least squares (RLS) techniques
3. Implementation of adaptive filters based on lattice filters
4. Noise and Interference cancellation using adaptive filter
5. Implement adaptive filter in DSP kit
6. Experiments using DSP toolbox for adaptive filters in MATLAB

Design based Problems (DP)/Open Ended Problem:

- Design acoustic echo control system using adaptive filter

Major Equipment:

- DSP Kit TMS320C6748 with Code Composer Studio
- RF Signal generator and Spectrum Analyzer

List of Open Source Software/learning website:

- **NPTEL Video lectures on adaptive signal processing**
  http://nptel.ac.in/video.php?subjectId=117105075
- **http://www.myprivatetutor.com/self-paced-tutorial/adaptive-signal-processing-tutorials/INR**
- **http://www.cs.tut.fi/~tabus/course/ASP/Lectures_ASP.html**

Review Presentation (RP): The concerned faculty member shall provide the list of peer reviewed Journals and Tier-I and Tier-II Conferences relating to the subject (or relating to the area of thesis for seminar) to the students in the beginning of the semester. The same list will be uploaded on GTU website during the first two weeks of the start of the semester. Every student or a group of students shall critically study 2 papers, integrate the details and make presentation in the last two weeks of the semester. The GTU marks entry portal will allow entry of marks only after uploading of the best 3 presentations. A unique id number will be generated only after uploading the presentations. Thereafter the entry of marks will be allowed. The best 3 presentations of each college will be uploaded on GTU website.