GUJARAT TECHNOLOGICAL UNIVERSITY

ELECTRONICS & COMMUNICATION (SIGNAL PROCESSING AND VLSI TECHNOLOGY) (26)

WAVELET TRANSFORM AND APPLICATIONS

SUBJECT CODE: 2712606

SEMESTER: I

Type of course: Advanced Signal Processing

Prerequisite: Understanding of discrete time signals and systems, Fourier Transform

Rationale: Wavelet has established itself as an important tool in modern signal processing as well as in applied mathematics. Students of ME in Signal Processing must require fundamental concepts of advance Signal Processing and application of it. Students also must understand theory and importance of wavelet transform for signal processing applications. The objective of this course is to apply the wavelet transform theory in necessary application and related constructions.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
L	T	P	C	Theory Marks		Practical Marks				
				ESE (E)	PA (M)	PA (V)		PA (I)		
						ESE	OEP	PA	RP	
3	0	2	4	70	30	20	10	20	0	150

Content:

Sr. No.	Topics	Teaching Hrs.	Module Weightage
1	**Introduction:** • Origin of wavelets and its history • Different communities of wavelet • Classification: continuous and discrete wavelet transforms • Developments in wavelet theory applications	6	14%
2	**Continuous Wavelet Transform:** • Introduction • Continuous time wavelets • Definition of CWT • Constant Q factor filtering interpretation and Time Frequency Resolution • CWT as an operator • Inverse CWT	6	14%
3	**Introduction to the Discrete Wavelet Transform and orthogonal Wavelet decomposition**: • Approximations of vectors in nested linear vector subspaces • Multi-resolution Analysis of $L^2(R)$ • Haar Scaling function • Haar wavelet • Haar wavelet decomposition. • Haar wavelet packets and application.	7	17%
4	**MRA Ortho-normal wavelets and their relationships to filter**	5	12%

	banks: • Construction of an ortho-normal MRA • Wavelet basis for the MRA • Digital filtering interpretation • Examples of orthogonal basis generating wavelets • Interpreting ortho-normal MRA for discrete time signals • Generating scaling functions and wavelets from filter coefficients.		
5	**Bi-orthogonal Wavelets**: • Bi-orthogonal Wavelet bases • Filtering relationship for Bi-orthogonal filters • Bi-orthogonal scaling functions and wavelets • Two dimensional wavelets • Non separable Multi-dimensional wavelets • Wavelet Packets.	6	14%
6	**Wavelength Transform and applications**: • Transform coding • DTWT for image compression, audio compression • Wavelet based audio coding, video coding and multi resolution Techniques • Wavelet de-noising, Speckle removal, Edge detection and object isolation • Image fusion, Object detection, discrete wavelet multi-tone modulation.	8	19%
7	**Beyond Wavelet**: • Ridge lets and curve lets: Ridge let transform and Digital Curve let transform • Curve let construction • Properties and applications.	4	10%

Reference Books:

1. RaguveerM.Rao and AjitS.Bopardikar-Wavelet Transforms –Introduction andapplications-Pearson Education, 2008
2. K.P Soman, K.I.Ramachandran –Insight into Wavelets from Theory to practice, PHI2006

Course Outcome:

After successfully completion of this course, students should able to –

1. Classify various wavelet transform and explain importance of it.
2. Describe Continuous Wavelet Transform (CWT) and Discrete Wavelet Transform (DWT).
3. Explain the properties and application of wavelet transform.
4. Develop and realize computationally efficient wavelet based algorithms for signal and image processing.
5. Explain brief features and strength of transform beyond wavelet.

List of Experiments:

1. To study various wavelets families.
2. To study Harr wavelets filter banks.
3. To study the Continuous Wavelet Transform: composition and decomposition.

4. To study the Discrete Wavelet Transform: composition and decomposition.
5. To write and verify code for signal/image smoothing using wavelet transform.
6. To write and verify code for signal/image de-noise using wavelet transform.
7. To write and verify code for signal/image compression using wavelet transforms.
8. To write and verify code for signal/image edge detection using wavelet transforms.
9. To write and verify code for signal/image matching using wavelet transforms.
10. To write and verify code for signal/image fusion using wavelet transforms.
11. To study the working principle of Ridge-let transforms.
12. To study the working principle of curve-let transforms.

Open Ended Problems:

1. Let p=[2 4 5 9 -4 -8 0 3 7 10 -2 0 -6 1 -3 5]. Perform the Haar decomposition using (1/2, 1/2) and (1/2, -1/2) as decomposition filters.
2. Write a program that will implement a two stage Haar wavelet analysis filter bank tree on signal p=sin(πt/8).
3. Write a program for generating Daubechies' orthogonal wavelet system coefficients.
4. Prove that if the variance of the signal is constant then the variance of the WT is a constant in each resolution level.
   Develop and realize Digital Curve let Transform decomposition algorithm

Major Equipments:

Computer System.

List of Software:

MATLAB, Scilab

Learning website:

www.nptel.ac.in