GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Engineering

Level: PG

Branch: Bio Medical Engineering

Course / Subject Code : ME01031061

Course /Subject Name : Biomedical Signal & Image Processing

w. e. f. Academic Year:	2024-25
Semester:	1st Semester
Category of the Course:	PEC

Prerequisite:	Fundamentals of signal and Image processing, Physics of Medical Imaging
Rationale:	The course aims at providing the students with the knowledge and methodology for extracting useful information, implement the advanced signal processing and pattern classification techniques on different biomedical signals like ECG, EEG, and EMG and from that interpret the results and validate the descriptors obtained in the light of knowledge of the biological system involved. Also, providing the fundamentals and various techniques of biomedical image processing to develop the algorithms for image analysis and diagnosis in medical imaging.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes
01	To understand human physiological system and acquisition of various Biomedical signals.
02	To understand basic and advanced digital filtering for Biomedical signals.
03	Students can able to design analog and digital IIR and FIR filters for various biomedical applications.
04	To implement advanced signal processing and classification techniques for biomedical signals to diagnose various diseases.
05	To understand the acquisition of digital images, various types of transforms, image enhancement operations, morphological operations and image segmentation operations.
06	To develop an algorithm for various real-time applications like counting the no. of objects in an image, extracting the feature of the objects form an input image, recognizing the objects from the input image based on the extracted features from the image database.
07	To design image processing algorithm for CT, MRI, Retinal, angiographic and PET-CT fusion images.
08	To conduct independent study and analysis of image processing problems and techniques.

**Revised Bloom's Taxonomy (RBT)*

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Teaching and Examination Scheme:

Teaching Scheme (in Hours)			Total Credits L+T+ (PR/2)	Assessment Pattern and Marks				Total Marks
				Theory		Tutorial / Practical		
L	T	PR	C	ESE (E)	PA / CA (M)	PA/CA (I)	ESE (V)	
3	0	2	4	70	30	20	30	150

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	**Fundamentals of Digital Signal Processing** Objectives of Biomedical Signal Analysis, Difficulties Encountered in Biomedical Signal Acquisition & Analysis **Filtering Techniques for Biomedical Signals:** Random noise, Structured Noise, Design of IIR & FIR filter, Optimal Filter, Adaptive Filter, Signal averaging, spectral analysis, multi resolution analysis. **Wavelet Transform:** 1-D Continuous Wavelet Transform, 1- D Discrete Wavelet Transform, Application of Wavelet Transform in Biomedical Signal Processing.	12	25%
2.	**EEG:** Signal of the Brain, Effect of CNS Diseases on EEG, Processing & Feature Extraction of EEG **EMG:** Signal of Muscles, Processing & Feature Extraction Of EMG. **Speech Signal:** Processing and Feature extraction of Speech	06	15%
3.	**ECG:** Signal of Heart, Effect of Cardiovascular Diseases on ECG, Processing & Feature Extraction of ECG, **PCG**: Sound of Heart, Processing & Feature Extraction of PCG.	05	15%
4.	**Fundamentals of Digital Image Processing** Image Acquisition, Image transforms- 2D- DFT, DCT, 2-D Discrete Wavelet Transform, Image Enhancement Techniques in Spatial & Frequency Domain, Morphological Image Processing.	10	15%
5.	**IMAGE SEGMENTATION AND FEATURE EXTRACTION** Intensity-based segmentation, Edge-based segmentation, Region-based segmentation, Linear & Circular Hough Transform, Simple		

	active contour models-snake algorithm, k means clustering. **Feature Extraction-** Types of Image Feature, Gabor filters method, GLCM method **Image Classification**: SVM, PCA, ICA, LDA Methods	06	15%
6.	**APPLICATIONS OF MEDICAL IMAGE ANALYSIS** CT Image Analysis, MRI Image Analysis, Angiographic image analysis, Retinal image analysis, Fusion of PET-CT Images.	06	15%
	Total	**45**	**100**

Reference Books:

1) Rangaraj M. Rangayyan, Biomedical Image Analysis, CRC Press
2) Kayvan Najarian, Robert Splinter 2nd Edition, Biomedical Signal and Image Processing
3) Thomas M. Deserno, Biomedical Image Processing
4) John L. Semmlow, Biosignal & Biomedical Image Processing
5) Isaac N. Bankman, Handbook of Medical Imaging Processing & Analysis
6) R.C. Gonzalez, R. E. Woods, "Digital Image Processing", 3/e Pearson Education.
7) William K. Pratt, Digital Image Processing, 4th Edition.

List of Experiments:

1) To acquire real-time or simulate the various Biosignal using MATLAB or LabVIEW.
2) To apply various types of noise on Biosignal and analyze the responses on frequency domain.
3) To design IIR & FIR filters.
4) Design an adaptive/Wiener filter to remove the artifacts in the ECG signal.
5) To apply wavelet transform on various Biosignal.
6) To design algorithms for QRS detection & Arrhythmia detection.
7) Design algorithms for EMG, EEG, PCG analysis.
8) Design an algorithm to identify the various components available in speech.
9) To Acquire medical image in MATLAB and perform basic image processing operation.
10) Design an algorithm for various transform techniques on medical images.
11) Design an algorithm for Image enhancement and morphological operation on images.
12) Design an algorithm for extracting the features of different objects present in an input image.
13) Design an algorithm for point, line and edge detection operations on an input image.
14) Design an algorithm for segmentation of region using region growing technique.
15) Design an algorithm for image classification for the medical images.
16) Design an algorithm of image analysis techniques for CT, MRI, PET-CT, Retinal and angiographicimages.

Major Hardware & Software: Data Acquisition System, MATLAB, LabVIEW, Motion Lab Software,Biomedical sensors toolkit.

List of Open Source Software/learning website:

1) https://www.physionet.org/
2) https://www.motion-labs.com/index_software.html
3) http://www.scilab.org/
4) http://ocw.mit.edu/resources/res-6-008-digital-signal-processing-spring-2011/video-lectures/
5) https://onlinecourses.nptel.ac.in/noc18_ec02/preview
6) https://onlinecourses.nptel.ac.in/noc17_ee01/preview

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