Pattern Recognition

Course Code:PGMTH3E014T

Course Title: Pattern Recognition

Semester: III

Credits: 04

Course Overview

This course covers the statistical, neural and structural approaches for the recognition and matching of various patterns in images. The focus is on issues that are critical to develop systems which are based on unsupervised learning techniques. The course deals with parametric and linear models for classification. Some part of the course reviews the theory of probability and statistics and then rest of the course covers the major approaches of pattern recognition.

Course Objective

- To discuss and compare different methods for pattern recognition along with their strengths and weaknesses
- To expose parametric and linear models for classification
- To make the students understand pattern recognition theories such as Bayes classifier, HMM, etc.
- To learn the various Statistical, Syntactical and Neural Pattern recognition techniques.
- To learn how to use pattern recognition for biometrics system.

Contents	**No of Lectures**
Unit-I Introduction to pattern recognition Learning paradigms, Supervised and unsupervised learning; Probability: independence of events, conditional and joint probability, Processes: Stationary and non-stationary processes, Expectation, Autocorrelation, Cross-Correlation, spectra. Introduction to Statistical, Structural and Neural Approaches.	**10**
Unit-II Statistical Pattern Recognition: Patterns and classification, discriminant functions, Bayes Decision Theory: Minimum-error-rate classification. Classifiers, Discriminant functions, Decision surfaces. Normal density and discriminant functions. Discrete features. Parameter Estimation Methods: Maximum-Likelihood Estimation: Gaussian case. Maximum a Posteriori estimation. Bayesian estimation: Gaussian case. Unsupervised learning and clustering - Criterion functions for clustering. Algorithms for clustering: K-Means, Hierarchical and other methods.	**10**
Unit-III Sequential Pattern Recognition. Hidden Markov Models (HMMs). Discrete HMMs. Continuous HMMs. Nonparametric techniques for density estimation. Parzen-window method. K-Nearest Neighbour method. Linear discriminant functions: Perceptron and training, LMSE approaches.	**10**

Feature extraction.	
Unit-IV Biometrics as a Pattern Recognition tool, Evolution, Biometric traits, Biometrics Vs traditional recognition techniques, Characteristics of a good biometrics, Benefits of biometrics, Key biometric processes: verification, identification and biometric matching, Performance measures in biometric systems: FAR, FRR, FTE, FTA rate, EER, ROC, DTE etc., Biometrics applications, Challenges to biometrics systems.	**10**
Unit-V Overview of uni-biometric systems, Fingerprint, Fingerprint Classification, Overview and working of Iris, Hand geometry, Face recognition biometrics systems, comparison of various biometrics, Limitations of Uni-biometrics, Taxonomy of multi-biometrics, Issues in Designing a Multibiometric System, Normalization strategy, Fusion techniques	**10**

Teaching Plan

SN	Topic	No. of Lectures	Reference
	Unit-I		
1	Introduction to pattern recognition Learning paradigms	**1**	T3, R3: Chapter 1
2	Supervised and unsupervised learning;	**1**	T3, R3: Chapter 1
3	Probability: independence of events, conditional and joint probability	**1**	T3, R3: Chapter 1
4	Processes: Stationary and non-stationary processes	**1**	T3, R3: Chapter 1
5	Expectation, Autocorrelation, Cross-Correlation, spectra.	**1**	T3, R3: Chapter 1
6	Introduction to Statistical, Structural and	**2**	T3, R3: Chapter 1
7	Neural Approaches.	**1**	T3, R3: Chapter 1
8	Neural Approaches.	**2**	T3, R3: Chapter 1
	Unit-II		
9	Introduction to Patterns and classification	**1**	T3, R4: Chapter 2
10	Discriminant functions	**1**	T3, R4: Chapter 2
11	Bayes Decision Theory: Minimum-error-rate classification	**1**	T3, R4: Chapter 2
12	Classifiers, Discriminant functions	**1**	T3, R4: Chapter 2
13	Decision surfaces	**1**	T3, R4: Chapter 2
14	Normal density and Discriminant functions	**1**	T3, R4: Chapter 2
15	Parameter Estimation Methods: Maximum-Likelihood Estimation: Gaussian case Maximum a Posteriori estimation. Bayesian estimation: Gaussian case.	**2**	T3, R4: Chapter 2
16	Unsupervised learning and clustering - Criterion functions for clustering. Algorithms for clustering: K-Means, Hierarchical and other methods.	**2**	T3, R4: Chapter 2
	Unit-III		
17	Sequential Pattern Recognition. Hidden Markov Models (HMMs). Discrete HMMs	**2**	T3,R4 and R3: Chapter 3

18	Continuous HMMs. Nonparametric techniques for density estimation. Parzen-window method	**2**	T3,R4 and R3: Chapter 3
19	K-Nearest Neighbour method	**1**	T3,R4 and R3: Chapter 3
20	Linear discriminant functions: Perceptron and training	**2**	T3,R4 and R3: Chapter 3
21	LMSE approaches.	**1**	T3,R4 and R3: Chapter 3
22	Feature extraction	**2**	T3,R4 and R3: Chapter 3
Unit-IV			
23	Biometrics as a Pattern Recognition tool	**1**	T1,T2
24	Evolution, Biometric traits	**1**	T1,T2
25	Biometrics Vs traditional recognition techniques	**1**	T1,T2
26	Characteristics of a good biometrics, Benefits of biometrics	**2**	T1,T2
27	Key biometric processes: verification, identification and biometric matching	**1**	T1,T2
28	Performance measures in biometric systems: FAR &	**1**	T1,T2
29	FRR, FTE, FTA rate, EER, ROC, DTE etc	**1**	T1,T2
30	Biometrics applications, Challenges to biometrics systems.	**2**	T1,T2
Unit-V			
31	Overview of Uni biometric systems	**1**	T1,T2
32	Fingerprint, Fingerprint Classification	**1**	T1,T2
33	Overview and working of Iris, Hand geometry, Face recognition biometrics systems	**2**	T1,T2
34	comparison of various biometrics, Limitations of Uni-biometrics	**2**	T1,T2
35	Taxonomy of multi-biometrics, Issues in Designing a Multibiometric System	**2**	T1,T2
36	Normalization strategy, Fusion techniques	**2**	T1,T2

Evaluation Scheme

S.No	Exam	Marks	Duration of Exam.	Coverage/Scope of Examination
1	Mid Term Exam.	25	2 Hours	2.5 units
2	End Term Exam.	50	3 Hours	All Five units
3	Continuous Assessment	25	Entire Semester	Assignments, Quizzes, Tests, Projects, Group Projects Presentations etc.

Text Books

T1: Arun A. Ross , Karthik Nandakumar, A.K.Jain, “Handbook of Multibiometrics”, Springer, New Delhi, 2006.

T2: Anil K Jain, Patrick Flynn, Arun A Ross, “Handbook of Biometrics”, Springer, 2008.

T3: C. M. Bishop, Neural Networks for Pattern Recognition, Oxford University Press, 1995.

Reference books

R1: V. N. Vapnik, The Nature of Statistical Learning Theory, Springer, 2000.
R2: N. Cristianini and J. Shawe-Taylor, An Introduction to Support Vector Machines, Cambridge University Press, 2000.
R3: R. J. Schalkoff, Pattern Recognition: Statistical, Structural and Neural Approaches, Wiley, 1992.
R4: Classification and Scene Analysis, Wiley, New York, 1973. L. Miclet, Structural Methods in Pattern Recognition North Oxford 3. Academic, London, 1986.
R5: Samir Nanavathi, Michel Thieme, and Raj Nanavathi, “Biometrics -Identity verification in a network”, Wiley Eastern, 2002.
R6: John Chirillo and Scott Blaul,” Implementing Biometric Security”, Wiley Eastern Publications, 2005