M.Tech Computer Science

(with specialization in Digital Image Computing)

Revised Scheme and Syllabus

(2013 Admission onwards)

Department of Computer Science,

University of Kerala,

Kariavattom, Thiruvananthapuram – 695581

Master of Technology (M.Tech) in Computer Science (with specialization in Digital Image Computing)

Course Structure

SEM	SUB CODE	Title	Hr/Week L-T-LR-P	CRD
I	COS 611	Mathematical Foundations of Image Processing	4-1-1-0	4
	COS 612	Soft Computing Techniques	4-1-1-0	4
	COS 613	Advanced Computer Graphics	4-1-1-0	4
	COS 614	Pattern Recognition	4-1-1-0	4
	COS 6***	Elective - I	3-0-0-0	3
	COS 615	Laboratory - I	0-0-0-12	4
	COS 616	Seminar	1-0-0-0	1
		TOTAL		**24**
II	COS 621	Applications of Image Processing	4-1-1-0	4
	COS 622	Computer Vision	4-1-1-0	4
	COS 623	Data Compression	4-1-1-0	4
	COS 624	Intelligent Data Mining	4-1-1-0	4
	COS 6***	Elective - II	3-0-0-0	3
	COS 625	Laboratory - II	0-0-0-12	4
	COS 626	Seminar	1-0-0-0	1
		TOTAL		**24**
III	COS 631	Research Methodology	2-1-1-0	2
	COS 632	Dissertation (Part 1)		6
		TOTAL		**8**
IV	COS 641	Dissertation		**16**
		TOTAL CREDITS		**72**

ELECTIVE - I

COS 6011	Wireless Sensor Networks	3-0-0-0	3
COS 6012	Artificial Intelligence and Robotics	3-0-0-0	3
COS 6013	Object Oriented Analysis and Design	3-0-0-0	3
COS 6014	Fractal Theory and Applications	3-0-0-0	3
COS 6015	Knowledge Based Systems	3-0-0-0	3

ELECTIVE - II

COS 6021	Wavelet Analysis and Applications	3-0-0-0	3
COS 6022	Embedded Systems	3-0-0-0	3
COS 6023	GIS and Remote Sensing	3-0-0-0	3
COS 6024	Video Surveillance	3-0-0-0	3
COS 6025	Parallel Computing	3-0-0-0	3

COS 611: MATHEMATICAL FOUNDATIONS OF IMAGE PROCESSING

Module I: Elements of Image Processing, Digital Image Processing, Image Processing Techniques, Digital Image representation, Digital Image Classification, Image Types, Applications of Image Processing. Signals, Impulse Sequence, Exponential Sequence, Periodic Sequence, Linear Systems, Shift-Invariant systems, Linear Shift Invariant (LSI) systems, Convolution and Correlation, Image Transforms, Classification of Image Transforms, Fourier Transform, Properties of Fourier Transform, 2D Discrete Fourier Transform (DFT), Z-transform, Causal Systems, Random Signals, Stationary Process, Markov Process, Karhunen-Loeve (KL) Transform.

Module II : Intensity Transformation and Spatial Filtering, Intensity Transformation Functions, Piecewise Linear Transformation Functions, Histogram Processing, Histogram Equalization, Histogram Matching, Local Enhancement, Histogram statistics, Enhancement using Arithmetic/Logic operations, Image Subtraction, Image Averaging, Spatial Filtering, Smoothening Spatial Filters, Sharpening Spatial Filters, Laplacian Filter, Unsharp masking and High Boost Filter, Gradient operators – Edge detection filters, Filtering in Frequency domain, Frequency Domain Smoothening Filters: Ideal Filter, Butterworth Filter, Gaussian Filter, Frequency Domain Sharpening Filters, Laplacian in Frequency domain, Homomorphic Filtering.

Module III: Image degradation/Restoration process model, Noise probability density functions, Spatial Filtering: Mean Filters, Order-statistics filter, Adaptive Filters, Periodic Noise Reduction – Frequency domain filters: Band-reject filters, Band-pass filters, Notch filters. Estimating the degradation function, Inverse filtering, Wiener filtering, Performance measures. Color image processing: Color fundamentals, Color models – RGB, CMYK, HSI. Full color image processing, Color image smoothening and sharpening, color edge detection. Point and line detection. Hough Transform. Image segmentation: Fundamentals, Thresholding, Optimum global thresholding – Otsu's method. Region-based segmentation: Region growing, Region Splitting and Merging. Segmentation using Morphological Watersheds.

Text book:

1. Rafael C. Gonzalez, Richard E. Woods, "Digital Image Processing", 3rd Ed., PHI, 2007.
2. Anil K. Jain, "Fundamentals of Digital image Processing", Prentice Hall, US Ed., 1989.

References:

1. William K. Pratt, "Digital Image Processing: PIKS Scientific Inside", Wiley Interscience, 4th Ed., 2007.
2. Azriel Rosenfield, Avinash C. Kak, "Digital Picture Processing", Morgan Kaufmann, 2nd Ed., 1982.
3. Bernd Jahne, "Digital Image Processing", Springer, 6th Ed., 1997.

COS 612: SOFT COMPUTING TECHNIQUES

Module I: Basic of Artificial Neural Networks – Characteristics, Terminology, Models of Neuron, Toplogy, Basic Learning laws. Activation and Synaptic Dynamics – Activation Dynamics and Synaptic Dynamics Models, Learning methods. Feed-Forward Neural Networks – Analysis of Pattern Association Networks – Linear Associative Network. Pattern Classification Networks – Perceptron, Perceptron classification, Perceptron learning law, Linear Separability, Multilayer Perceptron. Pattern Mapping Networks- Backpropagation algorithm

Module II: Feedback Neural Networks – Linear Auto Associative FF networks, Pattern Storage Networks – Hopfield Network, Stochastic networks and Simulated Annealing, Boltzmann machine. Associative memory, Bidirectional Associative Memory, Multidirectional Associative Memory, Temporal Associative Memory, Pattern Mapping, RBF Networks, Counter propagation network, Adaptive Resonance Theory (ART).

Module III: Classical Sets – Operations and properties, Fuzzy sets – Operations and Properties, Crisp Relations, Fuzzy Relations, Fuzzy Equivalence Relations, Features of Membership Functions, Various forms, Fuzzification and Defuzzification, λ-cuts for Fuzzy Relations, Classical Logic, Fuzzy Logic – Approximate reasoning. Fuzzy Rule-based Systems, Development of membership functions. Genetic Algorithms – Biological Terminology. Elements of GA – GA Operators, A Simple Genetic Algorithm. GA in Problem Solving – Data Analysis and Prediction, Mathematical Models of Simple GA. Encoding a problem for GA – Adapting the encoding – Selection methods – Genetic Operators.

Text Books:

1. B. Yegnanarayana, "Artificial Neural Networks", PHI, 1999.
2. Timothy J.Ross, "Fuzzy Logic Engineering Applications", John Wiley & Sons Ltd, 2nd Ed, 2004.
3. Mitchell Melanie, "An Introduction to Genetic Algorithms", MIT Press, 1998.

Reference books:

1. S.N. Sivanandam, S.N. Deepa, " Principles of Soft Computing", Wiley India, 2nd Ed., 2011.
2. Jang J.S.R.,Sun C.T and Mizutani E – "Neuro Fuzzy and Soft computing", Pearson education (Singapore) 2004
3. Laurene Fauseett: "Fundamentals of Neural Networks", Prentice Hall India, New Delhi,1994.
4. David A. Coley, "Introduction to Genetic Algorithms for Scientists and Engineers", World Scientific Publishers, 1999.
5. Simon Haykin, Neural Networks-A comprehensive Foundation, Pearson education.

COS 613: ADVANCED COMPUTER GRAPHICS

Module I: Introduction to Computer Graphics, Applications, Display Devices – CRT, LCD, TFT, LED. Basic Primitives: points, lines, circles. Line drawing algorithms- DDA, Bresenham, circle-drawing algorithms- Midpoint, Bresenham, Ellipse-generating algorithms – Bresenham. Filling Algorithms – Flood Fill, Boundary Fill. Window and Viewport, Window-to-Viewport Transformation, 2D Transformations, 3D Transformations, 3D rotation based on Arbitrary Axis.

Module II: Surfaces and Meshes. Subdivision, Distance fields and level sets, Physically-based Modeling, Stable fluid Solver, Lattice Boltzmann method, Bezier Curves, Splines, B-splines, Visible Surface Detection Methods, Projection – Perspective and Parallel, Surface Shading, Illumination Models, Shading Techniques – Constant Intensity Shading, Gouraud Shading, Phong Shading. Animation, Introduction to Fractals. Open GL:- OpenGL over windows, OpenGL over Linux, OpenGL extensions, OpenGL programming language, SDK, shadowing Techniques, pBuffer rendering, Texture mapping.

Module III: Direct X:- Direct 3D architecture, primitives – point, line, triangle, Overview of resources: Texture / vertex / buffers/ index buffers / Surface / depth buffers / stencil buffers / render targets / Flichain states, state management Textures: Filtering, texture mapping/ texture blending, anti-aliasing. Advanced Rendering Techniques:- Photorealistic rendering: Global Illumination, Participating media rendering, Ray Tracing, Monte Carlo algorithm, Photon mapping. Volume Rendering:- Volume graphics overview, Marching cubes, Direct volume rendering.

Text Books

1. David F. Rogers, "Procedural Elements for Computer Graphics", McGraw Hill, 2nd Ed., 1997.
2. Dave Shreiner, "OpenGL Programming Guide: The Official Guide to Learning OpenGL, Versions 3.0 and 3.1", Addison Wesley, 7th Ed., 2009

Reference Books

1. Steven Harrington, "Computer graphics: A Programming approach", McGraw Hill, 2nd Ed., 1987.
2. Donald D. Hearn, M Pauline Baker, Warren Carithers, " Computer Graphics with Open GL ", PHI, 4th Ed., 2010.
3. Tomas Akenine-Moller, Eric Haines, Naty Hoffman, "Real-Time Rendering", AK Peters, 3rd Ed., 2008.
4. Alan Watt and Mark Watt, "Advanced Animation and Rendering Techniques", Addison-Wesley, 1992.
5. Matt Pharr and Greg Humphreys, "Physically based rendering: From Theory to Implementation", Morgan Kaufmann, 2nd Ed., 2010.
6. James D. Foley, Andries van Dam, Steven K. Feiner and John F. Hughes, "Computer Graphics: Principles and Practice in C", Addison Wesley, 2nd Ed., 1995.

COS 614: PATTERN RECOGNITION

Module I

Introduction: Machine Perception, Image Processing and Pattern Recognition, Pattern Recognition Systems, Design cycle, Learning and Adaptation, Applications of pattern recognition; Statistical Pattern Recognition: Probability theory basics, Probability density function, Normal density, Bivariate and Multivariate density functions; Classifiers: Naives Classifier, Bayes Classifier, Discriminant Functions, Decision Surfaces, Linear Discriminant Function based classifiers, Perceptron, Support Vector Machine, Applications

Module II

Non Parametric Decision Making: Histograms, Kernel density estimation, Nearest Neighbor Classification, Adaptive Decision Boundaries, Adaptive Discriminant Functions, Minimum Squared Error functions. Clustering: Similarity measures, Clustering criteria, Distance functions, Hierarchical clustering, Single Linkage, Average Linkage and Complete Linkage algorithms, Ward's Method. Partitional Clustering, Forgy's Algorithm, K-means algorithm, Fuzzy C means algorithm, ISODATA algorithm. Clustering Large Datasets, DBSCAN

Module III

Feature Extraction and Selection: Entropy minimization, Karhunen Loeve transformation, Feature selection through functions approximation, Binary feature selection. Dimensionality Reduction: Problems of dimensionality, Component analysis and discriminants, Principal Component Analysis, Linear Discriminant Analysis. Recent advances in Pattern Recognition: Neural Network structures for Pattern Recognition, Self organizing networks, Fuzzy pattern classifiers, Pattern classification using Genetic Algorithms, real life applications

References :

1. R.O. Duda, P.E. Hart, D.G. Stork, "Pattern Classification", John Wiley and Sons, 2000.
2. V. S. Devi, M. N. Murty, "Pattern Recognition: An Introduction", Universities Press, Hyderabad, 2011.
3. Earl Gose , Steve Jost, "Pattern Recognition and Image Analysis", PHI Publishers, 1997.
4. Robert J. Schalkoff, "Pattern Recognition : Statistical Structural and Neural Approaches", John Wiley & Sons Inc., New York, 1992.
5. Tou and Gonzales, "Pattern Recognition Principles", Wesley Publications Company, London 1974.

COS 615: LABORATORY - I

Following experiments, related to image processing concepts need to be implemented:

- *Convolution*
- *Correlation*
- *Image Transforms*
- *Filtering in Spatial domain*
- *Filtering in Frequency domain*
- *Restoration*
- *Enhancement*
- *Color image processing*
- *Segmentation*

Students should undertake a mini project to get an exposure in developing image processing related algorithms. A detailed project report should be submitted and its evaluation should be conducted at the end of the semester.

COS 621: APPLICATIONS OF IMAGE PROCESSING

Module I

Medical Image Processing: Introduction to medical imaging, brief history, importance, applications, trends, challenges; Medical Image Formation Principles: X-Ray and Computed Tomography(CT) imaging , Basic principles of CT, 2D Image reconstruction- Fourier space and filtered backprojection methods, Iterative reconstruction, 3D reconstruction basics; Imaging Modalities: Magnetic Resonance Imaging (MRI) Mathematics of MR, spin physics, NMR spectroscopy, imaging principles, Nuclear Imaging- positron emission tomography (PET) , single photon emission Tomography (SPECT), Ultrasound Imaging ,mathematical principles, applications; Medical Image Storage: Archiving and Communication Systems and Formats Picture archiving and communication system (PACS), Formats - DICOM, Radiology Information Systems (RIS) and Hospital Information Systems (HIS); Medical Image Visualization: Fundamentals of visualization, different generations of visualization techniques, surface and volume rendering/visualization.

Module II

Medical Image Segmentation: Histogram-based methods, Region growing, watersheds, Multispectral Techniques, Segmentation by Fuzzy clustering methods and issues, Segmentation with Neural Networks, Segmentation with deformable models; Medical Image Registration: Introduction, Intensity-based methods, Joint histograms, Information theory measures, cost functions, clinical applications of Image registration; Medical Image Search and Retrieval: Current technology in medical image search, content-based image retrieval, new trends; Applications: Image Guided Surgery, Image Guided Therapy, Computer Aided Diagnosis/Diagnostic Support Systems .

Module III

Biometrics: Introduction, Finger print as a biometric, fingerprint based identification system architecture, finger print representation, feature extraction, classification, matching; Face recognition from Images and videos: face detection, feature extraction methods, Eigen faces, fisher faces, advanced feature extraction methods, classification and recognition, Neural network, fuzzy logic and genetic algorithm based techniques (over view) Iris Recognition: Locating iris, feature encoding, recognition methods.

References:

1. Bankman I.N. “Hand book of Medical Imaging-Processing and Analysis” , Academic Press
2. Bovik A.I. “Handbook of Image and Video processing”, Academic Press.
3. Jiri Jan, “Medical Image Processing, Reconstruction and Restoration- Concepts and Methods”, CRC Tayler & Francis, 2006.
4. L. Landini, V. Positano, M.L. Santarelli, “Advanced Image Processing in Magnetic Resonance Imaging”, CRC Tayler & Francis, 2005.

COS 622: COMPUTER VISION

Module I: Imaging and Image Representation: Imaging Devices, 3D structure from 2D images, Five frames of reference. Binary Image Analysis: Pixels and Neighborhoods, Applying masks to images, Counting the objects in an image, Connected components labeling, Binary image morphology, Region properties, Region adjacency graphs, Thresholding. Overview of Pattern Recognition and Image filtering concepts.

Module II: Color and Shading: Color bases, Color histograms, Color segmentation, Shading. Texture: Texture, Texels and Statistics, Texel based Texture Descriptions, Quantitative Texture Measures, Texture Segmentation. Content based image retrieval: Image distance measures, Database organization. Motion from 2D image sequences: Computing Motion Vectors, Computing paths of moving points, Detecting significant changes in video. Overview of image segmentation.

Module III: Matching in 2D: Registration of 2D data, Representation of points, Affine mapping functions, 2D object recognition via Affine and Relational Matching. Perceiving 3D from 2D images: Labeling of line drawings from blocks world, 3D cues available in 2D images, Perspective imaging model, Depth perception from stereo. 3D sensing and Object pose Computation: 3D Affine transformations, Camera Model, Affine calibration matrix, Improved Camera calibration method, Pose estimation, 3D object reconstruction.

References:

1. Linda G. Shapiro, George C. Stockman, "Computer Vision", Prentice Hall, 1st Ed., 2001.
2. Richard Szeliski, "Computer Vision: Algorithms and Applications", Springer, 1st Ed., 2010.
3. David A. Forsyth, Jean Ponce, "Computer Vision: A Modern Approach", 2nd Ed., 2011.
4. Simon J. D. Prince, "Computer Vision: Models, Learning, and Inference", Cambridge University Press, 1st Ed., 2012.
5. Ramesh Jain, Rangachar Kasturi, Brian G. Schunck, "Machine Vision", McGraw-Hill, 1st Ed., 1995.

COS 623: DATA COMPRESSION

Module I: Introduction: Compression Techniques, Modeling and Coding, Mathematical Preliminaries for Lossless compression: Information Theory, Models, Coding: Uniquely decodable codes, Prefix codes, Kraft-McMillan Inequality. Huffman Coding: Minimum Variance Huffman Codes, Length of Huffman Codes, Adaptive Huffman Coding, Golomb codes, Rice codes, Tunstall codes, Applications of Huffman Coding. Arithmetic Coding: Coding a sequence, Generating a binary code, Comparison of Huffman and arithmetic coding, Applications.

Module II: Dictionary Techniques: Static Dictionary, Digram coding, Adaptive Dictionary, LZ77, LZ78, LZW algorithms, Applications. Context-based Compression: Prediction with partial match (ppm), Burrows-Wheeler Transform (BWT). Old JPEG standard, CALIC, JPEG-LS, Run-Length Coding, JBIG, JBIG2.

Module III: Mathematical Preliminaries for Lossy Coding: Distortion Criteria, Rate Distortion Theory. Scalar Quantization: Quantization problem, Uniform Quantizer, Lloyd-Max Quantizer, Adaptive Quantization, Nonuniform Quantization, Entropy-Coded Quantization,. Vector Quantization: LBG Algorithm, Tree Structured and Structured Vector Quantizers. Differential Coding: Basic algorithm, DPCM. Transform Coding: Transforms of Interest, JPEG.

Text Books:

1. Khalid Sayood, "Introduction to Data Compression", Morgan Kaufmann Publishers, 3rd Ed., 2005.
2. David Salomon, "Data Compression – The Complete Reference", Springer, 3rd Ed., 2004.

References:

1. Alistair Moffat, Andrew Turpin, "Compression and Coding Algorithms", Kluwer Academic Publishers, 1st Ed., 2002.
2. Vasudev Bhaskaran, Konstantinos Konstantinides, "Image and Video Compression Standards", Kluwer Academic Publishers, 2nd Ed., 2003.
3. Mark Nelson, Jean-Loup Gailly, "The Data Compression Book", John Wiley & Sons, 2nd Ed., 1995.
4. John Miano, "Compressed Image File Formats", Addison Wesley Professional, 1st Ed., 1999.
5. Peter Wayner, "Compression Algorithms for Real Programmers", Morgan Kaufmann, 1st Ed., 1999.

COS 624: INTELLIGENT DATA MINING

Module I: Introduction: Fundamentals of data mining, Data Mining Functionalities, Classification of Data Mining systems, Major issues in Data Mining, Data Warehouse and OLAP Technology for Data Mining Data Warehouse, Multidimensional Data Model, Data Warehouse Architecture, Data Warehouse Implementation, Further Development of Data Cube Technology, From Data Warehousing to Data Mining. Data Preprocessing: Needs Preprocessing the Data, Data Cleaning, Data Integration and Transformation, Data Reduction, Discretization and Concept Hierarchy Generation, Online Data Storage.

Module II: Data Mining Primitives, Languages, and System Architectures: Data Mining Primitives, Data Mining Query Languages, Designing Graphical User Interfaces Based on a Data Mining Query Language Architectures of Data Mining Systems, Concepts Description: Characterization and Comparison: Data Generalization and Summarization-Based Characterization, Analytical Characterization: Analysis of Attribute Relevance, Mining Class Comparisons: Discriminating between Different Classes, Mining Descriptive Statistical Measures in Large Databases. Mining Association Rules in Large Databases: Association Rule Mining, Mining Single-Dimensional Boolean Association Rules from Transactional Databases, Mining Multilevel Association Rules from Transaction Databases, Mining Multidimensional Association Rules from Relational Databases and Data Warehouses.

Module III: Classification and Prediction: Issues Regarding Classification and Prediction, Classification by Decision Tree Induction, Bayesian Classification, Classification by Back propagation, Classification Based on Concepts from Association Rule Mining, Other Classification Methods, Prediction, Classifier Accuracy. Cluster Analysis Introduction :Types of Data in Cluster Analysis, A Categorization of Major Clustering Methods, Partitioning Methods, Density-Based Methods, Grid-Based Methods, Model-Based Clustering Methods, Outlier Analysis.

References:

1. Jiawei Han, Micheline Kamber, Jian Pei, "Data Mining: Concepts and Techniques", Morgan Kaufmann, 2nd Ed., 2005.
2. Margaret H. Dunham, "Data Mining: Introductory and Advanced Topics", Prentice Hall, 1st Ed., 2002.
3. Da Ruan, Guoqing Chen, Etienne E. Kerre, Geert Wets, "Intelligent Data Mining: Techniques and Applications (Studies in Computational Intelligence)", Springer, 1st Ed., 2010.
4. Masoud Mohammadian, "Intelligent Agents for Data Mining and Information Retrieval", Idea Group Publishing, 2004.

COS 625: LABORATORY - II

Following experiments, related to Data Compression concepts need to be implemented:

- *Entropy*
- *Huffman algorithm*
- *Adaptive Huffman algorithm*
- *Golomb code*
- *Rice code*
- *Tunstall code*
- *Arithmetic coding*
- *LZ77*
- *LZ78*
- *LZW*
- *Prediction with partial match (ppm)*
- *BWT*
- *CALIC*
- *Vector Quantization*
- *LBG*
- *JPEG*

COS 631: RESEARCH METHODOLOGY

Module I

Introduction to Research Methodology : Meaning of Research, Objectives of Research, Motivations in Research, Types of Research, Research Approaches, Significance of Research, Research Process, Creativity and innovation, Thinking skills, Critical Thinking, Productive Thinking, Experimental Skills; Problem Solving Strategies, Logical thinking, Inductive and Deductive logic. Criteria of a good research, Defining the Research Problem: Selecting the Problem, Motivation behind the Problem definition, Techniques in defining the problem, Research Ethics, Plagiarism

Module II

Research Formulation: Selecting the problem, Importance of literature review in selecting a problem, Literature review, primary and secondary sources, reviews, treatise, monographs, web as a source, searching the web, Critical literature review, Identifying gap areas from literature review, Development of working hypothesis. Research Design: Planning and designing experiments, Critical Analysis; Role of statistics in research, Testing of Hypothesis: Meaning, Basic concepts, Flow diagram, Power of a hypothesis test, Important parametric tests, hypothesis testing of correlation coefficients, Limitations of tests of hypothesis.

Module III

Structure and Components of Research Report, Data Presentation, Types of Report, Layout of Research Report, Mechanism of writing a research Thesis, Formats of a research paper (Science/ Engineering/ Technology research papers), IMRAD format, IEEE/ACM Professional Societies paper formats, Reference Citing Styles, Publication Process: Peer review process, Open Access publications, other emerging trends in research communications, Shodhganga, Advanced academic search skills in Internet, Google Scholar, Scopus, Impact Factor, h-Index, g- index, Copyrights and Patents, IPR Laws.

REFERENCES

1. Kothari, C.R., "Research Methodology: Methods and Techniques", New Age Publisher, 2006.
2. Michael P. Marder, "Research Methods for Science", Cambridge University Press, 1st Ed., 2011.
3. Donald H. McBurney, "Research Methods", 5th Edition, Thomson Learning, 2006.
4. Ranjit Kumar, "Research Methodology: A Step-by-Step Guide for Beginners", SAGE Publications, 3rd Ed., 2010.

COS 632: DISSERTATION (Part 1)

The objective of this programme is to help the students to identify a specific topic for dissertation in the area of Digital Image Processing. This consists of at least two seminar presentations and a first level thesis draft. The first level thesis draft shall be submitted towards the end of the 3rd semester and shall contain problem definition, a brief overview of literature, preliminary algorithms and their implementations, and elementary results on the investigations. The evaluation procedure shall be based on report and presentations.

COS 641: DISSERTATION

The final dissertation work shall be based on the work in part I (COS 632). At least one technical paper is to be prepared for possible publication in Journals/Conference Proceedings of good standard. The evaluation procedure shall be based on report and presentations. There shall be an internal evaluation for the final dissertation done by the MTech committee and an external evaluation by a board consisting of an External examiner, Head of the Department and the Internal Guide.

COS 6011: WIRELESS SENSOR NETWORKS

Module I

Introduction: Introduction to Sensor Networks, unique constraints and challenges, Advantage of Sensor Networks, Applications of Sensor Networks, Mobile Adhoc NETworks (MANETs) and Wireless Sensor Networks, Enabling technologies for Wireless Sensor Networks Sensor Node Hardware and Network Architecture: Single-node architecture, Hardware components & design constraints, Operating systems and execution environments, introduction to TinyOS and nesC, Network architecture, Optimization goals and figures of merit, Design principles for WSNs, Service interfaces of WSNs, Gateway concepts.

Module II

Deployment and Configuration: Localization and positioning, Coverage and connectivity, Single-hop and multihop localization, Self configuring localization systems, Sensor management Network Protocols: Issues in designing MAC protocol for WSNs, Classification of MAC Protocols, S-MAC Protocol, B-MAC protocol, IEEE 802.15.4 standard and Zig Bee, Dissemination protocol for large sensor network. Routing protocols: Issues in designing routing protocols, Classification of routing protocols, Energy-efficient routing, Unicast, Broadcast and multicast, Geographic routing.

Module III

Data Storage and Manipulation: Data centric and content based routing, storage and retrieval in network, Compression technologies for WSN: Image and Video compression, Data aggregation technique. Applications: Detecting unauthorized activity using a sensor network, WSN for Habitat Monitoring.

References:

1. Holger Kerl, Andreas Willig, “Protocols and Architectures for Wireless Sensor Network”, John Wiley and Sons 1st Ed., 2005.

2. Raghavendra, Cauligi S, Sivalingam, Krishna M., Zanti Taieb, “Wireless Sensor Network”, Springer 1st Ed., 2004.

3. Feng Zhao, Leonidas Guibas, “ Wireless Sensor Network”, Elsevier, 1st Ed., 2004.
4. Kazem, Sohraby, Daniel Minoli, Taieb Zanti, “Wireless Sensor Network: Technology, Protocols and Application”, John Wiley and Sons 1st Ed., 2007.

COS 6012: ARTIFICIAL INTELLIGENCE AND ROBOTICS

Module I: Overview: foundations, scope, problems, and approaches of AI. Intelligent agents: reactive, deliberative, goal-driven, utility-driven, and learning agents. Artificial Intelligence programming techniques. Problem-solving through Search: forward and backward, state-space, blind, heuristic, problem-reduction, A, A*, AO*, minimax, constraint propagation, neural, stochastic, and evolutionary search algorithms. Knowledge Representation and Reasoning: ontologies, foundations of knowledge representation and reasoning, representing and reasoning about objects, relations, events, actions, time, and space; predicate logic, situation calculus, description logics, reasoning with defaults, reasoning about knowledge, sample applications.

Module II: Planning: planning as search, partial order planning, construction and use of planning graphs. Representing and Reasoning with Uncertain Knowledge: probability, connection to logic, independence, Bayes rule, bayesian networks, probabilistic inference, sample applications. Decision-Making: basics of utility theory, decision theory, sequential decision problems, elementary game theory, sample applications. Machine Learning and Knowledge Acquisition: learning from memorization, examples, explanation, and exploration. learning nearest neighbor, naive Bayes, and decision tree classifiers, Q-learning for learning action policies, applications.

Module III: Introduction to Robots, manipulators, Robot arm geometry, forward and inverse kinematics problem, arm dynamics, D'Alembert's equation of motion, trajectory planning, Homogeneous transformations and co-ordinate frames. Actuators: Introduction, Characteristics of actuating systems, Electric motors. Sensors: Introduction, Sensor characteristics, Types of Sensors, Vision systems, Voice Recognition devices, Voice synthesizers, Remote center compliance device. Robot control: The control problem, State equation, Constant solutions, Linear feedback systems, Single-axis PID control, PD-Gravity control, Computed-Torque control, Variable-Structure control, Impedance control. Robot vision: Image representation, Template matching, Polyhedral objects Shape analysis, Segmentation, Iterative processing, Perspective Transformations, Structured illumination, Camera calibration.

References:

1. Stuart Russell and Peter Norvig, "Artificial Intelligence – A Modern Approach", 3rd Edition, Prentice Hall.
2. Elaine Rich and Kevin Knight, "Artificial Intelligence", 2nd Edition, Tata McGraw Hill.
3. Robert J.Schilling, "Fundamentals of Robotics: Analysis and Control", 1st Ed., Prentice Hall.
4. Saeed B.Niku, "Introduction to Robotics: Analysis, Systems, Applications", 1st Ed., Prentice Hall.
5. K. S. Fu,R.C. Gonzalez, C.S.G. Lee, "Robotics: Control, Sensing, Vision, and Intelligence", 1st Ed., Mc Graw Hill.
6. Amit Konar, "Computational Intelligence: Principles, Techniques and Applications", 1st Ed., Springer.
7. Mittal and Nagarath, "Robotics and Control", 1st. Edition, Mc Graw Hill.

COS 6013: OBJECT ORIENTED ANALYSIS AND DESIGN

Module I

Software Architecture: Introduction to Software Architecture- Scope of software architectures - Arriving at an architecture - Domain-specific software architectures (DSSA) -Architectural Styles-Service-Oriented Architectures. Introduction - Software Engineering, Why object orientation, Object Oriented Systems development life cycle. Object oriented methodologies- Patterns and Frameworks.

Module II

Fundamentals of Object Oriented design using Unified Modeling Language, UML extensibility. UML Modeling using Rational Rose. Object oriented analysis: Identifying use cases - Object Analysis - Classification, Identifying Object relationships - Attributes and Methods. Object oriented design: Design axioms - Designing Classes

Module III

Access Layer – Object Storage - Object Interoperability, View Layer: Designing interface objects. Object Oriented Software Metrics .Software Quality, Introduction to AOSE: High-Level Methodologies Design Methods Agents in the real world.

Text Books:

1. Ali Bahrami, Object Oriented Systems Development , Tata McGraw-Hill, 1999
2. Martin Fowler, UML Distilled , Second Edition, PHI/Pearson Education, 2002. (UNIT II)
3. D.E. Perry and A.L. Wolf, Foundations for the Study of Software Architecture, ACM SIGSOFT Software Engineering Notes, vol. 17, no. 4, pp. 40-52, October 1992.

References:

1. Roger Pressman. S., Software Engineering : A Practitioner s Approach, (4th Edition), McGraw Hill, 1997.
2. Stephen R. Schach, Introduction to Object Oriented Analysis and Design , Tata McGraw-Hill, 2003.
2. James Rumbaugh, Ivar Jacobson, Grady Booch The Unified Modeling Language Reference Manual , Addison Wesley, 1999.
3. Hans-Erik Eriksson, Magnus Penker, Brain Lyons, David Fado, UML Toolkit , OMG Press Wiley Publishing Inc., 2004.
5. A survey of Agent-Oriented Software Engineering. Amund Tveit.. Norwegian University of Science and Technology. May 8, 2001.

COS 6014: FRACTAL THEORY AND APPLICATIONS

Module I: Mathematical Background: Basic Set Theory, Functions and limits, Measures and mass distributions, Probability Theory. Hausdorff Measure and Dimension, Box Counting Dimensions, Properties and problems of box counting dimension, Modified box-counting dimensions. Techniques for calculating dimensions: Basic methods, Subsets of finite measure, Potential theoretic methods, Fourier transform methods, Calculating Fractal Dimension of Images – Box counting method, Sarkar method, Variation method.

Module II: Local Structure of Fractals: Densities, Structure of 1-sets, Tangents to s-sets, Projection of Fractals: projections of arbitrary sets, projections of s-sets of integral dimension, projections of arbitrary sets of integral dimension. Products of fractals: product formulae. Intersections of Fractals: intersection formulae. Iterated function systems, dimensions of self-similar sets, Self-affine sets. Applications to encoding images.

Module III: Iteration of complex functions: Julia Sets, Quadratic functions – Mandelbrot set, Julia sets of quadratic functions, Characterization of quasi-circles by dimension, Newton's method for solving polynomial equations. Random Fractals: A random Cantor set, Fractal Percolation. Brownian Motion, Fractional Brownian Motion, Fractional Brownian Surfaces. Multifractal measures: Coarse multifractal analysis, Fine multifractal analysis, Self-similar multifractals. Physical Applications: Fractal growth, fluid dynamics and turbulence, Fractal antennas, Fractals in finance. Applications of Fractals in Image Processing.

References:

1. Kenneth Falconer, "Fractal Geometry: Mathematical Foundations and Applications",2nd Ed., Wiley, 2003.
2. Nigel Lesmoir-Gordon, Ralph Edney, "Introducing Fractals: A Graphic Guide", Totem Books, 2005.
3. Benoit B. Mandelbrot, "Fractals and Chaos: The Mandelbrot Set and Beyond", 1st Ed., Springer, 2004.
4. Heinz-Otto Peitgen,Hartmut Jürgens, Dietmar Saupe, "Fractals for the Classroom: Part 1: Introduction to Fractals and Chaos", Springer, 1991.
5. Nigel Lesmoir-Gordon, Ralph Edney, "Introducing Fractal Geometry", Totem Books, 2000.

COS 6015: KNOWELEDGE BASED SYSTEMS

Module I

Introduction to Knowledge Based Systems – Objectives of KBS , Components, Categories, Difficulties with the KBS. Knowledge Based System Architecture – Source of Knowledge , Types of Knowledge, Basic Structure, Knowledge Bases, Inference Engine, Self Learning, Reasoning, Explanation, Applications. Limitations of Knowledge Based Systems.

Module II

Developing Knowledge Based Systems – Knowledge Based System development Model, Knowledge Acquisition, Techniques for Knowledge Acquisition, Sharing Knowledge, Updating Knowledge. Knowledge Representation and Reasoning – The propositional calculus and Resolution, Predicate calculus and Resolution, Representing Procedural Knowledge, Reasoning with Uncertain Information, Learning and Acting with Bayes Nets.

Module III

Knowledge Management - Introduction, Perspectives, Evolution, Elements of Knowledge Management, Knowledge Management Process, Tools and Technologies, Knowledge Management Roles and Responsibilities, Knowledge Management Models. Agent Based Systems – Characteristics, Types of Agents, Agent Communication Language, Multi Agent Systems.

References:

1. Rajendra Akerkar, Priti Sajja, "Knowledge-Based Systems", Jones & Bartlett Learning, 1st Ed., 2010.
2. Nils J Nilsson "Artificial Intelligence – A New Synthesis", Morgan Kaufman Publishers 1st Ed., 2003.
3. Cornelius T Leondes, "Knowledge-Based Systems: Techniques and Applications", Academic Press, 1st Ed., 2000.
4. Elias M Awad, Hassan M Ghaziri, "Knowledge Management", Pearson Education, 1st Ed., 2007.

COS 6021: WAVELET ANALYSIS AND APPLICATIONS

Module I: Introduction: Wavelet, Organization of Wavelets, Wavelet tree for a signal. Mathematical Framework: Fourier Transform to Gabor Transform, Continuous transform in wavelets, Orthonormal wavelet bases: Continuous to Discrete Transform, Multiresolution analysis, Scaling function and wavelet. Wavelet packets, Biorthogonal wavelet bases. From wavelet bases to Fast Algorithm: Mallat Algorithm, Efficient calculation of the coefficients, Justification: projection and twin scales, Complexity of the algorithm.

Module II: Wavelet families: Orthogonal wavelets with compact support: Daubechies wavelets, Symlets, Coiflets. Biorthogonal wavelets with compact support, Orthogonal wavelets with non-compact support, Real Wavelets without filters, Complex wavelets without filters. Finding and Designing a wavelet: Construction of wavelets for continuous analysis, Construction of wavelets for discrete analysis, Lifting.

Module III: Image Processing with wavelets: Wavelets for the image: 2D wavelet decomposition, Approximation and detail coefficients. Edge Detection and Textures, Fusion of images, Denoising of images, Image Compression: Compression and Wavelets, Principle of Compression by wavelets, Compression Methods: Thresholding Coefficients, Selection of Coefficients, True Compression, EZW Coding. Overview of Applications.

References:

1. Michel Misiti, Yves Misiti, Georges Oppenheim, Jean-Michel Poggi, "Wavelets and their Applications", Wiley-ISTE, 1st Ed., 2007.
2. David F. Walnut, "An Introduction to Wavelet Analysis", Birkhäuser, 1st Ed., 2001.
3. C. Sidney Burrus, Ramesh A. Gopinath, Haitao Guo, "Introduction to Wavelets and Wavelet Transforms: A Primer", Prentice Hall, 1st Ed., 1997.
4. Lakshman Prasad, S. Sitharama Iyengar, "Wavelet Analysis with Applications to Image Processing", CRC Press, 1st Ed., 1997.
5. Michael W. Frazier, "An Introduction to Wavelets Through Linear Algebra", Springer, 1st Ed., 1999.
6. Gerald Kaiser, "A Friendly Guide to Wavelets", Birkhäuser, 1st Ed., 2010.
7. P. Wojtaszczyk, "A Mathematical Introduction to Wavelets", Cambridge University Press, 1st Ed., 1997.

COS 6022: EMBEDDED SYSTEMS

Module I

Embedded Systems – Definition, examples, typical usage, Building blocks. Hardware – Microprocessors, Microcontrollers, peripherals ,IO Types, Serial Communication, Parallel device ports, timer and counters, watchdog, real time clock. Software – Characteristics of embedded software, low foot print, high speed, low memory requirements, high responsiveness, predictability. Embedded programming – low level languages, examples, advantages and disadvantages, high level languages- examples, advantages and disadvantages, cross compilation, memory optimization.

Module II

Real Time Systems – Definition, Types of real time systems – soft real time systems, hard real time systems. Introduction to real time operating systems, examples, features of RTOS – scalability, predictability. RTOS Architecture - Task and Task States, Tasks and Data, Semaphores, Mutex, Shared Data, Message Queues, Mailboxes and Pipes, Synchronization, Timer Functions, Events and Event handlers, Memory Management, Interrupt routines in RTOS environment.

Module III

Scheduling – round robin, round robin with interrupts, function-queue scheduling, Non-preemptive multitasking, preemptive multi tasking, Deadlock, priority inversion, priority boosting, RTOS selection criteria. Embedded System Development Tools – Concept of host and target, Communication between host and target, Compiling, cross compiling, linking, downloading to target, Debugging, simulators, emulators.

References:

1. David E Simon," An Embedded Software Primer", Addison-Wesley Professional, 12th Ed., 1999.

2. Raj Kamal, "Embedded Systems", McGraw-Hill, 2nd Ed., 2008.

3. Sriram V Iyer, Pankaj Gupta, "Embedded Realtime Systems Programming", Tata McGraw-Hill, 1st Ed., 2004.

4. Tammy Noergaard, "Embedded System Architecture – A Comprehensive Guide for Engineers and Programmers", Newnes, Elsevier, 1st Ed., 2005.

COS 6023: GIS AND REMOTE SENSING

Module I

Introduction to GIS- Evolution of GIS , Components of GIS, Basic Geographic concepts, GIS Applications GIS data models- Computer database structures for managing data- GIS model for multiple maps, Maps and GIS- Classes of Maps, Mapping process, Geographic coordinate system of earth. Digital representation of the geographic data- raster data, vector data and Object oriented data representation, Raster based GIS data processing, Vector based GIS data processing, Digital Photogrammetry, Global Positioning System, Data quality and data standards

Module II

Principles of Remote Sensing– Principles of electromagnetic remote sensing, Remote sensing system Classification. Image characteristics of remote sensing systems, extraction of metric information from remotely sensed images, Integration of GIS and remote sensing. Digital Terrain Modeling- approaches to digital terrain data, Acquisition of digital terrain data and – Data Analysis, Processing and Visualization- Applications of digital terrain models. Data Analysis and Modeling- descriptive statistics- Trend surface analysis_ network analysis- GIS modeling

Module III

Data fusion related to GIS and remote sensing- Why GIS remote sening fusion, Problems in GIS- remote sensing data fusion, Present and Future solutions. Image registration and Multi Image fusion, Image Rectification, Thematic Classification- Classification Process, Feature Extraction, Training the Classifier, Subpixel Classification, Hyper spectral Image analysis. Case Studies in GIS, GIS design, Research Areas in GIS, Familiarization with any GIS software.

Text Books:

1. Chor Pang Lo, Albert K. W. Yeung, Concepts and techniques of geographic information systems Prentice Hall, 2002.
2. Michael N. Demers, Fundamentals of Geographic Information Systems, 3rd Ed, John Wiley & Sons, 1999.

References:

1. Robert A. Schowengerdt, Remote Sensing: Models and Methods for Image Processing, Academic Press, 2007.
2. Victor Mesev, Integration of GIS and Remote Sensing (Mastering GIS: Technol, Applications & Mgmnt), John Wiley & Sons, 2007.
3. Heywood Ian, An Introduction To Geographical Information Systems, 3rd Edition, Pearson Education India, 2010.

COS 6024: VIDEO SURVEILLANCE

Module I: Fundamentals: Image feature extraction: Feature point detection, Scale Invariant Feature Transform, Edge Detection, Color features. Multiple View Geometry: Perspective Projection Camera Model, Epipolar Geometry, Probabilistic inference, Pattern recognition and Machine learning: SVM and AdaBoost. Background Modeling and Subtraction: Kernel Density Approximation, Background Modeling and Subtraction Algorithms.

Module II: Pedestrian Detection and Tracking: Pedestrian detection by boosting local shape features: Tree learning algorithms, Edgelet features. Occluded pedestrian detection by part combination. Pedestrian tracking by Associating Detection Responses. Vehicle Tracking and Recognition: Joint tracking and Recognition framework, Joint appearance-motion generative model, Inference algorithm for joint tracking and recognition.

Module III: Human Motion Tracking: Image feature representation, Dimension reduction and Movement dynamics learning. Human action recognition: Discriminative Gaussian Process dynamic model. Human Interaction recognition: Learning human activity, Track-body Synergy framework. Multi-camera calibration and global trajectory fusion: Non-overlapping and overlapping cameras. Applications: Attribute-based people search, Soft biometrics for video surveillance: Age estimation from face, Gender recognition from face and body.

References:

1. Yunqian Ma, Gang Qian, " Intelligent Video Surveillance: Systems and Technology", CRC Press (Taylor & Francis Group), 2010.
2. Fredrik Nilsson, Communications Axis, "Intelligent Network Video: Understanding Modern Video Surveillance Systems", CRC Press (Taylor & Francis Group), 2008.
3. Anthony C. Caputo, "Digital Video Surveillance and Security", Butterworth-Heinemann, 1st Ed., 2010.
4. Herman Kruegle, "CCTV Surveillance, Second Edition: Video Practices and Technology", Butterworth-Heinemann, 2nd Ed., 2006.

COS 6025: PARALLEL COMPUTING

Module I: Introduction: Serial to Parallel thinking, History of parallel computers, Performance metrics - speedup, utilization, efficiency, scalability. Models of Parallel Computation SIMD, MIMD, PRAM (EREQ, CREW, CRCW), NC. Parallel Computer Organization, Pipelining and Throughput, Latency and Latency hiding. Memory Organization, Inter-process communication, Inter-connection network, Message passing, Shared/Distributed memory.

Module II: Basic Parallel Algorithmic Techniques: Pointer Jumping, Divide-and-Conquer, Partitioning, Pipelining, Accelerated Cascading, Symmetry Breaking, Synchronization (Locked, Lock-free) Parallel Algorithms, Data organization for shared/distributed memory, Min/Max, Sum, Searching, Merging, Sorting, Prefix operations N-body problems, Matrix operations. Overview of Cluster based distributed computing: Hardware technologies for cluster computing, Software and software architectures for cluster computing: Shared memory (OpenMP) and Message-Passing (MPI/PVM) models. Dynamic process creation, one-sided communication, Parallel I/O.

Module III: Overview of GPUs: architecture, features and Programming model. System issues: cache and data management, languages and compilers, stream processing, GPU-CPU load balancing. Writing Parallel Programs, GPU-Compute Architecture, CUDA, Memory organization in CUDA, Multi-Core CPU programming, MPI, PVM, Performance evaluation and scalability, Image Processing using GPU and Cluster Computing.

References:

1. Joseph Jaja, "Introduction to Parallel Algorithms", Addison-Wesley Professional, 1st Ed., 1992.
2. Ananth Grama, George Karypis, Vipin Kumar, Anshul Gupta, "Introduction to Parallel Computing", Addison-Wesley Professional, 2nd Ed., 2003.
3. Michael Quinn, "Parallel Programming in C with MPI and OpenMP", McGraw-Hill, 1st Ed., 2003.
4. Jason Sanders, Edward Kandrot, "CUDA by Example: An Introduction to General-Purpose GPU Programming", Addison-Wesley Professional, 1st Ed., 2010.
5. David Culler, J.P. Singh, Anoop Gupta, "Parallel Computer Architecture: A Hardware/Software Approach", Morgan Kaufmann, 1st Ed., 1998.
6. William Gropp, Steven Huss-Lederman, Andrew Lumsdaine, Ewing L. Lusk, Bill Nitzberg, William Saphir, Marc Snir, "MPI - The Complete Reference. Volume 2, The MPI Extensions", MIT Press, 2nd Ed., 1998.
7. David B. Kirk, Wen-mei W. Hwu, "Programming Massively Parallel Processors: A Hands-on Approach", Morgan Kaufmann, 1st Ed., 2010.
8. Rob Farber, "CUDA Application Design and Development", Morgan Kaufmann, 1st Ed., 2011.