Computer Vision

[8th Semester, Fourth Year]

Course Description

Offered by Department	Credits	Status	Code
Electronics & Communication Engineering	3-0-0, (3)	Open Elective	EC108301EC

[Pre-requisites: EC105301EC-Digital Image Processing]

Course Objectives

1. To provide an overview of basic approaches and current techniques in computer vision.
2. To understand various mechanisms responsible for motion estimation, computational imaging and multiple view geometry.
3. To study various applications of computer vision systems.

Course Content

UNIT-I:

Image Formation:

Geometric primitives and transformations: Orthogonal, euclidean, affine, projective, etc. photometric image formation.

Feature Extraction:

Edges canny, LOG, DOG; line detectors (Hough transform), Corners Harris, Hessian Affine, orientation histogram, SIFT, SURF, HOG, GLOH.

UNIT-II:

Camera Geometry:

Camera parameters and perspective projection, affine camera, least-squares parameter estimation, linear approach to camera calibration, homography, rectification, auto calibration.

Color Space:

Linear color spaces: CIE XYZ, RGB, CMY, non-linear colour spaces: HSV, spatial and temporal effects.

UNIT-III:

Motion Analysis:

Translational alignment, parametric motion, spline-based motion, optical flow, KLT.

Stereo correspondence:

Epipolar geometry, sparse correspondence, dense correspondence, multi-view stereo.

UNIT-IV:

Basics of object detection, face recognition, instance recognition, category recognition, context and scene understanding, activity recognition, computational photography, shape from X.

Course Materials

Required Text: Text books

1. Computer Vision: Algorithms and Applications, Richard Szeliski, Springer, 2010.
2. Computer Vision, Shapiro and Stockman, Prentice Hall, 2001.

Optional Materials: Reference Books

1. Image Processing, Analysis, and Machine Vision, Sonka, Hlavac, and Boyle, Cengage Learning, 2009.
2. Fundamentals of Machine Vision, Harley R. Myler, PHI Learning, 2003.
3. Computer Vision: A Modern Approach, Forsyth, David A., Ponce, Jean, PHI Learning, 2009.
4. Digital image processing, Rafael C. Gonzalez and Richard E. Woods, Pearson Education 3rd Edition.

Free Space Optics

[8th Semester, Fourth Year]

Course Description

Offered by Department	Credits	Status	Code
Electronics & Communication Engineering	3-0-0, (3)	Open Elective	EC108302EC

[Pre-requisites: EC107101EC - Optical Communication]

Course Objectives

1. To gain knowledge about optical communication, FSO and its applications.
2. To learn about FSO channel models, its performance parameters.
3. To understand the challenges in FSO technology and its mitigation techniques.

Course Content

UNIT-I

Introduction: Introduction to optical communication, Emphasis on free-space optical communications, Propagation effects in free-space optical channels and corresponding channel impairments: laser beam propagation over the atmospheric turbulence channels, Kolmogorov theory of turbulence; modified von Karman, Andrews, and Tatarskii models; Rytov method, Gamma-gamma distribution, Fourier split-step beam propagation method, scattering effects; indoor optical communication channels, deep-space optical communication channels.

Unit- II

Free-space optical channel capacity studies and approaches to achieve it: free-space optical channels with and without memory, calculation of channel capacity and various techniques to achieve channel capacity: water-filling, channel inversion, optical phase conjugation, multiplexed coding and decoding, advanced detection techniques. Diversity and MIMO techniques: diversity techniques, MIMO channel model, parallel decomposition, beam forming, space-time modulation and coding.

Unit- III

Adaptive optics techniques: reference wave in an adaptive optics system, wavefront sensors (quadrature sensors, phase difference sensors, Hartmann sensor), wavefront correctors (modal correctors, deformable mirrors, segmented correctors), modal phase correction, modal phase conjugation. Adaptive coded modulation and software-defined techniques: variable-rate techniques, variable-power techniques, variable coding techniques, hybrid techniques, adaptive modulation and coding.

Unit- IV

Physical-layer security for FSO links: cryptography basics, information-theoretic security, quantum key distribution (QKD), post-quantum cryptography (PQC), and optical covert communications. Quantum FSO communications: quantum mechanics basics, quantum detection theory, quantum communication theory.

Course Materials

Required Text: Text books

1. I. B. Djordjevic, Advanced Optical and Wireless Communications Systems. Springer International Publishing AG, 2018.

Optional Materials: Reference Books

1. Digital Optical Communications, Le Nguyen Binh, CRC Press, Chennai, 2009.
2. Fiber-Optic Communication Systems, 4ed, G. P. Agrawal, John Wiley & Sons, NY, 2010.
3. Advanced Optical and Wireless Communication Systems, Ivan B. Djordjevic, Springer, 2018.
4. Optical Wireless Communications: System and Channel Modeling with Matlab, Z. Ghassemlooy, W. Popoola, S. Rajbhandari, CRC Press, 2013.

Natural Language Processing

[8th Semester, Fourth Year]

Course Description

Offered by Department	Credits	Status	Code
Electronics & Communication Engineering	3-0-0, (3)	Open Elective	EC108303EC

[Pre-requisites: Signals and systems]

Course Objectives

1. To gain an in-depth understanding of the computational properties of natural languages and the commonly used algorithms for processing linguistic information.
2. To examine the NLP models and algorithms using both the traditional symbolic and the more recent statistical approaches.
3. To enable students to be capable to describe the application based on natural language processing and to show the points of syntactic, semantic and pragmatic processing.

Course Content

UNIT-I:

Introduction to NLP. Applications of NLP, stages of NLP, Basic Text Processing, Spelling Correction, Edit Distance, Weighted Edit Distance, Other Variations, Noisy Channel Model for Spelling Correction, N-Gram Language Models, Evaluation of Language Models, Basic Smoothing, Advanced Smoothing Models

Unit- II:

Computational Morphology, Finite - State Methods for Morphology, Introduction to POS Tagging, Hidden Markov Models for POS Tagging, Maximum Entropy models. Viterbi Decoding for HMM, Parameter Learning.

Unit- III:

Introduction to Syntax, Syntax - Parsing I, Syntax - CKY, PCFGs, Dependency Grammars and Parsing, Probabilistic Parsing Algorithms, Transition Based Parsing : Formulation, MST-Based Dependency Parsing and learning.

Unit- IV:

Semantics – Introduction, Distributional Models of Semantics, Word Embeddings, Lexical Semantics, Word Sense detection, Text Summarization, Text Classification, Sentiment Analysis and Opinion Mining.

Course Materials

Required Text: Text books

1. “Natural Language Processing and Information Retrieval”, Tanveer Siddiqui, U.S. Tiwary, 3rd Edition, , Oxford University Press,2008.
2. “Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech”, 2ndEdition, Daniel Jurafsky, James H. Martin -Pearson Publication,2014.

Optional Materials: Reference Books

1. “Natural Language Processing with Python”, First Edition, Steven Bird, Ewan Klein and Edward Loper, OReilly Media,2009.
2. “Speech and Language Processing”, Jurafsky, Dan and Martin, James, Second Edition, Prentice Hall, 2008.
3. “Foundations of Statistical Natural Language Processing”, Manning, Christopher and Heinrich, Schutze, MIT Press, 1999.
4. “Handbook of Natural Language Processing”, Second, Nitin Indurkhya and Fred J. Damerau, Chapman and Hall/CRC Press, 2010.Edition.

VLSI Signal Processing

[8th Semester, Fourth Year]

Course Description

Offered by Department	Credits	Status	Code
Electronics & Communication Engineering	3-0-0, (3)	OPEN ELECTIVE	EC108304EC

[Pre-requisites: EC106103EC-VLSI Design,EC104102EC-Digital Signal Processing]

Course Objectives

1. To provide sound foundation of digital signal processing (DSP) architectures and designing efficient VLSI architectures for DSP systems.
2. To make the students to implement DSP algorithm in an optimized method.

Course Content

UNIT I

Transformations for retiming: Folding and unfolding DSP programs. Bit level arithmetic structures- parallel multipliers, interleaved floor plan and bit plan based digital filters. Bit serial multipliers. Bit serial filter design and implementation, Canonic signed digit arithmetic, Distributed arithmetic.

UNIT II

Redundant arithmetic: redundant number representations, carry free radix 2 addition and subtraction, Hybrid radix 4 addition. Radix 2 hybrid redundant multiplication architectures, data format conversion. Redundant to nonredundant converter. Numerical strength reduction.

UNIT III

Synchronous pipelining: clocking styles, clock skew and clock distribution in bit level pipelined VLSI designs. Wave pipelining, constraint space diagram and degree of wave pipelining. Implementation of wave-pipelined systems. Asynchronous pipelining.

UNIT IV

Scaling versus power consumption: Power analysis, power reduction techniques, power estimation techniques. Low power IIR filter design. Low power CMOS lattice IIR filter.

Course Materials

Required Text: Text books

1. VLSI Digital Signal Processing Systems: Design and Implementation, K KParhi, John Wiely, 2007
2. Digital Signal Processing, J. Proakis, PHI, Second edition.

Optional Materials: Reference Books

1. DSP Integrated Circuits, Lars Wanhammar, Academic Press, First edition, 1999
2.VLSI Design Methodologies for Digital Signal Processing Architectures. United States: Springer, 2012.

Cryptography and Network Security

[8th Semester, Fourth Year]

Course Description

Offered by Department	Credits	Status	Code
Electronics & Communication Engineering	3-0-0, (3)	OPEN ELECTIVE	EC108305EC

[Pre-requisites: NA]

Course Objectives

1. To understand the concepts of various Encryption, Authentication and Digital SignatureAlgorithms.
2. To learn about network and system level security.

Course Content

UNIT I

INTRODUCTION: OSI Security Architecture, Classical Encryption techniques, Cipher Principles, Data Encryption Standard – Block Cipher Design Principles and Modes of Operation - Evaluation criteria for AES – AES Cipher – Triple DES – Placement of Encryption Function – Traffic Confidentiality, Lightweight Cryptography.

UNIT II

PUBLIC KEY CRYPTOGRAPHY : Key Management - Diffie-Hellman key Exchange – Elliptic Curve Architecture and Cryptography - Introduction to Number Theory – Confidentiality using Symmetric Encryption – Public Key Cryptography and RSA, PKI.

UNIT III

AUTHENTICATION AND HASH FUNCTION: Authentication requirements – Authentication functions Message Authentication Codes – Hash Functions – Security of Hash Functions and MACs, MD5 message Digest algorithm, Secure Hash Algorithm, RIPEMD, HMAC Digital Signatures, Authentication Protocols – Digital Signature Standard.

UNIT IV

NETWORK AND SYSTEM LEVEL SECURITY: Authentication Applications: Kerberos – X.509, Authentication Service, Electronic Mail Security – PGP – S/MIME - IP Security – Web Security, Intrusion detection – password management – Viruses and related Threats – Virus Counter measures – Firewall Design Principles – Trusted Systems, Hardware trojan.

Course Materials

Required Text: Text books

1. Cryptography And Network Security – Principles and Practices, William Stallings, Prentice Hall of India, Third Edition, 2003.

Optional Materials: Reference Books

1. Network Security Private Communication in a public world, Charlie Kaufman, Radia Perlman & Mike Speciner, Prentice Hall of India Private Ltd., New Delhi.
2. Cryptography and Network Security, Atul Kahate, Tata McGraw-Hill, 2003.
3. Applied Cryptography, Bruce Schneier, John Wiley & Sons Inc, 2001.
4. The Hardware Trojan War: Attacks, Myths, and Defenses, Mark M. Tehranipoor, Springer International Publishing, 2017.
5. Networked RFID Systems and Light weight Cryptography Raising Barriers to Product Counterfeiting, Damith C. Ranasinghe, Peter H. Cole, Springer Berlin Heidelberg, 2008.

Introduction to Reinforcement Learning

[8th Semester, Fourth Year]

Course Description

Offered by Department	Credits	Status	Code
Electronics & Communication Engineering	3-0-0, (3)	OPEN ELECTIVE	EC108306EC

[Pre-requisites: NA]

Course Objectives

1. Model a control task in the framework of MDPs.
2. Understand the principles of model-based and model-free learning.
3. Understand the idea behind Bellman equation and Q-learning.
4. Understand and use deep learning methods to RL problems in practice.

Course Content

UNIT-I

Fundamentals of reinforcement learning (RL): Agent, environment, state, action, reward, Markov decision process (MDP), Bellman equation, Dynamic programming, Monte Carlo methods.

UNIT- II

Temporal difference (TD) learning: TD prediction, On-policy TD control (SARSA), Off-policy TD control (Q-learning). Introduction to AI Gym environment.

UNIT- III

Deep Q Networks (DQN): Architecture of DQN, Double DQN, DQN with prioritized experience replay, Deep recurrent Q network, Study of simple DQN implementations in Python.

UNIT- IV

Policy gradient method: Derivation of policy gradient, Variance reduction methods, Policy gradient with reward-to-go, REINFORCE algorithm, REINFORCE with baseline, Introduction to actor-critic algorithm, A2C vs A3C, Study of simple Python implementations.

Course Materials

Required Text: Text books

1. “Deep reinforcement learning with python, 2ed”, Sudarshan Ravichandiran, Packt Pub. 2020.
2. “Foundations of deep reinforcement learning”, Laura Graesser et al., Pearson Education, 2022.

Optional Materials: Reference Books

1. “Reinforcement learning: an introduction, 2ed”, Richard S. Sutton et al., MIT Press, 2018.

MEMS Systems

[8th Semester, Fourth Year]

Course Description

Offered by Department	Credits	Status	Code
Electronics & Communication Engineering	3-0-0, (3)	OPEN ELECTIVE	EC108307EC

[Pre-requisites: NA]

Course Objectives

1. To have a concept on the scope and recent development of the science and technology of microsystems;
2. To gain the physical knowledge underlying the operation principles and design of microsystems;
3. To learn some typical or potentially applicable microsystems at the frontier of the development of the field

Course Content

UNIT I

Historical Background: Silicon Pressure sensors, Micromachining, Micro Electromechanical Systems Micro-fabrication and Micromachining: Integrated Circuit Processes, Bulk Micromachining.

UNIT II

Isotropic Etching and Anisotropic Etching, Wafer Bonding, High Aspect-Ratio Processes (LIGA) Physical Microsensors. Classification of physical sensors, Integrated, Intelligent, or Smart sensors, Sensor Principles and Examples: Thermal sensors, Electrical Sensors, Mechanical Sensors, Chemical and Biosensors.

UNIT III

Electromagnetic and Thermal micro actuation, Mechanical design of micro actuators, Micro actuator examples: microvalves, micropumps, micromotors. Micro actuator systems: Success Stories, Ink-Jet printer heads, Micro-mirror TV Projector Surface Micromachining.

UNIT IV

One or two sacrificial layer processes, Surface micromachining requirements, Polysilicon surface micromachining, Other compatible materials, Silicon Dioxide, Silicon Nitride, Piezoelectric materials, Surface Micromachined Systems: Success Stories, Micromotors, Gear trains, Mechanisms.

Course Materials

Required Text: Text books

1. MEMS, Nitaigour, Premchand, Mahalik, Tata McGraw-Hill Education, 2007.
2. RF MEMS and their Applications, Varadan, Vinoy, Jose, Wiley, 2003.

Optional Materials: Reference Books

1. Smart Material Systems and MEMS: Design and Development Methodologies, Varadan, Vinoy, Gopalakrishnan, Wiley, 2006.
2. VLSI Technology, Sze, 2/E. India: McGraw-Hill Education (India) Pvt Limited, (2003).