COURSE OUTLINE

CS-4059 FUNDAMENTALS OF COMPUTER VISION (ELECTIVE – 3 CRH)

INSTRUCTOR: S. ASIF MAHMOOD GILANI, PH.D. (asif.gilani@nu.edu.pk)

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OFFICE: NB-F-010 (FIRST FLOOR, NEW BUILDING)

For the latest information, study material and handouts please visit at **(Google-Classroom)**

Class Timetable – FALL 2024

Sections	Start Date	Midterm-I	Midterm-II	End Date	Final	Lectures (Room: CS-**)	Office Time
BS (CS) **Section 7A**	19-08-2024	6th Week	11th Week	12 – 2023	18th Week	**Mon & Wed** 8:30-9:50 **(NB-201)**	**Tue; Thurs: 10-11** Or by appointment/ check in the office
BS (CS) **Section 7B**	19-08-2024	6th Week	11th Week	12 – 2023	18th Week	**Mon & Wed** 11:30-12:50 **(NB-202)**	

The course gives a broad overview of the concepts from the field of Computer Vision. It provides basis for advanced graduate level courses and research in computer/machine vision. The students will be required to practically implement various vision techniques to get hands-on experience with vision based applications. A reasonable level of Calculus background, Linear Algebra and Programming background is expected for this course.

The field itself combines ideas from several different areas including Machine Intelligence, Pattern Recognition, Image Processing, statistics and computer graphics. The focus of this course will be breadth knowledge of these ideas with moderate level of details of various algorithms and techniques.

This course is an elective for undergraduate students from both Computer Science and Computer Engineering.

Goals

- To introduce the basic concepts in Computer/machine Vision and to provide a reasonable insight into the problems, procedures and techniques in the field.
- Discuss the application and state of the art projects and research in Computer Vision.
- To make students learn from programming assignments and get comfortable with vision based solutions to various problems. This will develop in them the confidence to deal with Computer Vision applications.

Text and Reference Books

Course Slides and lectures will be the primary reference material taken largely from the following books:

- [Umbaugh] Computer Vision and Image Analysis, Fourth Edition, Scott E. Umbaugh, CRC Press, Taylor & Francis, 2023.
- [Mubarak Shah] Fundamentals of Computer Vision.
- [Szeliski] Computer Vision Algorithms and Applications, Richard Szeliski, Springer 2022.
- [Parker] practical Computer Vision using C, J. R. Parker, Johan Wiley & Sons Inc.
- [Gonzalez] Digital Image Processing, Gonzalez R.C., Woods R.E.,Pearson Education, 3rd Edition, 2008

Reference Web Links

http://cviptools.ece.siue.edu/

Grading (Tentative)

Instrument	Weight
Quiz, Assignment (Programming / Written) & Project	**25 %**
Midterms	**30%**
Final	**45%**

Contents (Tentative)

INTRODUCTION/COMPUTER IMAGING **(Week 1-2)**	▪ **Background** ▪ **Digital Image Representation** ▪ **Fundamental Steps in Image Processing** ▪ **Elements of Digital Image Processing Systems** • Acquisition • Storage • Processing • Communication • Display ▪ **Image Sampling and Quantization** ▪ **Image Types and Applications**
DIGITAL IMAGING PROCESSING AND ANALYSIS **(Week 2-3)**	▪ **Imaging systems Overview** ▪ **Image Formation and Sensing** • Visible light imaging • Imaging outside the Visible Range of the EM Spectrum • Acoustic Imaging • Electron Imaging • Laser Imaging • Computer Generated Images ▪ **CVIP(Computer Vision and Image Processing) tools** ▪ **Image Representation** • Binary Images • Gray-Scale Images • Multispectral Images • Digital Image File Formats
IMAGE ANALYSIS AND COMPUTER VISION **(Week 4-7)**	▪ **Introduction** ▪ **Preprocessing** • Region of Interest Image Geometry • Arithmetic and Logic Operations • Spatial Filters • Image Quantization ▪ **Binary Image Analysis** • Thresholding via Histogram • Connectivity and Labeling • Basic Binary Object Features • Binary Object Classification

EDGE/LINE DETECTION AND SEGMENTATION **(Week 7-11)**	▪ **Introduction** ▪ **Edge/Line Detection** • Gradient Operators • Compass Masks • Advanced Edge Detectors • Edges in Color Images • Edge Detector Performance • Hough Transform ▪ **Segmentation** • Region growing and Shrinking • Clustering Techniques • Boundary Detection • Deep Learning Segmentation Methods • Convolutional Neural Network • Combined Segmentation Approaches • Morphological Filtering
FEATURE EXTRACTION AND ANALYSIS **AND** **PATTERN CLASSIFCATION** **(Week 11-15)**	▪ **Introduction and Overview** ▪ **Feature Extraction** • Shape Features • Histogram Features • Color Features • Spectral Features • Texture Features • Region-Based Features: SIFT/SURF/GIST ▪ **Feature Analysis** • Feature Vectors and Feature Spaces • Distance and Similarity Measures • Data Preprocessing ▪ **Pattern Classification** • Algorithm Development: Training and Testing methods • Classification Algorithms and Methods • Nearest Neighbor (NN), K-NN, Nearest Centroid, Template Matching • Bayesian, Support Vector Machines, Random Forest Classifiers • Neural Networks and Deep Learning • Cost/Risk Functions and Success Measures. • Pattern Classification Tools: Python, R, Matlab

Note:

- Attendance should be maintained 100% except any emergency where the absent policy should be observed;
- Assignments, Quizzes and projects should be done independently, in case of Plagiarism, the student will be graded zero without any notice;
- The decorum of the class should be maintained at all times otherwise a severe penalty should be expected but the class participation will be valued open-heartedly;
- The students are encouraged to discuss subject problems even beyond class timings.

Wish you all the best