Course Title: Digital Image Processing   **Credit: 3**

Course No: CSIT.415.4   **Number of period per week: 3+3**

Nature of the Course: Theory + Lab   **Total hours: 45+45**

Year: Fourth, Semester: Seventh

Level: B. Sc. CSIT

1. Course Introduction

The course will cover techniques and tools for digital image processing, and finally also introduce image analysis techniques in the form of image segmentation. The course is primarily meant to develop on-hand experience in applying these tools to process these images. The students would be encouraged to develop the image processing tools from scratch, rather than using any image processing library functions.

2. Objectives

Upon completion of this course students should be able to:

→ Develop an overview of the field of image processing.
→ Understand the fundamental algorithms and how to implement them.
→ Prepare to read the current image processing research literature.
→ Gain experience in applying image processing algorithms to real problems.

3. Specific Objectives and Contents

Specific Objectives	Contents
• Discuss basics of image lightning and bright model • Describe geometry, projection, filtering, sampling and quantization	**Unit I: Introduction (4 hr)** 1.1. Light, Brightness adaption and discrimination, Pixels, coordinate conventions, Imaging 1.2. Geometry, Perspective Projection, Spatial Domain Filtering, sampling and quantization.
• Demonstrate the use or different filters • Exemplify intensity transformation and its application • Apply FFT in processing digital images • Discuss concept of time domain and frequency domain	**Unit II: Image Filtering (10 hr)** 2.1. Intensity transformations, contrast stretching, histogram equalization, Correlation and convolution Smoothing filters, sharpening filters, gradient and Laplacian 2.2. Hotelling Transform, Fourier Transforms and properties, FFT (Decimation in Frequency and Decimation in Time Techniques), Convolution, Correlation, 2-D sampling, Discrete Cosine Transform, Frequency domain filtering.
• Discuss need and importance of image restoration • Demonstrate different restoration	**Unit III: Image Restoration (6 Hrs)** 3.1. Basic Framework, Interactive Restoration, Image deformation and geometric transformations, image morphing, Restoration techniques

techniques with example • Explain technique of noise characterization and apply filters to remove noise • Exemplify estimation of degradation function	3.2. Noise characterization, Noise restoration filters, Adaptive filters, Linear, Position invariant degradations, Estimation of Degradation functions, Restoration from projections.
• Understand redundancies and its use in image compression • Discuss Shannon's theorem and its implication • Exemplify different types of coding techniques • Demonstrate the use of Thresholding • Discuss the concepts of refinement, transforms, and encoding	**Unit IV: Image Compression (13 Hrs)** 4.1. Encoder-Decoder model, Types of redundancies, Lossy and Lossless compression, Entropy of an information source, Shannon's 1st Theorem 4.2. Huffman Coding, Arithmetic Coding, Golomb Coding, LZW coding, Transform Coding 4.3. Sub-image size selection, blocking artifacts, DCT implementation using FFT 4.4. Run length coding, FAX compression (CCITT Group-3 and Group-4), Symbol-based coding, JBIG-2, Bit-plane encoding, Bit-allocation, Zonal Coding, Threshold Coding, JPEG, Lossless predictive coding, Lossy predictive coding, Motion Compensation 4.5. Expansion of functions, Multi-resolution analysis, Scaling functions, MRA refinement equation, Wavelet series expansion, Discrete Wavelet Transform (DWT), Continuous Wavelet Transform, Fast Wavelet Transform, 2-D wavelet Transform, JPEG-2000 encoding, Digital Image Watermarking
• Understand morphological features of images • Demonstrate boundary detection and holes filing techniques • Explain image processing by using different morphological features	**Unit V: Image Processing (6 Hrs)** 5.1. Basics, SE, Erosion, Dilation, Opening, Closing, Hit-or-Miss Transform, Boundary Detection, Hole filling 5.2. Connected components, convex hull, thinning, thickening, skeletons, pruning, Geodesic Dilation, Erosion, Reconstruction by dilation and erosion.
• Explain need and importance of image segmentation • Exemplify identification of boundaries and edges • Demonstrate image segmentation with suitable example	**Unit VI: Image Segmentation (6 Hrs)** 6.1. Boundary detection based techniques, Point, line detection, Edge detection, Edge linking, local processing, regional processing, Hough transform 6.2. Thresholding, Iterative Thresholding, Otsu's method, Moving averages, Multivariable Thresholding, 6.3. Region based segmentation, Watershed algorithm, Use of motion in segmentation

Evaluation System

Undergraduate Programs							
External Evaluation	**Marks**	**Internal Evaluation**	**Weight age**	**Marks**	**Practical**	**Weight age**	**Mark**
End semester examination	60	Assignments	20%	20	Practical Report copy	25%	20
(Details are given in the separate table at the end)		Quizzes	10%		Viva	25%	
		Attendance	20%		Practical Exam	50%	
		Internal Exams	50%				
Total External	60	Total Internal	100%	20		100%	20
Full Marks 60+20+20 = 100							

External evaluation

1. **End semester examination:**
   It is a written examination at the end of the semester. The questions will be asked covering all the units of the course. The question model, full marks, time and others will be as per the following grid.

2. **External Practical Evaluation:**
   After completing the end semester theoretical examination, practical examination will be held. External examiner will conduct the practical examination according to the above mentioned evaluation. There will be an internal examiner to assist the external examiner. Three hours time will be given for the practical examination. In this examination Students must demonstrate the knowledge of the subject matter.

Full Marks: 100, Pass Marks: 45, Time: 3 Hrs

Nature of question	**Total questions to be asked**	**Total questions to be answered**	**Total marks**	**Weightage**
Group A: multiple choice*	20	20	20×1 = 20	60%
Group B: Short answer type questions	7	6	6×8 = 48	60%
Group C: Long answer type questions	3	2	2×16 =32	60%
			100	100%

Each student must secure at least 50% marks in internal evaluation in order to appear in the end semester examination. Failed student will not be eligible to appear in the end semester examinations.

Internal evaluation

Assignment: Each student must submit the assignment individually. The stipulated time for submission of the assignment will be seriously taken.

Quizzes: Unannounced and announced quizzes/tests will be taken by the respective subject teachers. Such quizzes/tests will be conducted twice per semester. The students will be evaluated accordingly.

Attendance in class: Students should regularly attend and participate in class discussion. Eighty percent class attendance is mandatory for the students to enable them to appear in the end semester examination. Below 80% attendance in the class will signify NOT QUALIFIED (NQ) to attend the end semester examination.

Presentation: Students will be divided into groups and each group will be provided with a topic for presentation. It will be evaluated individually as well as group-wise. Individual students have to make presentations on the given topics.

Mid-term examination: It is a written examination and the questions will be asked covering all the topics in the session of the course.

Discussion and participation: Students will be evaluated on the basis of their active participation in the classroom discussions.

Instructional Techniques: All topics are discussed with emphasis on real-world application. List of instructional techniques is as follows:
- Lecture and Discussion
- Group work and Individual work
- Assignments
- Presentation by Students
- Quizzes
- Guest Lecture

Students are advised to attend all the classes and complete all the assignments within the specified time period. If a student does not attend the class(es), it is his/her sole responsibility to cover the topic(s) taught during that period. If a student fails to attend a formal exam/quiz/test, there won't be any provision for re-exam. Unless and until the student clears one semester he/she will not be allowed to study in the following semesters.

Laboratory Work

Student should implement different algorithms discussed in class by using programming language of interest and prepare to make a lab sheet. At least 15 algorithms needs to be implemented.

Prescribed Text

− Digital Image Processing, 3rd Edition, by Rafael C Gonzalez and Richard E Woods. Publisher: Pearson Education.

References

− N. Efford, Digital Image Processing, Addison Wesley 2000
− M Sonka, V Hlavac and R Boyle, Image Processing, Analysis and Machine Vision, PWS 1999
− W K Pratt, Digital Image Processing, John Wiley and Sons, 1991