GUJARAT TECHNOLOGICAL UNIVERSITY

Syllabus for Master of Computer Applications, 5th Semester
Subject Name: Image Processing (IP)
Subject Code: 4659309

With effective from academic year 2018-19

1. **Learning Objectives:**
   - To understand basic concepts and methodologies for digital image processing
   - To develop a foundation that can be used as the basis for further study and research in this field.
   - To provide understanding of the different types of image representations, enhancing image characteristics, image filtering, and reducing the effects of noise and blurring in an image.
   - To understand image processing needed for extracting information from an image.

2. **Prerequisites:** Knowledge of Computer Graphics is desirable.

3. **Course Contents:**

Unit	Course Content	Weightage Percentage
Unit I	**Introduction to Digital Image Processing and Fundamental** Introduction: What is Digital Image Processing? Fundamental steps in Digital Image processing, Components of Image Processing system Digital Image Fundamentals- Some basic relationships like Neighbours, Connectivity, and Distance Measures between pixels. Overview of mathematical tools used in digital image processing	10%
Unit II	**Transformations, Histogram Processing and Spatial Filtering** Image Enhancement in the spatial domain: Background, Some basic Gary Level Transformations, Histogram Processing, Fundamentals of spatial filtering, Smoothening and Sharpening Spatial Filters Filtering in the frequency Domain: Background, Introduction to Fourier Transform (FT) and frequency domain, Computing and Visualizing the Discrete Fourier Transform (DFT) of one variable, Extension to functions of two variables - 2D DFT, Image Smoothing and Sharpening Using Frequency Domain Filters	30%
Unit III	**Image Restoration** Image Restoration: A model of the Image Degradation/Restoration process, Noise Models, Restoration in the presence of noise only - Spatial filtering	15%
Unit IV	**Morphological Image Processing** Morphology: Dilation, Erosion, Opening and Closing, The Hit-or-Miss Transformation, Morphological Algorithms: Boundary Extraction, Region filling, Extraction of connected components, Convex Hull, Thinning, Thickening, Skeletons, Pruning, Morphological reconstruction	20%
Unit V	**Image Segmentation and Object Recognition** Image Segmentation: Fundamentals, Point, Line and Edge Detection, Region Based Segmentation Object Recognition : Pattern and Pattern Classes, Recognition Based on Decision Theoretic Methods- Matching, Optimal Statistical Classifier, Neural Networks, Object recognition based on structural methods – Matching Shape Numbers	25%

4. Text Book:

1) Richard E Woods, Rafael C Gonzalez , "Digital Image Processing", Pearson, 3rd Edition

5. Reference Books:

1) Anil K. Jain, "Fundamentals of Digital Image Processing", Prentice-Hall India, 1989
2) B. Chanda and D. Datta Majumder, "Digital Image Processing and Analysis", Prentice-Hall India, 2nd edition (October 30, 2011)
3) Madhuri A. Joshi, "Digital Image Processing", Prentice-Hall India, 2006

6. Chapter wise Coverage from the Text Book:

Unit #	Chapter
I	Chapter 1: 1.1, 1.4,1.5 Chapter 2: 2.5, 2.6
II	Chapter 3: 3.1, 3.2, 3.4, 3.5, 3.6 Chapter 4 : 4.1,4.2,4.4,4.5,4.8,4.9
III	Chapter 5: 5.1 ,5.2,5.3
IV	Chapter 9: 9.1,9.2,9.3,9.4, 9.5
V	Chapter 10: 10.1, 10.2, 10.4 Chapter 12: 12.1, 12.2, 12.3.1

7. Accomplishment of the student after completing the course:

1) Understanding of the principals the Digital Image Processing and terminology used to describe features of images.
2) Understanding of the mathematical foundations for digital manipulation of images; image acquisition; pre-processing; segmentation; Fourier domain processing.
3) Be able to write programs for implementing image processing tasks.
4) Learn and understand the Image Enhancement techniques.
5) Learn and understand Image Segmentation and Recognition concepts.

Practical List

Objective:

Learning the use of Python and OpenCV to implement basic image processing algorithms and to build and execute image processing based projects to solve real life problems

Prerequisites: Knowledge of OpenCV and Python

Lab Experiments:

1. Getting started with images
    a. Learn to load an image, display it and save it back
2. Drawing functions in OpenCV
    a. Draw lines, rectangles, ellipses, circles, ellipses, polygons, adding text to images
3. Perform Basic operations on images
    Read and edit pixel values, working with image -other basic operations.
4. Perform Arithmetic operations on images
5. For a sample images change images between different color spaces
6. Showing images in an OpenCV window
    Read, write, view images and conversion between different formats.
7. Write code to perform following:
    - Loads 2 images (Image 1 say I1 and Image 2 say I2)
    - Computes the pixel-wise difference between the two images
    - Computes an output image where each pixel of coordinates (x,y) contains the absolute difference of the corresponding pixels on I1 and I2
    - Out(x,y) = abs(I1(x,y) – I2(x,y))
    - Displays output image in a window
8. Write code to change brightness of the colour image and show negative of an image.
9. Histograms-1: Find, Plot, Analyze
    Find and draw contours
10. Histograms-2: Histogram Equalization
    Equalize histograms to get better contrast for images
11. Histograms-3: 2-D Histograms
    Find and plot 2-D histograms
12. Apply different Geometric transformations to images like rotation, translation, crop
13. Apply various Scaling operations on the image – resize, down size & upsize (preserve aspect ratio) , resize only width, resize only height, resize to fixed height and width
14. Convert images to binary images using global thresholding, adaptive thresholding, Otsu's binarization.
15. Blur the images, filter the images with custom kernels.
16. Find the Fourier Transform of images using OpenCV using the FFT functions available in Numpy.
17. OpenCV provides variations to remove Noise
    cv2.fastNlMeansDenoising()—works with a single grayscale images
    cv2.fastNlMeansDenoisingColored()—works with a color image.
    Use these functions to denoise grayscale and colour images.
18. Do you have an old degraded photo with many black spots and strokes on it? Take it. Try to restore it with a technique called image inpainting.
19. Perform Morphological Transformations - Erosion, Dilation, and Opening, Closing on a sample image.

20. Find Image Gradients.
21. Find edges with Canny Edge Detection.
22. Apply Hough Line Transform to Detect lines in an image.
23. Apply Hough Circle Transform to Detect circle in an image.
24. Apply Watershed Algorithm and k-means algorithm for Image Segmentation.
25. Search for an object in an image using Template Matching.
26. Detect QR code.
27. Detect text in natural scenes.

References:

1) Alexey Spizhevoy, Aleksadr Rybnikov, "OpenCV3 Computer Vision with Python Cookbook", Packt Publishing Ltd., 2018
2) https://opencv-python-tutroals.readthedocs.io/en/latest/py_tutorials/py_imgproc/py_colorspaces/py_colorspaces.html
3) OpenCV-Python Tutorials Documentation Release 1 , Alexander Mordvintsev & Abid K, Nov 05, 2017, https://media.readthedocs.org/pdf/opencv-python-tutroals/latest/opencv-python-tutroals.pdf
4) https://codewords.recurse.com/issues/six/image-processing-101
5) https://pythonprogramming.net/image-operations-python-opencv-tutorial/
6) http://www.imageprocessingplace.com/root_files_V3/image_databases.htm (to obtain sample images)