# GUJARAT TECHNOLOGICAL UNIVERSITY

## MECHATRONICS ENGINEERING (20)
## MACHINE VISION
## SUBJECT CODE: 2182006
## B.E. 8th SEMESTER

**Type of course:** Engineering Science (Departmental Elective - III)

**Prerequisite: N.A.**

**Rationale:** This subject is designed to understand the various image processing techniques to enhance the digital image for different applications. Enormous applications of digital image processing are covered in this syllabus to make it a multidisciplinary course. Importance of digital image processing is revealed in the content such as image enhancement, restoration, filtering, etc.

**Teaching and Examination Scheme:**

| Teaching Scheme | | | Credits | Examination Marks | | | | | | Total Marks |
|---|---|---|---|---|---|---|---|---|---|---|
| L | T | P | C | Theory Marks | | | Practical Marks | | | |
| | | | | ESE (E) | PA (M) | | ESE (V) | | PA (I) | |
| | | | | | PA | ALA | ESE | OEP | | |
| 3 | 0 | 2 | 5 | 70 | 20 | 10 | 20 | 10 | 20 | 150 |

**Content:**

| Sr. No. | Content | Total Hrs. | % Weightage |
|---|---|---|---|
| 1. | **Introduction:** Comparison with human visual system and perception level, digital image presentation, Definitions of digital image, Examples of the fields that use digital image processing, fundamental steps in image processing, components / elements of digital image processing systems, image acquisition, storage, processing, communication and display. | 4 | 10 |
| 2. | **Digital Image Fundamentals:** Elements of visual perception – brightness adaption and discrimination, light and electromagnetic spectrum, image sensing and acquisition, sampling and quantization, some basic relationships between pixels, connectivity, adjacency, distance measures, different types of image sensors, different types of file formats. | 5 | 12.5 |
| 3. | **Image Enhancement in Spatial Domain:** point processing and mask processing, Basic gray level transformations, histogram processing, histogram equalization, histogram matching, local enhancement, histogram statistics, image subtraction, image averaging, basics of spatial filtering – smoothing, sharpening filters and order statistics filters. | 8 | 20 |
| 4. | **Image Enhancement in Frequency domain:** introduction to Fourier Transform and frequency domain, The discrete Fourier Transforms – properties of 2-D Fourier Transform, smoothing frequency domain filters – ideal, butter worth, Gaussian low pass filters with additional examples of low pass filters, sharpening frequency domain filters – ideal, butter worth, Gaussian and Laplacian filters, unsharp masking, high boost filtering, homomorphic filtering, convolution and correlation, sampling, additional | 8 | 20 |

| | | | |
|---|---|---|---|
| | properties of 2-D Fourier transfer, Periodicity and need for padding. | | |
| 5. | **Image Restoration:** model for image degradation/restoration, noise models – probability density functions of noise, periodic noise and estimation of noise parameters; periodic noise reduction by frequency domain filtering, Arithmetic mean filters, geometric mean filters, adaptive filters, Band pass and band reject filters. | 5 | 12.5 |
| 6. | **Image compression:** fundamentals of image compression and types of redundancy, error free and lossy compression, variable length coding – Huffman coding, arithmetic coding, LZW coding, run length coding. | 5 | 12.5 |
| 7. | **Morphological Image Processing:** Basic concept, Dilation and Erosion process for binary and gray image with applications, Opening & Closing for binary and gray image with applications, Hit-or-Miss Transformation, Basic Morphological Algorithms, textural segmentation. | 5 | 12.5 |

**Suggested Specification table with Marks (Theory):**

| **Distribution of Theory Marks** | | | | | |
|---|---|---|---|---|---|
| R Level | U Level | A Level | N Level | E Level | C Level |
| **20** | **15** | **15** | **10** | **10** | **-** |

**Legends: R : Remembrance ; U = Understanding; A = Application and above Levels (Revised Bloom's Taxonomy)**

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table

**Reference Book:**


1. Refael C. Gonzalez and Richard E. Woods, Digital Image Processing, Addison-Wesley
2. Refael C. Gonzalez and Richard E. Woods Digital Image Processing Using MATLAB Addison-Wesley
3. Scott E Umbaugh, Computer Vision and Image Processing, Prentice-Hall International, Inc.
4. A.K. Jain, Fundamentals of Digital Image Processing, Prentice-Hall of India
5. Milan Sonka, Machine Vision and Image Processing
6. Castleman K.R. Digital Image Processing Prentice-Hall India


**Course Outcome:**

After learning the course the students should be able to:

1. Enhance digital image using various algorithms with the help of computer programming.
2. Understand the role of image processing in different fields such as medical, engineering, space, biotechnology, ocean, agriculture, food industry, etc.
3. Realize the significance of digital image processing in automation.
4. Know the mathematical calculations of basic filters used in digital image enhancement.

**List of Experiments:**

1. Learning and implementing basic MATLAB commands.

2. Forming script file and function file in MATLAB.
3. Understanding different image classes.
4. Use of arithmetic and logical operators on images.
5. Image segmentation.
6. Blurring the given image by spatial convolution method.
7. Blurring and sharpening of image with built in command and performing scaling of the image.
8. Performing negative, log, power-law and contrast stretching transformations on given image.
9. Matching of the histogram of image with the specified one.
10. Implementing 1-D and 2-D Discrete Fourier Transformation of given image.

**Design based Problems (DP)/Open Ended Problem:**

Student may be given a task to exhibit their knowledge of the course studied during the academic year.

**Major Equipments / software:**

Digital camera (gray scale) can be utilized to acquire digital images for further processing.

MATLAB or C language programming can be utilized for programming.

**List of Open Source Software/learning website:**

The website of NPTL may be utilized for additional learning.

**ACTIVE LEARNING ASSIGNMENTS:** Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.