# GUJARAT TECHNOLOGICAL UNIVERSITY

**Bachelor of Engineering**
**Subject Code: 3171109**
**Semester – VII**
**Subject Name: Digital Image and Video Processing**

**Type of course:** Professional Elective Course-V (PEC-V)

**Prerequisite:** Knowledge of Fourier Transform and Digital Signal Processing

**Rationale:**
This is fundamental course of computer vision. This course will strengthen fundamental knowledge about digital image and video processing techniques. Digital image and video processing is used in almost all engineering fields and wide range of applications in industrial automation, medical, agriculture, security, entertainment, education and many more.

**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) | |
| 3 | 0 | 2 | 4 | 70 | 30 | 30 | 20 | 150 |

**Content:**

| Sr. No. | Content | Total Hrs |
|---|---|---|
| 1 | **Digital Image Fundamentals**: Elements of visual perception, image sensing and acquisition, image sampling and quantization, basic relationships between pixels – neighborhood, adjacency, connectivity, distance measures, Applications of digital image processing | **4** |
| 2 | **Image Enhancements and Filtering**: Gray level transformations, histogram equalization and specifications, pixel-domain smoothing filters – linear and order-statistics, pixel-domain sharpening filters – first and second derivative, two-dimensional DFT and its inverse, frequency domain filters – low-pass and high-pass. | **7** |
| 3 | **Color Image Processing**: Color models–RGB, YUV, HSI; Color transformations–formulation, color complements, color slicing, tone and color corrections; Color image smoothing and sharpening; Color Segmentation. | **6** |
| 4 | **Image Segmentation**: Detection of discontinuities, edge linking and boundary detection, thresholding: global and adaptive, region-based segmentation. | **6** |
| 5 | **Wavelets and Multi-resolution image processing**: Uncertainty principles of Fourier Transform, Time-frequency localization, continuous wavelet transforms, wavelet bases and multi-resolution analysis, wavelets and Sub-band filter banks, wavelet packets. | **6** |
| 6 | **Image Compression:** Redundancy–inter-pixel and psycho-visual; Lossless compression – predictive, entropy; Lossy compression- predictive and transform coding; Discrete Cosine Transform; Still image compression standards – JPEG and JPEG-2000. | **5** |

| | | | |
|---|---|---|---|
| 7 | **Fundamentals of Video Coding:** Inter-frame redundancy, motion estimation techniques – full search, fast search strategies, forward and backward motion prediction, frame classification – I, P and B; Video sequence hierarchy – Group of pictures, frames, slices, macro-blocks and blocks; Elements of a video encoder and decoder; Video coding standards – MPEG and H.26X. | | **7** |
| 8 | **Video Segmentation**: Temporal segmentation–shot boundary detection, hard-cuts and soft-cuts; spatial segmentation – motion-based; Video object detection and tracking. | | **4** |

**Suggested Specification table with Marks (Theory): (For BE only)**

| Distribution of Theory Marks | | | | | |
|---|---|---|---|---|---|
| R Level | U Level | A Level | N Level | E Level | C Level |
| **15** | **20** | **25** | **20** | **15** | **5** |

**Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create 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 Books:**

1. R.C. Gonzalez and R.E. Woods, Digital Image Processing, Pearson Education 3rd edition
2. Anil Kumar Jain, Fundamentals of Digital Image Processing, Prentice Hall of India.2nd edition
3. Murat Tekalp , Digital Video Processing" Prentice Hall, 2nd edition
4. S Jayaraman, S Esakkirajan, T Veerakumar Digital Image Processing, , Tata McGraw Hill Publication
5. S Sridhar, Digital Image Processing, Oxford University Press.

**Course Outcomes:**

| Sr. No. | CO statement | Marks % weightage |
|---|---|---|
| CO-1 | Enhance digital image quality by spatial and frequency domain filtering and histogram equalization techniques | 25% |
| CO-2 | Apply suitable image restoration technique to minimize effect of degradation and noise for digital image | 20% |
| CO-3 | Compress digital image and video by applying digital image and video compression algorithm | 20% |
| CO-4 | Analyse given digital image and video by segmentation and morphological | 20% |

| | operations | |
|---|---|---|
| CO-5 | Design digital image and video processing micro-project to solve real life challenge | 15% |

**List of Experiments:**

List of sample experiments is given only for reference. Faculty should modify it as per expertise and software available in the laboratory.

1. To install OpenCV and Eclipse in Ubuntu Linux operating system and to run simple program to read image data and display image
2. To write and execute spatial domain image processing programs using pixel processing (point processing).
   - To apply threshold operation on given image (Use track bar to change threshold value and see effect on output image)
   - To increase and decrease brightness of image
   - To obtain negative image
   - To apply contrast stretching
   - To flip image horizontally and vertically.
3. To understand image restoration techniques and to implement median filtering using OpenCV.
4. To write and execute basic image processing programs in OpenCV and Python. Learn installation procedure to use openCV library functions in Python.
5. To install OpenCV library in Raspberry PI board for Computer vision experiments. Write and execute basic image processing programs in Raspberry PI board.
6. Digital image filtering in frequency domain using low pass and high pass filter mask.
7. Write digital image processing programs using SCILAB
   - Become familiar with SCILAB Basic commands
   - Read and display image in SCILAB
   - Resize given image
   - Convert given color image into gray-scale image
   - Convert given color/gray-scale image into black & white image
   - Draw image profile
   - Separate color image in three R G & B planes
   - Create color image using R, G and B three separate planes
   - Flow control and LOOP in SCILAB
   - Write given 2-D data in image file
   - Write and execute SCILAB programs for Histogram, Spatial domain Mask Processing
8. Write and execute programs for Image edge detection using C language and Python OpenCV library functions

9.  Write and execute programs for arithmetic and logical operations using Python and OpenCV library functions.

10. Write and execute programs for morphological operations Erosion, Dilation, Opening, Closing etc. using Python and OpenCV library functions.

11. Write and execute programs for Geometrical transformation of given image in Pyhon and OpenCV library

12. Write and execute program for Object detection and tracking


**Major Equipment:** Raspberry PI boards with web camera for hardware implementation

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

- SCILAB
- Open CV
- Python

**NPTEL:** https://nptel.ac.in/courses/117/105/117105079/

*w.e.f. AY 2018-19*