

Course Code	Course Title	L	T	P	C
1152EC136	Digital Video Signal Processing	3	0	0	3

a) Course Category

Program elective

b) Preamble

Video processing refers to digital manipulation of 2D images that are sequentially ordered in time. This Digital Video Signal Processing course introduces fundamental theory and techniques for efficient representation and processing of video signals. This course also covers Fourier analysis of video signals, properties of the human visual system, motion estimation, and basic video compression techniques.

c) Prerequisite

Digital Signal Processing, Digital Image Processing

d) Related Courses

Signal Processing Techniques for Speech Recognition

e) Course educational objectives

Understand the basic concepts that are widely used in digital video processing

Learn frequency response of the video signal and sampling process

Interpret the performance of different motion estimation methods and video coding.

Familiarize with MATLAB computer vision system Toolbox

f) Course Outcomes

Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Explain the basic concepts of human vision, analog and digital video representations	K2
CO2	Discuss the frequency domain characteristics and response of the video signal	K2
CO3	Describe the video sampling mechanism by using lattice theory	K2
CO4	Apply the appropriate motion estimation technique for a	K3

	given video processing applications	
CO5	Explain the advanced motion estimation techniques and appropriate coding system for a given video	K2

g) Correlation of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	L	L	-	-	L	L	L	L	L	L	-	L	L	-
CO2	M	L	L	L	L	L	-	-	-	-	-	L	L	-
CO3	M	L	L	-	L	L	-	L	-	-	-	L	-	-
CO4	L	L	L	M	L	L	L	L	M	L	-	M	M	-
CO5	H	L	L	-	L	L	-	L	L	L	-	M	L	-

h) Course Content

UNIT I INTRODUCTION TO DIGITAL IMAGES AND VIDEO 9

Human Visual System and Color: Color Vision and Models, Contrast Sensitivity, Spatio-Temporal Frequency Response, Analog Video: Progressive vs. Interlaced Scanning, Analog-to-Digital Conversion, Digital Video: Spatial Resolution and Frame Rate, Color, Dynamic Range, and Bit-Depth, Image and Video Quality

UNIT II FOURIER ANALYSIS OF VIDEO SIGNALS AND FREQUENCY RESPONSE OF THE HUMAN VISUAL SYSTEM 11

Multidimensional Continuous-Space Signals and Systems, Multidimensional discrete Space Signals and Systems, Frequency Domain Characterization of Video Signals- Spatial and Temporal Frequencies, Temporal Frequencies Caused by Linear Motion, Frequency Response of the Human Visual System- Temporal Frequency Response and Flicker Perception, Spatial Frequency Response, Spatiotemporal Frequency Response, Smooth Pursuit Eye Movement

UNIT III VIDEO SAMPLING 8

Basics of the Lattice Theory, Sampling over Lattices: Sampling Process and Sampled-Space Fourier Transform, The Generalized Nyquist Sampling Theorem, Sampling Efficiency, Implementation of the Prefilter and Reconstruction Filter, Sampling of Video Signals: Required Sampling Rates, Sampling Video in Two Dimensions: Progressive versus Interlaced Scans, Spatial and Temporal Aliasing.

UNIT IV TWO DIMENSIONAL MOTION ESTIMATION METHODS 8

Camera model, object model, 2D motion models, Optical flow, general methodologies, pixel based motion

estimation, block based motion estimation, Deformable Block-Matching Algorithms.

UNIT V	ADVANCED TWO DIMENSIONAL MOTION ESTIMATION METHODS AND VIDEO CODING	9
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Mesh-Based Motion Estimation, Global Motion Estimation, Region Based Motion Estimation, Application of Motion Estimation in Video Coding, Video Coding: Overview of Coding Systems, Basic Notions in Probability and Information Theory, Information Theory for Source Coding, Binary Encoding.

Total	45	Hrs
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i) Learning Resources

Text Books

1. A. Murat Tekalp, "Digital Video Processing", 2nd edition, Prentice Hall, 2015.
2. Yao Wang, Jorn Ostermann, Ya-Qin Zhang, "Video Processing and Communications", 1st edition, Prentice Hall, 2002

Reference Books

1. Alan C. Bovik, "The Essential Guide to Video Processing", 2nd edition, Elsevier Science, 2009

Online Resources

1. Prof. Sumana Gupta, Video lecture on Digital Video Signal Processing, Centre for Educational Technology, IIT Kanpur Sponsored by National Programme on Technology Enhanced Learning (NPTEL). <http://nptel.ac.in/syllabus/117104020/>