COURSE TITLE	**COMPUTER VISION**
COURSE CODE	**01CT1621**
COURSE CREDITS	**4**

Objective:

1 Computer vision focuses on the development of algorithms and techniques to analyze and interpret the visible world around us. This requires an understanding of the fundamental concepts related to multi-dimensional signal processing, feature extraction, stochastic optimization, deep neural networks etc. Knowledge of these concepts is necessary for research and further developments in the field of computer vision. Applications range from biometrics, medical diagnosis, document processing, mining of visual content, surveillance, advanced rendering, etc.

2 Computer vision focuses on the development of algorithms and techniques to analyze and interpret the visible world around us. This requires an understanding of the fundamental concepts related to multi-dimensional signal processing, feature extraction, stochastic optimization, etc. Knowledge of these concepts is necessary for research and further developments in the field of computer vision. Applications range from Biometrics, Medical diagnosis, document processing, mining of visual content, surveillance, advanced rendering, etc.

Course Outcomes: After completion of this course, student will be able to:

1 Understand the foundations of image formation and the working of deep learning and computer vision algorithms.

2 Implement low, mid, and high-level computer vision algorithms.

3 Apply deep learning and computer vision techniques on images and videos to get the desired output.

4 Analyze the strengths and weaknesses of different computer vision methods and techniques for computer vision problems.

5 Develop an application using deep learning and computer vision concepts.

Pre-requisite of course: Linear Algebra, Vector Calculus, Programming using Python, Basics of Machine Learning

Teaching and Examination Scheme

Theory Hours	Tutorial Hours	Practical Hours	ESE	IA	CSE	Viva	Term Work
3	0	2	50	30	20	25	25

MR. CHANDRASINH DHIRUBHA PARMAR
Digitally signed by (Name of HOD)

DR. RAJENDRASINH BAHADURSINH JADEJA
Digitally signed by (Name of Dean/ Principal)

Contents : Unit	Topics	Contact Hours
1	**Image Formation** Orthographic and Perspective Projection, Camera model, Camera calibration, Intrinsic and Extrinsic parameters, Binocular Stereopsis: Camera and Epipolar Geometry, Homography, Rectification, DLT, RANSAC, Stereo Vision	9
2	**Feature Extraction** Edge Detection, Line Detection, Interest Points and Corners Detection, Shape Analysis, SIFT, SURF, HOG.	9
3	**Shape from X** Light at Surfaces, Phong Model, Reflectance, Photometric Stereo, Surface Properties, Shape from Shading, Shape from Texture, Motion and Edges	6
4	**Segmentation** Region Growing, Basic Clustering Methods, Watershed algorithm, K-Means algorithm, Mean-Shift algorithm, Agglomerative Clustering with a graph, Normalized cuts, Grab-cut, Hough Transform	9
5	**Recent trends and applications** CNN, R-CNN, U-Nets, Mask R-CNN for computer vision, Self-supervised Learning, Reinforcement Learning in vision, Face Recognition, Emotion Recognition,, Activity Recognition, Optical Character Recognition, Biometrics, In-vehicle vision systems	9
Total Hours		**42**

Suggested List of Experiments:

Contents : Unit	Topics	Contact Hours
1	**Experiment 1** Simulate Camera Calibration	2
2	**Experiment 2** Simulate Image Rectification	2
3	**Experiment 3** Simulate Image Stitching using key points detection, matching the descriptors, RANSAC and wrapping transformation using Homography	2
4	**Experiment 4** Simulate Edge detection using Laplacian, Sobel, Prewitt and Canny detectors	2
5	**Experiment 5** Simulate Corner detection using Harris and Shi-Tomasi detectors	2
6	**Experiment 6** Implement code to i. Calculate fundamental matrix using SIFT and FLANN and ii. Find and draw Epilines on images.	2
7	**Experiment 7** Reconstruct 3D object using Shape from Shading approach	2

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Digitally signed by (Name of HOD)

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Digitally signed by (Name of Dean/ Principal)

Suggested List of Experiments:

Contents : Unit	Topics	Contact Hours
8	**Experiment 8** Simulate code to calculate Histogram of Gradients	2
9	**Experiment 9** Simulate code to create Depth map from Stereo images	2
10	**Experiment 10** Simulate code to segment an image of mutually touching coins using distance transform along with Watershed algorithm	2
11	**Experiment 11** Simulate code to segment images using K-means algorithm	2
12	**Experiment 12** Simulate code to segment images using mean-shift algorithm.	2
13	**Experiment 13** Simulate code to segment images using Grab-cut algorithm	2
14	**Experiment 14** Perform object detection with R-CNN	2
15	**Experiment 15** Perform object detection with YOLO algorithm	2
16	**Experiment 16** Perform semantic image segmentation with U-Nets	2
17	**Experiment 17** Perform image segmentation with Mask R-CNN	2
Total Hours		**34**

Textbook :

1 Computer Vision- A model approach, D. Forsyth , Pearson, 2016

2 Computer Vision: Algorithms and Applications, Szeliski Richard, Springer, 2010

References:

1 Digital Image Processing, Digital Image Processing, Rafael C. Gonzalez , PrenticeHall, 2008

2 Computer and Machine Vision: Theory, Algorithms, Practicalities, Computer and Machine Vision: Theory, Algorithms, Practicalities, E. R. Davies, Elsevier Science , 2012

3 Practical Machine Learning for Computer Vision, Practical Machine Learning for Computer Vision, Valliappa Lakshmanan, O'RELLY, 2021

4 Deep Learning for Computer Vision, Deep Learning for Computer Vision, Adrian Rosebrock, PyImageSearch, 2017

5 Robot Vision, Robot Vision, BKP Horn, MIT Press , 1986

Suggested Theory Distribution:

The suggested theory distribution as per Bloom's taxonomy is as follows. This distribution serves as guidelines for teachers and students to achieve effective teaching-learning process

Distribution of Theory for course delivery					
Remember / Knowledge	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Higher order Thinking / Creative**
5.00	20.00	30.00	15.00	20.00	10.00

Instructional Method:

1. The internal evaluation will be done on the basis of continuous evaluation of students in the laboratory and class-room.
2. Practical examination will be conducted at the end of the semester for evaluation of performance of students in laboratory.
3. Students may use supplementary resources such as online videos, NPTEL videos, e-courses, Virtual Laboratory, etc.
4. The course delivery method will depend upon the requirement of content and need of the students. The teacher in addition to conventional teaching method (Chalk and Talk) may use any of the tools such as demonstration, role play, Quiz, brainstorming, Flipped class, Project based learning, Collaborative learning, MOOCs etc. for effective teaching.

Supplementary Resources:

1. https://nptel.ac.in/courses/106105216/
2. https://nptel.ac.in/courses/106106224/
3. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-801-machine-visionfall-2004/index.htm
4. https://www.udacity.com/course/introduction-to-computer-vision--ud810
5. https://www.coursera.org/learn/computer-vision-basics/

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