Short Syllabus

BCSE425L Robotic Perception (3-0-0-3)

Fundamentals - Robot Sensing & Vision - segmentation- Thresholding- edge detection- binary morphology – grey morphology and Application of Machine Vision System, Robotic Assembly Sensors and Intelligent Sensors, visual servo-control - Vision Algorithms - Estimation in Robotics - Object Recognition - Image Feature Extraction & Multiple Images - Robotic Learning.

Course Code	Course Title	L	T	P	C
BCSE425L	Robotic Perception	3	0	0	3
Pre-requisite	NIL	Syllabus Version			
		1.0			

Course Objectives:

1. To learn basic robotic sensing and vision
2. To learn computer vision for robot motion control
3. To recognize objects and the basics of visual learning and neural networks for the purpose of classification
4. To learn the applications of vision system in modern manufacturing environment

Course Outcomes:

After the completion of the course, student will be able to:

1. Understand the basic robotic sensing and vision
2. Design controllers for tracking control of a robot
3. Apply computer vision control of robotic systems
4. Learn the applications of vision system in modern manufacturing environment

Module:1	**Basics / Fundamentals**	**2 hours**
Perception and Decision-Making in Robotics Overview, Specifications of Robots.		
Module:2	**Robot Sensing & Vision:**	**7 Hours**
Use of Sensors and Sensor Based System in Robotics, Machine Vision System, Description, Sensing, Digitizing, Image Processing and Analysis, segmentation-Thresholding- edge detection- binary morphology – grey morphology and Application of Machine Vision System, Robotic Assembly Sensors and Intelligent Sensors, visual servo-control.		
Module:3	**Vision Algorithms**	**7 Hours**
Fundamental Data Structures: Images, Regions, Sub-pixel Precise Contours – Image Enhancement : Gray value transformations, image smoothing, Fourier Transform – Geometric Transformation – Image segmentation – Segmentation of contours, lines, circles and ellipses – Camera calibration – Stereo Reconstruction.		
Module:4	**Estimation in Robotics**	**5 Hours**
Optimal Estimation in Robotics: Applications, Overview of general principle, Derivation of Linear Kalman Filter, Optimal Integration of Sensor Measurements in Humans.		
Module:5	**Object Recognition**	**8 hours**
Object recognition, Approaches to Object Recognition, Recognition by combination of views – objects with sharp edges, using two views only, using a single view, use of depth values. Histogram of oriented gradients (HOG), R-CNNs (Region based CNNs), YOLO's architecture based on CNNs		
Module:6	**Image Feature Extraction & Multiple Images**	**8 hours**
Region Features, Line Features, Point Features. Using Multiple Images: Geometry of Multiple Views, Stereo Vision, Bundle Adjustment, Point Clouds.		
Module:7	**Robotic Learning**	**6 hours**
Vision-Based Control, Position-Based Visual Servoing, Image-Based Visual Servoing, Using Other Image Features		
Module:8	**Contemporary issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)	
1.	Richard Szeliski, Computer Vision: Algorithms and Applications, Springer-Verlag London Limited 2011.
2.	Peter Corke, Robotics, Vision and Control: Fundamental Algorithms, Springer Tracts in Advanced Robotics, Volume 118, Second Edition, 2016
3.	Kevin M. Lynch and Frank C. Park, Modern Robotics Mechanics, Planning, And Control, May 3, 2017
Reference Books	
1.	David Forsyth and Jean Ponce, Computer Vision: A modern Approach, Prentice Hall India 2004
2.	Klafter, Chmielewski and Negin, *Robotic Engineering - An Integrated approach,* PHI, 1st edition, 2009.
3.	Robert J. Schilling, "Fundamentals of Robotics Analysis and Control", PHI Learning, 2009.
4.	Deb S R and Deb S, "Robotics Technology and Flexible Automation", Tata McGraw Hill Education Pvt. Ltd, 2010.

Mode of Evaluation: Continuous Assessment Test –I (CAT-I), Continuous Assessment Test –II (CAT-II), Digital Assignments/ Quiz / Completion of MOOC, Final Assessment Test (FAT).			
Recommended by Board of Studies	13-05-2022		
Approved by Academic Council	No. 66	Date	16-06-2022