

Subject Description Form

Subject Code	DSAI5206
Subject Title	Machine Vision and Intelligence
Credit Value	3
Level	5
Pre-requisite/ Co-requisite/ Exclusion	Nil
Objectives	• Provide students with knowledge of the fundamentals of machine vision and image processing. • Provide students with knowledge of advanced computer vision algorithms and techniques. • Train students to apply machine vision and intelligence to develop real-world applications.
Intended Learning Outcomes	Upon completion of the subject, students will be able to: a) Understand fundamental concepts of machine vision and image processing techniques. b) Implement advanced computer vision algorithms for visual recognition tasks such as classification and detection. c) Address real-world challenges using machine vision applications across various domains; and d) Critically assess and strengthen skills for integrating machine learning methods with machine vision to develop intelligent systems.
Subject Synopsis/ Indicative Syllabus	1. Image Acquisition and Representation Image acquisition, cameral models, perspective projection; image representation, color fundamentals, RGB, CMYK, HSL/HSV color models; video representations. 2. Image Processing Techniques Image filters, linear/non-linear filters, convolutional filters; edge detection, image gradient, Sobel filter, Canny edge detector, Hough transform; local invariant features, corner detection, Harris corner detector, blob detection, Laplacian of Gaussian, SIFT detector and features, image matching, image stitching, image mosaicking. 3. Machine Learning for Vision Supervised learning, classical statistical learning, cross validation; unsupervised learning, clustering algorithms, self-supervised learning, pre-training and fine-tuning, transfer learning; deep learning architectures, multi-layer perceptrons (MLP), convolutional neural networks (CNNs), UNet, vision transformer (ViT); back propagation, (stochastic) gradient descent; regularization, overfitting, underfitting. 4. Visual Recognition Tasks and Algorithms Semantic segmentation, classic segmentation methods (e.g., mean shift), foundation segmentation models (e.g.,SAM); object detection, region proposal,

	R-CNN series, YOLO series; instance segmentation; object tracking, optical flow, tracking by detection, multi-object tracking; multimodal learning, contrastive language-Image pre-training (CLIP), cross-modal image retrieval, image captioning, visual question answering, vision-language models (VLMs); image generation, generative adversarial network (GAN), diffusion models.					
	5. Advanced Topics in Vision and Intelligence Multimodal large language models (MLLMs); 3D vision and depth perception, vision in robotics and autonomous systems; reinforcement learning in vision systems; ethical considerations and challenges in machine vision.					
Teaching/Learning Methodology	The course material will be delivered as a combination of lectures, tutorials, and small group projects. Students will get familiar with basic concepts and technologies of visual data processing, representations and applications.					
Assessment Methods in Alignment with Intended Learning Outcomes	Specific assessment methods/tasks	% weighting	Intended subject learning outcomes to be assessed			
			a	b	c	d
	1. Assignments, Quizzes and Projects	55%	✓	✓	✓	✓
	2. Final Examination	45%	✓	✓	✓	✓
	Total	100 %				
	Explanation of the appropriateness of the assessment methods in assessing the intended learning outcomes: The examination and assignments are designed to evaluate the students’ understanding of machine vision-related concepts and algorithms. The project, on the other hand, is designed to evaluate the students’ practical skills in using machine learning methods and AI models for processing visual data and tasks for real-world problems.					
Student Study Effort Expected	Class contact:					
	▪ Lectures / Tutorials / Labs			39 Hours		
	Other student study effort:					
	▪ Assignment, Project, Quizzes, and Examination			66 Hours		
	Total student study effort			105 Hrs.		
Reading List and References	1. R. Shanmugamani, <i>Deep Learning for Computer Vision</i> , Packt Publishing, Jan 2018. 2. Zhang, Aston and Lipton, Zachary C. and Li, Mu and Smola, Alexander J., <i>Dive into Deep Learning</i> , arXiv preprint arXiv:2106.11342, 2021. Website: https://d2l.ai/ . 3. Mohamed Elgendy, <i>Deep Learning for Vision Systems</i> , October 2020. 4. Richard Szeliski, <i>Computer Vision: Algorithms and Applications</i> , Springer, 2022. Free for download at https://szeliski.org/Book/ .					

	5. Computer Vision: Models, Learning, and Inference http://www.computervisionmodels.com/ 6. Computer Vision Lectures https://fpcv.cs.columbia.edu/ (also available on YouTube) 7. Keith Price Bibliography Annotated Computer Vision Bibliography: Table of Contents
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