Title (Units): **COMP4026 Computer Vision and Pattern Recognition (3,2,1)**

Course Aims: This course aims to give students a broad knowledge, algorithms and methodology in computer vision and pattern recognition. Basic concepts and principles of computer vision and pattern recognition will be introduced with examples of conventional approaches before deep learning. After that, deep learning methods for computer vision and pattern recognition will be discussed. Students will go through the process for developing a complete computer vision and pattern recognition application prototype using Python, OpenCV and/or PyTorch.

Prerequisite: COMP3057 Introduction to AI and ML OR COMP3117 Applied Artificial Intelligence

Course Intended Learning Outcomes (CILOs):
Upon successful completion of this course, students should be able to:

No.	Course Intended Learning Outcomes (CILOs)
	Knowledge
1	Explain fundamental theories and techniques in computer vision and pattern recognition
2	Identify various approaches to computer vision and pattern recognition
3	Identify conventional and deep learning approaches to computer vision and pattern recognition
4	Describe the basic functions and methods for image processing
	Professional Skill
5	Develop a computer vision and pattern recognition application prototype

Calendar Description: This course aims to give students a broad knowledge, algorithms and methodology in computer vision and pattern recognition. Basic concepts and principles of computer vision and pattern recognition will be introduced with examples of conventional approaches before deep learning. After that, deep learning methods for computer vision and pattern recognition will be discussed. Students will go through the process for developing a complete computer vision and pattern recognition application prototype using Python, OpenCV and/or PyTorch.

Teaching and Learning Activities (TLAs):

CILOs	Type of TLA
1-4	Students will learn computer vision and pattern recognition knowledge through lectures and tutorials. In order to help students to have good understanding, laboratory sessions will be designed so that students could apply what they have learnt in lectures. Besides, written assignment(s), laboratory exercise(s) and final examination will be designed to evaluate the students' level of understanding.
1-5	Based on the theories of computer vision and pattern recognition they have learned, students are required to develop an application prototype using an API, such as OpenCV and PyTorch. Students are also required to give a preliminary proposal, a final formal presentation and report on their project. Course instructor(s), teaching assistant and other students would ask questions related to their project. In this way, we could assess their understanding of computer vision and pattern recognition, as well as their proposed method.

Assessment:

No.	Assessment Methods	Weighting	CILOs to be addressed	Description of Assessment Tasks
1	Written Assignment and Laboratory Exercises	20%	1 - 5	The written assignment(s) and laboratory exercise(s) and project are designed to measure how well students have learned the fundamentals and major concepts of computer vision and pattern recognition.

2	Project	40%	1 - 5	A group project is designed to measure how well students can analyse and apply computer vision and pattern recognition concepts and algorithms to solve a practical vision problem. Each group needs to submit (i) an initial proposed method, (ii) a presentation (and then Q&A), (iii) a project report. Each group member is required to declare their responsibility in the project.
3	Examination	40%	1 - 4	Final examination questions are designed to see how far students have achieved their course intended learning outcomes.

Assessment Rubrics:

Excellent (A)	• Achieve the five CILOs, with solid evidence of having achieved the last CILO, demonstrating a good mastery of both the theoretical and practical aspects of the knowledge and skills associated with computer vision and pattern recognition • Able to develop correct solutions to problems • Demonstrate a thorough understanding and solid knowledge of computer vision and pattern recognition • Able to apply a variety of techniques and relevant knowledge for solving problems in computer vision and pattern recognition
Good (B)	• Achieve most of the five CILOs, with evidence of having achieved the last CILO, demonstrating a good understanding of the knowledge and skills associated with computer vision and pattern recognition • Able to develop correct solutions to problems • Demonstrate a competent level of knowledge of computer vision and pattern recognition • Ability to make use of appropriate techniques and knowledge and apply them to familiar problems
Satisfactory (C)	• Achieve some of the five CILOs, demonstrating a basic level of understanding of the knowledge and skills associated with computer vision and pattern recognition • Able to provide acceptable solutions to problems • Demonstrate an adequate level of knowledge of computer vision and pattern recognition • Ability to make use of some techniques and knowledge and apply them to familiar situations
Marginal Pass (D)	• Achieve few of the five CILOs, with minimal understanding of the associated concepts and underlying methodologies • Able to provide solutions to simple problems • Demonstrate a basic level of knowledge of computer vision and pattern recognition • Ability to apply some techniques and knowledge to a limited number of typical situations
Fail (F)	• Achieve very few of the five CILOs, with little understanding of the associated concepts and underlying methodologies • Unable to provide solutions to simple problems • Knowledge of computer vision and pattern recognition falling below the basic minimum level • Unable to apply techniques and knowledge to situations or problems

Course Content and CILOs Mapping:

Content		**CILO No.**
I	Introduction to computer vision and pattern recognition	1,2
II	Convention computer vision and pattern recognition algorithms	1,2,3,4,5
III	Deep learning for computer vision and pattern recognition	1,2,3,4,5

References:

- R. O. Duda, P. E. Hart and D. G. Stork, Pattern Classification, 2nd Edition, John Wiley & Sons, Inc, 2000.
- L.G. Shapiro and G. C. Stockman, Computer Vision, Prentice Hall, 2001.
- Richard Szeliski, Computer Vision: Algorithms and Applications, Springer, 2nd edition, 2022.
- Klette, Reinhard, Concise computer vision - An introduction into theory and algorithm, Springer, 2014.
- Goodfellow, Bengio, and Courville, Deep Learning, MIT Press, 2016.
- Andrew Zhu and Matthew Fisher, Using Stable Diffusion with Python: Leverage Python to control and automate high-quality AI image generation using Stable Diffusion, Packt Publishing, June 2024
- IEEE Transactions on Pattern Analysis and Machine Intelligence.
- IEEE Transactions on Image Processing.
- International Journal on Computer Vision.
- Journal of Pattern Recognition.

Course Content:

Topic

I. Introduction to computer vision and pattern recognition
   1. Human vision and image formation
   2. How does a machine see and recognise things?
   3. Applications
   4. Programming environment: Python, PyTorch and OpenCV

II. Convention computer vision and pattern recognition algorithms
   1. Basic image processing techniques
   2. Segmentation and object detection
   3. Visual object feature extraction
   4. Matching and visual object recognition

III. Deep learning for computer vision and pattern recognition
   1. Feature learning and visual object recognition methods
   2. Visual object detection methods
   3. Segmentation methods
   4. Image generation methods and data augmentation
   5. Fine-tuning techniques for pretrained vision models