Title (Units): **COMP7055 Computer Vision (3,2,1)**

Course Aims: To give students a comprehensive knowledge on computer vision, to discuss recent research advancements in selected computer vision topics, to design and develop a computer vision application prototype.

Prerequisite: Nil

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 basic theories and techniques in computer vision.
2	Identify various approaches of computer vision, and design the components of computer vision systems.
3	Describe and discuss the basic functions and methods for image processing.
	Professional Skill
4	Design and develop a computer vision application prototype.

Calendar Description: This course gives students a comprehensive knowledge on computer vision. Recent research advancements in selected computer vision topics will be covered. The student will also be required to design and develop a computer vision application prototype.

Teaching and Learning Activities (TLAs):

CILOs	Type of TLA
1-3	Students will learn knowledge of computer vision 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.
2,4	Based on the theories of computer vision they have learnt, students are required to develop an application prototype using an API, such as OpenCV. Students are required to give a preliminary demonstration as well as a final formal presentation on their project. In both cases, instructor(s), teaching assistant and other students would ask questions related to their project. In this way, we could assess their understanding of the theories 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	Continuous Assessment	50%	1-4	Continuous assessments, including written assignment, laboratory exercises and projects are designed to measure how well students have learned the fundamentals and major concepts of computer vision.
2	Examination	50%	1-3	Final examination questions are designed to see how far students have achieved their course intended learning outcomes.

Assessment Rubrics:

Excellent (A)	• Achieve the first five CILOs, demonstrating a good mastery of both the theoretical and practical aspects of database design and administration

	• Have a thorough understanding of database system concepts, and be able to explain and highlight the key points of these concepts • Achieve the first four CILOs, with strong 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 • Able to apply a variety of techniques and relevant knowledge for solving problems in computer vision
Good (B)	• Achieve most of the first four CILOs, with evidence of having achieved the last CILO, demonstrating a good understanding of the knowledge and skills associated with computer vision • Able to develop correct solutions to problems • Demonstrate a competent level of knowledge of computer vision • Ability to make use of appropriate techniques and knowledge and apply them to familiar problems
Satisfactory (C)	• Achieve some of the first four CILOs, demonstrating a basic level of understanding of the knowledge and skills associated with computer vision • Able to provide acceptable solutions to problems • Demonstrate an adequate level of knowledge of computer vision • Ability to make use of some techniques and knowledge and apply them to familiar situations
Fail (F)	• Achieve none of the first four CILOs, with little understanding of the associated concepts and underlying methodologies • Unable to provide solutions to simple problems • Knowledge of computer vision 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	1
II	Image Formation: Geometry and Photometry	1,3
III	Image Segmentation and Feature Extraction: Conventional Methods	1,2,3
IV	Multi-view Geometry	1,2
V	Object Detection: Conventional Methods	1,2,3,4
VI	Introduction to Neural Networks	1
VII	Convolution Neural Networks and Vision Transformers	1,2,3,4
VIII	Object Detection: Deep Learning Methods	1,2,3,4
IX	Image Segmentation: Deep Learning Methods	1,2,3,4
X	Temporal Processing and Recurrent Neural Network	1,2,4

References:

- Joseph Howse and Joe Minichino. Learning OpenCV 4 Computer Vision with Python 3: Get to grips with tools, techniques, and algorithms for computer vision and machine learning. Packt Publishing Ltd, 2020.
- Richard Szeliski, Computer Vision: Algorithms and Applications, Springer, 2010
- David Forsyth and Jean Ponce: Computer Vision: A Modern Approach, Prentice hall, 2011
- Ian Goodfellow, Yoshua, Bengio, and Aaron Courville, Deep Learning, MIT Press, 2016.
- IEEE Transactions on Pattern Analysis and Machine Intelligence.
- IEEE Transactions on Image Processing.
- International Journal on Computer Vision.

Course Content:

Topic

I. Introduction to Computer Vision
Background, requirements and issues, human vision, applications

II. Image Formation: Geometry and Photometry
Geometry, photometry (brightness and color), quantization, camera calibration

III. Image Segmentation and Feature Extraction: Conventional Methods
Various methods of image segmentation, edge detection, object proposals

IV. Multi-view Geometry
Shape from stereo and motion, feature matching

V. Object Detection: Conventional Methods
HoG/SIFT features, Bayes classifiers, SVM classifiers

VI. Introduction to Neural Networks
Key components and basic architecture of deep neural network, loss functions, backpropagation and SGD, Batch Normalization

VII. Convolution Neural Networks and Vision Transformers
Famous CNN architectures, training strategies
Basic Architecture and Developments of Vision Transformers

VIII. Object Detection: Deep Learning Methods
Background and principles of R-CNN, fast/faster R-CNN

IX. Image Segmentation: Deep Learning Methods
Seminal architectures for image segmentation, e.g., auto-encoder networks, U-Net, Mask R-CNN

X. Temporal Processing and Recurrent Neural Network
Background and principles of RNN, image captioning, action recognition, motion prediction applications