Subject Description Form

Subject Code	COMP4423
Subject Title	Computer Vision
Credit Value	3
Level	4
Pre-requisite / Co-requisite / Exclusion	**Pre-requisite:** COMP2011 *or* EIE2106 (Signals and Systems) for EIE students
Objectives	This course is designed for the students interested in learning fundamental principles and important applications of computer vision using digital imaging. These images can be acquired using digital cameras in smartphones, infrared cameras, radars, or specialized sensors such as those employed for the medical imaging. This course will introduce a number of fundamental concepts in computer vision. During this course, the students will gain hands-on experience on a number of computer vision algorithms for the real-world applications.
Intended Learning Outcomes	Upon completion of the subject, students will be able to: (a) understand image sensing, pixel arrays and 2D/3D digital image representations; (b) perform basic image processing operations for image enhancement and analysis; (c) apply computer vision algorithms for object detection, feature extraction and 3D reconstruction; (d) apply computer vision and image processing methods for real-world problems; and (e) learn applications of deep learning in computer vision.
Subject Synopsis/ Indicative Syllabus	This course introduces the principles, mathematical models and applications of computer vision. The major topics to be covered in this course include: image processing operations, imaging models, feature extraction techniques, stereo vision and 3D reconstruction techniques. The students will learn basic concepts of computer vision as well as avail hands on experience in solving real world vision problems.

Topic
1. Introduction to Computer Vision Introduction to Human Visual System, Image Formation and Digital Image Representations, Camera Model and Geometry
2. Image Processing Operations Image Enhancement, Image Sampling and Rotation, Image Filtering, Edge Detection, Morphological Operations

	3. Feature Extraction Designing Image Descriptors, Feature Descriptors, Object Detection and Recognition **4. 3D Image Representation and Reconstruction** Common 3D Image Representation Formats, Stereo Vision, Pattern Lighting, Ultrasound Imaging and Photometric Stereo-based 3D imaging Systems **5. Deep Neural Networks** Perceptron, Neural Network, Perceptron Training, Gradient Descent, Backpropagation, Convolutional Neural Networks and Deep Learning Architectures for Computer Vision
Teaching/ Learning Methodology	Lectures: The lectures will focus on the introduction of computer vision and fundamental image processing operations. The lectures will include feature extraction, image enhancement, 3D reconstruction and object recognition principles for real-world applications. Tutorials: Students will work on different tutorial problems to gain hands-on experience with the application of computer vision algorithms. Each of the weekly tutorials are designed to focus on specific image(s) analysis problems and students will be invited to develop their own solutions for the given problem. Assignments: The students will implement specific computer vision algorithms and develop solutions for the real world problems. The students will also analyze the performance and learn to justify their solutions for the given real-world problems. Project: The students will design and develop appropriate computer vision-based solution for a real-world application. The students will incorporate image processing principles that they have learnt from this course and learn to develop expected or new solution for the given problem.
Assessment Methods in Alignment with Intended Learning Outcomes	

Specific assessment methods/tasks	% weighting	Intended subject learning outcomes to be assessed (Please tick as appropriate)				
		a	b	c	d	e
Continuous Assessment	**55%**					
1. Assignment I	15%	✓	✓			
2. Assignment II	15%	✓		✓	✓	
3. Project	25%	✓	✓	✓	✓	✓
Examination	**45%**	✓	✓	✓	✓	✓
Total	100%					

Explanation of the appropriateness of the assessment methods in assessing the intended learning outcomes:

<table>
<tr><td></td><td colspan="2">Assignments; The assignments are designed to ascertain the effectiveness of selected computer vision algorithms and techniques. These assignments require implementation of algorithms and/or analyze the performance.

Project: The project will help to ascertain the ability of students in designing, selecting and implementing appropriate computer vision algorithms for real world applications. The students can be in a group of 2-3 students for any specific project.

Examination: The examination component will help to ascertain the students capability to understand computer vision algorithms, apply them with appropriate modifications for a given problem and ascertain the performance from the applications of basic image processing operations.</td></tr>
<tr><td rowspan="6">Student Study Effort Expected</td><td colspan="2">Class contact:</td></tr>
<tr><td>▪ Lecture</td><td>26 Hrs.</td></tr>
<tr><td>▪ Tutorial/Lab</td><td>13 Hrs.</td></tr>
<tr><td colspan="2">Other student study effort:</td></tr>
<tr><td>▪ Regular Reading and Assignment Effort</td><td>80 Hrs.</td></tr>
<tr><td>Total student study effort</td><td>119 Hrs.</td></tr>
<tr><td>Reading List and References</td><td colspan="2">Reference Books:

1. Forsyth, David A. and Ponce, Jean, Computer Vision: A Modern Approach, 2nd Edition, Pearson, 2019.

2. Szeliski, Richard, Computer Vision: Algorithms and Applications, Springer, 2011.

3. Gonzalez, Rafael and Woods, Richard, Digital Image Processing, 4th Edition, 2018.</td></tr>
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