Subject Description Form

Subject Code	COMP4423
Subject Title	Computer Vision
Credit Value	3
Level	4
Pre-requisite / Co-requisite / Exclusion	**Pre-requisite:** COMP1011/COMP1012 *or* ENG2002 (Computer Programming) for EEE students
Objectives	The objectives of this subject are: 1. Provide an understanding of the fundamental principles of computer vision. 2. Offer hands-on experience to students in applying machine learning and deep learning for real-world applications. 3. Showcase breakthrough applications across different domains enabled by computer vision.
Intended Learning Outcomes	Upon completion of this course, students will: (a) Demonstrate a solid understanding of image sensing, pixel arrays, and digital image representations. (b) Effectively apply image processing techniques for image enhancement and analysis. (c) Implement computer vision algorithms for feature extraction, image classification, image retrieval, object detection, feature extraction, and image generation. (d) Apply computer vision and image processing methods to solve real-world problems. (e) Recognize and evaluate the significance of deep learning applications in computer vision.

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<tr><td>Subject Synopsis/ Indicative Syllabus</td><td>This course provides an introduction to computer vision, covering its principles, mathematical models, and practical applications. The key topics encompassed in this course include image processing, feature extraction, image classification and retrieval, object detection, image segmentation, and image synthesis. These topics will be explored within the framework of both traditional machine learning and deep learning. Students will develop a solid understanding of the fundamental concepts of computer vision and gain practical 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, Global and Local Features, Feature Maps, Feature Aggregation

4. Computer Vision Tasks
Image Classification and Retrieval, Object Detection, Image Segmentation, Image Synthesis

5. Deep Neural Networks
Perceptron, Neural Network, Perceptron Training, Gradient Descent, Backpropagation, Convolutional Neural Networks, Attention Mechanisms, Few-shot Learning, Generative Adversarial Network, Transformers, Large-Scale Pretraining, Generative Models</td></tr>
<tr><td>Teaching/ Learning Methodology</td><td>Lectures: The primary focus will be on introducing computer vision and covering fundamental image processing operations. The lectures will delve into topics such as feature extraction, image enhancement, image classification, and object recognition principles, all of which are relevant to real-world applications.

Tutorials: Students will engage in practical exercises to gain firsthand experience in applying computer vision algorithms. Each week, a set of tutorial problems will be assigned, focusing on specific image analysis challenges. Students will be encouraged to develop their own solutions to these problems, fostering their problem-solving skills in the realm of computer vision.

Assignments: Students will be tasked with implementing specific computer vision algorithms and devising solutions for real-world problems. They will also analyze the performance of their solutions and learn to justify their approaches in tackling the given real-world challenges. This will enable students to enhance their practical skills in applying computer vision techniques and develop critical thinking in evaluating and justifying their chosen solutions.

Project: Students will have the opportunity to design and develop a relevant computer vision-based solution for a real-world application. By applying the image processing principles learned in this course, they will gain experience in developing expected or</td></tr>
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<tr><td></td><td>innovative solutions for the assigned problem. This project will allow students to showcase their understanding of computer vision concepts and their ability to apply them effectively to address practical challenges.</td></tr>
<tr><td>Assessment Methods in Alignment with Intended Learning Outcomes</td><td>
<table>
<tr><td rowspan="2">Specific assessment methods/tasks</td><td rowspan="2">% weighting</td><td colspan="5">Intended subject learning outcomes to be assessed</td></tr>
<tr><td>a</td><td>b</td><td>c</td><td>d</td><td>e</td></tr>
<tr><td>Continuous Assessment</td><td>55%</td><td colspan="5"></td></tr>
<tr><td>1. Assignment I</td><td>15%</td><td>✓</td><td>✓</td><td></td><td></td><td></td></tr>
<tr><td>2. Assignment II</td><td>15%</td><td>✓</td><td></td><td>✓</td><td>✓</td><td></td></tr>
<tr><td>3. Project</td><td>25%</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td></tr>
<tr><td>Examination</td><td>45%</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td></tr>
<tr><td>Total</td><td>100%</td><td colspan="5"></td></tr>
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Explanation of the appropriateness of the assessment methods in assessing the intended learning outcomes:

Assignments: The assignments are designed to ascertain the effectiveness of selected computer vision algorithms and techniques. These assignments require implementation of algorithms and/or analyse 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>Student Study Effort Expected</td><td>
<table>
<tr><td>Class contact:</td><td></td></tr>
<tr><td>▪ Lecture</td><td>26 Hrs.</td></tr>
<tr><td>▪ Tutorial/Lab</td><td>13 Hrs.</td></tr>
<tr><td>Other student study effort:</td><td></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>
</table>
</td></tr>
<tr><td>Reading List and References</td><td>Reference Books:

1. Forsyth, David A. and Ponce, Jean, Computer Vision: A Modern Approach, 2nd Edition, Pearson, 2019.</td></tr>
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	2. Szeliski, Richard, *Computer Vision: Algorithms and Applications (2nd Ed.)*, Springer, 2022. 3. Gonzalez, Rafael and Woods, Richard, *Digital Image Processing*, 4th Edition, 2018.