MODULE DESCRIPTION FORM

نموذج وصف المادة الدراسية

| **Module Information**  **معلومات المادة الدراسية** | | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Module Title** | Computer vision | | | | **Module Delivery** | | |
| **Module Type** | Core | | | | * **☒ Theory** * **☐ Lecture** * **☒ Lab** * **☐ Tutorial** * **☐ Practical** * **☐ Seminar** | | |
| **Module Code** | BMI323 | | | |
| **ECTS Credits** | 5.00 | | | |
| **SWL (hr/sem)** | 125 | | | |
| **Module Level** | | UGx1 3 | **Semester of Delivery** | | | | 6 |
| **Administering Department** | | BID | **College** | BMIC | | | |
| **Module Leader** | Lec. Jwan K ALwan | | **e-mail** | [E-jwanism@uoitc.edu.iq](mailto:E-jwanism@uoitc.edu.iq) | | | |
| **Module Leader’s Acad. Title** | | Lecturer | **Module Leader’s Qualification** | | | | M.Sc |
| **Module Tutor** | Non | | **e-mail** | E-mail | | | |
| **Peer Reviewer Name** | | omar A.M | **e-mail** | omara.m@uoitc.edu.iq | | | |
| **Scientific Committee Approval Date** | | 18/06/2023 | **Version Number** | | | 1.0 | |

| **Relation with other Modules**  **العلاقة مع المواد الدراسية الأخرى** | | | |
| --- | --- | --- | --- |
| **Prerequisite module** | Image Processing / BMI312 | **Semester** | 5 |
| **Co-requisites module** | None | **Semester** |  |

| **Module Aims, Learning Outcomes and Indicative Contents**  **أهداف المادة الدراسية ونتائج التعلم والمحتويات الإرشادية** | |
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| **Module Aims**  **أهداف المادة الدراسية** | * Provide students with a solid foundation in computer vision, enabling them to understand, analyze, and develop computer vision systems and algorithms for real-world applications. |
| **Module Learning Outcomes**  **مخرجات التعلم للمادة الدراسية** | Upon completion of the module on Computer Vision, students should be able to demonstrate the following learning outcomes:   1. Understand the fundamental concepts and theories of computer vision, including image formation, image representation, and human visual perception. 2. Apply various image processing techniques, such as filtering, enhancement, transformation, and restoration, to improve image quality and extract relevant information. 3. Detect and extract meaningful features from images, such as edges, corners, and texture descriptors, and describe these features for efficient object recognition and matching. 4. Apply object detection and localization techniques to identify and locate objects in images and videos. 5. Understand motion estimation and tracking algorithms to analyze and track objects over time in video sequences. 6. Apply machine learning algorithms, including supervised and unsupervised learning, to perform image classification, object detection, and image segmentation tasks in computer vision. 7. Utilize deep learning approaches, such as Convolutional Neural Networks (CNNs), for computer vision tasks and understand their strengths and limitations. 8. Explore practical applications of computer vision, such as autonomous vehicles, surveillance systems, medical imaging, and augmented reality, and understand the challenges and considerations in implementing computer vision systems in different domains. 9. Develop critical thinking and problem-solving skills in the context of computer vision by analyzing visual data, formulating solutions, and evaluating the performance of computer vision algorithms. 10. Demonstrate proficiency in using software tools and libraries commonly used in computer vision, and effectively implement computer vision algorithms in practical scenarios. 11. Communicate effectively about computer vision concepts, techniques, and applications through written reports, presentations, and demonstrations. 12. Work collaboratively in teams to tackle computer vision problems, effectively share knowledge and resources, and contribute to the development of computer vision solutions. |
| **Indicative Contents**  **المحتويات الإرشادية** | Indicative content includes the following:   1. Introduction to Computer Vision  * Overview of computer vision and its applications * Historical development and current trends in computer vision * Challenges and limitations in computer vision  1. Image Formation and Preprocessing  * Image formation process and camera models * Color spaces and color image processing * Image enhancement techniques (e.g., contrast enhancement, histogram equalization)  1. Image Filtering and Restoration  * Spatial and frequency domain filtering * Linear and nonlinear filtering techniques * Image denoising and deblurring methods  1. Feature Detection and Description  * Edge detection algorithms (e.g., Canny edge detector, Sobel operator) * Corner detection algorithms (e.g., Harris corner detector) * Scale-invariant feature transform (SIFT) and other feature descriptors  1. Image Segmentation  * Thresholding techniques * Region-based segmentation methods (e.g., region growing, graph cuts) * Contour-based segmentation (e.g., active contours, level sets)  1. Object Detection and Recognition  * Object localization and bounding box detection * Feature-based object recognition methods * Deep learning approaches for object detection (e.g., R-CNN, YOLO)  1. Object Tracking  * Single object tracking algorithms * Multiple object tracking techniques * Tracking in video sequences and handling occlusions  1. 3D Vision and Stereo Reconstruction  * Stereo vision principles and algorithms * Depth estimation and disparity maps * Structure from motion (SFM) and 3D reconstruction techniques  1. Machine Learning in Computer Vision  * Supervised learning algorithms (e.g., support vector machines, random forests) for computer vision tasks * Unsupervised learning methods (e.g., clustering, dimensionality reduction) in computer vision * Deep learning architectures (e.g., CNNs, autoencoders) for computer vision applications  1. Advanced Topics in Computer Vision  * Object recognition in challenging conditions (e.g., occlusion, illumination changes) * Image and video retrieval * Biometrics and face recognition * Augmented reality and virtual reality applications |

| **Learning and Teaching Strategies**  **استراتيجيات التعلم والتعليم** | |
| --- | --- |
| **Strategies** | The goal is to have respectful discussions that do not violate the community space created for these conversations. Here are some productive ways to engage in this course:   * **Participate:** This is a community. Read what others have written and listen to recordings others have posted and share your thoughts. * **Stay curious:** Learn from experts and each other by listening and asking questions, not making assumptions. * **Keep your passion positive:** When replying to a discussion forum post, respond with thoughts on what was said, not about the person who posted. Avoid using all caps, too many exclamation points, or aggressive language. * **Acknowledge discomfort:** The topics discussed in this course might be challenging or hard to talk about. Stick with it and remember the benefits of having these tough conversations that surface from multiple perspectives. |

| **Student Workload (SWL)**  **الحمل الدراسي للطالب** | | | |
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| **Structured SWL (h/sem)**  **الحمل الدراسي المنتظم للطالب خلال الفصل** | 64 | **Structured SWL (h/w)**  **الحمل الدراسي المنتظم للطالب أسبوعيا** | 4 |
| **Unstructured SWL (h/sem)**  **الحمل الدراسي غير المنتظم للطالب خلال الفصل** | 61 | **Unstructured SWL (h/w)**  **الحمل الدراسي غير المنتظم للطالب أسبوعيا** | 4 |
| **Total SWL (h/sem)**  **الحمل الدراسي الكلي للطالب خلال الفصل** | 125 | | |

| **Module Evaluation**  **تقييم المادة الدراسية** | | | | | |
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| **As** | | **Time/Number** | **Weight (Marks)** | **Week Due** | **Relevant Learning Outcome** |
| **Formative assessment** | **Quizzes** | 2 | 10% (10) | 5, 12 | LO #1, 2, 10 and 12 |
| **Assignments** | 2 | 10% (10) | 2, 12 | LO # 3, 4, 6 and 7 |
| **Projects / Lab.** | 1 | 10% (10) | Continuous |  |
| **Report** | 1 | 10% (10) | 13 | LO # 5, 8 and 12 |
| **Summative assessment** | **Midterm Exam** | 2 hr | 10% (10) | 7 | LO # 1-7 |
| **Final Exam** | 3hr | 50% (50) | 16 | All |
| **Total assessment** | | | 100% (100 Marks) |  |  |

| **Delivery Plan (Weekly Syllabus)**  **المنهاج الاسبوعي النظري** | |
| --- | --- |
| **Week** | **Material Covered** |
| **Week 1** | * Introduction to Computer Vision * Overview of applications and challenges in computer vision |
| **Week 2** | * Image Formation and Preprocessing * Camera models and image acquisition * Color spaces and color image processing |
| **Week 3** | * Image Filtering and Restoration * Spatial and frequency domain filtering techniques * Image denoising and deblurring methods |
| **Week 4** | * Feature Detection and Description * Edge detection algorithms * Corner detection algorithms |
| **Week 5** | * Feature Detection and Description (continued) * Scale-invariant feature transform (SIFT) and other feature descriptors |
| **Week 6** | * Image Segmentation * Thresholding techniques * Region-based and contour-based segmentation methods |
|  | * **first mid exam** |
| **Week 8** | * Object Tracking * Single object tracking algorithms * Multiple object tracking techniques |
| **Week 9** | * 3D Vision and Stereo Reconstruction * Stereo vision principles and algorithms * Depth estimation and disparity maps |
| **Week 10** | * 3D Vision and Stereo Reconstruction (continued) * Structure from motion (SFM) and 3D reconstruction techniques |
| **Week 11** | * Machine Learning in Computer Vision * Supervised learning algorithms for computer vision tasks * Unsupervised learning methods in computer vision |
| **Week 12** | * Machine Learning in Computer Vision (continued) * Deep learning architectures for computer vision applications |
| **Week 13** | * Advanced Topics in Computer Vision * Object recognition in challenging conditions * Image and video retrieval |
| **Week 14** | * Advanced Topics in Computer Vision (continued) |
| **Week 15** | * Biometrics and face recognition |

| **Delivery Plan (Weekly Lab. Syllabus)**  **المنهاج الاسبوعي للمختبر** | |
| --- | --- |
| **Week** | **Material Covered(non )** |
| **Week 1** | Introduction to Computer Vision Tools and Environment   * Familiarize students with computer vision software tools (e.g., OpenCV) and programming environments. |
| **Week 2** | * Basic image manipulation and visualization using the chosen tools. * Perform simple image filtering and enhancement techniques. |
| **Week 3** | : Image Feature Detection and Description   * Implement edge detection algorithms (e.g., Canny edge detector) and corner detection algorithms (e.g., Harris corner detector). * Extract and describe features using algorithms such as the Scale-Invariant Feature Transform (SIFT). |
| **Week 4** | * Apply feature matching techniques to find correspondences between images. |
| **Week 5** | Image Segmentation and Object Recognition   * Implement thresholding techniques for image segmentation. * Use region-based segmentation methods (e.g., region growing) to segment objects in images. |
| **Week 6** | * Perform object recognition using feature-based approaches (e.g., feature matching and homography estimation). |
| **Week 7** | object Tracking in Video Sequences   * Implement a simple single object tracker (e.g., correlation-based tracking). |
| **Week 8** | * Explore multiple object tracking techniques (e.g., Kalman filters, particle filters) in a video sequence. * Evaluate the performance of the implemented trackers on challenging scenarios. |
| **Week 9** | 3D Vision and Stereo Reconstruction   * Implement stereo vision algorithms for depth estimation and disparity maps. * Use the disparity maps to perform 3D reconstruction of scenes or objects. |
| **Week 10** | * Visualize and analyze the reconstructed 3D models. |
| **Week 11** | Machine Learning in Computer Vision   * Apply supervised learning algorithms (e.g., support vector machines) for image classification tasks. * Explore unsupervised learning methods (e.g., clustering) for image segmentation. |
| **Week 12** | * Implement a basic Convolutional Neural Network (CNN) for image classification. |
| **Week 13** | Advanced Topics and Project Showcase   * Explore advanced computer vision topics based on student interests or emerging trends. |
| **Week 14** | * Students present their final projects, demonstrating the application of computer vision techniques to a real-world problem. |
| **Week 15** | * Review |

| **Learning and Teaching Resources**  **مصادر التعلم والتدريس** | | |
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|  | **Text** | **Available in the Library?** |
| **Required Texts** | Title: "Computer Vision: Algorithms and Applications" Authors: Richard Szeliski Publisher: Springer Year: 2010 | No |
| **Recommended Texts** | Computer Vision: Models, Learning, and Inference" Authors: Simon J.D. Prince Publisher: Cambridge University Press Year: 2012 | No |
| **Websites** |  | |

| **Grading Scheme**  **مخطط الدرجات** | | | | |
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| **Group** | **Grade** | التقدير | **Marks (%)** | **Definition** |
| **Success Group**  **(50 - 100)** | **A -** Excellent | **امتياز** | 90 - 100 | Outstanding Performance |
| **B -** Very Good | **جيد جدا** | 80 - 89 | Above average with some errors |
| **C –** Good | **جيد** | 70 - 79 | Sound work with notable errors |
| **D -** Satisfactory | **متوسط** | 60 - 69 | Fair but with major shortcomings |
| **E -** Sufficient | **مقبول** | 50 - 59 | Work meets minimum criteria |
| **Fail Group**  **(0 – 49)** | **FX –** Fail | **راسب (قيد المعالجة)** | (45-49) | More work required but credit awarded |
| **F –** Fail | **راسب** | (0-44) | Considerable amount of work required |
|  |  |  |  |  |
| **Note:** Marks Decimal places above or below 0.5 will be rounded to the higher or lower full mark (for example a mark of 54.5 will be rounded to 55, whereas a mark of 54.4 will be rounded to 54. The University has a policy NOT to condone "near-pass fails" so the only adjustment to marks awarded by the original marker(s) will be the automatic rounding outlined above. | | | | |