



# UNIVERSITAS GADJAH MADA

Faculty of Mathematics and Natural Sciences

Department of Computer Science and Electronics

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## Bachelor in Computer Science

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## Module Handbook

|   |  |
|---|--|
| Module name   | <b>Computer Vision and Image Analysis</b>  |
| Module level  | Undergraduate  |
| Code  | MII21-2206   |
| Courses (if applicable)                               | Computer Vision and Image Analysis   |
| Semester  | Winter (Genap)   |
| Contact person  | Wahyono, S.Kom, Ph.D.  |
| Lecturer  | Wahyono, S.Kom, Ph.D.<br>Agus Harjoko, Drs., M.Sc., Ph.D.<br>Moh. Edi Wibowo, S.Kom., M.Kom, Ph.D.<br>Muhammad Alfian Amrizal, B.Eng., M.I.S., Ph.D.   |
| Language  | Bahasa Indonesia<br>English  |
| Relation to curriculum                                | Undergraduate degree program, elective, 5th semester.  |
| Type of teaching, contact hours                       | Undergraduate degree program: lectures, project based  |
| Workload  | 1. Lectures: 3 x 50 = 100 minutes (2.5 hours) per week.<br>2. Exercises and Assignments: 3 x 60 = 180 minutes (2 hours) per week.<br>3. Private study: 3 x 60 = 180 minutes (3 hours) per week.  |
| Credit points   | 3 credit points (sks).   |
| Requirements according to the examination regulations | A student must have attended at least 75% of the lectures to sit in the exams.   |
| Recommended prerequisites                             | Digital Image Processing*. Machine Learning  |
| Learning outcomes and their corresponding PLOs        | After completing this module, a student is expected to:<br><br>CO1 Students can understand the importance of vision sensors for creating intelligent systems and basic concepts of digital image processing.<br>CO2 Students can understand and explain how to collect and augment the dataset using vision sensor.<br>CO3 Students can understand and explain how to find the object candidate on image as well as video using one of object localization and detection algorithms.<br>CO4 Students can understand and explain the object classification, recognition, and identification; and differentiating between them.<br>CO5 Students can understand and explain object tracking and behavior analysis based on spatial and temporal information of vision data.<br>CO6 Students can understand the concept of the geometric relationships between 2D images and the 3D world.<br>CO7 Be able to develop the practical skills necessary to build computer vision applications. |

|   | <table border="1"> <thead> <tr> <th colspan="2">PLO</th> <th>CO1</th> <th>CO2</th> <th>CO3</th> <th>CO4</th> <th>CO6</th> <th>CO6</th> <th>CO7</th> </tr> </thead> <tbody> <tr> <td rowspan="5">Program Learning Outcome (PLO)</td> <td>PLO1</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>PLO2</td> <td>v</td> <td></td> <td></td> <td></td> <td></td> <td>v</td> <td></td> </tr> <tr> <td>PLO3</td> <td>v</td> <td>v</td> <td></td> <td></td> <td></td> <td>v</td> <td></td> </tr> <tr> <td>PLO4</td> <td></td> <td></td> <td>v</td> <td>v</td> <td>v</td> <td></td> <td></td> </tr> <tr> <td>PLO5</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>v</td> </tr> </tbody> </table>   | PLO  |     | CO1 | CO2 | CO3 | CO4 | CO6 | CO6 | CO7 | Program Learning Outcome (PLO) | PLO1 |   |   |   |  |  |  |  | PLO2             | v  |  |  |  |   | v |   | PLO3 | v                | v  |  |   |   | v |  | PLO4 |  |              | v  | v | v |  |  | PLO5 |  |   |               |    |  |  | v |  |   |  |  |       |     |    |    |    |    |    |    |    |
|---|--|------|-----|-----|-----|-----|-----|-----|-----|-----|--------------------------------|------|---|---|---|--|--|--|--|------------------|----|--|--|--|---|---|---|------|------------------|----|--|---|---|---|--|------|--|--------------|----|---|---|--|--|------|--|---|---------------|----|--|--|---|--|---|--|--|-------|-----|----|----|----|----|----|----|----|
| PLO   |  | CO1  | CO2 | CO3 | CO4 | CO6 | CO6 | CO7 |     |     |                                |      |   |   |   |  |  |  |  |                  |    |  |  |  |   |   |   |      |                  |    |  |   |   |   |  |      |  |              |    |   |   |  |  |      |  |   |               |    |  |  |   |  |   |  |  |       |     |    |    |    |    |    |    |    |
| Program Learning Outcome (PLO)                              | PLO1   |      |     |     |     |     |     |     |     |     |                                |      |   |   |   |  |  |  |  |                  |    |  |  |  |   |   |   |      |                  |    |  |   |   |   |  |      |  |              |    |   |   |  |  |      |  |   |               |    |  |  |   |  |   |  |  |       |     |    |    |    |    |    |    |    |
|   | PLO2   | v    |     |     |     |     | v   |     |     |     |                                |      |   |   |   |  |  |  |  |                  |    |  |  |  |   |   |   |      |                  |    |  |   |   |   |  |      |  |              |    |   |   |  |  |      |  |   |               |    |  |  |   |  |   |  |  |       |     |    |    |    |    |    |    |    |
|   | PLO3   | v    | v   |     |     |     | v   |     |     |     |                                |      |   |   |   |  |  |  |  |                  |    |  |  |  |   |   |   |      |                  |    |  |   |   |   |  |      |  |              |    |   |   |  |  |      |  |   |               |    |  |  |   |  |   |  |  |       |     |    |    |    |    |    |    |    |
|   | PLO4   |      |     | v   | v   | v   |     |     |     |     |                                |      |   |   |   |  |  |  |  |                  |    |  |  |  |   |   |   |      |                  |    |  |   |   |   |  |      |  |              |    |   |   |  |  |      |  |   |               |    |  |  |   |  |   |  |  |       |     |    |    |    |    |    |    |    |
|   | PLO5   |      |     |     |     |     |     | v   |     |     |                                |      |   |   |   |  |  |  |  |                  |    |  |  |  |   |   |   |      |                  |    |  |   |   |   |  |      |  |              |    |   |   |  |  |      |  |   |               |    |  |  |   |  |   |  |  |       |     |    |    |    |    |    |    |    |
| Content   | <p>In this course, students will learn.</p> <ol style="list-style-type: none"> <li>1. Introduction to computer vision and its applications: Augmented reality, Surveillance systems, traffic monitoring</li> <li>2. Digital image processing review: color space, image quality enhancement, feature extraction, feature representation</li> <li>3. Image data acquisition and augmentation: data acquisition, data augmentation, data preprocessing</li> <li>4. Localization and object detection: sliding windows with template matching, feature-based object detection, background subtraction (static and moving cameras)</li> <li>5. Object classification in digital images: binary classification, multiclass classification, image &amp; shape analysis</li> <li>6. Object recognition and identification: face recognition, person re-identification, person attribute identification, scene recognition</li> <li>7. Object search: template-based matching, Kalman Filter, Multiple Camera Tracking</li> <li>8. Object Behavior Analysis: Optical Flow, Spatial and Temporal Motion Analysis</li> <li>9. Introduction to three-dimensional reconstruction: Key point Detector, Image Stitching, Calibration and Visual Geometry, Structure from motion</li> <li>10. Vision-based intelligent project</li> </ol> |      |     |     |     |     |     |     |     |     |                                |      |   |   |   |  |  |  |  |                  |    |  |  |  |   |   |   |      |                  |    |  |   |   |   |  |      |  |              |    |   |   |  |  |      |  |   |               |    |  |  |   |  |   |  |  |       |     |    |    |    |    |    |    |    |
| Study and examination requirements and forms of examination | Assignments, midterms examination, and final examination.  |      |     |     |     |     |     |     |     |     |                                |      |   |   |   |  |  |  |  |                  |    |  |  |  |   |   |   |      |                  |    |  |   |   |   |  |      |  |              |    |   |   |  |  |      |  |   |               |    |  |  |   |  |   |  |  |       |     |    |    |    |    |    |    |    |
| Media employed  | LCD, blackboard, websites, and programming tools   |      |     |     |     |     |     |     |     |     |                                |      |   |   |   |  |  |  |  |                  |    |  |  |  |   |   |   |      |                  |    |  |   |   |   |  |      |  |              |    |   |   |  |  |      |  |   |               |    |  |  |   |  |   |  |  |       |     |    |    |    |    |    |    |    |
| Assessments and Evaluation                                  | <table border="1"> <thead> <tr> <th>Type</th> <th>PCT</th> <th>CO1</th> <th>CO2</th> <th>CO3</th> <th>CO4</th> <th>CO5</th> <th>CO6</th> <th>CO7</th> </tr> </thead> <tbody> <tr> <td>Assessment 1,2,3</td> <td>15</td> <td>v</td> <td>v</td> <td>v</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>Assessment 4,5,6</td> <td>25</td> <td></td> <td></td> <td></td> <td>v</td> <td>v</td> <td>v</td> <td></td> </tr> <tr> <td>Assessment 7,8,9</td> <td>25</td> <td></td> <td>v</td> <td>v</td> <td>v</td> <td></td> <td></td> <td></td> </tr> <tr> <td>Project 1, 2</td> <td>20</td> <td>v</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>v</td> </tr> <tr> <td>Final project</td> <td>15</td> <td></td> <td></td> <td></td> <td></td> <td>v</td> <td></td> <td></td> </tr> <tr> <td>Total</td> <td>100</td> <td>10</td> <td>15</td> <td>15</td> <td>15</td> <td>15</td> <td>10</td> <td>20</td> </tr> </tbody> </table>  | Type | PCT | CO1 | CO2 | CO3 | CO4 | CO5 | CO6 | CO7 | Assessment 1,2,3               | 15   | v | v | v |  |  |  |  | Assessment 4,5,6 | 25 |  |  |  | v | v | v |      | Assessment 7,8,9 | 25 |  | v | v | v |  |      |  | Project 1, 2 | 20 | v |   |  |  |      |  | v | Final project | 15 |  |  |   |  | v |  |  | Total | 100 | 10 | 15 | 15 | 15 | 15 | 10 | 20 |
| Type  | PCT  | CO1  | CO2 | CO3 | CO4 | CO5 | CO6 | CO7 |     |     |                                |      |   |   |   |  |  |  |  |                  |    |  |  |  |   |   |   |      |                  |    |  |   |   |   |  |      |  |              |    |   |   |  |  |      |  |   |               |    |  |  |   |  |   |  |  |       |     |    |    |    |    |    |    |    |
| Assessment 1,2,3  | 15   | v    | v   | v   |     |     |     |     |     |     |                                |      |   |   |   |  |  |  |  |                  |    |  |  |  |   |   |   |      |                  |    |  |   |   |   |  |      |  |              |    |   |   |  |  |      |  |   |               |    |  |  |   |  |   |  |  |       |     |    |    |    |    |    |    |    |
| Assessment 4,5,6  | 25   |      |     |     | v   | v   | v   |     |     |     |                                |      |   |   |   |  |  |  |  |                  |    |  |  |  |   |   |   |      |                  |    |  |   |   |   |  |      |  |              |    |   |   |  |  |      |  |   |               |    |  |  |   |  |   |  |  |       |     |    |    |    |    |    |    |    |
| Assessment 7,8,9  | 25   |      | v   | v   | v   |     |     |     |     |     |                                |      |   |   |   |  |  |  |  |                  |    |  |  |  |   |   |   |      |                  |    |  |   |   |   |  |      |  |              |    |   |   |  |  |      |  |   |               |    |  |  |   |  |   |  |  |       |     |    |    |    |    |    |    |    |
| Project 1, 2  | 20   | v    |     |     |     |     |     | v   |     |     |                                |      |   |   |   |  |  |  |  |                  |    |  |  |  |   |   |   |      |                  |    |  |   |   |   |  |      |  |              |    |   |   |  |  |      |  |   |               |    |  |  |   |  |   |  |  |       |     |    |    |    |    |    |    |    |
| Final project   | 15   |      |     |     |     | v   |     |     |     |     |                                |      |   |   |   |  |  |  |  |                  |    |  |  |  |   |   |   |      |                  |    |  |   |   |   |  |      |  |              |    |   |   |  |  |      |  |   |               |    |  |  |   |  |   |  |  |       |     |    |    |    |    |    |    |    |
| Total   | 100  | 10   | 15  | 15  | 15  | 15  | 10  | 20  |     |     |                                |      |   |   |   |  |  |  |  |                  |    |  |  |  |   |   |   |      |                  |    |  |   |   |   |  |      |  |              |    |   |   |  |  |      |  |   |               |    |  |  |   |  |   |  |  |       |     |    |    |    |    |    |    |    |
| Reading List  | <ol style="list-style-type: none"> <li>1. Richard Szeliski, 2022, Computer Vision: Algorithms and Applications (2nd ed), Springer, ISBN-10: 3030343715, ISBN-13: 978-3030343712</li> <li>2. Roberto Brunelli, 2009, Template Matching Techniques in Computer Vision: Theory and Practice, John Wiley. ISBN:9780470517062, eISBN:9780470744055</li> <li>3. S. Nagabhushana, 2005, Computer Vision and Image Processing, New Age International Publisher, ISBN-13978-8122416428</li> <li>4. Forsyth Ponce, 2011, Computer Vision: A Modern Approach (2nd ed), . Pearson, ISBN-13978- 0136085928</li> </ol>   |      |     |     |     |     |     |     |     |     |                                |      |   |   |   |  |  |  |  |                  |    |  |  |  |   |   |   |      |                  |    |  |   |   |   |  |      |  |              |    |   |   |  |  |      |  |   |               |    |  |  |   |  |   |  |  |       |     |    |    |    |    |    |    |    |