**Mukesh Patel School of Technology Management & Engineering**

# Course Policy Document

**Course Name - (Code):** Computer Vision (702AI0C017)

<table>
<tr><td>Program and Semester: B Tech (Comp), MBA Tech (CE), Sem VIII, BTech AIDS semester VI, BTech Intg (CE) Sem XII</td><td colspan="2">Pre-requisite Course: Programming concepts and Image Processing fundamentals</td></tr>
<tr><td>Academic Year: 2024-25</td><td>Credit Details:</td><td><table><tr><td>L</td><td>T</td><td>P</td><td>C</td><td>H</td></tr><tr><td>2</td><td>0</td><td>2</td><td>3</td><td>4</td></tr></table></td></tr>
<tr><td>Name of Course Faculty:<br>Program: B Tech Intg (CE)<br>Contact Details: archana.bhise@nmims.edu<br>Office Hours: 9:00 am – 5:00 pm</td><td colspan="2">Faculty associated with the course: -<br>1. Dr. Shailendra Aote (Navi Mumbai campus)<br>2. Dr. Supriya Agrawal (Mumbai campus)</td></tr>
<tr><td colspan="3">Pre-Course Activity:<br>• Understanding the difficulties in handling image datasets<br>• Revisit the basics of image processing<br>• Familiarize yourself with Python programming<br>• Get familiar with OpenCV (Open Source Computer Vision) library</td></tr>
<tr><td colspan="3">Course link: MS Teams<br>CV_BTI_B_2024_25_TH | General | Microsoft Teams</td></tr>
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# 1. Introduction to the Course

## 1.1 Importance of the Course

### 1.1.1 **Domain** Relevance**:**

Computer vision is a rapidly evolving field that deals with how computers can gain understanding from digital images or videos. Its applications span across various domains such as healthcare, automotive, security, and entertainment. Understanding computer vision is crucial for developing technologies like facial recognition, medical imaging analysis, autonomous driving, etc.

### 1.1.2 **Industry** Relevance**:**

The industry demand for computer vision experts is growing exponentially as businesses seek to leverage visual data for improving products and services. From quality control in manufacturing to enhancing user experiences with augmented reality, the applications of computer vision are vast and impactful. This course prepares students for high-demand roles in tech companies, startups, and research institutions focused on innovative visual data solutions.

### 1.2 Objectives of the Course:

**1.2.1** The objective of this course is to provide an introduction of Computer Vision concepts and its application.

## 2. Course Outcomes (COs), Mapping with Program Outcomes (POs), and Program Specific Outcomes (PSOs)

### 2.1 Course Outcomes (COs): After completion of the course, students will be able to;

**2.1.1** **CO1:** Describe the fundamental image processing techniques required for computer vision.

**2.1.2** **CO2:** Apply features extraction and image segmentation techniques.

**2.1.3** **CO3:** Understand the concept of image classification.

**2.1.4** **CO4:** Analyse applications using computer vision techniques.

### 2.2 Program Outcomes (POs):

**2.2.1** **PO-1:** An ability to apply knowledge of mathematics, science, and engineering for problem solving.

**2.2.2** **PO-2:** An ability to research, design and conduct experiments, as well as to analyze and interpret data.

**2.2.3** **PO-3:** An ability to design, implement, and evaluate a computer-based system, process, component, or program to meet desired needs.

**2.2.4** **PO-4:** An ability to function effectively on teams to accomplish a common goal.

**2.2.5** **PO-5:** An ability to identify, formulate and provide effective IT solution for engineering problems.

**2.2.6** **PO-6:** An understanding of professional, legal, security and social issues and responsibilities.

**2.2.7** **PO-7:** An ability to communicate effectively with a range of audiences.

**2.2.8** **PO-8:** The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.

**2.2.9** **PO-9:** Recognition of the need for and an ability to engage in continuing professional development and self-learning.

**2.2.10** **PO-10:** An ability to apply ethical principles in development of IT solutions.

**2.2.11** **PO-11:** An ability to use the techniques, skills, and modern engineering tools necessary for developing effective IT solutions.

**2.2.12** **PO-12:** An ability to identify and analyze user needs and take them into account in the selection, creation/integration, evaluation and administration of IT-based solutions.

### 2.3 Program Specific Outcomes (PSOs):

**2.3.1** **PSO-1:** Demonstrate an ability to visualize, architect and create appropriate solutions for IT related projects.

**2.3.2** **PSO-2:** Demonstrate an ability to professionally manage, monitor and safeguard IT resources.

### CO-PO Mapping

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 2 | 2 | | | | | | | | | | | |
| CO2 | 2 | 2 | 2 | | | | | | | | | | | |
| CO3 | 2 | 2 | 2 | | | | | | | | | | | |
| CO4 | 2 | 2 | 2 | | 3 | | | | | | | | 3 | |

***Mapping Levels: 1- High, 2-Medium, 3-Low***

### 2.4 Student Outcomes (SOs) (for ABET accredited programs):

**2.4.1** **SO-1:** Analyze a complex computing problem and to apply principles of computing and other relevant disciplines to identify solutions.

**2.4.2** **SO-2:** Design, implement, and evaluate a computing-based solution to meet a given set of computing requirements in the context of the program's discipline.

**2.4.3** **SO-3:** Communicate effectively in a variety of professional contexts.

**2.4.4** **SO**-4: Recognize professional responsibilities and make informed judgments in computing practice based on legal and ethical principles.

**2.4.5** **SO**-5: Function effectively as a member or leader of a team engaged in activities appropriate to the program's discipline.

**2.4.6** **SO**-6: Identify and analyze user needs and to take them into account in the selection, creation, integration, evaluation, and administration of computing-based systems.

# 3. Teaching-learning methodology

## 3.1 Instruction Plan

| Lecture No. | Topic | Teaching Method * | Blooms Level | Resources (Books) | COs mapped | Assessment and Evaluation |
|---|---|---|---|---|---|---|
| **Unit 1: Introduction** | | | | | | |
| 1. | The Process of Recognition, Tackling the Recognition Problem | Whiteboard, PPT | Understanding | T1, R1 | CO1 | Class test-1, TEE |

| | | | | | | |
|---|---|---|---|---|---|---|
| 2. | Introduction to Computer Vision Low-level, Mid-level, High-level | | Understanding | T1, R1 | CO1 | Lab performance, Class test-1, TEE |
| 3. | Overview of Diverse Computer Vision Applications | | Understanding | T1, R1 | CO1 | Class test-1, TEE |
| **Unit 2: Feature Extraction** | | | | | | |
| 4. | Global and regional features | Whiteboard, PPT | Applying | T2, R1, R2 | CO2 | Class test-1, TEE |
| 5. | DOG | | Applying | T2, R1, R2 | CO2 | Lab performance, Class test-1, TEE |
| 6. | HOG | | Applying | T2, R1, R2 | CO2 | Lab performance, Class test-1, TEE |
| 7. | Corner and Interest Point Detection | | Applying | T2, R1, R2 | CO2 | Lab performance, Class test-1, TEE |
| 8. | Local invariant feature detectors and descriptors | | Applying | T2, R1, R2 | CO2 | Class test-1, TEE |
| 9. | SIFT | | Applying | T2, R1, R2 | CO2 | Lab performance, Class test-1, TEE |
| 10. | SURF | | Applying | T2, R1, R2 | CO2 | Class test-1, TEE |
| 11. | local texture representation using filters | | Applying | T2, R1, R2 | CO2 | Class test-1, TEE |
| **Unit 3: Image Segmentation** | | | | | | |
| 12. | Image Segmentation by Clustering Pixels | Whiteboard, PPT | Applying | T1, R1 | CO2 | Lab performance, Class test-2, TEE |
| 13. | The watershed Algorithm | | Applying | T1, R1 | CO2 | Class test-2, TEE |
| 14. | Mean-Shift | | Applying | T1, R1 | CO2 | Class test-2, TEE |
| 15. | Motion Segmentation: Optical Flow | | Applying | T1, R1 | CO2 | Class test-2, TEE |
| 16. | Background subtraction | | Applying | T1, R1 | CO2 | Lab performance, Class test-2, TEE |
| **Unit 4: 3D Vision and Motion** | | | | | | |
| 17. | 3D vision | Whiteboard, PPT | Understanding | T1, T2 | CO1 | Class test-2, TEE |
| 18. | Projection schemes for three-dimensional vision | | Understanding | T1, T2 | CO1 | Class test-2, TEE |
| 19. | shape from shading | | Understanding | T1, T2 | CO1 | Class test-2, TEE |
| 20. | Tackling the Perspective n-point Problem | | Understanding | T1, T2 | CO1 | Class test-2, TEE |
| 21. | Invariants and Perspective | | Understanding | T1, T2 | CO1 | Class test-2, TEE |
| 22. | Image Transformations | | Understanding | T1, T2 | CO1 | Class test-2, TEE |
| 23. | Camera Calibration | | Understanding | T1, T2 | CO1 | Class test-2, TEE |
| 24. | Motion | | Understanding | T1, T2 | CO1 | Class test-2, TEE |
| **Unit 5: Real-Time Pattern Recognition Systems** | | | | | | |
| 25. | Automated Visual Inspection | Whiteboard, PPT | Understanding | R1, R2 | CO3, CO4 | TEE |
| 26. | Inspection of Cereal Grains | | Applying | R1, R2 | CO3, CO4 | TEE |
| 27. | Inspection of Cereal Grains | | Applying | R1, R2 | CO3, CO4 | TEE |
| 28. | Surveillance | | Understanding | R1, R2 | CO3, CO4 | Lab performance, TEE |

| | | | | | | |
|---|---|---|---|---|---|---|
| 29. | In-Vehicle Vision Systems | | Understanding | R1, R2 | CO3, CO4 | TEE |
| 30. | In-Vehicle Vision Systems | | Understanding | R1, R2 | CO3, CO4 | TEE |

**Text Books:**

1. E. R. Davies, Matthew Turk, Advanced Methods and Deep Learning in Computer vision, Academic Press Inc, 2021.
2. D. Forsyth, J. Ponce, Computer Vision: A Modern Approach, 2nd Edition, Pearson Education India, 2015.

**Reference Books:**

1. Richard Szeliski, Computer Vision: Algorithms and Applications, Springer, 2010.
2. Simon J. D. Prince, Computer Vision: Models, Learning, and Inference, 1st Edition, Cambridge University Press, June 18, 2012.

***Note: The latest edition of books should be referred.***

# 4. Assessment and Evaluation Scheme

| | **Internal Continuous Assessment (ICA) (50 Marks)** | | | | |
|---|---|---|---|---|---|
| | **Class Tests (20 Marks)** | | **Term-work (30 Marks)** | | |
| **Assessment Component** | Class Test-1 | Class Test-2 | Lab Performance | Viva/ Quiz/ Class Participation | Mini project/ research paper publication |
| **Marks** | 10 | 10 | 10 | 10 | 10 |

## 4.1 Internal Continuous Assessment (ICA) – 50 marks

Assessment of mini projects/ acceptance of research paper publication will be based on the successful implementation and relevance of recent applications. Evaluation of lab assignments will be based on correctness and timely submission **Late submissions will be penalized. It is important that all the assignments and lab submissions are done before the deadline**.

One of the components of class participation is question answer session in the class. Assessment will be based on the correctness of answer given by the student.

## 4.2 Term End Examination (TEE) – (100 marks scaled down to 50)

A 100-mark TEE with 3 hours of duration will be conducted at the end of the semester. Marks scored will be scaled to 50. There will be 7 questions, each for 20 marks. Usually, Q1 is a compulsory question and any 4 from the remaining 6 are to be solved. However, students must refer to the instructions written on the TEE question paper for better clarification.

## 4.3 Course Passing Criteria

**4.3.1** ICA (50 marks) – No minimum marks

**4.3.2** TEE (100 marks scaled to 50) – 40% required for passing

**4.3.3** (ICA + TEE) (100 marks) - 50% required for passing

### 4.4 Assessments and Mapping to Course Outcomes

| | **Internal Continuous Assessment (ICA)** | | | | | **Term End Examination (TEE)** |
|---|---|---|---|---|---|---|
| Course Outcomes | Class Test-1 | Class Test-2 | Lab Performance | QA in class/ Quiz | Mini Project/ Research paper publication | TEE |
| CO1 | Y | Y | Y | Y | Y | Y |
| CO2 | Y | Y | Y | Y | Y | Y |
| CO3 | | | Y | Y | Y | Y |
| CO4 | | | Y | Y | Y | Y |

## 5. Laboratory details

The following 10 programming exercises will form the submission for laboratory coursework.

| **Exp. no.** | **Week no.** | **Programming Topic** | **Mapped CO** |
|---|---|---|---|
| 1. | 1 | - Determine Image gradient using Sobel filter for the given image.<br>- Change the parameters to observe the effect on output image<br>- Comment on the results before and after changing the parameters | CO1 |
| 2. | 2 | - Determine Difference of Gaussian for the given image<br>- Use different pairs of standard deviations to detect fine and broad edges<br>- Comment on the results before and after changing the parameters | CO2 |
| 3. | 3 | - Determine Histogram of Gradients for the given image<br>- Use different pairs of standard deviations to detect fine and broad edges<br>- Comment on the results before and after changing the parameters | CO2 |
| | 4 | Mini Project (Topic approval) | All COs |
| 4. | 5 | - Apply Harris corner detector to detect corners in an image.<br>- Apply the techniques on different images<br>- Change the parameters to observe the effect on output image.<br>- Comment on the results before and after changing the parameters | CO2 |
| 5. | 6 | - Determine interest points using SIFT parameters. Use interest points to match corner points of two images.<br>- Rotate and scale one image and match corner points<br>- Comment on the results before and after changing the parameters | CO2 |
| 6. | 7 | - Use K-means algorithm to segment the image<br>- Change the value of K and observe the effect | CO3 |
| | 8, 9 | Final presentation and submission of Mini Project | All COs |
| 7. | 10 | - Use Mean Shift algorithm to segment images<br>- Change the values of parameters and observe the effect | CO3 |
| 8. | 11 | - Use Gabor filter to identify objects of an image<br>- Apply the techniques on different images<br>- Change the parameters to observe the effect on output image.<br>- Comment on the results before and after changing the parameters | |
| 9. | 12 | - Use GMM for Background subtraction to segment an image | CO4 |

| | | | |
|---|---|---|---|
| | | - Apply the techniques on different images<br>- Change the parameters to observe the effect on output image.<br>- Comment on the results before and after changing the parameters | |
| 10. | 13 | - Determine depth image from the given stereo images<br>- Change the parameters to observe the effect on output image.<br>- Comment on the results before and after changing the parameters | CO4 |
| | 14, 15 | - Review of Mini Project | All COs |

# 6. Tutorial Plan

Not applicable to this course.

# 7. Course Material

References and lab manuals will be uploaded on MS Teams by faculty every week.

# 8. GenAI Usage

**8.1 Pre-class Activity:** Provide interactive simulations and visualizations of image processing techniques and computer vision algorithms. GenAI can help generate and explain these visual tools, making abstract concepts such as convolutional filters, edge detection, and feature extraction more tangible.

**8.2 In-class Activity:** For mini projects, students can use GenAI tools to analyze image data, classify objects, detect features, and enhance images.

# 9. Academic Integrity Statement

Original work expected from students for all of the **assigned assessment work**. Copying in any form not acceptable and will invite strict disciplinary action. Evaluation of corresponding component will be affected proportionately in such cases. Plagiarism detection software will be used to check plagiarism wherever applicable. Academic integrity is expected from students in all components of course assessment.

*** Only Teaching Method in the Instruction Plan for the course may vary for different faculty teaching the course, rest of the Course Policy Document will not change.**