# CSIS-504: COMPUTER VISION

**Effective Term**
Fall 2026

**BOT Approval Date**
05/15/2025

**Discipline**
CSIS - Computer Sci/Info Systems

**Course Number**
504

**Course Title**
Computer Vision

**Short Title**
Computer Vision

**Credit Status (CB 04)**
D - Credit - Degree applicable

## Units

**Lecture Units**
3.00

**Total Units**
3.00

## Hours

**Lecture Contact Hours**
48-54

**Out of Class Hours Lecture**
96-108

**Total Contact Hours**
48 - 54

**Total Out of Class Hours**
96 - 108

**Total Student Learning Hours**
144 - 162

**Distance Education**
Yes

## Distance Education

**Distance Education Type**
Both Fully Online and Hybrid Online

**Fully Online Delivery Requirements:**
**a. Students must be notified via the college schedule of classes and the syllabus for the class if proctored tests are required for this course**
**b. Any planned face-to-face meetings, such as an orientation or study session, must be optional**

**c. The MSJC curriculum committee requires the use of accessible, asynchronous discussion as a component of every fully online course**

**Are you using publisher content?**

No

**Regular Substantive Interaction**

Instructor-to-student, student-to-student, and student-to-content contact shall be distributed in a manner that will ensure regular substantive interaction (RSI) is maintained not only weekly but also for the duration of the course. Instructor interactions should be equivalent in time, quality and consistency to the engagement students would receive in a face-to-face course—for example, through announcements, discussion participation, personalized feedback, video messages, or other instructional communications. Instructors are expected to be responsive to student inquiries within a 24-72 hour time frame excluding holidays. RSI will be maintained through a variety of methods: • Orientation - Students must be oriented to the online and face-to-face portions at the start of the course. • Announcements - Announcements using the course management system must be posted at least weekly to keep students current on course events, due dates, materials, etc. • Discussion Forums - Content-related discussion forums within the designated CMS will include appropriate instructor participation and will be initiated and maintained, with timely feedback provided. Instructors are required to monitor the discussions and related activities to provide guidance and direction. Open-ended discussion boards may be used to further learning and interaction. • MSJC Communication – Instructor will use MSJC-administered communication tools (such as email or the designated CMS communication tools) to regularly communicate with and provide ease of access to students. • Timely Feedback - Timely feedback on student work will be provided by the instructor, which may include comments and/or rubrics, within the Grades area of the designated CMS. • Scheduled Meetings – Hybrid and synchronous courses will meet at regularly scheduled times. ADA Compliance - All course interactions and content must be designed with accessibility in mind and meet ADA requirements.

**Catalog Description**

This course introduces students to the concepts where machines gain the ability to interpret and understand the visual world. Computer vision is found in applications ranging from image and video analysis to autonomous vehicles and facial recognition. Students will learn how computers are trained to automatically process, extract, and manipulate visual data from images and video.

## Requisites

**Prerequisite(s)**

| Prerequisite(s) (must be taken before) |
|---|
| CSIS-502 (with a grade of C or better) |

## Codes

**TOP Code (CB 03)**

0702.00* - *Computer Information Systems

**CIP Code**

11.0102 - Artificial Intelligence.

**Repeatability Code**

No

**Grading Option**

Letter grade OR P/NP

**Minimum Qualifications**

| Minimum Qualifications | And/Or |
|---|---|
| Computer Information Systems | End |

## Learning Objectives

**Learning Objectives**

| Learning Objective |
|---|
| 1. Evaluate computer vision concepts and their role in artificial intelligence. |
| 2. Analyze how computers recognize images and represent them as matrices. |

3. Appraise the various techniques for extracting relevant features from images.
4. Assess the concepts of image segmentation.
5. Investigate the architecture and principles of convolutional neural networks.
6. Evaluate techniques for detecting and localizing objects in images.
7. Investigate feature-matching techniques across images.
8. Evaluate how algorithmic bias in language models results in societal inequities in race, culture, gender, or sexuality.

## Learning Outcome Information

**Course Learning Outcomes**

| Learning Outcome |
| --- |
| 1. Students will apply computer vision algorithms to real-world problems and develop practical solutions. |
| 2. Students will develop and implement hands-on projects that apply computer vision concepts. |
| 3. Students will evaluate and optimize computer vision models using appropriate metrics and techniques. |
| 4. Students will analyze and address ethical considerations related to computer vision, including privacy concerns, bias, and fairness. |

## Content

**Course Lecture Content**

1. Computer vision fundamentals
   a. Overview of computer vision.
   b. Historical perspectives and evolution.
   c. Applications in various domains.
   d. Challenges and opportunities.
2. Image processing techniques
   a. Image processing basics.
   b. Image enhancement techniques.
   c. Image filtering and transformation.
   d. Practical applications.
3. Feature extraction
   a. Importance of feature extraction.
   b. Feature types (edges, corners, textures).
   c. Feature extraction techniques.
4. Image classification and object recognition
   a. Image classification fundamentals.
   b. Supervised and unsupervised classification.
   c. Object recognition techniques.
   d. Evaluation metrics and model selection.
5. Image segmentation
   a. Image segmentation Key concepts.
   b. Segmentation methods
   c. Thresholding.
   d. Region-based.
   e. Contour-based.
   f. Segmentation applications.
6. Convolution neural networks
   a. Neural networks fundamentals.
   b. Introduction to convolution neural networks.
   c. Training and optimization for image analysis.
   d. Transfer learning with pre-trained models.
7. Object detections and location
   a. Object detection algorithms.
   b. R-CNN.

c. YOLO.
d. Localization techniques.
e. Object detection integration scenarios.

8. Feature Matching and Homography
   a. Feature matching across images.
   b. Homography and geometric transformations.
   c. Image stitching and alignment.
9. 3D Computer Vision
   a. Fundamental concepts.
   b. Stereopsis and depth perception.
   c. Structure from motion.
   d. Reconstruction of 3D scenes.
10. Video analysis and tracking video analysis techniques.
    a. Object tracking algorithms.
    b. Temporal aspects of visual data.
    c. Surveillance and action recognition.
11. Applications and case studies
    a. Real-world applications.
    b. Case studies.
    c. Healthcare.
    d. Autonomous vehicles.
    e. Security.
    f. Ethical considerations and societal impacts.
12. Diversity, Equity, and Inclusion in Computer Vision
    a. Bias in Computer Vision.
    b. Ethical Implications of Computer Vision Systems.
    c. Fairness in Computer Vision Models.
    d. Inclusive Datasets and Data Collection Practices.
    e. Cultural Sensitivity in Visual Data.
    f. Bias Mitigation Techniques in Computer Vision.

## Methods of Instruction

**Method**

Lecture

**Integration**

Lectures will be presented with supporting visual materials (slide set presentation or multimedia). They will introduce conceptual and practical skills such as image segmentation, image recognition, matrices, convolutional neural networks, and the ethical considerations related to computer vision.

**DE Adaptations for MOI**

Lectures will be delivered using video capture software to embed voice into lecture slides. Larger videos will be broken down into shorter digestible segments. All videos will be closed-captioned with synchronized audio. Transcripts of the lectures will be provided upon request. Any external links included will have descriptive text explaining the link's destination. Images included in virtual lectures will have alternate text that provides a detailed image description. Any resources or documents will comply with accessibility standards. All lectures will be delivered using the course management system. During the lectures, students will be encouraged to ask questions through the system's discussion board.

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**Method**

Observation and Demonstration

**Integration**

Live demonstrations, coding exercises, and experiments will be conducted to illustrate computer vision concepts such as the role computer vision takes in artificial intelligence, convolutional neural networks, localizing objects in images, feature matching, and bias and fairness in compute vision algorithms.

**DE Adaptations for MOI**

Demonstrations, coding exercises, and experiments will be pre-recorded to video and delivered via the course management system. All videos will be closed-captioned with synchronized text.
Any external link will have descriptive text explaining the link's destination. All images will have alternate text that provides a detailed image description. Any resources or documents will comply with accessibility standards. Interactive notebooks (e.g., Jupyter) will be used for shared hands-on exercises and delivered via the course management system.

**Method**

Discussion

**Integration**

Weekly discussions will explore natural language processing topics such as privacy concerns, bias and fairness in computer vision, computer vision models, model optimization, image segmentation, and extracting features from images.

**DE Adaptations for MOI**

Weekly discussions will be administered using the course management system's discussion tool. Images included in discussions will have alternate text provided that provides a detailed image description. If videos are provided, they will be closed-captioned with synchronized audio. Any external link within the discussion will have descriptive text explaining the link's destination. Any resources or documents will comply with accessibility standards. Documents embedded in any discussion will be provided in accessible file formats such as HTML, accessible PDF, and text.

## Methods of Evaluation

**Method**

Quizzes

**Integration**

Monthly quizzes consisting of multiple choice, short answer, and small coding problems will be given to evaluate the student's knowledge of matrices, feature matching, segmentation, convolutional neural networks, and algorithm bias.

**DE Adaptations for MOE**

Quizzes will be administered and collected using the quizzes tool within the course management system. Alternate text will be provided for images that give a detailed image description. Any external link within the quiz will have descriptive text explaining the link's destination. Any resources or documents will comply with accessibility standards. Feedback will be provided via the comments section of the quizzes tool.

**Method**

Exams/Tests

**Integration**

A midterm and final exam consisting of short answer questions and small coding problems will evaluate the student's understanding of feature matching techniques, matrices, image segmentation, localizing objects, bias, inclusive data sets, cultural sensitivity in visual data, and ethical considerations related to computer vision.

**DE Adaptations for MOE**

Exams will be administered and collected using the quizzes tool within the course management system. Images included in any exam question will have alternate text provided that provides a detailed description of the image. Any external link within the exam will have descriptive text explaining the link's destination. All videos will be closed-captioned with synchronized audio. Any resources or documents will comply with accessibility standards. Feedback for exams will be provided via the comments section of the quizzes tool within the course management system.

**Method**

Homework

**Integration**

Weekly homework assignments consisting of small coding problems will evaluate the student's knowledge of computer vision concepts in artificial intelligence, extracting features from images, feature matching, matrices, localizing objects in images, and privacy concerns in computer vision will be given.

**DE Adaptations for MOE**

Homework assignments will be provided in accessible file formats such as HTML, accessible PDF, and text. Any external link within the assignment will have descriptive text explaining the link's destination. All videos will be closed-captioned with synchronized audio. Any resources or documents will comply with accessibility standards. Assignments will be delivered via the course management system's assignment tool. Feedback will be provided in the comments section of the tool.

## Assignments

**Assignment Type**

Writing

**In-class and/or outside of class**

Outside of class

**Formative or Summative**

Summative

**Assignment**

For this assignment, you will design and implement a computer vision application that solves a real-world problem. The project should demonstrate proficiency in computer vision techniques, algorithm implementation, and practical application.
Submit a project proposal that outlines the chosen problem, its relevance in a real-world context, and the proposed computer vision solution. Detail the computer vision techniques and technologies (e.g., OpenCV, TensorFlow, PyTorch) that will be used.
Develop your application with clear documentation of the code. The application might include features like image classification, object detection, facial recognition, or other relevant computer vision functionality. Ensure the application is user-friendly and has a basic interface if applicable.
Perform thorough testing of the application to ensure it works under various conditions. Validate the results with real-world data, if possible. Analyze the performance of your application. Include metrics such as accuracy, processing time, and resource utilization. Compare with existing solutions, if any.
Compile a comprehensive report that includes the proposal, methodology, testing and validation, performance analysis, and ethical considerations. The report should also include a discussion section reflecting on challenges, lessons learned, and potential improvements or future work.

This assignment will be graded based on completeness, accuracy, and how well the directions are followed.

**How assignment will be adapted in online format**

Assignments will be distributed and collected through the assignments tool of the course management system. Any external link within the assignment will have descriptive text explaining the link's destination. If images are included as part of the assignment, they will have alternate text provided that provides a detailed description of the image. All videos will be closed-captioned with synchronized audio. Any resources or documents will comply with accessibility standards. Feedback for the assignment will be given via the comments section in the grade book.

**Assignment Type**

Reading

**In-class and/or outside of class**

Outside of class

**Formative or Summative**

Formative

**Assignment**

Use the provided links in the lecture material to select a recent research paper from Computer Vision. Try to choose a topic that you have an interest in. Thoroughly read the selected paper and write a concise summary of the paper, covering the key research question, methodology, findings, and conclusions.
Implement a small-scale experiment or a basic prototype based on a concept or technique discussed in the paper. This could involve replicating a part of the paper's methodology or applying its techniques to a new dataset. Document the implementation process, challenges faced, and results obtained.
Please submit your report and source code for your experiment.

This assignment will be evaluated based on how well directions were followed, completeness, and accuracy.

**How assignment will be adapted in online format**

Assignments will be distributed and collected through the assignments tool of the course management system. Any external link within the assignment will have descriptive text explaining the link's destination. If images are included as part of the assignment, they will have alternate text provided that provides a detailed description of the image. All videos will be closed-captioned with synchronized audio. Any resources or documents will comply with accessibility standards. Feedback for the assignment will be given via the comments section in the grade book.

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**Assignment Type**

Writing

**In-class and/or outside of class**

In-class

**Formative or Summative**

Summative

**Assignment**

Select a pre-trained model that performs a specific computer vision task, such as facial recognition, object detection, or image classification. You can use models available in popular libraries such as TensorFlow, PyTorch, or OpenCV.

Find or create a dataset that includes images from diverse demographic groups (e.g., different races, genders, age groups, etc.).

Run the selected model on this dataset and record its performance. Be sure to measure and compare each demographic group's accuracy, precision, recall, and other relevant metrics.

Analyze the results to identify any significant performance differences across demographic groups. For example, does the model perform better on certain skin tones, facial features, or age groups?

Based on your analysis, propose at least two strategies to mitigate the identified biases. These could include:
Data augmentation or rebalancing techniques to create a more diverse training dataset.
Fine-tuning the model on a more representative dataset.
Applying fairness constraints or debiasing techniques during model training.

Explain the rationale behind each proposed strategy and how it could improve the model's fairness.

Submit a description of the data set used for testing and a detailed analysis of the model's performance across different demographic groups, including metrics and visual examples.

This assignment will be graded based on how well the directions were followed, the completeness and accuracy of proposed strategies, and the analysis of computer vision model performance.

**How assignment will be adapted in online format**

Assignments will be distributed and collected through the assignments tool of the course management system. Any external link within the assignment will have descriptive text explaining the link's destination. If images are included as part of the assignment, they will have alternate text provided that provides a detailed description of the image. All videos will be closed-captioned with synchronized audio. Any resources or documents will comply with accessibility standards. Feedback for the assignment will be given via the comments section in the grade book.

## Course Materials

**Textbooks**

Foundations of Computer Vision (Adaptive Computation and Machine Learning series)
Antonio Torralba, Phillip Isola, William T. Freeman
ISBN: 978-0262048972
MIT Press 2024

## Class Size Information

**Class Size**

35

**Class Size Category**

B - Facilitated learning 35

## Diversity and Inclusion

Course Design and Materials: Course will incorporate diverse perspectives, authors, and examples that reflect a variety of cultures, identities, and lived experiences. Instructional materials will be reviewed regularly to ensure representation, inclusivity, and alignment with equity-minded practices across disciplines.

Inclusive Learning Environment: Instructors will establish classroom norms and policies that promote respect, civil discourse, and belonging in both online and face-to-face classes. Clear expectations for communication and engagement will support a learning space where all students feel valued and heard.

Accessible Instruction: Course content will be delivered using accessible design. Materials will follow accessibility guidelines within the CMS, including captioned media, readable document formats, and multiple means of engagement to support diverse learning.

Equitable Teaching Practices: Instructors will use transparent and grading criteria, varied assessment methods, and timely feedback to promote fairness and student success. Opportunities for revision, reflection, and multiple demonstrations of learning may be incorporated when appropriate to the discipline.

Culturally Responsive Pedagogies: Instructional strategies will encourage critical thinking about diverse perspectives and systems of power relevant to the course content. Faculty will foster opportunities for students to connect course material to real-world contexts.

Ongoing Reflection and Improvement: Faculty will engage in continuous professional development related to IDEAA principles and reflect on course practices using metacognition to identify opportunities for increased equity, inclusion, and accessibility.

**Explain how diversity and inclusion(e.g., gender, culture/race, sexuality, etc.) is infused into the course.**

Diversity and inclusion will be infused into this course in the following ways. First, racial and gender biases found in pre-trained computer vision models will be highlighted and explored. Biases in natural language processing tools and ways to de-bias computer vision algorithms will also be discussed.
Data sets used to train computer vision models in this course will be inclusive and represent a range of cultural, racial, and gender identities.
The course lectures will include ways to measure algorithm bias and how to best obtain fairness in computer vision models.

**Describe how assignments, instruction, evaluation, course content, and interactions are contextualized for diverse learners promoting an equitable course.**

Assignments in the course will address diverse real-world issues, encouraging students to think about applying computer vision in different cultural, social, and economic contexts. Where possible, flexible deadlines will be provided to accommodate students with different time constraints due to work, family, or other commitments. In addition, assignments will be evaluated in various ways, including using project-based methods, coding exercises, and written analyses. This will provide students with multiple ways to demonstrate their understanding of the material being given.

A feedback mechanism will allow students to express concerns about assessment or request accommodation. The grading criteria and expectations will be communicated to ensure they are fair and objective.

The lecture material will incorporate content that addresses ethical issues, biases in computer vision, and the importance of designing inclusive computer vision systems.

The discussions in this course will foster an environment that values and respects diverse opinions and encourages students to learn from each other.

## Interactions

**Explain how the course will incorporate student-to-student interaction.**

Collaborative demonstrations and guided practice showing computer vision fundamentals, Image processing techniques, and image classification will facilitate diverse student interactions. The course discussions will encourage students to share experiences and insights.

Online demonstrations will be conducted using closed-captioned video recordings, and discussions will be conducted using the course management systems discussion board tool.

Peer code reviews will allow students to exchange code and provide feedback on each other's computer vision projects or assignments. This will promote collaboration, help students learn different coding styles and problem-solving techniques, and reinforce key computer vision concepts.

Students will be assigned group projects, where they can collaborate on building computer vision models, implementing algorithms, and solving real-world problems using computer vision techniques.

**Explain how the course will incorporate instructor-to-student interaction.**

Discussion boards will be provided where the instructor will participate in discussions related to computer vision fundamentals, image classification, real-world vision applications, and equity and inclusion in computer vision. Office hours will be provided where students can meet with the instructor in one-on-one or small groups to discuss computer vision topics, seek clarification, or receive additional help and feedback on assignments. Online students will meet with the instructor through online conference software or the discussion board tool in the course management system.
Guided practice and demonstration on topics such as homography, video analysis, image processing, and neural networks will allow students to work directly with the instructor in a problem-solving environment.
Recorded videos will provide online guided practice on computer vision, image processing, image segmentation, and object recognition. The practice will be distributed through the assignments tool in the course management system.

**Explain how the course will incorporate student-to-content interaction.**

The lectures in the class will incorporate demonstrations, multimedia, and interactive tools to make the content more engaging. For example, they will showcase real-time computer vision applications or use software to demonstrate algorithms.
Guided practice and demonstration will provide practical lab-type applications where students work directly with computer vision tools and technologies. Online guided practice will be administered using recorded video on the assignments tool within the course management system.
The course will provide an online discussion platform where students can discuss course content, share resources, and ask questions.

**Explain how the course will incorporate student-to-self interaction (metacognitive).**

The class assignments are geared toward critical thinking and problem-solving. They will include object detection, neural networks, bias in computer vision, and image segmentation. They will encourage students to reflect on their problem-solving approach and consider alternative solutions.
The course content will include several self-evaluation quizzes to gauge students' understanding of such topics as feature matching, video analysis techniques, and neural networks. The quizzes will offer immediate feedback to help students identify topics they have mastered and those that need further study. They will be administered via the quizzes tool in the course management system.
The class's guided practice and demonstration exercises will allow students to formulate solutions to the presented problems, such as image classification, feature extraction, and object detection. They will also allow students to reflect on the solution once it has been derived or supplied by the instructor.

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