

Course Information

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| Course Number: | CSC 422/522 |
| Title: | Computer Vision and Pattern Recognition |
| Credits: | 3 |
| Academic Term/Year: | Spring, 2026 |
| Course Description: | This course introduces fundamentals and applications, and recent advances in computer vision and pattern recognition. Topics covered in this course include single-view and two-view geometry, multi-view 3D reconstruction and registration, 2D/3D features and descriptors, object detection and tracking, and semantic scene understanding using deep convolutional neural networks (CNN). Students will have hands-on experience in implementing computer vision algorithms and deep CNN architectures in solving real-world problems. |
| Course Prerequisites: | MATH 250 (for CSC 422) |
| Instructional Mode: | Face-to-Face |

Instructor Information

Instructor of Record:
Ruyi Lian, Ph.D.
DEH 117
Ruyi.Lian@sdstate.edu
Office Hours:
Tuesday, Wednesday, and Thursday: 2:30 – 3:30 PM
Other times available by appointment only.

Course Meeting Time and Location

Tuesday and Thursday, 03:30 - 04:45 PM, DEH 118
Final Exam (i.e., Exam #2): 4:00-6:00 PM, May 8, 2026, at DEH 118

Course Description and Student Learning Outcomes

Upon completion of this course, students will understand the fundamental concepts and algorithms in Computer Vision and Pattern Recognition and be ready to apply the theoretical knowledge for the development of software systems. Specifically, students will improve their abilities in the following areas:

1. An ability to apply mathematical foundations, algorithmic principles, and computer science theory in the modeling and design of computer-based systems in a way that demonstrates comprehension of the tradeoffs involved in design choices.
2. An ability to use the state-of-the-art Computer Vision and Pattern Recognition related techniques, skills, and tools.
3. An ability to evaluate outcomes derived from assignments and exam questions, aimed at measuring students' understanding of Computer Vision algorithms and their applications.

Course Required Course Content/Reading

We do not have a single textbook but rather assemble readings from different sources. As optional supplementary reading, consider the following textbooks:

- "Computer Vision: Algorithms and Applications" by Richard Szeliski, Springer, 2nd Edition.
- "Multi View Geometry in Computer Vision" by Richard Hartley and Andrew Zisserman, Cambridge, 2nd Edition.

Instructional Methods

This course is composed with lectures, in-class exercise, and discussion. You will have many advanced Computer Vision and Pattern Recognition related materials from outside of textbook.

Grading Policy/Class Assignments

| CSC 422 | | CSC 522 | |
|---------------|------------|-----------------------|------------|
| Exam #1 | 100 points | Exam #1 | 100 points |
| Exam #2 | 100 points | Exam #2 | 100 points |
| Final Project | 150 points | Final Project | 150 points |
| Assignments | 200 points | Assignments | 200 points |
| Participation | 50 points | Participation | 50 points |
| | | Research Paper Review | 100 points |
| Total | 600 points | Total | 700 points |

Grading Scale:

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|-----------|---|
| 90 – 100% | A |
| 80 – 89% | B |
| 70 – 79% | C |
| 60 – 69% | D |
| 0 – 59 | F |

Participation: Pop quizzes will be given from time to time, which will be counted toward the participation grade.

Assignments: There will be three coding assignments to practice non-deep-learning-based algorithms and train a simple CNN. They will be primarily scheduled in the first half of the semester, allowing the second half of the semester to be devoted to the final project.

The recommended programming language for this course is Python, particularly for implementing CNNs. Other programming languages, such as C++, are permitted. However, the assignments include Python warm-up exercises, and students are strongly encouraged to use Python, as it is widely adopted in the computer vision community.

Assignments are due **at the beginning of class** on their respective due dates. Late assignments will have a reduction in points of 30% for the next class period and **absolutely** no late assignments will be accepted after the first reduction.

Final project: the final project will be evaluated based on code implementation, written report, and in-class presentation.

The exam dates will be announced at least one week in advance. The tentative exam schedule is as follows:

- Exam #1: March 12, class meeting time (the Thursday before the Spring Break)
- Final Presentation: April 28 and April 30 (before the final week)
- Exam #2: May 8, 4-6PM (according to SDSU Spring Final Exam Schedule)

Students who need to miss an exam are required to notify me in advance. Acceptable reasons for missing exams include business, medical, or school related circumstances. A written excuse **MUST** be provided. Emergency situations (e.g., medical or family emergency) should be handled by notifying the Dean of Student

Affairs (688-4493). **Excused** make-up exams will only be given for (i) absences resulting from documented emergency situations or (ii) university excused trips; students must present the completed approved trip absence card to the faculty member prior to the trip or event. The make-up exam **MUST** be completed within one week of the original exam date; failure to do so will result in a grade of zero.

Tentative Course Schedule

Note: subject to change (Please check the latest version posted in D2L)

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| 13-Jan | Introduction and Logistics |
| 15-Jan | Image Formation: Geometric Primitives and Transformations |
| 20-Jan | Image Formation: Camera Geometry |
| 22-Jan | Image Processing: Point Operators |
| 27-Jan | Image Processing: Filtering |
| 29-Jan | Image Processing: Fourier Transforms |
| 3-Feb | Feature Detection, Matching, RANSAC |
| 5-Feb | Image Alignment and Stitching |
| 10-Feb | Motion Estimation (Emphasizing Optical Flow) |
| 12-Feb | Structure from Motion and SLAM I |
| 17-Feb | Structure from Motion and SLAM II |
| 19-Feb | Neural Networks: Basic Architecture |
| 24-Feb | Neural Networks: Training and Inference |
| 26-Feb | CNN: Basic Architecture |
| 3-Mar | CNN: Backpropagation |
| 5-Mar | CNN Based Classification |
| 10-Mar | Review Topics for Exam 1 |
| 12-Mar | Exam 1 |
| 17-Mar | Spring Break |
| 19-Mar | Spring Break |
| 24-Mar | CNN Based Object Detection |
| 26-Mar | CNN Based Object Tracking |
| 31-Mar | CNN Based Segmentation |
| 2-Apr | Depth Estimation (emphasizing Epipolar Geometry) |
| 7-Apr | temp: Pose Estimation, 3D Reconstruction |
| 9-Apr | temp: Neural Rendering and Scene Understanding |
| 14-Apr | Generative Models |
| 16-Apr | Transformers and Foundation Models |
| 21-Apr | Application of CNNs in Medical/Scientific Imaging |
| 23-Apr | Review Topics for Exam 2 |
| 28-Apr | Final Project Presentation |
| 30-Apr | Final Project Presentation |

Attendance Policy

If a student misses a class without a valid excuse (e.g., business, medical and/or school related), then the student should not expect individualized instructions over what was missed due to the student's lack of initiative.

ADA Statement

South Dakota State University strives to ensure that physical resources, as well as information and communication technologies, are reasonably accessible to users in order to provide equal access to all. If you encounter any accessibility issues, you are encouraged to immediately contact the instructor of the course and the Office of Disability Services (Phone: 605-688-4504; Fax: 605-688-4987; E-mail: Nancy.Crooks@sdstate.edu or SDSU.Disabilityservices@sdstate.edu; Address: Room 271, Box 2815C, University Student Union, Brookings South Dakota 57007), which will work to resolve the issue as quickly as possible. Please note: if your home institution is not the institution you are enrolled at for a course (host institution), then you should contact your home institution's Office of Disability services. The disability services at the home and host institution will work together to ensure your request is evaluated and responded to.

Freedom in Learning Statement

Under the Board of Regents and Regental Institutions policy, student academic performance may be evaluated solely on an academic basis, not on opinions or conduct in matters unrelated to academic standards. Discussion and debate are critical to education and professional development. Students should be free to take reasoned exception to the data or views offered in any course of study and to reserve judgment about matters of opinion, but they are responsible for learning the content of any course of study for which they are enrolled. Students who believe that an academic evaluation reflects prejudiced or capricious consideration of student opinions or conduct unrelated to academic standards should contact their home institution to initiate a review of the evaluation.

Academic Dishonesty and Misconduct

Cheating and other forms of academic dishonesty and misconduct run contrary to the purposes of higher education and will not be tolerated. Academic dishonesty includes, but is not limited to, plagiarism, copying answers or work done by another student (either on an exam or an assignment), allowing another student to copy from you, and using unauthorized materials during an exam. The Regental Institution's policy and procedures on cheating and academic dishonesty can be found in [SDSU Policy 2:4](#) and the governing Board of Regents policies can be found in [BOR Policy 2.9.2](#) and [BOR Policy 3.4.1](#). The consequences for cheating and academic dishonesty are outlined in policy.

Acceptable Use of Technology

While Regental Institutions strive to provide access to computer labs and other technology, it is the student's responsibility to ensure adequate access to the technology required for a course. This may include access to a computer (not Chromebooks, iPads, etc.), webcam, internet, adequate bandwidth, etc. While utilizing any of the information technology systems students, faculty and staff should observe all relevant laws, regulations, [BOR Policy 7.1](#), and any institutional procedural requirements.

Emergency Alert Communication

In the event of an emergency arising on campus under [BOR Policy 7.3](#), your Regental Home Institution will notify the campus community via the emergency alert system. It is the responsibility of the student to ensure that their information is updated in the emergency alert system. The student's cell phone will be automatically inserted if available and if not, their email address is loaded. Students can at any time update their information in the student alert system.

Complaint Procedure and Academic Appeals

South Dakota State University's primary objective is to assist students in meeting their academic goals through a positive and rigorous academic experience. In the case that a student has a concern, the University's [procedures](#) should be followed to address these concerns and/or complaints. [Policy 2:4](#) outlines procedures for academic appeals.

Student Success Services and Supports

Information about student success services and supports, including tutoring and supplemental instruction, can be found at the [Wintrobe Student Success and Opportunity Center website](#).