USC Viterbi
School of Engineering

CSCI 599: 3D Vision

Units: 4.0
Spring 2024 — TuesThurs — 5:00-6:50pm

Location: TBD

Instructor: Yajie Zhao
Office: USC-ICT 380
Office Hours: TBD
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Catalogue Description
3D vision; Multi-view Geometry; Image formation; Rendering; Radiance Field; 3D gaussian Splatting;

Course Description
This course is designed for students interested in the basics of 3D vision and its latest-and-greatest advancements. It offers hands-on experience through practical projects. Students will learn the basics, classic algorithms, and learning-based approaches in geometry representations, image formation, single/multi-view 3D reconstruction, and neural radiance fields. The course evaluation will be based on four coding assignments and one final assignment. The final assignment can be a project, a survey of a research direction, an improvement of a research paper or a new idea backed by moderate experimentation. Students are expected to propose their final project or presentation. The course aims to help students draw a connection between 3D vision and real-world problems and research topics.

Learning Objectives
By the end of this course, students will:

- Enhance understanding of 3D vision.
- Gain experience in reading, understanding, and discussing research papers about 3D vision.
- Obtain hands-on experience with both classic and latest 3D vision algorithms.
- Improve academic writing and presentation skills.

Recommended Preparation
Students are strongly recommended to be familiar with linear algebra and machine learning.

Course Notes
Slides and other class information will be posted to the course website or online platform such as Piazza.

Technological Proficiency and Hardware/Software Required
Ability to understand classic and machine learning algorithms and to translate algorithms to code (usually using Python and C++) as needed.

Optional Readings and Supplementary Materials
- Hartley, Richard, and Andrew Zisserman. Multiple view geometry in computer vision. Cambridge university press, 2003.

Description of Assignments and How They Will Be Assessed
Assignments will be posted on the course website and Piazza, and the teaching assistant will provide starting code along with instruction.

Participation
This course is an in-person class. Active participation is required of all students.

Grading Breakdown

Assessment Tool (assignments)	% of Grade
Assignments	80
Final presentation	20
TOTAL	100

Grading Scale

A	94-100
A-	90-93
B+	87-89
B	83-86
B-	80-82
C+	77-79
C	73-76
C-	70-72
D+	67-69
D	63-66
D-	60-62
F	59 and below

Assignment Submission Policy

Assignments are due two or three weeks after being assigned, and students should submit them through Piazza. Assignments are due at 11:59pm on the due date.

Attendance

Attendance is required unless you have notified the instructor in advance (e.g., due to conference travel).

Academic Integrity

Unless otherwise noted, this course will follow the expectations for academic integrity as stated in the USC Student Handbook. The general USC guidelines on Academic Integrity and Course Content Distribution are provided in the subsequent "Statement on Academic Conduct and Support Systems" section.

For this class, unless specifically designated as a 'group project,' all assignments are expected to be completed individually.

Please ask the instructor [and/or TA(s)] if you are unsure about what constitutes unauthorized assistance on an exam or assignment, or what information requires citation and/or attribution.

You may not record this class without the express permission of the instructor and all other students in the class. Distribution of any notes, recordings, exams, or other materials from a university class or lectures — other than for individual or class group study — is prohibited without the express permission of the instructor.

Use of Generative AI in this Course

Since creating, analytical, and critical thinking skills are part of the learning outcomes of this course, all assignments should be prepared by the student working individually or in groups as described on each assignment. Students may not have another person or entity complete any portion of the assignment. Developing strong competencies in these areas will prepare you for a competitive workplace. Therefore, using AI-generated tools is prohibited in this course, will be identified as plagiarism, and will be reported to the Office of Academic Integrity.

Course Schedule

	Topics/Daily Activities	Readings/Preparation	Deliverables
Week 1	Introduction to 3D vision; Introduction to Pytorch 3D (basics)	Course Syllabus/ Website	
Week 2	3D representations (Point cloud, Surface mesh, implicit representation, Volumetric representation);	Course Syllabus/ Website	
Week 3	Geometry Processing (Mesh operation, simplification, decimation, triangulation)	Course Syllabus/ Website	
Week 4	Image formation (Camera Transformation, Rendering)	Course Syllabus/ Website	Due of Assignment 1 (Get to know representations and geometry processing)
Week 5	(classic approach) Depth estimation from two views; Geometry Reconstruction from multi-view; Using Pytorch 3D in practical project.	Course Syllabus/ Website	
Week 6	Tour to USC-ICT (The Light Stage technology and Digital Human: from Capture to Rendering)		
Week 7	(Learning based approach) Depth estimation from two views; Geometry Reconstruction from multi-views	Course Syllabus/ Website; Selected works	Due of Assignment 2 (Write your own shader)
Week 8	Single-view geometry (classic approach); Differentiable rendering;	Course Syllabus/ Website; Selected works	Propose for final presentation topics
Week 9	Single-view depth estimation (Learning based approach)	Course Syllabus/ Website; Selected works	
Week 10	**Spring Break**		Due of Assignment 3 (3D reconstruction using stereo-matching and SFM)
Week 11	Neural Radiance Field (latest and greatest); Guest lecture 1	Selected works	
Week 12	Neural Radiance Field (applications, deformation, generalizable nerf); Guest lecture 2	Selected works	
Week 13	Neural Radiance Field (simulation, relightable)	Selected works	
Week 14	3D Gaussian Splatting, Light Field	Selected works	Due of Assignment 4 (Neural Radiance Field Playground)
Week 15	Diffusion model meets neural radiance field	Selected works	
FINAL	Final Presentations		**Due on the university-scheduled date of the final exam.**

Statement on Academic Conduct and Support Systems

Academic Integrity:
The University of Southern California is a learning community committed to developing successful scholars and researchers dedicated to the pursuit of knowledge and the dissemination of ideas. Academic misconduct, which includes any act of dishonesty in the production or submission of academic work, comprises the integrity of the person who commits the act and can impugn the perceived integrity of the entire university community. It stands in opposition to the university's mission to research, educate, and contribute productively to our community and the world.

All students are expected to submit assignments that represent their own original work, and that have been prepared specifically for the course or section for which they have been submitted. You may not submit work written by others or "recycle" work prepared for other courses without obtaining written permission from the instructor(s).

Other violations of academic integrity include, but are not limited to, cheating, plagiarism, fabrication (e.g., falsifying data), collusion, knowingly assisting others in acts of academic dishonesty, and any act that gains or is intended to gain an unfair academic advantage.

The impact of academic dishonesty is far-reaching and is considered a serious offense against the university. All incidences of academic misconduct will be reported to the Office of Academic Integrity and could result in outcomes such as failure on the assignment, failure in the course, suspension, or even expulsion from the university.

For more information about academic integrity see the student handbook or the Office of Academic Integrity's website, and university policies on Research and Scholarship Misconduct.

Please ask your instructor if you are unsure what constitutes unauthorized assistance on an exam or assignment, or what information requires citation and/or attribution.

Course Content Distribution and Synchronous Session Recordings Policies
USC has policies that prohibit recording and distribution of any synchronous and asynchronous course content outside of the learning environment.

Recording a university class without the express permission of the instructor and announcement to the class, or unless conducted pursuant to an Office of Student Accessibility Services (OSAS) accommodation. Recording can inhibit free discussion in the future, and thus infringe on the academic freedom of other students as well as the instructor. (Living our Unifying Values: The USC Student Handbook, page 13).

Distribution or use of notes, recordings, exams, or other intellectual property, based on university classes or lectures without the express permission of the instructor for purposes other than individual or group study. This includes but is not limited to providing materials for distribution by services publishing course materials. This restriction on unauthorized use also applies to all information, which had been distributed to students or in any way had been displayed for use in relationship to the class, whether obtained in class, via email, on the internet, or via any other media. (Living our Unifying Values: The USC Student Handbook, page 13).

Students and Disability Accommodations:
USC welcomes students with disabilities into all of the University's educational programs. The Office of Student Accessibility Services (OSAS) is responsible for the determination of appropriate accommodations for students who encounter disability-related barriers. Once a student has completed the OSAS process (registration, initial appointment, and submitted documentation) and accommodations are determined to be reasonable and appropriate, a Letter of Accommodation (LOA) will be available to generate for each

course. The LOA must be given to each course instructor by the student and followed up with a discussion. This should be done as early in the semester as possible as accommodations are not retroactive. More information can be found at osas.usc.edu. You may contact OSAS at (213) 740-0776 or via email at osasfrontdesk@usc.edu.

Support Systems:

Counseling and Mental Health - (213) 740-9355 – 24/7 on call
Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention.

988 Suicide and Crisis Lifeline - 988 for both calls and text messages – 24/7 on call
The 988 Suicide and Crisis Lifeline (formerly known as the National Suicide Prevention Lifeline) provides free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week, across the United States. The Lifeline is comprised of a national network of over 200 local crisis centers, combining custom local care and resources with national standards and best practices. The new, shorter phone number makes it easier for people to remember and access mental health crisis services (though the previous 1 (800) 273-8255 number will continue to function indefinitely) and represents a continued commitment to those in crisis.

Relationship and Sexual Violence Prevention Services (RSVP) - (213) 740-9355(WELL) – 24/7 on call
Free and confidential therapy services, workshops, and training for situations related to gender- and power-based harm (including sexual assault, intimate partner violence, and stalking).

Office for Equity, Equal Opportunity, and Title IX (EEO-TIX) - (213) 740-5086
Information about how to get help or help someone affected by harassment or discrimination, rights of protected classes, reporting options, and additional resources for students, faculty, staff, visitors, and applicants.

Reporting Incidents of Bias or Harassment - (213) 740-5086 or (213) 821-8298
Avenue to report incidents of bias, hate crimes, and microaggressions to the Office for Equity, Equal Opportunity, and Title for appropriate investigation, supportive measures, and response.

The Office of Student Accessibility Services (OSAS) - (213) 740-0776
OSAS ensures equal access for students with disabilities through providing academic accommodations and auxiliary aids in accordance with federal laws and university policy.

USC Campus Support and Intervention - (213) 740-0411
Assists students and families in resolving complex personal, financial, and academic issues adversely affecting their success as a student.

Diversity, Equity and Inclusion - (213) 740-2101
Information on events, programs and training, the Provost's Diversity and Inclusion Council, Diversity Liaisons for each academic school, chronology, participation, and various resources for students.

USC Emergency - UPC: (213) 740-4321, HSC: (323) 442-1000 – 24/7 on call
Emergency assistance and avenue to report a crime. Latest updates regarding safety, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible.

USC Department of Public Safety - UPC: (213) 740-6000, HSC: (323) 442-1200 – 24/7 on call
Non-emergency assistance or information.

Office of the Ombuds - (213) 821-9556 (UPC) / (323-442-0382 (HSC)

A safe and confidential place to share your USC-related issues with a University Ombuds who will work with you to explore options or paths to manage your concern.

Occupational Therapy Faculty Practice - (323) 442-2850 or otfp@med.usc.edu
Confidential Lifestyle Redesign services for USC students to support health promoting habits and routines that enhance quality of life and academic performance.