

CPSC 8190 Physically Based Visual Effects

Sections: All

MW 2:30-3:45pm (Spring 2023)

In-Person and Online live lectures via Zoom.

Webpage: <https://people.cs.clemson.edu/~jtessen/cpsc8190>

Recordings: No Recordings planned.

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TA
Office
Office Hours
Email

Description: We focus on the theory and practice behind the generation, manipulation, and rendering of volumetric entities within a computer graphics context. Topics include scalar, vector, color and matrix fields, implicit surfaces, rendering, ray marching and single scattering, grid-based fields, manipulation of fields, fluid-like motion, conversion between levelsets and polygonal surfaces, VFX missile trails, clouds, and wisps. An understanding of their nature and technology is essential to anyone pursuing an academic or professional career in 3D computer graphics.

Outcomes: At the completion of the course, students will be able to:

- Write C++ code for common volumetric modeling and rendering algorithms
- Run the C++ code and produce visualizations of the volume algorithms
- Creatively alter the algorithms for fun and other purposes
- Communicate clearly and effectively about the code and phenomena

Topical Outline Specific topics are flexible depending on the needs of the students as the course progresses. The planned set of topics includes:

- Introduction to Volumetric FX in film, and the course
- 3D fields, data types, transformations
- Field algebra, C++ class structure, operator overloading
- Basic field class $\text{Volume}\langle U \rangle$
- Implicit functions, Constructive Solid Geometry, Signed-Distance Fields
- Volume rendering, optics, ray marching
- Curved ray marching for mirages, black holes, and fun
- Wedges, turntables, rendering with color fields
- Rectangular grids, sparse grids, frustum grids, dense grids
- Block-based sparse grids
- Grid Artifacts
- OpenVDB
- Accelerating ray marches using AABB
- Deep Shadow Maps (DSMs): Rectangular and frustum
- Demonstration of the Impact of Lighting
- Levelsets of triangulated geometry
- Holdouts, rendering hints
- Noise, fractal sums, pyroclastic spheres
- Pyroclastic sphere
- Closest Point Transform and Near Point Transform
- Pyroclastic displacement of arbitrary shapes, Cumulo clouds
- Particle systems for missile trails
- Missile trails I: pyroclastic trails
- Stamping noise into grids
- Wisps, motion blurred wisps
- Missile trails II: spline wisps

- Terrains
- Planckian locus
- Constructing velocity fields: noise, gradients, other
- Incompressible vector fields
- Velocity fields, advection, characteristic maps
- Rendertime gridless advection
- Advection for long time and long time steps
- Advection schemes
- Navier-Stokes equations, gas solutions.
- Multiple Scattering
- Volumetric compositing
- Levelset Smoothing and filtering
- Meepzoids (Signed-distance preserving maps)

Prerequisites: CPSC 4190/6190, or permission of instructor.

Assignments: Most homework assignments involve programming in C++ and require the use of the open source libraries OpenImageIO, OpenGL, GLUT, and others. Work may be done on any computer supporting C++ and the necessary libraries. However, before turning in an assignment, the program must be compiled and tested under the School of Computing's Ubuntu Linux environment, and both a working compile script (Makefile, CMakeLists.txt, etc.) and README must be provided. It is acceptable for students to access a suitable School of Computing linux computer via a browser directed to <https://virtual.computing.clemson.edu>. In order to turn in programming assignments, all students will need to use their computer science account and the handin system: <https://handin.cs.clemson.edu>. All students enrolled in CS courses should automatically be assigned CS accounts. You will need to login early in the semester to change your password, or the account may be expired. If you have problems logging in, send an email to ithelp@clemson.edu from your Clemson email account, or stop by on the first floor McAdams with a picture ID. More information here: <http://www.cs.clemson.edu/help/>. Each assignment has a due date, but no points are deducted for turning in an assignment after the due date. Assignment grades will be posted in CANVAS.

Grading: The grade is a combination of class participation and project assignments. There are no written exams. There are 5 projects in this class. Each is worth 15 points. There are also 25 points possible for class participation (which means you *really should* participate actively in class, and *attend* class, whether in-person or online). There is a total of 100 possible points. The grade is relative to the percentage of 100 points achieved. Grades will be posted in CANVAS. Each assignment has a due date, but no points are deducted for turning in an assignment after the due date.

Required Text: No textbook. Multiple readings will be assigned.

Additional Reading: Many more documents recommended in class.

Communications: Communications between the students and instructor/TA will be via the following mechanisms:

1. In person verbal discussion.
2. Zoom: this will be the video conference platform for live lectures to classrooms not on the Clemson campus. It will also be used for online office hours. During the live lectures, students are highly encouraged to ask questions and challenge the lectures, via direct questioning of the instructor.
3. Canvas: Announcements for the class will be posted to canvas, including invitations to Zoom meetings. Canvas will also be the location where assignment grades are posted.
4. Email: This mechanism is available as a means of having one-on-one conversations if needed. In unforeseen circumstances, announcements to the class may be posted via email.

POLICIES

Instructor's Attendance Policy In-person attendance for lectures is the best opportunity for students to learn the content of the course. Students are strongly encouraged to attend in-person whenever feasible, and when they cannot attend in-person, they should participate via the university's live video feed system. All lectures will be recorded and posted on ensemble.clemson.edu, and can be viewed by students at a later date. During the pandemic, in-person classes may be unfeasible, and lectures will be live

video conference sessions on Zoom that are recorded and posted. During the pandemic, if a student is uncomfortable with in-person attendance, they are not required to do so, and will not be penalized for not attending in-person.

Inclement Weather: Any exam that was scheduled at the time of a class cancellation due to inclement weather, University power outage, etc. will be given at the next class meeting unless contacted by the instructor. Any assignments due at the time of a class cancellation due to inclement weather will be due at the next class meeting unless the instructor contacts students. Any extension or postponement of assignments or exams must be granted by the instructor via email or Canvas within 24 hours of the weather-related cancellation.

COVID-19: For a student who reports testing positive or is being asked to quarantine/isolate because of exposure to the virus, it will be up to the student to inform the instructor that they will be moving to online only instruction for at least the next two weeks. Students are directed to use the Notification of Absence module in Canvas to initiate this notification. Additional communication via email is encouraged; students should follow up with their instructor to develop a continued plan of study for each course. Students cannot be penalized in their grade for needing to move to online instruction.

Conduct Policy Students are expected to be courteous and respectful in all interactions with fellow class members, TAs, and the instructor (whether this interaction occurs online, during class, or outside of class). Student misconduct will not be tolerated. Student misconduct includes, but not limited to, arguing with an instructor or TA about course policies, being rude or disrespectful towards a fellow class member or an instructor, sleeping in class, disrupting class, using a computer or other device during class without authorization from the instructor, showing up to class late or leaving class early without permission from the instructor, and refusing to follow course policies or instructions stated by an instructor. The instructor and TAs have the right to assign seats or to ask students to move to another seat if they feel it is necessary, and refusing to sit in an assigned seat will also be considered as an act of student misconduct. NO tobacco products or electronic cigarettes are allowed to be used during class or labs, including cigarettes, cigars, chewing tobacco, dip, etc. For the first case of student misconduct, students may have points deducted from their Quiz grades or their final grade might be lowered by one full letter grade (i.e. an A becomes a B, B becomes a C, etc.) at the instructor's discretion. In extreme cases, or if the misconduct persists, a grade of F will be assigned to the student, and the student will not be allowed to attend class thereafter.

Academic Honesty "As members of the Clemson University community, we have inherited Thomas Green Clemson's vision of this institution as a high seminary of learning. Fundamental to this vision is a mutual commitment to truthfulness, honor, and responsibility, without which we cannot earn the trust and respect of others. Furthermore, we recognize that academic dishonesty detracts from the value of a Clemson degree. Therefore, we shall not tolerate lying, cheating, or stealing in any form."

When, in the opinion of a course instructor, there is evidence that a student has committed an act of academic dishonesty, the instructor must make a formal written charge of academic dishonesty, including a description of the misconduct to Dr. Jeff Appling, Associate Dean of Undergraduate Studies. The reporting instructor may, at his/her discretion, inform each involved student privately of the nature of the alleged charge. In cases of plagiarism (I.B.2.) instructors may use the Plagiarism Resolution Form available from the Office of Undergraduate Studies.

Steps to help prevent academic dishonesty are:

1. Familiarize yourself with the regulations.
2. Refuse to assist students who want to cheat.
3. Protect your work! Do not allow anyone to copy any part of your work, and report anyone who tries to copy from you to the instructor or TA.
4. Do not copy any code from any unauthorized source. An unauthorized source includes, but not limited to, any webpage, online source, document, book, or person not affiliated with our course.
5. If you have any doubt about what constitutes academic dishonesty, ask your instructor before you turn in an assignment.

Furthermore, selling, posting, or giving away course content such as slides, notes, or any information about exams, quizzes, assignments, projects, or lectures is considered an act of academic dishonesty (unauthorized assistance) unless you have written permission from the instructor. All work submitted for grades should be your own work, and you cannot copy, paraphrase, or modify any work from any source not explicitly permitted by the instructor. The instructor has the right to run programs to detect evidence of unauthorized assistance (usually in the form of copying from another person or unauthorized source) in any assignment submitted by a student in this semester, previous semesters, or future semesters. Cheating has severe consequences, please do your own work!

Class Accommodation and Accessibility Clemson University values the diversity of our student body as a strength and a critical component of our dynamic community. Students with disabilities or temporary injuries/conditions may require accommodations due to barriers in the structure of facilities, course design, technology used for curricular purposes, or other campus resources. Students who experience a barrier to full access to a class should let the professor know, and make an appointment to meet with a staff member in Student Accessibility Services as soon as possible. You can make an appointment by calling 864- 656-6848, by emailing studentaccess@lists.clemson.edu, or by visiting Suite 239 in the Academic Success Center building. Appointments are strongly encouraged. Drop-ins will be seen if possible, but there could be a significant wait due to scheduled appointments. Students who receive Academic Access Letters are strongly encouraged to request, obtain and present these to their professors as early in the semester as possible so that accommodations can be made in a timely manner. It is the student's responsibility to follow this process each semester. You can access further information here: <http://www.clemson.edu/campus-life/campus-services/sds/>.

Inclement Weather Policy If a class is cancelled due to inclement weather, the instructor will make alternative arrangements for submitting work that was due that day. Usually the work will be due the next class, unless specified otherwise.

Academic Continuity Plan Clemson has developed an Academic Continuity Plan for academic operations. Should university administration officially determine that the physical classroom facility is not available to conduct classes in, class will be conducted in a virtual (online) format. The University issues official disruption notifications through email/www/text notification/Social Media. When notified, students will use Clemson Canvas to find important information about the class. Teachers will also provide students with information on what to do in this case.

Late Instructor Policy If the instructor or a lab instructor is late to class or labs, then students should wait at least 15 minutes and check the course announcements before leaving.

Clemson University Title IX (Sexual Harassment) Clemson University is committed to a policy of equal opportunity for all persons and does not discriminate on the basis of race, color, religion, sex, sexual orientation, gender, pregnancy, national origin, age, disability, veteran's status, genetic information or protected activity in employment, educational programs and activities, admissions and financial aid. This includes a prohibition against sexual harassment and sexual violence as mandated by Title IX of the Education Amendments of 1972.

Syllabus Policy Students are responsible for learning and following all policies stated in this syllabus. This course syllabus is a general plan for the course; deviations announced to the class by the instructor may be necessary. Tentative course schedule will be frequently updated.

COVID-19 Related Expectations for Face Coverings While on campus, face coverings are required in all buildings and classrooms. Face coverings are also required in outdoor spaces where physical distance cannot be guaranteed. Please be familiar with the additional information on the Healthy Clemson website, such as the use of wipes for in-person classes. If an instructor does not have a face covering or refuses to wear an approved face covering without valid accommodation, students should notify the department chair. If a student does not have a face covering or refuses to wear an approved face covering without valid accommodation, the instructor will ask the student to leave the academic space and may report the student's actions to the Office of Community & Ethical Standards as a violation of the Student Code of Conduct. If the student's actions disrupt the class to the extent that an immediate response is needed, the instructor may call the Clemson University Police Department at 656-2222.