CS185c Spring 2019 Sec1 Home Page/Syllabus

Virtual Reality Programming

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Office Hours: MW 4:30-5:30pm
Class Meets:
Sec1 MW 3:00-4:15pm in MH422

Prerequisites

To take this class you must have taken:
CS146
MA129A
with a grade of C- or better.

Texts and Links

Required Texts:	Virtual Reality. Steven M. LaValle
Online References and Other Links:	Oculus Developer Site. Building Virtual Reality with Unity and Steam VR - Jeff Murray. Learning Virtual Reality - Tony Parisi.

Description

Virtual Reality (VR) programming is the branch of computer science which studies the creation of immersive simulated environments. These environments can be similar to the real world or fantastical. VR has found applications in video gaming; real estate, for previewing homes; medicine, allowing surgeons to test out surgeries virtually before performing them on a real patient; scientific visualization, etc. Recently, the price of virtual reality (VR) headsets has come down to the cost of an average textbook in the case of phone-based systems, and to the cost of an expensive textbook in the case of dedicated, non-tethered systems such as the Oculus Go. With this price fall, VR is poised to become increasingly mainstream. Virtual Reality programming lies at the intersection of computer graphics, video game and user interface design, web development, and mobile development -- a combined skillset that is relatively rare. This class aims to provide an introduction for students ready for an intro graphics class to this exciting area. In it, we will survey web-based VR development using Javascript, WebGL, and WebVR; the Oculus Mobile Development using Android, and VR game design using Unity. We discuss techniques for producing and managing 360 3D and 3D audio assets. We will look at unique aspects of VR development such as binocular output, head tracking, and unique kinds of motion controllers. This class will have a final project which will be a complete VR application of the student's choice for one of the platforms we discuss during the class and there will be a demo day to show it off.

Course Learning Outcomes (CLOs)

By the end of this course, a student should be able to:

CLO1 -- Be able to create VR apps using WebVR, a VR mobile SDK, or Unity game engine.

CLO2 -- Be able to calculate by hand the effects of various VR rendering transformations on different input vectors.

CLO3 -- Be able to manipulate 360 and 360 3D image and video resources and programmatically display them in a virtual environment.

CLO4 -- Be able create models in a popular 3D model format, and programmatically read and display them into a VR environment.

CLO5 -- Be able to code a VR app in which objects move according to some kind of simulated physics and in which collisions are detected.

CLO6 -- Be able to code a VR app that does head motion tracking.

CLO7 -- Be able to code a VR app that syncs 3D audio and 3D video.

CLO8 -- Be able to code a VR app that makes use of hand based gesture inputs and haptic feedback.

Course Schedule

Below is a tentative time table for when we'll do things this quarter:

Week 1:Jan 28, Jan 30	Ch 1 Definition of VR, history
Week 2:Feb 4, Feb 6(Project Proposals Due)	Ch 2 Survey of VR Hardware, sensors, game engines, perceptual psychology. Crash course in Javascript.
Week 3:Feb 11(Hw1), Feb 13	Ch 3 Geometric modeling, transforms, rotations, perspective, and eye transforms. Start WebGL and shaders.
Week 4:Feb 18, Feb 20	Ch 4 Light Propagation. Optics. Basics of WebVR.
Week 5:Feb 25, Feb 27	Ch 5 Physiology of Human Vision and its implications to VR. Intro to Android for VR.
Week 6:Feb 25, Feb 27	Ch 6 Depth and motion perception. Using ffmpeg to create and manipulate 360 and 360 3D video and image resources.
Week 7:Mar 4(Hw2), Mar 6	Ch 7 Graphical rendering and VR rendering, displaying panoramas and cubemaps in WebVR and in an app.
Week 8:Mar 11(Project Milestone 1), Mar 13	Ch 8 Virtual World physics. Intro to the Unity game engine and VR programming for it.
Week 9:Mar 18, Mar 20	Ch 9 Tracking Systems in VR.
Week 10:Mar 25(Hw3), Mar 27	Review
Week 11:Apr 1, Apr 3	Spring Recess
Week 12:Apr 8, Apr 10(Project Milestone 2)	Ch 10 Interaction, VR user interfaces and how to program them in WebVR, in a mobile VR app, and in Unity.
Week 13:Apr 15, Apr 17(Hw4)	Ch 11 Sound, sound in VR SDKs. Manipulating sound resources using Audacity and ffmpeg.
Week 14:Apr 22, Apr 24	Finish Ch 35
Week 15:Apr 29, May 1	Start Ch 5 The Probabilistic Method (MR)
Week 16:May 6, May 8	Ch 12 Evaluating VR systems and Experiences. Frontiers of VR.
Week 17:May 13(Project)	Review

Grading

HWs and Quizzes	40%
Midterm	15%
Project	20%
Final	25%
Total	100%

Grades will be calculated in the following manner: The person or persons with the highest aggregate score will receive an A+. A score of 55 will be the cut-off for a C-. The region between this high and low score will be divided into eight equal-sized regions. From the top region to the low region, a score falling within a region receives the grade: A, A-, B+, B, B-, C+, C, C-. If the boundary between an A and an A- is 85, then the score 85 counts as an A-. Scores below 55 but above 50 receive the grade D. Those below 50 receive the grade F.

Course Requirements, Homework, Quiz Info, and In-class exercises

This semester we will have four homeworks, weekly quizzes, and weekly in-class exercises. There will also be a project (discussed in the next section).

Every Monday this semester, except the first day of class, the Midterm Review Day, and holidays, there will be a quiz on the previous week's material. The answer to the quiz will either be multiple choice, true-false, or a simple numeric answer that does not require a calculator. Each quiz is worth a maximum of 1pt with no partial credit being given. Out of the total of twelve quizzes this semester, I will keep your ten best scores.

On Wednesday's, we will spend 15-20 minutes of class on an in-class exercise. You will be asked to post your solution to these exercises to the class discussion board. Doing so is worth 1 "pre-point" towards your grade. A "pre-point" can be used to get one missed point back on a midterm or final, up to half of that test's total score. For example, if you scored 0 on the midterm and have 10 pre-points, you can use your pre-points, so that your midterm score is a 10. On the other hand, if you score 18/20 on the midterm, you can use at most 1 pre-point since half of what you missed (2pts) on the midterm is 1pt.

Links to the current list of homeworks and quizzes can be found on the left hand side of the class homepage. After an assignment has been returned, a link to its solution (based on the best student solutions) will be placed off the assignment page. Material from assignments may appear on midterms and finals. **For homeworks you are encouraged to work in groups of up to three people. Only one person out of this group needs to submit the homework assignment; however, the members of the group need to be clearly identified in all submitted files.**

Homeworks for this class will be submitted and returned completely electronically. To submit an assignment click on the submit homework link for your section on the left hand side of the homepage and filling out the on-line form. Hardcopies or e-mail versions of your assignments will be rejected and not receive credit. Homeworks will always be due by the start of class on the day their due. Late homeworks will not be accepted and missed quizzes cannot be made up; however, your lowest score amongst the five homeworks and your quiz total will be dropped.

When doing the programming part of an assignment please make sure to adhere to the specification given as closely as possible. Names of files should be as given, etc. Failure to follow the specification may result in your homework not being graded and you receiving a zero for your work.

Final Project

This course will have a semester long project in which you get to create a cool VR app of your choice for one of the VR platforms we consider. To ensure that the programming of this app is not left to the last minute intermediate deliverables will be due throughout the semester. The first of these is a proposal where you describe what you want to do for your final app and give me a timeline for when you expect to complete various portions of it. This will be worth 2pts and I will offer feedback as to the scoping and feasibility of your project. Before the actual demo day there will be two milestones. By the first milestone, I expect a skeleton of your code to be implemented, team mate roles to be solidified, and a more detailed design description and timeline. By the second milestone, I want to see at least a couple of the features you intend for your app working. Each milestone will be discussed in class and I will try to give suggestions and feedback to help you proceed with your project. Each milestone is worth 3 points. The final project itself is worth 10pts and participation in the demo is worth 2pts. You will submit your final project code to me on the demo day and we will both verbally go over whether it meets the requirements on projects and I will also review your code to check this. More details on that the final project must satisfy can be found under the project's link.

Classroom Protocol

I will start lecturing close to the official start time for this class modulo getting tangled up in any audio/visual presentation tools I am using. Once I start lecturing, please refrain from talking to each other, answering your cell phone, etc. If something I am talking about is unclear to you, feel free to ask a question about it. Typically, on practice tests days, you will get to work in groups, and in so doing, turn your desks facing each other, etc. Please return your desks back to the way they were at the end of class. This class has an online class discussion board which can be used to post questions relating to the homework and tests. Please keep discussions on this board civil. This board will be moderated. Class and discussion board participation, although not a component of your grade, will be considered if you ask me to write you a letter of recommendation.

Exams

The midterm will be during class time on: Mar 27.

The final will be: Monday, May 20 from 12:15pm-2:30pm.

All exams are closed book, closed notes and in this classroom. You will be allowed only the test and your pen or pencil on your desk during these exams. The final will cover material from the whole semester although there will be an emphasis on material after the last midterm. No make ups will be given. The final exam may be scaled to replace a midterm grade if it was missed under provably legitimate circumstances. These exams will test whether or not you have mastered the material both presented in class or assigned as homework during the quarter. My exams usually consist of a series of essay style questions. I try to avoid making tricky problems. The week before each exam I will give out a list of problems representative of the level of difficulty of problems the student will be expected to answer on the exam. Any disputes concerning grades on exams should be directed to me, Professor Pollett.

Regrades

If you believe an error was made in the grading of your program or exam, you may request **in person** a regrade from me, Professor Pollett, during my office hours. **I do not accept e-mail requests for regrades.** A request for a regrade must be made no more than a week after the homework or a midterm is returned. If you cannot find me before the end of the semester and you would like to request a regrade of your final, you may see me **in person** at the start of the immediately following semester.

University Policies and Procedures

Per University Policy S16-9, university-wide policy information relevant to all courses, such as academic integrity, accommodations, etc. will be available on Office of Graduate and Undergraduate Programs' Syllabus Information web page at http://www.sjsu.edu/gup/syllabusinfo/. Below are some brief comments on some of these policies as they pertain to this class.

Academic Integrity

For this class, you should obviously not cheat on tests. For homeworks, you should not discuss or share code or problem solutions between groups! At a minimum a 0 on the assignment or test will be given. A student caught using resources like Rent-a-coder will receive an F for the course. Faculty members are required to report all infractions to the Office of Student Conduct and Ethical Development.

Accommodations

If you need a classroom accommodation for this class, and have registered with the Accessible Education Center, please come see me earlier rather than later in the semester to give me a heads up on how to be of assistance.