Course Description

This is a project-focused course where students will design and develop an application in virtual, augmented, or mixed reality, all further referred to as extended reality (XR), while learning about the foundational technologies that make modern XR devices work. The course will consist of weekly lectures split between XR development workflows and related topics such as graphics, computer vision, and human-computer interaction. All assignments build towards developing a minimum viable product of an extended reality application, including project planning deliverables, multiple iterations of prototypes, and weekly project updates starting from halfway in the quarter.

Recommended Prerequisites

- Object-Oriented Programming
- Software Design
- Linear Algebra

Learning Objectives

At the end of this course students will demonstrate the ability to:

- Create a project plan to develop a software application to minimum viable product
- Utilize 3D engines to build extended reality applications
- Design extended reality interactions to improve user experience
- Rapid prototype and iterate based on user feedback
- Optimize 3D applications to run performantly on limited compute platforms

Course Topics

Introduction to XR Technologies

- A brief history of XR technologies
- Basics of 3D rendering
- Overview of 3D engines

The Human Visual System, Optics, and Perception

- Understanding how our eyes work
- Optical systems for VR displays and AR glasses
- Depth perception in virtual reality

Tracking Systems and Reconstructions

- 3 degrees of freedom tracking with inertial measurement units
- Outside-in tracking
- Simultaneous localization and mapping (SLAM)
- Current 3D reconstruction approaches

3D and XR Application Optimizations

- Render pipelines
- Tuning build settings
- Optimizing 3D scenes and assets
- Configuring lighting
- Checking performance

User Interfaces and Spatial Interface Design

- Creating UIs for 3D
- Designing against motion/simulator sickness
- Planning immersive environments for better user experience

Multi-User Applications and the Metaverse

- Developing real-time networked XR applications
- Spatial anchors for augmented reality
- Logistics of creating a metaverse

Course Materials

There is no required textbook for this course. Additional readings, research publications, and other media will be provided throughout the course. The primary software for the course is Unity, a 3D engine with extensive XR support and free for personal use. The target device will be the Meta Quest 3, which will be provided as a loan to students for the duration of the course. Other devices and sensors may be available on a per case basis for specific project ideas.

Course Policies

Academic Integrity

Engineering is a profession demanding a high level of personal honesty, integrity and responsibility. Therefore, it is essential that engineering students, in fulfillment of their academic requirements and in preparation to enter the engineering profession, adhere to the College of Engineering Statement of Principles. Any student in this course suspected of academic misconduct (e.g., cheating, plagiarism, or falsification) will be reported to the College of Engineering Dean's Office and the University's Office of Community Standards and Student Conduct to initiate the student conduct process.

Collaboration

Discussing ideas and implementation details, sharing resources, and testing each other's projects is encouraged throughout the course. However, students must develop their own original projects and deliverables. Students are expected to be able to explain any code used and any decisions made about the design of the project.

Use of Generative AI

Large language models and other forms of generative artificial intelligence are allowed for developing the project, generating assets, and other deliverables. These models should be considered as tools to help in the development process, and students are expected to understand and be able to explain any code included in their project. Also be aware that XR technologies are rapidly evolving, and generative models may use incorrect or deprecated syntax and libraries.

Religious Accommodations

Washington state law requires that UW develop a policy for accommodation of student absences or significant hardship due to reasons of faith or conscience, or for organized religious activities. The UW's policy, including more information about how to request an accommodation, is available at Religious Accommodations Policy (https://registrar.washington.edu/staffandfaculty/religious-accommodations-policy/).

Accommodations must be requested within the first two weeks of this course using the Religious Accommodations Request form (https://registrar.washington.edu/students/religious-accommodations-request/).

Accommodations & Access

If you have already established accommodations with Disability Resources for Students (DRS), please communicate your approved accommodations to me at your earliest convenience so we can discuss your needs in this course. If you have not yet established services through DRS, but have a temporary health condition or permanent disability that requires accommodations (conditions include but not limited to; mental health, attention-related, learning, vision, hearing, physical or health impacts), you are welcome to contact DRS at 206-543-8924 or uwdrs@uw.edu or disability.uw.edu. DRS offers resources and coordinates reasonable accommodations for students with disabilities and/or temporary health conditions. Reasonable accommodations are established through an interactive process between the student, instructor, and DRS. It is the policy and practice of the University of Washington to create inclusive and accessible learning environments consistent with federal and state law.

Title IX

The UW, through numerous policies, prohibits sex- and gender-based violence, harassment, and discrimination and expects students, faculty, and staff to act professionally and respectfully in all work, learning, and research environments.

For support, resources, and reporting options related to sex- and gender-based violence, harassment, or discrimination, refer to the UW Title IX's website, specifically the *Know Your Rights & Resources* guide. Should you wish to make the Office of the Office of the Title IX Coordinator aware of a Title IX concern, visit the Make a Title IX Report webpage.

Please know that if you choose to disclose information to me about sex- or gender-based violence, harassment, or discrimination, I will connect you (or the person who experienced the conduct) with resources and individuals who can best provide support and options. You can also access additional resources directly:

- You can request anonymous support, from SafeCampus
- You can request confidential support, from a confidential advocate.
- If you know you want to submit a formal complaint, contact the Civil Rights Investigation Office.

Please note that some senior leaders and other specified employees have been identified as *Officials Required to Report*. If an Official Required to Report learns of possible sex- or gender-based violence, harassment, or discrimination they are required to contact the Office of the Title IX Coordinator and report all the details they have in order to ensure that the person who experienced harm is offered support and reporting options.

Relevant Websites

- Title IX: uw.edu/titleix/
- Survivor resources: uw.edu/titleix/survivor-resources/
- Confidential advocates: uw.edu/sexualassault/support/advocacy/
- SafeCampus: uw.edu/safecampus/
- Officials Required to Report: uw.edu/titleix/employee-reporting-expectations/
- Policies: uw.edu/titleix/policies/