Welcome!

Instructor: Evan Suma Rosenberg
they/them/their

Grad TA: Jerald Thomas
he/him/his
Who am I?

- I started working with virtual reality technology as an undergraduate in 2003.

- Received Ph.D. in 2010 with a research focus on locomotion in virtual environments.

- Researcher at the University of Southern California Institute for Creative Technologies from 2010-2018.

- Joined the University of Minnesota in 2018.
Who am I?

I'm also a lifelong video gamer.

First game: Breakout (Atari 2600)

Last game: Spider-Man Miles Morales (PS5)

Current game: Ratchet & Clank: Rift Apart (PS5)

Most anticipated game: Horizon Forbidden West (PS5)

No, I won't tell you my Nintendo, Playstation, or Steam IDs. :)
After completing this course, you will understand:

- ... how virtual reality technologies, software, and systems work
- ... how to develop virtual reality applications and 3D user interfaces
- ... how to implement common spatial interaction techniques
- ... how to critically evaluate what makes a virtual reality experience effective and compelling
  (and conversely, what doesn’t)
What won't you learn in this class?

- How to create art assets (3D models, textures, etc.)
- How to design narrative content for video games
- How to physically construct or reverse engineer virtual reality devices
Prerequisites

To succeed in this class, you should be...

- ... self-motivated
- ... interested in thinking critically about virtual reality
- ... willing to commit sufficient time
  3 credits = 9 hours / week for an “average” student to get a C

Familiarity with computer graphics or game engines is beneficial, but not required.
READ THE SYLLABUS
YOU MUST!
I am planning to teach this course in-person. However, we will follow University guidance regarding the teaching modality.

Lectures will also be recorded. The videos will be posted online in Canvas after class ends.
COVID-19 Precautions
Vaccination and Masking

The University requires that all students are fully vaccinated and that faculty and staff provide a written attestation of their vaccination status.

Everyone is required to wear a mask while inside a University building, regardless of vaccination status.

Please ensure that you follow these requirements and, to the extent possible, practice appropriate social distancing in the classroom.
COVID-19 Precautions

Stable Seating

The University recommends that students try to sit in the same seat for every lecture.

This will facilitate contact tracing in the event someone tests COVID-positive during the semester.
COVID-19 Precautions
Coursework Submission

To minimize potential virus transmission, there will be no exchange of any paper materials during the semester.

All coursework will be submitted, graded, and returned online.
COVID-19 Precautions
Online Access to Lectures

You will **not** be penalized for staying at home if you are feeling sick or test positive for COVID-19.
The recorded lectures provide an alternative method of accessing this content to allow students who test positive to continue taking the course remotely.

**Most lectures will include a participation exercise.**
You will have 24 hours to complete the participation exercise (submitted through Canvas) to get credit for attending the class.
Each student in this course will receive an Oculus Quest virtual reality system for the entire semester.
COVID-19 Precautions

VR Headset Sanitation

To reduce the chances of transmitting an illness, I recommend that you avoid sharing the headset with anyone else.

If you would like to sanitize your headset or controllers, we have a CleanBox decontamination system in the Keller 2-208. This has been reported to kill the virus that causes COVID-19 with 99.9% efficiency.
Oculus Quest Checkout

You can check out your Oculus Quest at the **CSE-IT Help Desk** at 1-201 Keller Hall.

You can also email **csehelp@umn.edu** if you have any questions.
Each controller uses one AA battery.
You are responsible for purchasing your own batteries. I recommend always keeping a spare set in case they need to be replaced in the middle of an assignment!

You may also need a USB-A to USB-C cable.
Understanding Virtual Reality: Interface, Application, and Design (Second Edition)

William R. Sherman and Alan B. Craig. ISBN: 978-0-12-800965-9

The textbook is required, and you will be expected to read the chapters associated with each class topic.

Quizzes may include content from both the lecture and textbook.

This textbook is available for free through the University's subscription to ScienceDirect!

**Additional Reading (Optional)**

**3D User Interfaces: Theory and Practice (Second Edition)**
LaViola, Kruijff, McMahan, Bowman, and Poupyrev. ISBN: 978-0134034324
https://www.amazon.com/3D-User-Interfaces-Practice-Usability/dp/0134034325

This textbook provides supplemental reading that more closely follows the lecture material.
This is entirely optional for those that are interested in taking a deeper dive into the topics covered in this course.

⚠️ Make sure you purchase the second edition that was published in 2017, not the older version from 2004!
Software

- In this class, you will learn how to create virtual reality experiences using two different software platforms.

- **Unity - the most popular game engine in the world**
  You can install it on your own computer for free or use the Windows machines in CSE Labs. For compatibility reasons, all applications in this course must use version 2020.3.17f1 (LTS). Programming will be accomplished using C#.

- **Babylon.js a - web based game engine**
  This is open-source and will run in major web browsers (e.g., Chrome, Firefox, Edge). Programming will be accomplished using TypeScript.
Grading

- **35% - Programming Assignments**
  Seven assignments, each worth either 10 or 20 points.

- **35% - Project**
  Due at the end of the course.

- **20% - Quizzes**
  Six quizzes, administered through Canvas.

- **10% - Participation**
  Most classes will involve a participation exercise.

No midterm or final exam.
Class Participation

- Each exercise will be scored out of 2 points
  1 point for a legitimate attempt
  1 point for correct completion

- Due within 24 hours of the end of class
  Most of the time this will be submitted on Canvas

- Lowest 2 scores will be dropped automatically to accommodate for the occasional absence
Quizzes

- We will have smaller quizzes throughout the semester instead of a midterm or final exam.
  See the schedule on Canvas for the estimated timeline.

- Quizzes will be administered asynchronously on Canvas.
  They must be completed within 24 hours of posting.

- Quizzes are open-book and non-cumulative.
  They will be designed to evaluate knowledge from lectures and assigned readings that occurred after the previous quiz.
Programming Assignments

- Check Canvas for a tentative assignment schedule.

- The first 3 assignments are worth 10 points and will be due one week after posting.

- The other 4 assignments will be worth 20 points and will be due two weeks after posting.

- Assignments will often include a bonus challenge for additional points.

  This typically involves implementing something original or creative.
Late Policy

Each student gets a total of 7 late points at the beginning of the semester.
Each point is worth a 24-hour extension for any programming assignment.

You are free to allocate them however you want throughout the course.
For example, you could use all your points for a 7-day extension on a single assignment, or a single point for 1-day extensions on 7 different assignments.
Late Policy

The late policy intended to provide flexibility for missed work. This includes those due to legitimate absences.

If you have points remaining, you do not need to contact me for an extension on programming assignments.

If you have not already missed more than two participation exercises, you do not need to contact me if you miss one.

If you go over these limit and anticipate further difficulties in completing work on time, then you should contact me to discuss your situation.
Assignments and Quizzes are Individual Work!

- **Don't search** for problems on the internet
  
  If it's not something that you could find in the official documentation for the software tools or languages, you probably shouldn't be searching for it.

- **Don't post** problems on the internet for help
  
  We can use Google too, and we have accounts on those sites

- **Don't work** with other students
  
  If another student looks at your code or quiz, it's cheating. Changing variable names does not fool similarity checkers.
Academic Dishonesty

First offense
0 on the assignment

Second offense
F in the class

Third offense
Expelled from the University

Instructors are required to report these incidents to the University when they occur.
You are permitted to use art assets from the internet in programming assignments and the project. This includes 3D models, textures, etc.

You must cite all third-party content in a readme file. This is important! Students often forget this.
Getting Help

The best way to communicate with the instructor and TA is through the course Slack workspace.
https://join.slack.com/t/csci5619/signup

Questions that aren't specific to you and don't require posting code should be posted to the #general channel.
Otherwise, you should send a direct message to me or the TA.

The Zoom integration has been installed in Slack.
When you click the call button, it will initiate a Zoom meeting.
Office Hours

Office hours for myself and the TA will be held on Gather.Town.
Check the syllabus on Canvas for the current schedule.

We are also happy to answer questions asynchronously.
If it is a quick question, we will answer directly on Slack.
If it requires more explanation, we may initiate a Zoom call.
Course Feedback

There will be an anonymous course feedback form available on Canvas throughout this semester.
Please feel free to let me know how things are going!
Many students ask me for recommendation letters after taking this class. Good letters are able to talk about the student beyond just grades.

It is hard to get to know each of you in lecture. If you think you might want to request a recommendation letter, then it is a good idea to visit my office hours sometime during the semester.
Questions?
Elements of Virtual Reality

Reading: Understanding Virtual Reality (2nd Edition), Ch.1 pp. 5-27
Virtual

*being in essence of effect, but not in fact*

Reality

The state or quality of being real.

Something that exists independently of ideas concerning it.

Something that constitutes a real or actual thing
Key Elements of Virtual Reality

1. Virtual Environment
2. Immersion
3. Interactivity
4. Participants
Key Elements of Virtual Reality

1. Virtual Environment
2. Immersion
3. Interactivity
4. Participants
Virtual World

A virtual world is an **imaginary space** often manifested through a medium.

A description of a collection of objects in a space and the rules and relationships governing them.
Virtual World
Virtual Environment

- A **virtual environment** is a specific type of imaginary world

- Synthetic world created with 3D computer graphics

- Usually seen from a first-person point of view

- The viewpoint is under the real-time control of the user
Key Elements of Virtual Reality

1. Virtual Environment
2. Immersion
3. Interactivity
4. Participants
Immersion

- Sensation of being in an environment
- Can be a purely mental state
- Can be accomplished through physical means
- **Physical immersion** is a defining characteristic of VR
Physical Immersion

- Synthetic stimulus of the senses via technology

- Immersive displays “surround” users with stereoscopic (3D) graphics

- Head tracking enables graphics to update in real-time as users move
Mental Immersion

- Mental immersion is a principal goal of most media creators
- State of being deeply engaged
- Suspension of disbelief
- In VR, we refer to this as the sense of presence
- VR uses physical immersion to create mental immersion
Is this VR?

https://youtu.be/-xNN-bJQ4vI?t=10
Key Elements of Virtual Reality

1. Virtual Environment
2. Immersion
3. Interactivity
4. Participants
Interactivity

- For VR to seem authentic, it should respond to user actions

- Users must be able to influence the virtual environment
  - Moving through the world
  - Picking up objects
  - Flipping switches
  - Interacting with characters

- The environment must be responsive to the user’s actions

- 3D interaction is the most challenging element for VR developers
Key Elements of Virtual Reality

1. Virtual Environment
2. Immersion
3. Interactivity
4. Participants
Human Participants

- The *magic* of VR happens in the minds of participants

- Each person brings their own physical attributes, capabilities, interpretations, backgrounds, and history

- Everyone experiences VR in their own unique way

- Don’t ever tell a participant what they are supposed to feel!
VR Technologies

- In this course, we will be working with headsets

- You will also learn about other types of VR technologies

- Many of the concepts you learn about will also apply to augmented or mixed reality
**Terminology**

**Virtual Reality (VR)**
purely virtual, real world not visible

**Augmented Reality (AR)**
mostly physical, some virtual elements

**Augmented Virtuality (AV)**
mostly virtual, some real world elements

**Mixed Reality (MR)**
entire spectrum from VR to physical world
The Virtuality Continuum

REALITY
AUGMENTED REALITY:
Virtual content augments the real world.

VIRTUAL REALITY
AUGMENTED VIRTUALITY:
Real content augments a virtual world.

MIXED REALITY
A blanket term to describe any experience between the extremes of the continuum.

REality:
The completely real, physical world we live in.

VIRTUAL REALITY:
A completely synthetic, digitally-created world.

Reality-Virtuality Continuum Created by Paul Milgram (1994)
Terminology (Industry Usage)

**Mixed Reality (MR)**
often used as a synonym for AR (thanks Microsoft)

**Spatial Computing (AV)**
another made-up term for AR (thanks Magic Leap)

**X Reality, Cross Reality, or eXtended Reality (XR)**
nobody actually knows what it's supposed to stand for
basically a marketing term for MR from the Virtuality Continuum
VR as a Medium

- Virtual reality is a medium
  - an intermediary that interfaces two entities
  - a channel or system of communication, information, or entertainment

- A medium must be able to store its contents until they are delivered

- Books, images, and videos are all forms of media
User Interface

- Participants need to access the contents of media
  A novel is presented to the reader as words on pages that have a sequential order

- This access point is called the user interface (UI)

- Information transfers between the creator and the recipient via the user interface
3D User Interfaces

- In VR, participants interact with a **3D user interface (3DUI)** to experience the virtual world.

- **Components include:**
  - Input devices
  - Output devices
  - Interaction techniques
  - UI metaphors

- Understanding 3D user interfaces is a key objective of this class.
Why Study 3D User Interfaces?

- Technologies that require 3DUIs are rapidly maturing
- 3D interaction is complex and challenging
- Many 3DUIs from inexperienced developers lack usability
- There are numerous industry opportunities for people with experience in 3DUI design and implementation
Reminder

Check out your Oculus Quest from CSE-IT!
If you are not sure if you are going to drop the class, you can wait until you have made a final decision.

Also, sign up for the course Slack workspace.
https://join.slack.com/t/csci5619/signup