Course Syllabus
SIE 516 Topics in Virtual Reality: Research and Applications

Instructor:

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Office Hours:

Office hours for this course are by appointment: students are welcome to contact the instructor or TA by email to arrange a time to meet.

Course Description:

This course is designed to provide students with an overview of the basic principles of virtual reality (VR) and virtual environment technology (VET). There is a strong emphasis on the use of this technology as a tool for conducting scientific research and as a platform for real-world applications. The course will be comprised of instructor lectures, student-led in-class discussions on selected topics, and a VR lab where we will learn about the basics of scripting and rendering virtual environments and using VR technology to conduct scientific research. The goal is to learn enough about the strengths and limitations of VR technology in order to be able to construct simple immersive environments as well as to understand the human factors and cognitive issues that should be considered when using this medium. Students in the course will be given an opportunity to interact directly with immersive virtual environment technology in the lab and will gain first-hand experience by developing a VR-based research demo / application as a final project and paper.

Credits: 3

Prerequisites: none

Course Goals and Objectives:

By the end of this course, students will:

1. Understand how the design of VR technology relates to human perception and cognition.
2. Discuss applications of VR to the conduct of scientific research, training, and industrial design.
3. Gain first-hand experience with using virtual environment technology, including 3D rendering software, tracking hardware, and input/output functions for capturing user data.
4. Learn the fundamental aspects of designing and implementing rigorous empirical experiments using VR.
5. Learn about multimodal virtual displays for conveying and presenting information and techniques for evaluating good and bad virtual interfaces.

Course readings:

The primary readings will consist of selected materials based on seminal works, general overviews, emerging topics, and class interests. Readings will be sent via email, accessible from the course website, or via hardcopy on reserve. Other course material and assignments will also be emailed or accessed via the website.

The course website is:

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PLEASE NOTE: Slides are not a substitute for taking notes. I use slides to complement my lecture by providing key points, showing graphics, or giving examples only. In order to truly learn the material, you will need to participate in class. I strongly advise taking thorough notes and asking questions, as projects build on material from lectures, interactive student discussions, and readings.

Class Sessions:

Tuesday and Thursday from 12:30pm - 1:45pm.

Grading, Class Policies, and Course Expectations:

Grades in this course will be based on class participation, as well as the quality and completion of all class assignments and papers/projects listed on the syllabus.

NOTE: As we are incorporating a component of interviewing / experimentation for the class project, all students need to complete the online module for protection of human subjects from the UMaine Institutional Review Board (IRB). If students have not previously taken this course, they must complete the module in the first 2 weeks of the semester. The web-based tutorial can be found at:

http://www.umaine.edu/research/research-compliance/institutional-review-board-for-the-protection-of-human-subjects-irb/required-training/
You are expected to exhibit high quality work that demonstrates sound understanding of the concepts and their complexity. Earning an "A" represents oral and written work that is of exceptionally high quality and demonstrates superb understanding of the course material. A "B" grade represents oral and written work that is of good quality and demonstrates a sound understanding of course material. A "C" grade represents a minimally adequate completion of assignments and participation demonstrating a limited understanding of course material. A "D" grade represents less than adequate completion of assignments and participation demonstrating nominal understanding of course material. An "F" failing grade represents an unacceptable level of completion of assignments and participation demonstrating a lack of understanding of course material. Note: generally graduate students must receive at least a B- in order to pass a graduate course.

Grading criteria:
Class participation and presentations– 30%
Lab Participation & Assignments – 30%
Final VR Design Project – 40% (10% interim deliverables, 15% presentation and 15% paper)

Illness:
If you are absent due to illness or a similar valid excuse, please notify me of your situation at nicholas.giudice@maine.edu prior to (or immediately after) your absence.

Course Schedule:
See the attached schedule of class session topics, reading assignment due dates, and dates for presentations/projects.

Class Policies:
Regular attendance at class meetings is expected. I place a high value on questions and interactivity, and a significant percent of the course grade is based on your constructive in-class input or subsequent comments.

Late assignments and make-up:
Assignments submitted after the due date are docked 10 percent per day and will not be accepted for credit after a week. If you miss an assignment or presentation due to an illness or emergency, you must send notification to me by email prior to

(or soon thereafter the due date if there are mitigating circumstances). Special arrangements will be made on a case by case basis.

Etiquette and other class policies:

Please submit all class assignments with the following information in the header: your name, assignment title, date, and class number/name. Since I often comment on the assignment in-text or cut and paste them into a single document for distribution to the class for discussion, it is easier to have them in a readily editable format rather than a PDF. Thus, for any assignments being sent to me vs. posted on the website, please submit documents as a MS word (or PC compatible) document, or in rich text format, or as a text file.

Required Syllabus Information:

There are five policy statements required for every syllabus at the University of Maine. These include:

- Academic Honesty Statement
- Student Accessibility Services Statement
- Course Schedule Disclaimer
- Observance of Religious Holidays/Events
- Sexual Discrimination Reporting

Please see the following URL for descriptions of all of the above policies: https://umaine.edu/citl/teaching-resources-2/required-syllabus-information/

Tentative Course Schedule

Week 1 (Tuesday):

- Introduction to the course and to Virtual Environment Technology
- What is Virtual Reality?
- Some definitions and explanations
- Recurrent themes of the course
- Student introductions and experiences

Week 1 (Thursday):

- The history of VR
- Key VR terminology
- Types of VR technology
- VR and its relation to humans
- Discuss Final Project and student interests

Week 2 (Tuesday):

- Applications 1:
  - The relation of VR to research, training, design, and manufacturing.
  - An overview of VR applications.
  - VR design: perceptual and cognitive factors.
- Please download Unity for Thursday and bring your computer to class. https://unity3d.com

Week 2 (Thursday): Lab 1 / Introduction to Unity:

- Interface overview and navigation
- Creating a new project, importing standard assets, adding a player character
- Objects, lighting, scenes, prefabs, asset store

Week 3 (Tuesday):

- Presence in VR: What is it? How do you quantify it? How do you foster it?
- Tracking, Latency, Field of View in Real life, HMDs, Caves, Desktop VR, Fidelity, depth, isolation, smell, range of motion (DoF)
- Sensory Influence: Kinetics, Spatial Audio, Haptics, Other senses?
- What can you do in your projects to encourage presence? How important is presence to the experience you are creating?
- Problems with movement - interaction, limited area of movement, VR sickness. How can you avoid these?

- If we have time, lead into next class: What role does presence play in tele-present operations? What about in AR?

Week 3 (Thursday): Lab 2 / Scripting in Unity:

- Creating a New Script, (naming) Syntax, Functions, Variables, Key / Mouse Input, Unity Support
- Object-Oriented Scripting in Unity
- Public variables, the inspector
- Unity support

Week 4 (Tuesday):

- Spatial knowledge acquisition, orientation, and wayfinding in virtual environments.
- "Cognitive Maps"
- GPS (advantages/disadvantages)
- Indoor Wayfinding
- Current and experimental systems

Week 4 (Thursday): Lab 3 / More Scripting in Unity:

- File I/O
- Enumerators
- Instantiating a Prefab during runtime
- Singleton
- Accessing other scripts

Week 5 (Tuesday):

- Augmented Reality
- Google glass, hololens. See-through vs screens vs projection
- Fiducial-oriented advertisements. Social implications (ex: hololens outrage)
- Challenges unique to AR

Week 5 (Thursday):

- Discuss final project concepts.
- Discuss final project execution.

Week 6 (Tuesday):

- Motion in VR
- Position, Orientation Tracking

- Desk Space vs. Room Space
- Latency, accuracy, precision
- Briefly cover VR sickness and perceptual augmentation

Week 6 (Thursday): Lab 4 Intro to Maya:
- Basic concepts of 3D modelling
- Bevel, Cone, Extrude, Smooth, Booleans
- Exporting files for Unity

Maya Reference: xxx

Week 7 (Tuesday): FALL BREAK

Week 7 (Thursday): Lab 5 Continuing Maya:
- Quick Review
- Symmetry
- NURBS vs. Vertices
- Revolve Tool
- Bridge Tool
- Materials vs Textures
- Exporting files for Unity

Maya Reference: xxx

Week 8 (Tuesday): Audio:
- Audio
- How does audio differ from vision?
- Audio in VR
    - Head Related Transfer Function
    - Establish a Scene
    - Direct Attention
- Uncanny Valley
- Implementations
    - Unity
    - Breaking Immersion (things to avoid)

Week 8 (Thursday): Audio Lab:
- Audio Lab in Unity
- Unity 2D-3D sounds
- Unity Audio Mixer (two rooms to compare)

- Component > Reverb Zone
- Component > Filters
- High vs Low quality sounds
- Audio Import Settings
- Scripting: AudioSource variables and functions

Week 9 (Tuesday):
- Haptics
- Tactile Feedback vs Force feedback
- Vibration
- Haptic Input and Output
- Common Uses / Limitations
- Multisensory Design
- Unity Sound Design

Week 9 (Thursday):
- In-class project work-day

Week 10 (Tuesday): Survey Lecture:
- Good/Bad of Survey design.
- When to ask what kind of questions.
- What kind of surveys will our final projects need?

Week 10 (Thursday): Survey Lab:
- Come to lab with draft of survey for your project.
- We will discuss these drafts and make them usable for final projects.

Week 11 (Tuesday):
- Project check-in
- The current state of your projects
- Progress on your project survey / documentation (final, or close to final).
- VR requirements (vive, oculus, spatial headphones, computer, etc).
- Small lecture about different VR headset requirements/benefits.
- Plans for project participants (approx. 6).

Week 11 (Thursday):
- VR Unity Integration (At VEMI Lab)
- VR Controllers

    - Types of interaction
    - Intuitive Controls
    - VRTK: https://vrtoolkit.readme.io/docs/getting-started
    - SteamVR: https://www.raywenderlich.com/149239/htc-vive-tutorial-unity

Week 12 (Tuesday):

- Simulator Sickness
    - Movement
    - Headset quality (resolution, field of view)
    - Audience considerations
    - Proposed solutions

Week 12 (Thursday):

- Using the example project given, try implementing an experimental means of reducing motion sickness.

Week 13 (Tuesday):

- Psychological Measures
    - Sensors Types
    - Effect on Immersion
    - Gaming Application
    - Research Applications
    - Data visualizations

Week 13 (Thursday):

- Statistics review
- Presentation prep and project testing

Week 14 (Tuesday):

- VEMI Tour

Week 14 (Thursday):

- Data Logging - why, when, how, best practices.
- Data Visualization using sample datasets

Week 14 (Tuesday-Thursday):

- Project Presentations