IT382001-User Interfaces for XR

Organizational

Instructor: Dr. Margarita Vinnikov, margarita.vinnikov@njit.edu

TA: David Garcia, dg533@njit.edu

Class time and location: GITC 3200, Monday and Wednesday from 11:30 AM - 12:50 PM.

The 1.5 hr. lab sessions will be divided into lecture time, discussion, and group work, as well as practical experimentation for the development, presentation, and demonstration of XR projects. Hence, attendance and participation throughout the entire class, during every class, is highly recommended as it will ensure successful completion of the course.

Office hours: GITC, 3802 or virtually. Monday from 1:00 p.m. to 2:00 p.m. and Wednesday from 10:30 a.m. to 11:30 a.m. By appointment only.

TA office hours: GITC, MIXR Lab, or online. Monday & Wednesday: 13:00 - 14:30. Other time is possible by appointment.

Discord server: https://discord.gg/5NWwzzxgYP

Overview

The course presents the concepts and hardware and software technologies for mixed reality (virtual and augmented reality) applications. During the course, the students will have an opportunity to build a virtual or augmented reality application and test it with Oculus, Vive, Magic Leap, or HoloLens. During this course, students will learn to design and develop immersive experiences with VR/AR headsets, stereo displays, and large projection screens. They will incorporate body and eye trackers discuss the latest AR/VR trends for games and other applications and explore why some games make people feel immersed and others make people sick. Students will also explore the differences and similarities between computer and human vision. This course is hands-on; It will utilize Unity 3D or Unreal Engine. The end-of-the-semester project will showcase all the different skills and knowledge acquired throughout the semester.

Material Covered During the Semester

1. VR, AR, and XR platforms; XR technical framework such as360 Video and model-based VR; XR applications: Traditional Applications of XR, Emerging Applications of XR such as sports, news and documentary films, scientific data visualization, design, training, physical rehabilitation and psychotherapy, games, meeting other people, telecommunication, and collaborative applications.
2. Computing Architectures for XR (graphical pipeline, graphical cards, physical processing units, game consoles, tilted displays, distributed VR systems) and

Programming in XR: geometric modeling, physical modeling, intelligent behavior; Real-time rendering (levels of detail, impostors, etc.); Event-driven simulation, procedural animation, physics-based modeling, collision detection, and response, simulation and rendering in parallel simulation. Unity and AR/VR mobile apps; AR and ARKits; ARCore and Vuforia; Plane detection in AR.

3. Human sensorimotor systems and capabilities
4. Displays: Vision: distributed VR systems and tiled displays (Cave), HMDs (Oculus, HTC, Sony play station); Mobile VR (Google and Samsung); Stereo Displays; How to choose a display? Audio: Spatial Audio, Ambisonic, and Binaural Sound (headphones, speakers); Smell and taste displays.
5. Controllers and input devices; Filtering and tracking (Head, Body, and Eyes); Navigation; Haptic feedback; Microphones; Touch and kinematics; Haptic and sensing gloves.
6. Human factors: Levels of immersion of VR system; Presence; Sensorimotor Contingency (SC); VR Hardware and Immersion, Nausea, Simulation/Cyber/Motion sickness (framerate, latency, vergence vs. accommodation, visual vs. vestibular, etc.), Realism vs. Graphics vs. Animation; Depth perception (Visual/Audio); Fields of view, effective field of view, sound discrimination; Immersive sound and music; Training (fidelity, transfer); Human studies.
7. Other possible topics: Room Scale VR, BBOC, Light Field, VR design and VR cardboard project; Scene for VR; Moving in VR; 360 Video and 360 location recording; Immersive Storytelling.

Course Outcomes

Upon completing this course, students will:

C1. Be able to communicate effectively and critically, both verbally and in writing, on various topics in XR.

C2. Be able to design, implement, and evaluate XR applications.

C3. Be able to identify user needs in the context of XR applications.

Grading

Grades will be distributed as follows:

Topic of Interest (In teams of two)	**15%**
Development Project Overview	**45%**
Technology Critical Blog/Vlog	**10%**

Midterm + Final Exam	**30%**
Bonus Marks	**5%**

Topic of Interest

During the semester, you will be asked to choose two topics not covered in class and give a **15-minute presentation + 5 minutes** to a Q&A period. The project will be evaluated based on critical thinking and evaluation of the topic, as well as on oral presentation skills and PowerPoint presentation. Details about the project will be posted on Canvas. The mark would also include students' participation in the Q&A session for other presentations. You can choose to work in a pair or individually. The scope of the project will be proportional to the group size.

Development Project

The project will be broken into different stages throughout the semester. You will need to complete all milestones for full marks. The project will be based on different concepts discussed in class throughout the semester and will solve a "real-world" problem of your choosing. Through the different stages of the project, you are to demonstrate your mastery of the concepts, methods, tools, and techniques covered in class. You will work in teams of two. You will be required to view the project from many angles. It is important to make sure to discuss each stage of the project with me before submission and make sure to submit each milestone on time for full marks. Details about the project will be posted on Canvas.

Technology Critical Vlog

During the duration of the course, you are to produce two short vlogs or blogs discussing a subject of interest related to XR games. It can be a review of an XR game, a technical discussion, or a tutorial. Other ideas are also welcome. Marks will be given for the quality of the presented material and creativity. You will also be asked to review each other's work to provide useful feedback.

Tests and Final Exam

There will be one short test that will be administered. Before each examination, there will be a discussion forum where students can discuss topics covered during the module (usually two weeks). Online participation in discussion forums will add bonus points.

The Final Exam will cover all the material covered in class.

Bonus Points

A list of studies will be presented to you during class. You can participate in any or all studies for bonus marks. You can schedule to take the study when it's convenient for you during the semester. Participating in a study will give you a learning experience into

how UX research is done as part of the HCI component of the class. To verify completion, you need to bring a waiver signed by an experimenter.

Grading Legend

Letter Grade to % Correspondence

Undergraduate

Grades	Significance	Approx. points
A	Superior	90-100
B+	Excellent	86-89
B	Very Good	80-85
C+	Good	76-79
C	Acceptable	70-75
D	Minimum	60-69
F	Inadequate	0-59

Late Grading policy

- *Late submission will have severe consequences – 10% off each day you are late. In other words, if you were late for one day, your grade will be 90% or less; 2 days late and your mark will be 80% or less*
- *You will receive 0 for a missed presentation or final exam. If you know you will not be on the day of your presentation or an exam, please inform me at least a week beforehand to make alternative arrangements. There will be no make-up exams otherwise.*

References

Suggested readings will be provided weekly, **but no books are required** for purchase.

A possible book you might want to use as a reference (available in the bookstore):

LaViola Jr, J. J., Kruijff, E., McMahan, R. P., Bowman, D., & Poupyrev, I. P. (2017). 3D user interfaces: theory and practice. Addison-Wesley Professional.

Academic Integrity

Academic Integrity is the cornerstone of higher education and is central to the ideals of this course and the university. Cheating is strictly prohibited and devalues the degree that you are working on. As a member of the NJIT community, it is your responsibility to protect your educational investment by knowing and following the academic code of integrity policy that is found at:

http://www5.njit.edu/policies/sites/policies/files/academic-integrity-code.pdf.

Please note that it is my professional obligation and responsibility to report any academic misconduct to the Dean of Students Office. ***Any student found in violation of the code by cheating, plagiarizing or misusing any online software will result in disciplinary action. This may include a failing grade of F, and/or suspension or dismissal from the university.*** *If you have any questions about the code of Academic Integrity, please contact the Dean of Students Office at* ***dos@njit.edu***

Illustrative Schedule

Any changes will be announced in class and in Canvas.

Color annotation: Topic of Interest; Development Project; Technical Blog/Vlog; Tests

Week 1: September 3 – 9

- *W Class:* Intro class. XR Overview: VR, AR, and XR platforms and technical framework
- *Tasks: Start Unity or Unreal Tutorials*. Think about a game/application you would like to build in XR. Introduce yourself in discord.

Week 2: September 10 – 16

- *M Class:* Traditional and Emerging XR Applications of XR.
- W Class: GitLab and Mendeley. Design Document. Getting started with XR; Vive, Oculus, HoloLens. Other technical issues.

- Tasks: Meet your classmates in class and continue the discussion in Discord; decide whom you want to work with, what topics you want to read on, and what application you want to build. Continue through tutorials to get familiar with Unity or Unreal.
- **Due Friday:** 1. Two Topics of interest, group names for the topic of interest, and dates you would prefer to present (two dates). 2. Approve game teams (names) and themes.

Week 3: September 17 – 23

- M Class: Design Principles and Current Technology.
- W Class: Overview of Human sensorimotor systems and capabilities
- **Due end of the week: 1.** Reading list for topic #1; 2. Goals and Objectives document. 3. Configure a Gitlab project and add all the group members, course instructors, and TA. 3. GitLab project setup with milestones and tasks.

Week 4: September 24 – 30

- M & W Classes: Sight. Visual displays; How to write/make blogs/vlogs;
- W Class: Topic of Interest Presentation Demo.
- **Due end of the week**: 1. Short progress report describing tasks achieved in GitLab + Video of your scene.

Week 5: October 1 – 7

- M & W Classes: Audio displays.
- W Class: Topic of Interest Presentation.
- **Due end of the week:** 1. Short progress report describing tasks achieved in GitLab + Video of your scene. 2. Technical Blog/Vlog.

Week 6: October 8– 14

- M & W Class: Touch, Smell, and Taste displays.
- W Class: Topic of Interest Presentation.
- Tasks: Working on input and controllers for your application.
- **Due end of the week:** 1. Visual & Other Interfaces Report + short progress report describing Visual World and tasks achieved in GitLab + Video of your scene.

Week 7: October 15 – 21

- M & W Classes: Review for midterm; Input devices and Tracking
- W Class: Midterm;
- **Due at the end of the week:** Short progress report describing Interaction and tasks achieved in GitLab + Video of your scene.

Week 8: October 22 –28

- M Class: Input devices and Tracking.
- W Class: Topic of Interest Presentation.
- **Due end of the week: 1.** Interaction Report + progress report describing Interaction and tasks achieved in GitLab + Video of your scene. **2.** Reading list for topic #2;

Week 9: October 29 -November 4

- T & W Classes: System evaluation; Contingency and concurrency; Human factors studies and user evaluation.
- W Class: Topic of Interest Presentation.
- **Due end of the week**: 1. System Requirements Report (System specifications and identifying sources of lag and delay) + 2. Short progress report describing tasks achieved in GitLab + Video of your scene.

Week 10: November 5 – 11

- M Class: User Study Design.
- M Class: Topic of Interest Presentation.
- **Due end of the week:** 1. IRB certificate; 2. Short progress report describing tasks achieved in GitLab + Video of your scene.

Week 11: November 12 – 18 [Note: November 13 is the last day to withdraw]

- M & W Classes: Levels of immersion, Presence, Fidelity, and Simulation sickness.
- W Class: Topic of Interest Presentation.
- **Due end of the week:** 1. Evaluation plans 2. Consent forms 3. Study questionnaires and other printable material. 4. Short progress report describing tasks achieved in GitLab + Video of your scene.

Week 12: November 21 – 27 [Thanksgiving Recess]

- M: Testing; Data Analysis. The topic of Interest Presentation and Testing. Design Recommendations for XR.
- W Class: No class
- Tasks: Preparing for Testing; 2. Running pilot.
- **Due end of the week:** short progress report describing tasks achieved in GitLab + Video of your scene.

Week 13: November 26 – December 2

- M & W Class: Data Collection & Testing.
- Tasks: Fixing Bugs and issues discovered during the testing phase
- **Due end of the week**: Raw Data + Short progress report describing tasks achieved in GitLab.

Week 14: December 3 – 9

- M & W Class: Data Collection & Testing.
- W: HS visiting
- **Due end of the week**: **1.** Preliminary Data Analysis and lessons learned from user studies. **2.** Technical Blog/Vlog.

Week 15: December 10 – 15

- M Class: Review the entire course and preparation for the final exam.
- W Class: Project presentations. Discussions will be based on the presented topic.
- **Due end of the week:** Final project report and final video.

Final Exam