

Fall 2019

IT 485-001: Cross Reality (XR) Design

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IT 485004-Cross Reality (XR) Design (3 credits)

Fall 2019

Instructor:

Dr. Margarita Vinnikov

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Class time and location: GITC 3200. Tuesday and Thursday from 11:30 am to 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. Tuesday from 12:50 am to 1:50 pm and Thursday from 2:30 pm to 3:30 pm.
By appointment only.

TA office hours: Ian Rosenberg will be helping the class. He will be available tentatively Tuesday and Thursday 4 pm -8 pm. Any changes will be announced in class and in Canvas.

Overview

The course presents the concepts as well as 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; follow and discuss the latest AR/VR trends for games and other applications; 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 a hands-on course; It will be utilizing Unity 3D or Unreal Engine. The end of the year 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 as 360 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 (frame-rate, latency, vergence vs. accommodation, visual vs. vestibular, etc.), Realism vs. Graphics vs. Animation; Depth perception (Visual/auditorial); 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;

Illustrative Schedule

Any changes will be announced in class and in Canvas.

Week 1: September 2 - 8

T Class: Intro class. XR Overview: VR, AR and XR platforms and technical framework.

R Class: Traditional and Emerging XR Applications of XR.

Tasks: 1. Selecting project groups and project topics during office hrs. 2. Assigning discussion leaders.

Due End of the Week: 1. Approve group and topic during office hours. 2. Schedule for in-class discussions

Week 2: September 9 – September 15

T & R Classes: XR Software: Unity and Unreal. Software architecture and programming.

Tasks: 1. Identifying and working through tutorials to get familiar with Unity or Unreal 2. Creating the first scene for the selected project.

Discussion 1: XR applications.

Due End of the Week: Approve project goals and objectives during office hours.

Week 3: September 16 – 22

T & R Class: Overview of Human sensorimotor systems and capabilities. Sight and Visual displays.

Tasks: 1. Completing the visual scene. 2. Designing and working on an audio scene

Discussion 2: Examples of various displays.

Due end of the week: Visual scene should be demonstrated for approval in person or via Moodle.

Week 4: September 23 – 29 [I will be away on the 26th] – work period

T&R Class: Hearing and Audio displays. Smell and Taste displays.

Tasks: 1. Completing the audio scene. 2. Deciding and working on input and controllers for application

Discussion 3: Audio, smell and taste displays.

Due end of the week: Audio Scene should be demonstrated for approval in person or via Moodle.

Week 5: September 30 – October 6

T & R Class: Touch and kinematics. Haptic and sensing gloves. Controllers and input devices;

Tasks: 1. Working on input and controllers for your application.

Discussion 4: Haptic feedback.

Week 6: October 7 – 13

T & R class: Sense of space; Navigation in Virtual and Augmented Space; Tracking;

Tasks: 1. Working on input devices.

Due end of the week: Input devices should be demonstrated for approval in person or via Moodle.

Discussion 5: System evaluation, Navigation, and Tracking.

Week 7: October 14 – 20

T & R class: System evaluation; Simulation sickness; Contingency and concurrency;

Tasks: 1. Completing all outstanding problems and issues before the system evaluation phase. 2.

Debugging the project.

Due end of the week: Acquire IRB certificate

Discussion 6: Human factors studies ,Immersion, Presence, and Fidelity

Week 8: October 21 – 27

T & R class: Human Factors and Human studies; Levels of immersion, Presence, and Fidelity.

Tasks: 1. Debugging the project. 2. Writing system evaluation plan and preparing for system evaluation.

Due end of the week: 1. Topics of interest and presentation schedule have to be approved in person or via Moodle. 2. The entire system has to be approved for the next stage.

Discussion 7: Data processing and analysis.

Week 9: October 28 – November 3

T & R class: Data processing and analysis.

Topic of Interest Presentations. Discussions will be based on the presented topic.

Tasks: System testing and human in the loop evaluations.

Due end of the week: System evaluation plans should be demonstrated for approval in person or via Moodle.

Week 10: November 4 - 10

T & R class: Two Topic of Interest Presentations. Discussions will be based on the presented topic;

Tasks: 1. System testing and human in the loop evaluations wrap up. 2. Evaluating and reflecting on the study.

Due April 11: Draft of the written reports for the Topics of Interests presentations.

Week 11: November 11 – 17 [Note: November 11 is the last day to withdraw]

T & R class: Topic of Interest Presentations. Discussions will be based on the presented topic;

Tasks: 1. Evaluating and reflecting on the study. 2. Developing a report and outline the final steps in project development based on what was learned during the study.

Due end of the week: Report and final steps for the project should be discussed and approved in person.

Week 12: November 18 – 24

T & R Classes: Topic of Interest Presentations. Discussions will be based on the presented topic;

Tasks: 1. Completing all the outstanding issues associated with a project. 2. Preparing for presentation.

Week 13: November 25 – December 1 [Thanksgiving Recess]

T Class: All outstanding Topic of Interest Presentations. Discussions will be based on the presented topic;

Task: Final report and presentation for the final project.

Due end of the week: Written Reports for the Topics of Interests presentations.

Week 14: December 2 – 8

T Class: Project presentations.

R Class: Review of the entire course and preparation for the final exam.

Due end of the week: Final project.

Week 15: December 9 – 11

T Class: Review of the entire course and preparation for the final exam.

Due end of the week: Final project report.

Final Exam

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

Grading

Grades will be distributed as follows:

• Weekly discussions	15%
• Reflection Log	5%
• Development Project	40%
• Topic of interest	20%
• Final Exams	20%

Weekly Discussions

In the first half of the semester, you will be part of in-class discussions. During each class, you will be required to read and discuss a few articles or research papers. You will be asked to act as a group leader on one of the papers or blogs. As a group leader, you will be presenting an article and posting two questions for the class to answer. You can also take the initiative and bring other material related to your paper. Make sure to ask thought-provoking questions. You will also post these questions, as well as the critical points from in-class discussion on Canvas to continue an online debate. The entire class is required to maintain the class discussion online. The overall grade will be based on the quality of your responses during both in class and/or on Moodle discussions, as well as on your effort as a group leader. Please note that posting questions late or not at all WILL impact your grade significantly. More details will be posted on Moodle.

Development Project (In teams of two)

The Project will be divided 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 various stages of the project, you are to demonstrate your mastery of the concepts, methods, tools, and techniques covered in class. You can choose to work in a pair or individually. The scope of the project will be proportional to the group size. You will be required to view the project from many angles. It is essential to make sure to discuss each stage of the project with me before submission and also make sure to submit each milestone on time for full marks. Details about the project will be posted on Moodle.

Topic of interest

- In-class presentation 8%
- Written Report 7%
- Participation in class discussion 5%

During the semester you will be asked to choose a topic not covered in class and give a 15 minutes presentation + 5 minutes to a Q&A period. You will need to write a critical report that would outline the topic and highlight the different challenges associated with your topic. The project will be evaluated based on critical thinking and evaluation of the topic, as well as on oral presentation skills and written report. Details about the project will be posted on Moodle. Part of the mark would also include students' participation in Q&A session for other presentations.

Final Exam

The final exam will all be based on everything discussed or explored in class, including topics of interest and in class discussions.

Grading Legend

	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 per 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.

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***

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