ITEC 4016 A (0.5 credit)
Virtual and Augmented Reality

Instructor: Hossain Samar Qorbani (Sam)
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Office Hours: Mondays 11:00 – 12:00 pm
Lecture: Mondays 12:05 – 2:55 pm
Location:
Tutorial/Lab: Wednesdays 8:35 – 10:25 am
Location:
TA: N.A.

Course Description:

Design, development, and evaluation of virtual and augmented reality systems. Topics include VR/AR history, applications, hardware (display and input devices), software, interaction techniques for navigation, selection, manipulation, human factors, and empirical validation. Projects will use modern 3D game engines and VR/AR devices. *Prerequisite(s):* IMD 2006 and IMD 3002 or equivalent

Course Objectives/Learning Outcomes:

By the end of this course students should be able to:
- Understand VR/AR principles, e.g., application areas, classes of interaction methods, hardware/software foundations, etc.
- Employ best practices in designing VR/AR systems (e.g., appropriate choice of interaction technique, avoiding cybersickness, etc.)
- Develop VR/AR applications using a game engine (e.g., Unity) and recent hardware (e.g., Oculus Quest)

Textbook/Readings (Optional):

- The VR Book: Human-Centered Design for Virtual Reality, Jason Jerald, 2015. ISBN: 1970001127
- 3D User Interfaces: Theory and Practice, by Joseph LaViola Jr. et.al. ISBN: 0134034325
- Human-Computer Interaction: An Empirical Research Perspective, I. Scott MacKenzie, 2013. ISBN: 978-0124058651.
- Additional materials may be assigned on certain topics

Required Equipment:

- A computer capable of running Unity 2019.3 or up
- An Oculus Quest headset version 1 or 2
- Oculus link (USB3 to USB C) cable – note that a specific cable (that can support data transfer and power simultaneously) is required

The School of Information Technology has 10 Oculus Quest 2 headsets and special Oculus link cables available for local students and will be ready to pick up in January 2022. Students can use the headset for the duration of this course and return them upon the completion of their project. The exact date and place to pick up the headsets will be announced. This is the link to the type of cable that works perfectly; for those who may consider to buy it: https://www.amazon.ca/gp/product/B01MZIPYPY/ref=ppx_yo_dt_b_search_asin_title?ie=UTF8&psc=1

Course Organization:

This course involves a series of lectures and tutorials on the design and development of interactive VR applications. Participation in in-class activities is also expected.

Course Grading Summary:

Item	Due Date	%
Tutorials (best 8 of 9)	Weekly (See course topic schedule)	15
Project document (Design brief, project timeline, Implementation, tracking plan)	Jan. 24, 2022	15
Reading assignment and seminar on academic papers	Weekly (See reading assignment section for dates)	10
Midterm test: Component 1: Knowledge test (to be done online) 8% Component 2: Submit project on 3D interaction, UI etc. 12%	Feb. 28, 2022	20
Final Project submission: • Component 1: Project file submission + presentation 25% • Component 2: (Project report paper) 5%	Apr.11, 2022 Apr.12, 2022	30
Participation in the form of weekly project update/discussion		10
TOTAL		**100%**

Online Course Details

Due to the ongoing COVID-19 pandemic, this course will be offered in a blended asynchronous/synchronous online format for winter 2022. Lectures will be synchronous (real-time), and tutorials will be posted on Brightspace in advance. The instructor will be available online for questions/consultation on Zoom (links to be provided on Brightspace) for tutorials to assess class participation, understanding of materials, etc. Students will be scheduled to deliver presentations after lectures.

Students are advised to attend online during the scheduled lecture timeslot. If they cannot attend, prior notification is required. Missing more than two sessions will not be acceptable and will reduce participation grades.

Students are responsible to view any posted video materials and keep up with the course content schedule (see below). Trying to cram everything the night before an exam is likely to lead to poor performance in the course.

Tutorials (Individual) 15% total

There are eight tutorials starting Jan. 10. Tutorials must be completed **alone**. Tutorials generally consist of a guided "pre-homework" part, and homework components assigned at the end of the scheduled Wednesday classes. Completed tutorials are due at the start of the following Wednesday class, when you will present your solution for grading. All tutorials are graded on a 4-point scale according to the following rubric:

Grade Item	3 – Good	2 – OK	1 – Poor	0 – Incomplete
Description	All homework components complete and working, with a high level of polish (e.g., bug-checking, visual quality, etc.)	All pre-homework components completed, homework components attempted but incomplete or buggy.	All pre-homework components completed; homework components not attempted.	Tutorial not done.

The tutorial component of your final grade will be based on your eight best scoring tutorials, i.e., the lowest scoring tutorial will be dropped, and the average on the rest will be scaled to 15% of your final grade.

Tutorials
Tutorial time slots are when the instructor will be available online to help on assignments/tutorials and may present a sample solution to the previous week's tutorial. Video walkthroughs of *guided* (i.e., *not* homework) parts of tutorials will be provided. Homework parts of tutorials are for you to complete on your own time.
Exam and final project (Individual) 50% total
A midterm exam will be held during class time, as scheduled below, and a final project submission and project presentation will be held at the end of the course (schedule TBD).
Component 1 of the mid-term will be a knowledge test to be held online. (Details TBD).
Component 2 will be the developed parts that can be used in the final project. Consider this as the working parts or even a prototype for the final project.

Project ideas:
Please note that these are only suggestions and students can make any other projects that can apply the techniques learned during the course.
Students may choose to build:
- a bowling alley in VR
- a fast-food restaurant scene in VR
- a hospital room (for training nursing students) in VR
- a science lab /room for students' safety training in VR
- a puzzle game in VR
- a shooting game in VR (Only one room and a few targets would suffice)
- a VR art gallery/museum

Each project should have the following components:
- Environment building (importing assets)
- Interactions
- UI elements
- Locomotion

Reading assignment: (Each student will be assigned to read and present a paper).
- presentation 1 – Jan 17: Applications and History: Brooks, F. (1999). What's real about virtual reality? In *IEEE Computer Graphics and Applications*, 19(6), pp. 16-27.
- presentation 2 – Jan. 24: **Immersion, Presence: Paper 2-**Bowman, D. A, McMahan, R. P. (2007).Virtual reality: How much immersion is enough?, *IEEE Computer*, 40 (7), pp. 36-43.
- presentation 3 – Jan. 31: 3D Display Technology: Paper 3 - Qi, W., Taylor II, R. M., Healey, C. G., & Martens, J. B. (2006). A comparison of immersive HMD, fish tank VR and fish tank with haptics displays for volume visualization. In the *ACM Symposium on Applied Perception in Graphics and Visualization*, pp. 51-58.
- presentation 4 – Feb. 7: 3D Input Technology: Paper 4- Achibet, M., & Marchai, M. (2016). DesktopGlove: A multi-finger force feedback interface separating degrees of freedom between hands. In *IEEE Symposium on 3D User Interfaces – 3DUI 2016,* pp. 3-12.

- presentation 5 – Feb. 14: 3D Selection and Manipulation: Paper 5- Argelaguet, F., Andujar, C. (2013). A survey of 3D object selection techniques for virtual environments. *Computers & Graphics*, 37(3), pp. 121-136.

- presentation 6 – Mar. 7: Navigation: Paper 6- Riecke, B.E., Bodenheimer, B., McNamara, T.P., Williams, B., Peng, P. and Feuereissen, D. (2010). Do we need to walk for effective virtual reality navigation? physical rotations alone may suffice. *International Conference on Spatial Cognition*, pp. 234-247.

- presentation 7 – Mar. 14: 3D User Interfaces: paper 7: McMahan, R.P., Bowman, D.A., Zielinski, D.J. and Brady, R.B. (2012). Evaluating display fidelity and interaction fidelity in a virtual reality game. *IEEE Transactions on Visualization and Computer Graphics*, 18(4), pp.626-633.

- presentation 8 – Apr. 4: Farmani, Y., Teather, R.J., (2020) Evaluating discrete viewpoint control to reduce cybersickness in virtual reality , *Virtual Reality*, in press.

- presentation 9 – Apr. 4: T.Babic et.al (2018) Pocket6: A 6Dof Controller based on a simple smartphone Application.

Course Topic Schedule

Week	Date	Topics	Work Due, Tutorials Available
1	Jan. 10	Course Introduction, Policies Introduction to VR/AR/3DUIs History and Application Areas Introduction to project management	*Tutorial 1: Getting up and running in Unity VR*
2	Jan. 17	Immersion, Presence, Embodiment Intro to XR Frameworks in Unity Project selection	*Tutorial 2: Stereo rendering in Unity*
3	Jan. 24	3D Display Technologies Visual Perception, Stereo Rendering Stereo Rendering in Unity -Importin/converting assets from 3D software into Unity (using Blende free/opensource software)	*Project design document/schedule* *Tutorial 3: Controllers and head-tracking*
4	Jan. 31	3D Input Technologies Tracking Systems, Haptic Devices Trackers in Unity Oculus Integration package set up vs XR SDK	*Tutorial 4: Interactors and Interactable*
5	Feb. 7	3D Interaction Part 1: Selection & Manipulation Interaction with Objects in Unity Discussion on alternative SDKs (such as VRTK)	*Tutorial 5: Advance Interaction Techniques*
6	Feb. 14	3D Interaction Part 2: Navigation Moving in 3D environments in Unity walking vs teleportation in Unity using XR sdk	*Tutorial 6: Navigation Techniques*
	Feb. 21-25	*Reading week – No class*	

7	Feb. 28	Midterm Exam 3D Interaction Part 3: System Control, Symbolic Input, 3D User Interfaces (menus, etc.)	*Tutorial 7: 3D User Interfaces*
9	Mar. 7	Cybersickness: Causes, symptoms, quantifying, and methods to reduce/avoid it	*Tutorial 8: Cybersickness Reduction Methods*
9	Mar. 14	Low-Fi XR Environments: Smartphone VR, tracking, Google Cardboard, WebXR and Three.js	*Tutorial 9: Google Cardboard*
10	Mar. 21	Perceptual Illusions & Visuo-haptic remapping: Redirected walking, redirected touching, haptic retargeting	
11	Mar. 28	Evaluating virtual environments: Metrics and methods Unity profiler	
12	Apr. 4	*Screen based AR* *Marker based and marker less AR* *Vuforia and Open XR SDKs*	
13	Apr. 11	Final Project build (project files) and presentations	

While every attempt will be made to keep to the schedule listed above, circumstances may necessitate modifications throughout the semester.
Email Policy:
In order to ensure a timely response to your email queries, **the email must contain the course code in the subject** (i.e., ITEC 4016) in addition to the original subject of the email. Otherwise, your emails may inadvertently end up in a spam folder. You can generally expect a reply to email within 24 hours.

Instructors must use a Carleton email address to communicate private information to students (grade information, accommodations, etc.). Please contact university staff and faculty through your official Carleton email address. We have no way of confirming the identity of someone using non- Carleton email (i.e. Gmail, yahoo, rogers, etc.), and cannot provide any academic information to non-Carleton addresses.

Dispute Resolution:
If you have any disagreements with your marks, or the way the mark was assigned, first bring this to the attention of the TA who marked your assignment **within 1 week of grade availability**. Beyond this window, re-mark requests will not be considered. If discussion with the TA does not resolve the dispute, please have the TA send me an email and indicate the date that resolution was attempted. You can then visit me during my office hours and I will determine an outcome on the dispute. Note that this means I will regrade the entire assignment (not just the parts in question) and your grade could increase, decrease, or stay the same.

Posted Grades, Announcements:
Term marks and any announcements will also be posted on Brightspace. It is your responsibility to check the web site frequently and make sure that your marks are correctly recorded. All marked assignments, tests, midterms and projects should be retained by students as proof of completion and grade.

Inability to Complete an Assignment or Test due to Illness:
Students who are not able to contribute to a group project, submit an assignment, or write the midterm due to a certified illness will have the weight of the assignment/exam added to their final exam, with appropriate

documentation. Students will still be permitted to take the midterm exam as a formative exercise, but without a grade being awarded. Please note that in all occasions that call for a medical certificate you must use or furnish the information demanded in the standard university form. *http://www.carleton.ca/registrar/forms/*

Academic Accommodations for Students with Disabilities:

The Paul Menton Centre for Students with Disabilities (PMC) provides services to students with Learning Disabilities (LD), psychiatric/mental health disabilities, Attention Deficit Hyperactivity Disorder (ADHD), Autism Spectrum Disorders (ASD), chronic medical conditions, and impairments in mobility, hearing, and vision. If you have a disability requiring academic accommodations in this course, please contact PMC at 613-520-6608 or pmc@carleton.ca for a formal evaluation. If you are already registered with the PMC, contact your PMC coordinator to send me your *Letter of Accommodation* at the beginning of the term, and no later than two weeks before the first in-class scheduled test or exam requiring accommodation (*if applicable*). **Requests made within two weeks will be reviewed on a case-by-case basis.** After requesting accommodation from PMC, meet with me to ensure accommodation arrangements are made. Please consult the PMC website (www.carleton.ca/pmc) for the deadline to request accommodations for the formally-scheduled exam (*if applicable*).

Survivors of Sexual Violence:

As a community, Carleton University is committed to maintaining a positive learning, working, and living environment where sexual violence will not be tolerated, and where survivors are supported through academic accommodations as per Carleton's Sexual Violence Policy. For more information about the services available at the university and to obtain information about sexual violence and/or support, visit https://carleton.ca/sexual-violence-support/

Accommodation for Student Activities:

Carleton University recognizes the substantial benefits, both to the individual student and for the university, that result from a student participating in activities beyond the classroom experience. Reasonable accommodation must be provided to students who compete or perform at the national or international level. Please contact your instructor with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details, visit **https://carleton.ca/senate/wp-content/uploads/Accommodation-for-Student-Activities-1.pdf**

ACADEMIC INTEGRITY

The University Senate defines plagiarism in the regulations on instructional offenses as "to use and pass off as one's own idea or product work of another without expressly giving credit to another."
Borrowing someone else's answers, unauthorized possession of tests or answers to tests, or possession of material designed in answering exam questions, are also subject to university policy regarding instructional offences. Students who post their code online are making themselves a potential party to plagiarism and are subject to the consequences. For more information on Carleton University's Academic Integrity Policy, consult https://carleton.ca/secretariat/wp-content/uploads/Academic-Integrity-Policy-2021.pdf.

COURSE COPYRIGHT

Student or professor materials created for this course (including presentations and posted notes, labs, case studies, assignments, and exams) remain the intellectual property of the author(s). They are intended for personal use and may not be reproduced or redistributed without prior written consent of the author(s).

For a complete listing of academic and financial dates and deadlines for the 2020/2021 academic year, please visit https://carleton.ca/registrar/registration/dates-and-deadlines/.