CM3025: Virtual Reality

Module description

This module introduces you to the medium of Virtual Reality (VR) and to VR development. The module will combine the theory and psychology of VR with practical development skills. You will learn the skills needed to design compelling VR environments and the skills that are applicable in creative practice, science and industry.

Content Differentiation

This module aims to give you the skills needed to develop VR. This includes understanding the basic theory of presence in VR, which underlies the basic design principles. You will also learn practical development skills, using an appropriate 3D engine to create interactive virtual environments. These skills will include creating 3D environments, designing and implementing 3D interaction for VR and creating social VR experiences with interactive virtual characters.

The topics listed here are an approximation of what will be covered. The topics presented may be slightly revised to ensure currency and relevance. Students will be advised of any changes in advance of their study.

1. Introduction to VR
2. The Psychology of VR
3. VR Interaction
4. Navigation in VR
5. Object Interaction
6. Movement Interaction
7. Haptics and GUI
8. Immersive Audio
9. Embodiment
10. Social VR

Module goals and objectives

Students who successfully complete this module will to be able to:

1. Understand and apply the theoretical principles of 3D virtual environments

2. Understand and appraise many virtual reality techniques used in contemporary VR applications

3. Design and implement basic but complete interactive virtual reality experiences

4. Analyse and evaluate the use of 3d virtual environments in practical applications

5. Plan and implement a small piece of VR software taking into account technical and aesthetic considerations.

Textbook and Readings

There is no specific text book for this module, but there will be suggested readings throughout.

Students wishing to read further might be interested in the Proceedings of the IEEE conference on Virtual Reality.

The two following books are more general/popular books that student might find interesting

This is a book introducing the potential of VR from one of the founders of the field

Jeremy Bailenson. *Experience on Demand: What Virtual Reality is, how it works and what it can do.* W. W. Norton and Company. 2018

This is a memoir and introduction to VR by the excentric pioneer who coined the phrase "Virtual Reality"

Jaron Lanier. *Dawn of the New Everything: a journey through Virtual Reality*. Vintage 2017

Module outline

The module consists of ten topics that focus on key areas of the fundamentals of computer science.

Topic 1: Introduction to Virtual Reality	**Key concepts:** This topic will introduce the basics of virtual reality: what it is, how it is different from other media and how the hardware works. It will give a basic history of VR and explain many of the current and potential applications of VR. It will also introduce the

	basics of Unity, the platform we will be using in this module.
	Learning outcomes:
	• Explain the basic idea of virtual reality and differentiate between VR and non-VR applications • Explain the role of hardware in VR and choose appropriate hardware for a project • Explain possible applications of VR
Topic 2: The Psychology of VR	**Key concepts:** This topic will introduce the psychological impact of VR, how it affects us and how to use this knowledge to build better VR experience. It will introduce the concepts of Presence, Place Illusion and Plausibility.
	Learning outcomes:
	• Create a simple VR scene • Apply PI and PSI to the design and evaluation of VR experiences. • Explain the concepts of place illusion and plausibility
Topic 3: VR Interaction	**Key concepts:** In this topic we will discuss how people interact with VR experiences, how VR interaction can mimic how we interact with the real world and also how it can go beyond what is possible in the real world, while still feeling real. It will also discuss how controller hardware supports interaction.
	Learning outcomes:
	• Create a simple interactive VR experience • Explain key VR interaction techniques and select appropriate techniques for a project • Explain key challenges of VR

Topic 4: Navigation in VR	**Key concepts:** This topic will explain how you can move around VR worlds including popular methods such as walking in place and teleporting. It will also explain how navigation can result in nausea and how to avoid it. **Learning outcomes:** • Create a VR navigation system • Evaluate the benefits and disadvantages of different navigation techniques for a VR application • Explain key VR navigation techniques and select appropriate techniques for a project
Topic 5: Object Interaction	**Key concepts:** This topic explains methods for interacting with objects and the environment in VR, including the use of physics simulation. **Learning outcomes:** • Plan a small piece of VR software taking into account technical and aesthetic considerations. • Design and implement a VR object interaction system. • Evaluate the benefits and disadvantages of different object interaction techniques for a VR application
Topic 6: Movement Interaction	**Key concepts:** This topic goes further into the use of our whole body movement as a way of interacting with VR and how machine learning can be used to implement this. It also addresses ethical issues in VR. **Learning outcomes:** • Design movement based interaction techniques • Explain the value of embodied interaction in VR

	• Analyse and evaluate ethical issues with VR applications
Topic 7: Haptics and GUI	**Key concepts:** This topic introduces Haptics: the use of touch feedback in VR, including applications of haptics and hardware techniques. It also explains how traditional Graphical User Interfaces can be used in VR. **Learning outcomes:** • Design and implement haptic interaction in VR • Analyse and evaluate haptic and GUI interaction in VR • Design and implement GUIs for VR
Topic 8: Immersive Audio	**Key concepts:** This topic explains the use of sound in VR and in particular how spatialised sound can create as much of an immersive experience as visuals. **Learning outcomes:** • Design and implement audio based interaction for VR • Design and implement auditory VR experience • Analyse and evaluate the use of audio in VR
Topic 9: Embodiment	**Key concepts:** This topic will discuss how VR can be used not only to be somewhere else, but to be some one else, by allowing people to inhabit a virtual body. **Learning outcomes:** • Understand the theory of embodiment and apply it to designing VR experiences

	• Analyse and evaluate VR embodiment experiences • Design and implement a VR embodiment experience
Topic 10: Social VR	**Key concepts:** This final topic discusses how we can use VR to meet and interact with other people, both real and virtual and the potential benefits of this kind of social VR experience. **Learning outcomes:** • Implement a small piece of VR software taking into account technical and aesthetic consideration • Analyse and Evaluate social VR applications • Understand and appraise social interaction techniques for VR

Activities of this module

The module is comprised of the following elements*:*

- *Lecture videos.*
- *Practice Quizzes.*
- *A major project including peer reviews and staff graded assignments on work in progress*
- *Discussion Prompts*
- *Readings.*

How to pass this module

The assessment of this module consists in a major project in which you will develop a Virtual Reality Experience. The coursework will be submitted at the end of the module, but you will also submit a preliminary design of the project half way through the course. You will also be able to submit your work in progress for peer review feedback in every topic.

Activity	Required?	Deadline week	Estimated time per module	% of final grade
Project Proposal and Plan	Yes	12	Approximately 15 hours	30%
Final Project submission	Yes	22	Approximately 35 hours	70%