

# Introduction to Virtual and Augmented Reality

COMP 30025J

Dr. Abraham Campbell

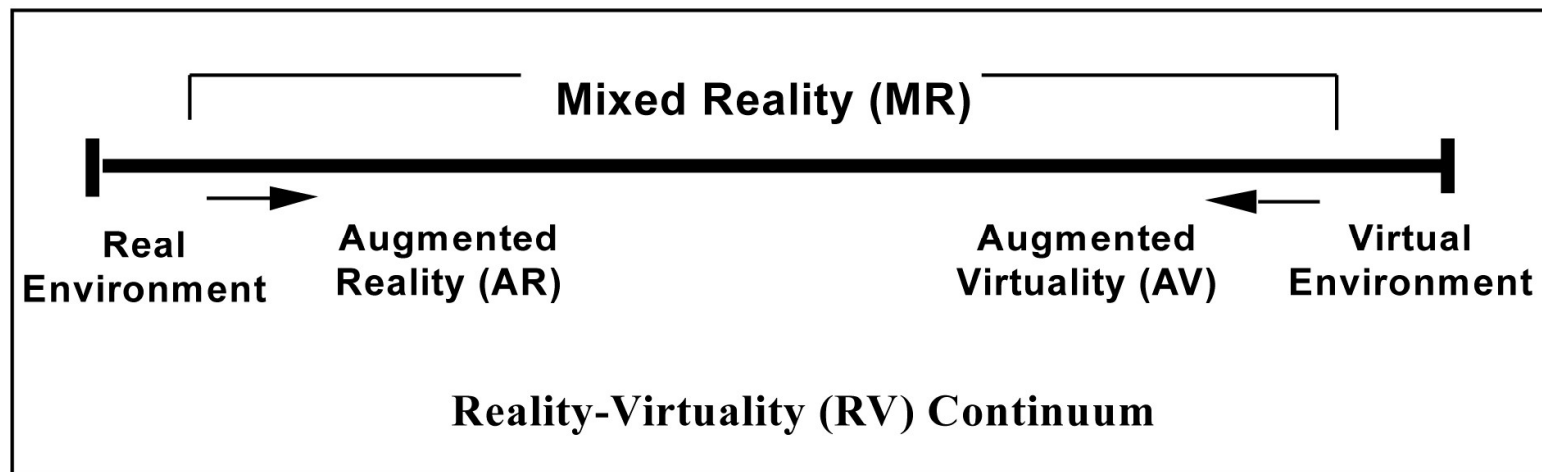


# Aims of the course

- To give you a broad understanding of the general topic of Augmented Reality and Virtual Reality
- To act as a capstone to your previous modules on Computer Graphics and Mobile Development.
- To help teach you how to read and understand academic papers.
- To facilitate the development of a complex single man team project in either VR / AR or both with limited supervision.



# The course name says its about Virtual and Augmented Reality, why not Mixed Reality ?



(Milgram et al 1994)

I'd love to call this course MIXED REALITY, but no employer or sadly even most academic institutions would understand your transcripts so we got to go with both names 😊



# Why is it important to learn about Mixed Reality as a software Engineer

I think one of the things that really separates us from the high primates is that we're tool builders. I read a study that measured the efficiency of locomotion for various species on the planet. The condor used the least energy to move a kilometre. And, humans came in with a rather unimpressive showing, about a third of the way down the list. It was not too proud a showing for the crown of creation. So, that didn't look so good. But, then somebody at Scientific American had the insight to test the efficiency of locomotion for a man on a bicycle. And, a man on a bicycle, a human on a bicycle, blew the condor away, completely off the top of the charts.

•

And that's what a computer is to me. What a computer is to me is it's the most remarkable tool that we've ever come up with, and it's the equivalent of a bicycle for our minds." ~ Steve Jobs

If a computer using a 2D display screen can be a Bicycle  
for the mind .

Then a AR/VR display is a motorbike



# It is the Final Display

- The full ability to quite literally create and control a Virtual world around us
- It augments a humans abilities.
- It allows an unlimited creativity in creating interfaces between us and computers



# Applications of Mixed Reality

- Endless applications
  - Education
  - Gaming
  - Industry
  - Commerce
  - Translation
- Final display/Interface technology
  - Desktop computer
  - Laptop
  - Smartphone
  - AR headset



# Course Evaluation

- 50% final exam – Answer 3 out of 5
- 50% practical
  - Attendance & Participation(5%)
  - Essay on AR/VR topic (10%)
    - Should ideally serve as the foundation / background research to your project
    - Due Week 8
  - Project on AR or VR topic (35%)
    - Interviews / submission Week 14



# Course Structure

- The course will be structure around roughly 18 (may go up or down) Academic papers covering the whole Mixed Reality Spectrum.
- Some weeks will be 2 or 3 small papers or 1 big paper
- Some weeks will be just a short 2 page paper





# Notes will be uploaded after Lecture

- Slides will be on the Moodle:
  - New MOODLE for Computer Science Students
  - <https://csmoodle.ucd.ie/>
  - Logon using your UCD connect account
  - Click on COMP3025J
- And enrolment key is “**COMP3025Jab**”



# Course Structure

- This course is structured as a Research Seminar, where reading of the papers before class is essential.
- The exam will be just a simple questions about the topic that you need to address in a detailed 1000 word or more essay
  - For example
  - Is it important to have a taxonomy to explain how different displays allow for Virtual Reality and Augmented Reality applications ? Please give an detailed answer in 1000 words or more included detailed references to explain your arguments.
- You will not taught a set programming language or IDE or game engine to complete the practical side of this course



# Course Structure ( cont.)

- I will be random asking peoples opinions.
- You are allowed and encouraged to challenge me and tell me I'm wrong
- I will some times play devils advocate, and say something I do not agree with
- Academic papers are how knowledge grows, peer review is not perfect, but over time the best ideas come to the fore.
- Imperfect ones still can aid the field



Each week, we have to read a paper beforehand and then we will discuss it ?

Are you Serious Dr. Campbell ?  
YES , Yes I am



First Paper will be

**Augmented Reality: A class of displays on the reality-virtuality continuum by Paul Milgram, Haruo Takemura, Akira Utsumi, Fumio Kishino (1994)**

**I will pass out handouts now**



# How do you read an Academic paper ?

- This may seem to be a stupid question at first .
- The most obvious answer would be start reading at the beginning and keep reading till the end
- Academic papers are not stories, they are reports
- They are presentations though so they do tell the story about how research was conducted.



# So how do I read this paper

Papers are broken down into several common sections, not every paper will have all sections but in general these are the most common.

- Abstract
- Introduction
- Background

The report sections ( one or more sections )

- Implementation / Concept / Experimental setup /
- Taxonomy / Development / Research results / Future work
- Conclusions

References and extra information

- References / Appendix



# So how do I read this paper

- You should always read the **abstract** first, but after that it depends on why you are reading the paper
- In general you are trying to understand what **Research Question** is this paper answering
- If you can understand that from the **abstract**, then after briefly looking at the **introduction**, you should read the **conclusion**.
- On caveat on all this, if you are very familiar with the field after reading the **abstract**, you actually read the **references** first. This is because you want to know who the authors have referenced to understand their approach.





# So how do I read this paper

- Once you have read the **conclusion**, you should now examine the structure of the paper.
- Reading all **headings** and looking at all the **diagrams** within the paper
- Once you understand the papers premise and structure
- You now read the paper sequentially.
- Normally, you will have to read the paper multiple times.



# After you have read the paper

- You should write your own short summary of the paper ( 150 – 200 words)
- Write this on actual paper.
- I will ask everyone to show me this before class.
- **If you do not have it, you can not attend!!!**
- After writing this, you need to ask yourself
  - What research question did this paper address ?
    - Did it achieve its goal ?
  - What more research questions have been generated ?
    - Is it reproducible ?
  - Are the good ideas from this paper that can applied to other areas?
    - Is it connected to other ideas ?



# Topics in Mixed Reality space are vast

## What are we going to study ?

- Display technologies to produce AR/VR environment
- History of Augmented and Virtual Reality
- Tracking technologies (Active / Passive)
- 3D photogrammetry
- VR/AR Game Engines
- CAVE VR Environments
- Mobile AR/VR
- Current VR HMD's
- Interaction devices in VR and AR HMD
- Abstractions to aid in developing AR/VR applications
- Tele-Presence & Educational VR/AR applications



# Reading list ( Suggested )

Copies will be place in the BDIC library  
These are books that are both fiction and nonfiction that are heavily used to discuss these topics in academic circles and as such I will make reference to them during the course

Virtual Reality by Howard Rheingold (put in already)

Snow Crash by Neal Stephenson ( buying shortly) Still looking for a copy

The Diamond Age by Neal Stephenson ( buying shortly) Still looking for a copy

Rainbows End by Verner Vinge ( buying shortly) Still looking for a copy



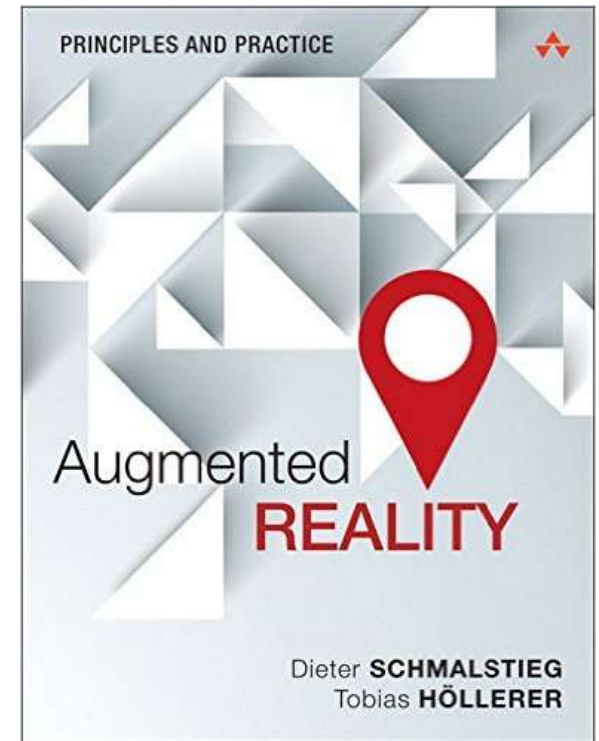
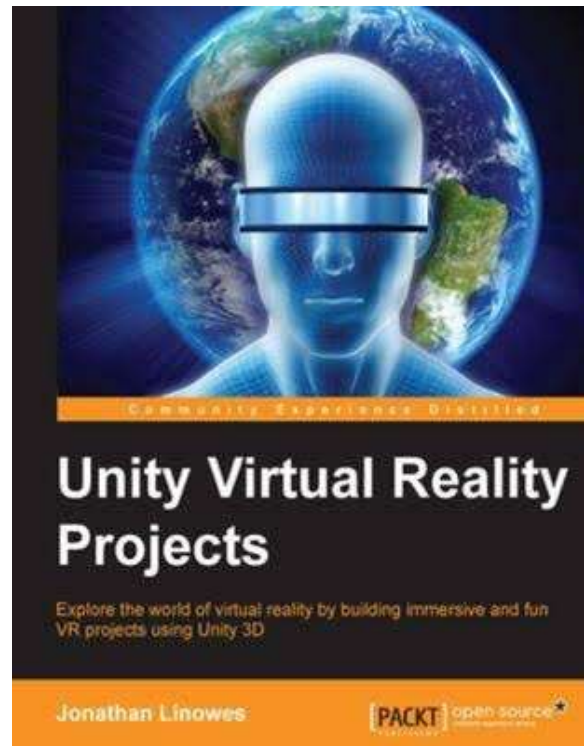
# Text books

- This is a paper based course, and I will be giving you photocopies of all the papers.
- Textbooks are chosen to give you information on where much of the content of my lectures will be based on and an idea of reference material to aid in the development of your projects.
- In the exam, the papers & my notes are all you need to get an A+ grade
- The textbooks maybe hard to get in China which I understand , I have one copy of each with me in china and will do my best to give you all access to them during our studio sessions. In future I plan for a reference edition to be in the library but this is the first time around so that will not be possible.



# Textbooks for the course

- 3D Game Engine Design by David H. Eberly
- Unity Virtual Reality Projects by Jonathan Linowes
- Augmented Reality: Principles and Practice (Usability) by Dieter Schmalstieg & Tobias Hollerer



# Projects & Essays

- I will discuss the projects and essays later in week 3.
- You will choose one area within AR or VR to make a demonstration application.
- You can build on last years projects that you completed in Mobile Computing and Computer Graphics last year, or learn a completely new technology.



# How to approach the project ?

- I'd suggest that a game engine like UNITY would be the easiest way to approach a VR project
- In terms of AR, ARTOOLKIT for Android using the Eclipse IDE would probably be the best starting point for an AR project.
- The project will be up to you and I will aid you in both coming up with a project and helping you complete it during our studio time from week 4 onwards.
- The essay will be a companion piece to this project , discussing the area of research.





# Scheduling

- Lectures are Friday 8.00 in Room 620. TB4
  - (From week 1 – 12)
- AR/VR Studio/lab time Wednesdays 9:55  
Zhixing Building
  - (Starts Week 3 – Week 13)
  - First Studio time will be dedicated to scanning our own 3D objects 😊

