COMS W4172

Introduction

Steven Feiner
Department of Computer Science
Columbia University
New York, NY  10027

www.cs.columbia.edu/graphics/courses/csw4172

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Goal

- Learn how to design, develop, and evaluate effective 3D user interfaces
  - Emphasis on Augmented Reality (AR)
What is Augmented Reality?

- Augment the real world with computer-generated virtual material (addressing any sense)
  - Combine real and virtual
    - Much work addresses only visual AR [Azuma 97]
  - Interactive in real time
  - Registered in 3D
- Unlike virtual reality (VR)
  - Supplement rather than replace real world
  - Design virtual world to complement real world

Interactive in real time
Registered in 3D

Unlike virtual reality (VR)
Supplement rather than replace real world
Design virtual world to complement real world

Combining Real and Virtual

- Variations
  - Diminished reality
    - Remove real objects
  - Mediated reality
    - Modify real objects

http://www.epfl.ch/~lepeltit/movies/lepeltit_ismr01.mpg

S. Mann and J. Fung, ISMR 2001

Feiner, COMS W4172, Spring 2016
Why Now?

- Commodity devices are finally sufficiently
  - Powerful
  - Small
  - Inexpensive

Columbia Mobile Augmented Reality System, 1996 –

Wikitude AR, Layar, Nearest Tube, Aurasma, City Lens..., 2008 –

Why Now?

- Commodity eyewear is imminent

Oculus Rift

Microsoft Hololens

Epson Moverio BT-200

metaPro prototype

www.spaceglasses.com

www.epson.com/cgi-bin/Store/pt/Landing/moverio-bt-200-smart-glasses.do

https://apps.fcc.gov/eas/GetApplicationAttachment.html?id=2662237
Why Now?

http://google.com/trends

Approach

- Lectures
- Design, development, and evaluation assignments
  - Unity 5.3
    - Game development environment
  - PTC Vuforia 5
    - Camera-based position and orientation tracking
  - ≥ Windows 7 SP1 or OS X 10.6 for development
  - ≥ Android OS 4.0.3 or
    ≥ iOS 7.0/XCode 6.0 for deployment
**Approach**

- **Team final projects**
  - Topics and teams proposed by you

**Professor**

- **Steve Feiner** (feiner@cs.columbia.edu)
  - Director, Computer Graphics and User Interfaces Lab
  - HCI
  - Interactive 3D UIs
  - Augmented reality
  - Wearable/mobile computing
  - Hybrid UIs (combining different technologies)
  - Knowledge-based design of graphics/multimedia
  - Virtual environments
  - Games
  - Information visualization
  - Office hours: Mon/Wed 1–2pm
  - Schapiro CEPSR 609, 212 939 7083
IAs

- Morgan Thompson (mzt2102@columbia.edu)
  - Senior in CS Vision and Graphics Track
  - Office hours: Wed 2–4pm
    Schapiro CEPSR 6LE3
- Luis Tolosa (let2120@columbia.edu)
  - Senior in CS
  - Office hours: Wed 4:10–6:10pm
    Schapiro CEPSR 6LE3

Prereqs

- COMS W4160 (Computer Graphics) or equivalent
  - or
- COMS W4170 (User Interface Design) or equivalent
  - or
  Ask me!

- Math?
  - Covered in class
Text

- For this week: Chaps 1–2, 12.1, 10 (except 10.2.3)

Grading

- Individual Assignments 60%
  - “Hello interactive 3D world” 10%
  - UI Evaluation 10%
  - Interaction techniques 20%
  - Written 3DUI analysis 20%
- Team project 40%
**Lateness Policy**

- All assignments due at 1:10pm on scheduled due date
- Four “late days” allowed during semester for which lateness is not penalized
  - None can be used for final project
  - Only one can be used for first assignment
  - Anything turned in past 1:10pm until midnight the next day is one day late
  - Every (partial) day thereafter that an assignment is late (including weekends and holidays) counts as an additional late day
- Absolutely no late work accepted beyond that accounted for by late days
- If not done on time, turn in whatever you have completed on time to receive partial credit

**Academic Honesty Policy**

- Department of Computer Science *Policies and Procedures Regarding Academic Honesty*
  - www.cs.columbia.edu/education/honesty
- Any use of GitHub or similar collaborative code dev sites must be done using private repos, open only to appropriate parties
- Infractions will be referred to the CUCS Academic Committee and the Deans
Syllabus
www.cs.columbia.edu/graphics/courses/csw4172

- Intro and history
- Design principles (reality, metaphor, magic)
- Case studies
- 3D math
- Development tools
- 3D perception, displays, and devices
- Selection
- Manipulation
- Travel
- Wayfinding
- Control: menus ↔ multimodal
- Symbolic input
- Design issues
  - Two-handed, whole-body, immersion, presence
- Evaluation
- Augmented reality
- Tangible user interfaces
- Future directions
- Guest lectures

Early History

- Flight simulators
  - Mechanical
    - Link Trainer, 1930s
  - Analog video
    - Full-motion cameras
      - “flown” over 3D terrain models/photos
  - Digital
    - NASA space program,
      - 1960s
Early History

- Timothy Johnson, Sketchpad III (1963)
  - Built using Ivan Sutherland’s 2D Sketchpad
  - 3D CAD with 2D interaction devices
  - 3D interaction device
  - Tracks 3D position of tip
  - Ultrasonic

Early History

- Charles Comeau and James Bryan (Philco), Head-tracked orientation control of remote camera (1961)
  - Head orientation sensor
  - Head-worn display
  - Video from remote camera controlled by head orientation

Early History

- Ivan Sutherland, Head-tracked VR/AR (1965–70s)
  - Stereo, see-through head-worn display
  - Synthesized imagery combined with view of real world

- Robert Burton, Scene scanning / tracking (1973)
  - Real-time 3D tracking of multiple LEDs, laser scanning of scene
  - Laser scanning of scene (H. Fuchs)
3D UI Taxonomy

- Objects  representational ↔ abstract, hybrid
  - Mapping from task domain to object properties
- Space  natural ↔ abstract, hybrid
  - Mapping from task domain to spatial axes
- Actions  representational ↔ abstract, hybrid
  - Mapping from task domain to actions
- Users  skills, experience, abilities, body, age, gender,…
- Collaboration  individual ↔ community
- Tasks  work, learn, play,…