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

![Augmented Reality Diagram](image)

A. Webster et al., Proc. ASCE Congress on Computing in Civil Engineering, 1996

Combining Real and Virtual

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

![Combining Real and Virtual](image)

S. Mann and J. Fung, ISMR 2001

Original Diminished Reality Mediated Reality

http://cvlab.epfl.ch/~lepetit/movies/lepetit_ismr01.mpg
**Why Now?**

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


**Why Now?**

- Commodity eyewear is imminent

Google Glass
www.google.com/glass

GlassUp
glassup.net

Epson Moverio BT-200
www.epson.com/epstore/jsp/Landing/moverio-bt-200-smartglasses.do

metaPro prototype
www.spaceglasses.com
Why Now?

http://google.com/trends

Approach

- Lectures
- Design, development, and evaluation assignments
  - Unity 3D 4.3.3
  - Game development environment
  - Qualcomm Vuforia v2.8
  - Camera-based position and orientation tracking
  - ≥ Windows 7 SP1 or OS X 10.6 for development
  - Android or iOS for deployment

For detailed hw/sw requirements see graphics.cs.columbia.edu/wiki/doku.php?id=wiki:comsw4172_ta_2014spring
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
TA

- Carmine Elvezio (ce2236@columbia.edu)
  - MS in CS, Columbia
  - Interested in augmented reality, multicore and GPU development, low-level code optimization
  - Office hours: Tue/Thu 3–5pm
    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)

Conferences

- IEEE Symp. on 3D User Interfaces
  http://conferences.computer.org/3dui/
- IEEE Virtual Reality
  http://conferences.computer.org/vr/
- ACM Symp. on Spatial User Interaction
  http://sui.ict.usc.edu/
- ACM Symp. on User Interface Software and Technology
  http://www.ui.st.org
- ACM Symp. on Virtual Reality Software and Technology
  http://www.vrst.org
- ACM Symp. on Interactive 3D Graphics and Games
  http://www.siggraph.org/conferences/i3d
- IEEE Int. Symp. on Mixed and Augmented Reality
  http://www.ismar.net/
- IEEE Int. Symp. on Wearable Computers
  http://www.iswc.net
Grading

- Individual Assignments 60%
  - “Hello interactive 3D world” 10%
  - UI Evaluation 10%
  - Interaction techniques 20%
  - Written 3DUI analysis 20%
    (more info shortly)
- 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
- 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

- Timothy Johnson, Sketchpad III (1963)
  - 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
Early History

- 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,…