CSE 118 - Tue 10/23

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Today

- Admin
  - Project Assignment #3
- Mini Quiz
- Eye-Tracking
- Wearable Trackers and Quantified Self
This week you will be using PrototipAR to create prototypes for your project idea(s) in their intended environment. For example, an application that is meant to be a surgical aid will need to be prototyped in an operation room. One that’s meant to be used in a bus will be prototyped on, say, one of the campus shuttles.

If you need help getting access to an environment of your choice, reach out to your mentor TA.

You are required to submit the following:

1. Prototype Videos: each prototype you create will require two videos:
   HoloLens Perspective (recorded through the HoloLens)
   Third-person Perspective (recorded through another device like your phone)

2. A description of the prototype (max 1/2 page): This should include a description of the environment as well as the specific problem you are designing for. You should also include any other contextual details or clarifications that help us understand your videos.

3. A google doc detailing your experience with the tool: This document only serves as a way for you to document your experience with PrototipAR. What worked? What was hard? What are your thoughts or feelings about it? You can also include details about any errors or bugs you see, something you would like to change etc. Feel free to include videos or pictures to this document if it helps make your point. This is NOT a formal document so don’t worry too much about using formal language, we just want you to capture your experience and encourage you to do so after each session or even during one.
Mini Quiz on Week 3

On Google Classroom

https://docs.google.com/forms/d/16_IF-UY-TtU01kC3t0yvFWUT2j0t1RgE4VIfH5fslv4/edit
Eye-Tracking

Credits: Wen-Hung Liao, Antti Aaltonen, Andrew Duchowsky, Sean Burke, Pavan Kumar, Sneha Venkatesh Yelimeli and Brian Anderson
An eye tracker is a device for measuring eye positions and eye movements.

The most popular variant uses video images from which the eye position is extracted.

Input source: visible spectrum vs. infrared
Physiology of Eye

- Cornea is a transparent structure that covers the iris and pupil; a part of the focusing system of an eye.
- Pupil is the adjustable opening at the center of the iris that allows varying amounts of light to enter the eye.
- Lens helps to focus light on the retina.
- Retina includes rods (94%), which are sensitive to light and cones (6%) that capture colors. Cones are concentrated in the centre of the retina - the fovea.
Eye Movements

- Eyes move all the time (even during sleep)
- Several different movement types, such as
  - Pursuit
  - Tremor
  - Rotation
  - Drift
- But the most interesting types are
  - Fixation
  - Saccade
Fixation

- Eye is a (relatively) still and “fixated” to the certain point. *E.g.* reading a single word.
- All the information from the scene is (mainly) acquired during fixation.
- Duration varies from 120-1000 ms, typically 200-600 ms.
- Typical fixation frequency is < 3 Hz
- Interspersed with saccades...
Saccade

- “Jumps” which connect fixations
- Very rapid -- duration is typically only 40-120 ms
- Very fast (up to 600 °/s) and therefore the vision system is suppressed during the movement
- Ballistic; the end point of saccade cannot be changed during the movement
- Saccades are used to move the fixation point
  - If larger than 30 degree movement is required, head moves along with eyes
Eye Movements

- **Eye movements** are typically divided into **fixations** (when the eye gaze pauses in a certain position) and **saccades** (when it moves to another position).
Eye Tracking Methods

• Electronic methods
• Mechanical methods
• Video-based methods
  • Single point
  • Two point
Eye Tracking Techniques

Electro-OculoGraphy (EOG)

Scleral Contact Lens / Search Coil

Photo/Video-OculoGraphy (POG)

Video-Based Combined Pupil / Corneal Reflection

Eye Tracking Methodology - Theory and Practice, Second Edition by Andrew Duchowski
Some terms

- **Accuracy**
  - The expected difference in degrees of visual angle between true eye position and mean computed eye position during a fixation.
  - Because of the vision system and physiology of eye the accuracy is usually $0.5-1^\circ$.

- **Spatial Resolution**
  - The smallest change in eye position that can be measured.

- **Temporal Resolution (sampling rate)**
  - Number of recorded eye positions per second.
## Eye Tracking Calibration

### Calibration Process

<table>
<thead>
<tr>
<th>DISPLAY OBJECTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>DETERMINE EYE MOVEMENT INFORMATION</td>
</tr>
<tr>
<td>ASSOCIATE EYE MOVEMENT INFORMATION WITH A LOCATION OF ONE OR MORE OBJECTS DISPLAYED</td>
</tr>
<tr>
<td>CALCULATE CALIBRATION PARAMETERS BASED ON THE ASSOCIATION OF THE EYE MOVEMENT INFORMATION AND THE LOCATION OF ONE OR MORE OBJECTS DISPLAYED</td>
</tr>
</tbody>
</table>

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*Eye Tracking Methodology - Theory and Practice, Second Edition by Andrew Duchowski*  
*Systems and methods of eye tracking calibration - US 20140226131 A1*
State-of-the-art Eye tracking Technology
ASL 4000-series (1996)

- Main components
  - Floor mounted optics
  - Control unit
  - 2 computers (control & subject)

- Head movements (partially) compensated with tracking mirrors and extended head movement options

- Temporal resolution 50 Hz
- Spatial resolution 0.5°
- Tracks only one eye
- Poor analysing software and no API
SMI EyeLink (1999)

- Contains
  - Head mounted optics
  - 2 computers (control & subject)
- Temporal resolution 250 Hz
- Spatial resolution <0.01°
- Tracks both eyes
- Reasonable analysis software
- WIN API’s for Microsoft Visual C++
Present Technology

Tabletop
User must be semi-stationary
Approx USD 30,000
No API for development

Wearables
Google Glass (?)
Tobii, SMI
Smart Phone

- **Samsung Smart Stay**
  - Scrolls when viewing edge of screen
  - Pauses when looking away
  - Uses front-facing camera

- **Amazon Fire Phone**
  - Dynamic Perspective
  - Eye/Head Tracking
Eyetribe Eye Tracker

- **Features**
  - Camera, multiple infrared LEDs
  - Band-pass filter
  - Operating Range: 45 - 75cm
  - USB 3.0 Superspeed
  - API/SDK: C++, C#, Java
  - Cost: $99
Tobii EyeX + 4C

https://tobiigaming.com/
Tobii
Applications
Overview

- Computer Science
- Cognitive Science
- Psychology
- Neuroscience
Usability Study
Driving Behavior
Gaming
CS - Selective Systems

- Eye tracker as input device
  - Explicit - eg. eye typing
  - Implicit - eg. MAGIC pointing
Character Input
CS - Gaze Contingent Display

- Real time display manipulation to match eye gaze
  - Screen based
  - Model based
  - Attentive UIs
Psychology

- Reading patterns
- Word fixation and scanning
- Spritz - Full Product
  - Reduce need for scanning
Assistive Technology: LIS
Wearable Trackers
The Future of YOU

https://www.youtube.com/watch?v=QTyWv2eIyWs
Next Steps

- Readings to discuss on Thursday
  - Design Paper: Dow, Steven, Blair MacIntyre, Jaemin Lee, Christopher Oezbek, Jay David Bolter, and Maribeth Gandy. "Wizard of Oz support throughout an iterative design process.”
Wizard of Oz Prototyping

And pay no attention to the little man behind the curtain...
Optional Papers


Next Steps

• Submit your reading-summary and annotations by Thu 12.30pm
• Read/Annotate all papers
• Assignment #3
Thanks