SHaZam: The Magic Lamp

Chaim Leib-Halbert
Dexter Scobee
Edward Zhao
What is SHaZam?
How?

- User
- IR LEDs
- WiiMote
- Bluetooth Dongle
- Raspberry Pi
- SparkFun RS-485 Breakout
- RX-24F Motors
- Flashlight
How?
Models

- AUTO
  - A/LED (2+3)
  - Paired/LED (1+4)
  - A+B/LED (1+4)

- BLUEETOOTH_PAIRING

- MANUAL
  - A/LED (2+3)
  - Paired/LED (1+4)
Pitch/Yaw

Δ\(\Theta\) < minThresh 
or 
Δ\(\Theta\) > maxThresh

Δ\(\Theta\) > minThresh 
or 
Δ\(\Theta\) < maxThresh
Headgear Design
Tracking Formula

\[
\tan(\psi_3) = \frac{y_3}{x_3}
\]
\[
\tan(\theta_2) = \frac{y_3 + l \cos(\psi)}{x_3 - l \sin(\psi)}
\]
\[
\tan(\theta_3) = \frac{y_3 + m \cos(\psi)}{x_3 - m \sin(\psi)}
\]
\[
c = \frac{l_{23} \tan(\psi_1) - \tan(\psi_3)}{l \tan(\psi_2) - \tan(\psi_3)}
\]
\[
a = 1 - c
\]
\[
b = \tan(\psi_1) - c \tan(\psi_2)
\]
\[
\psi_{user} = \tan^{-1}\left(\frac{-a}{b}\right)
\]
\[
x_3 = \frac{l(\cos(\psi_{user}) + \sin(\psi_{user}) \tan(\psi_1))}{\tan(\psi_1) - \tan(\psi_3)}
\]
\[
y_3 = x_3 \tan(\psi_3)
\]
Putting It All Together

• Read data from WiiMote at fixed, repeating interval
• Use data from WiiMote to calculate user’s position
• Use user’s position to calculate the angle to which motors need to move
Demo
Issues

• BlueSMirF Gold doesn’t work with HID, only serial
• BlueSmirF HID didn’t work either!
  – Could not act as HID host
Solution
More Issues

• Gaze tracking algorithm is numerically unstable

• In simulation, one degree of error could result in ~50 degrees of change in estimated user yaw angle
Solutions

• Reduce problem to following user’s head position
• Add auto/manual mode functionality
• Manual mode still allows SHaZam to be used as an adjustable desk lamp.
Moving Forward

• Explore algorithmic improvements to gaze tracking
  – Perhaps a numerical approximation method would be more stable than the exact solution
• Use facial recognition / eye tracking via visual camera and computer vision
• Improve usability and aesthetics
Credits

• CWiiD – Donnie Smith:
  – https://github.com/abstrakraft/cwiid
• Johnny Chung Lee
  – http://johnnylee.net
• Wiibrew and community of WiiMote hackers
Thank You!

• Professor Lee & Sangiovanni-Vincentelli
• John & Antonio
• Ben Zhang