SHaZam: The Magic Lamp

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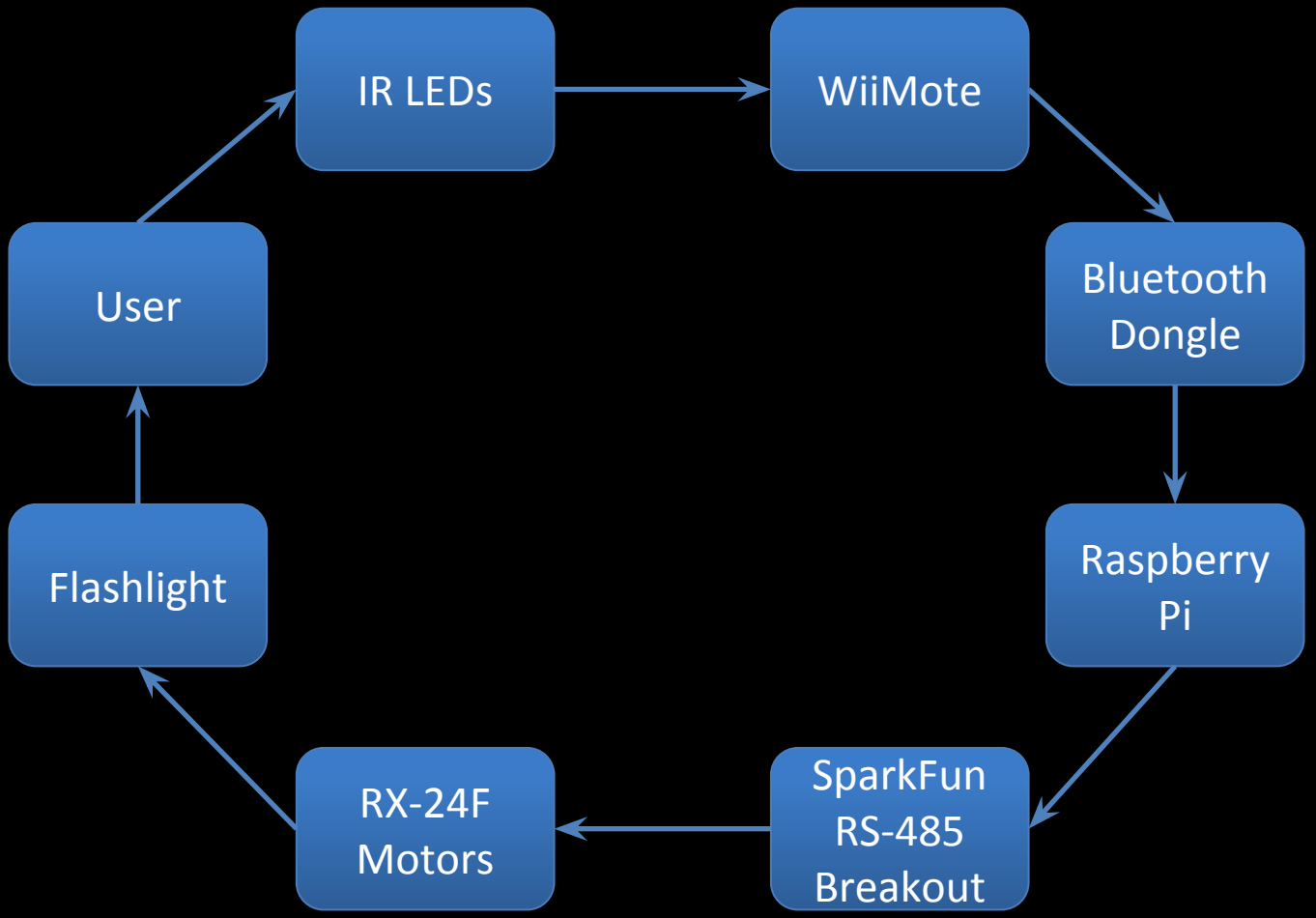
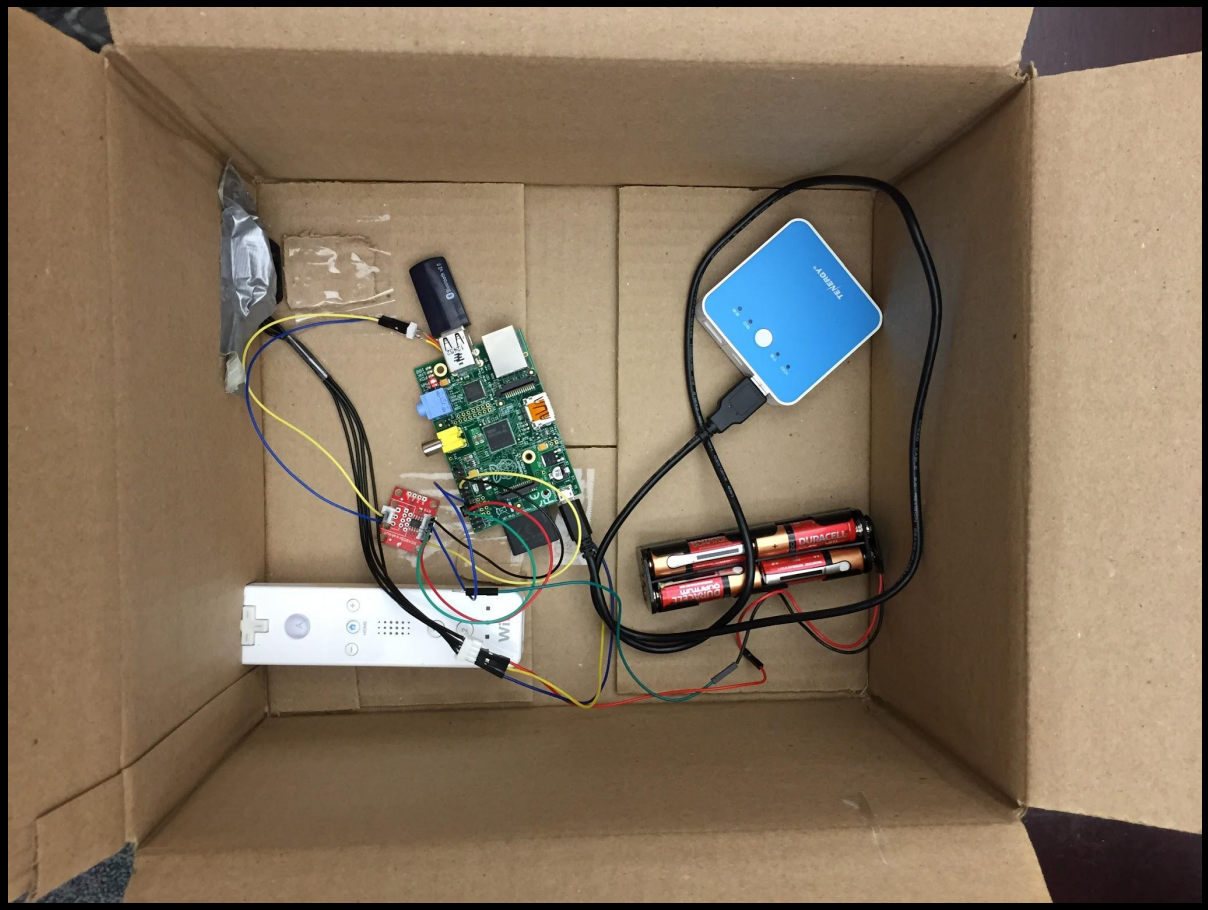
What is SHaZam?

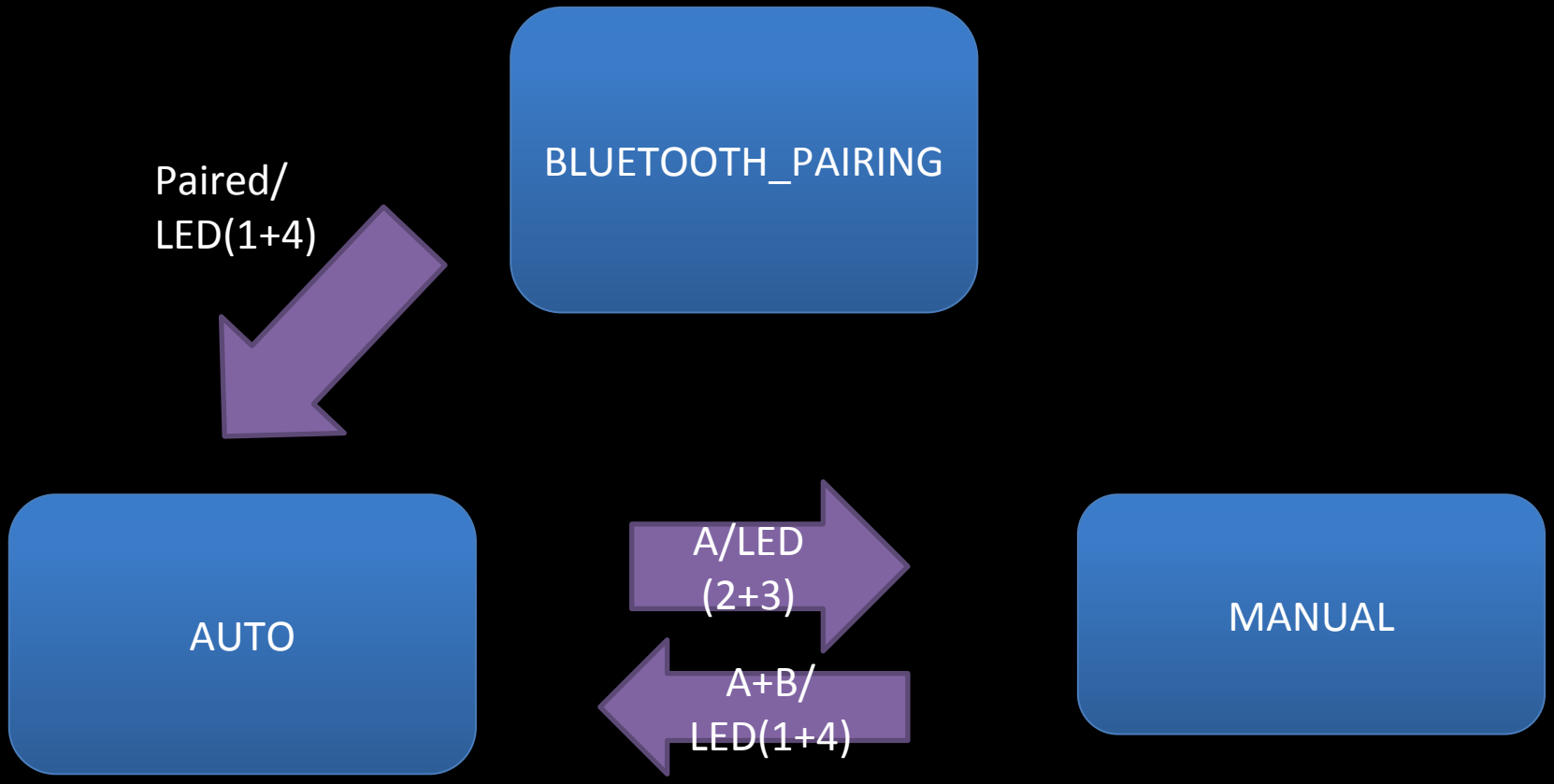
How?


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

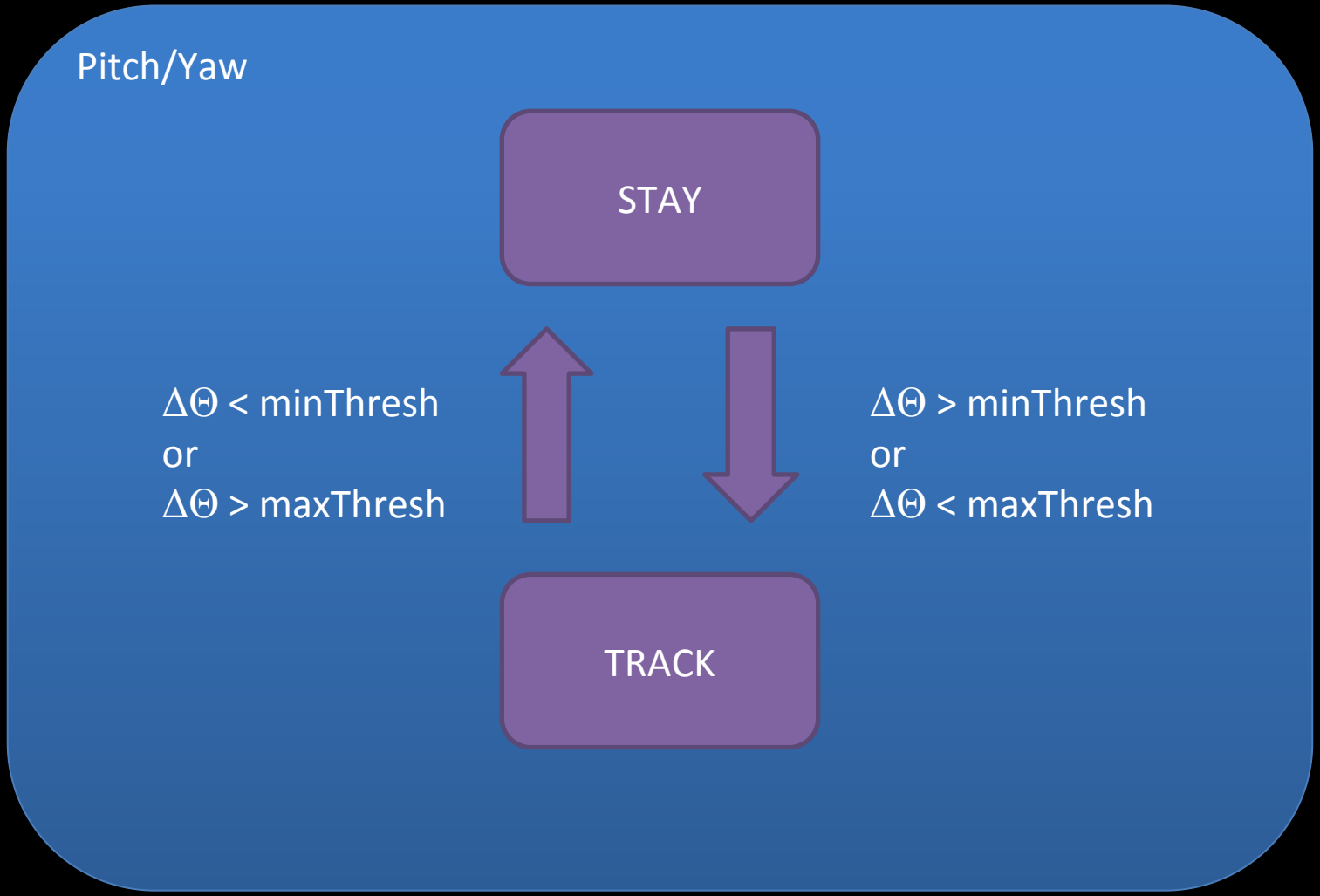
How?



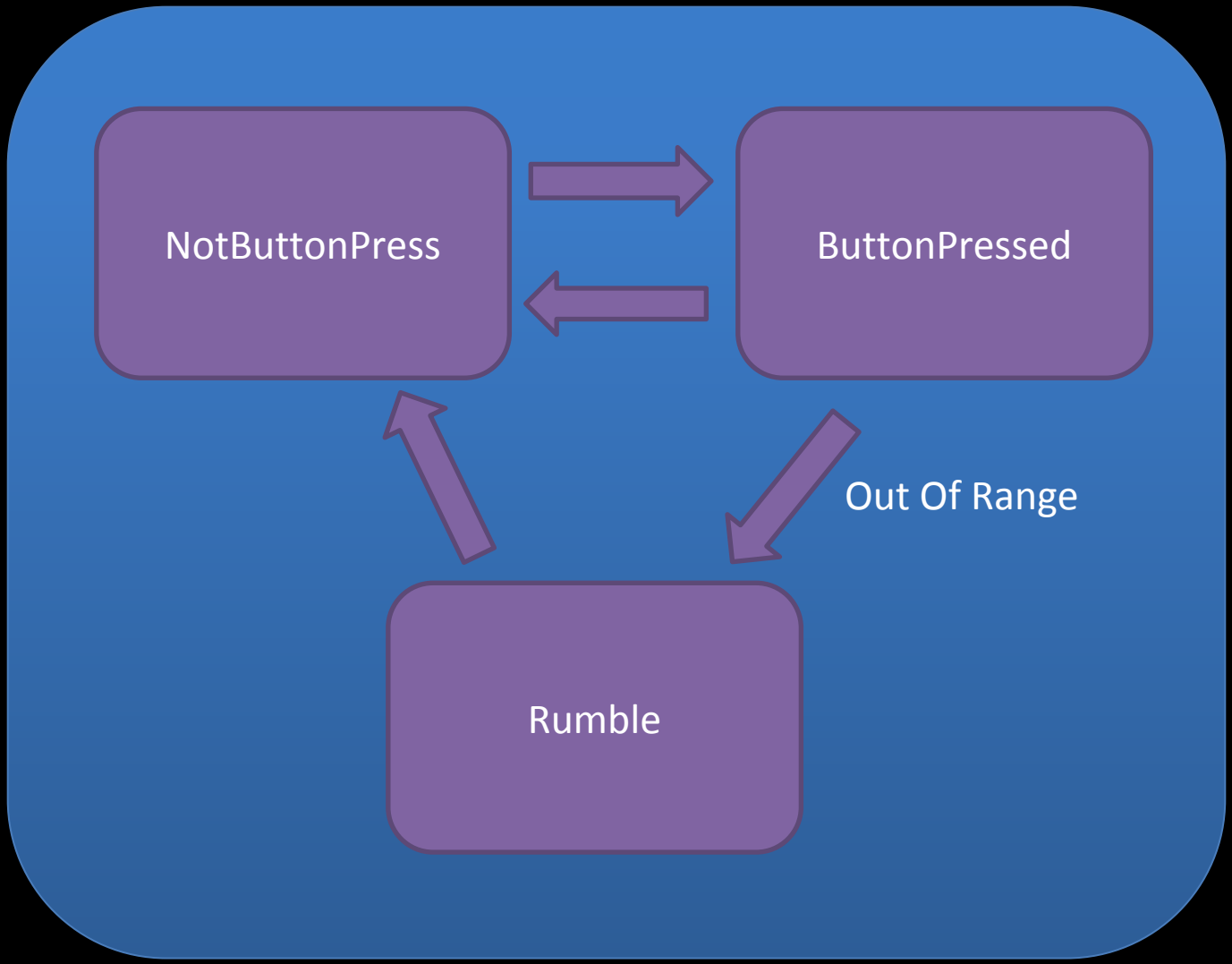
Models


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

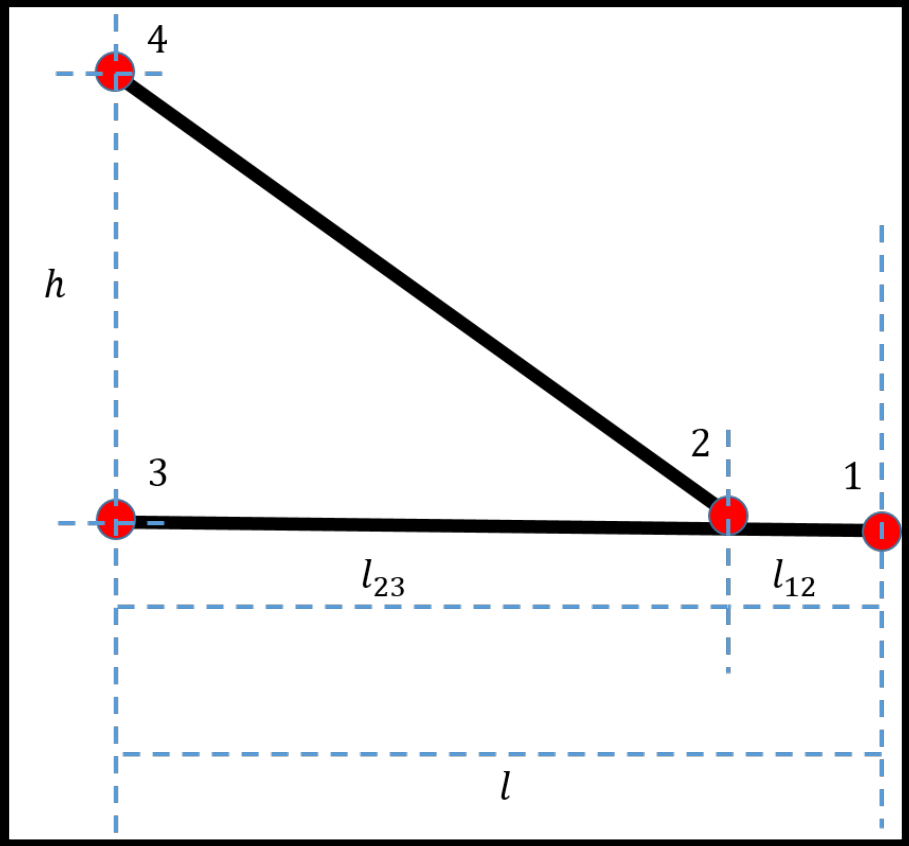
AUTO


Pitch/Yaw
STAY
TRACK
ΔΘ < minThresh
or
ΔΘ > maxThresh
ΔΘ > minThresh
or
ΔΘ < maxThresh

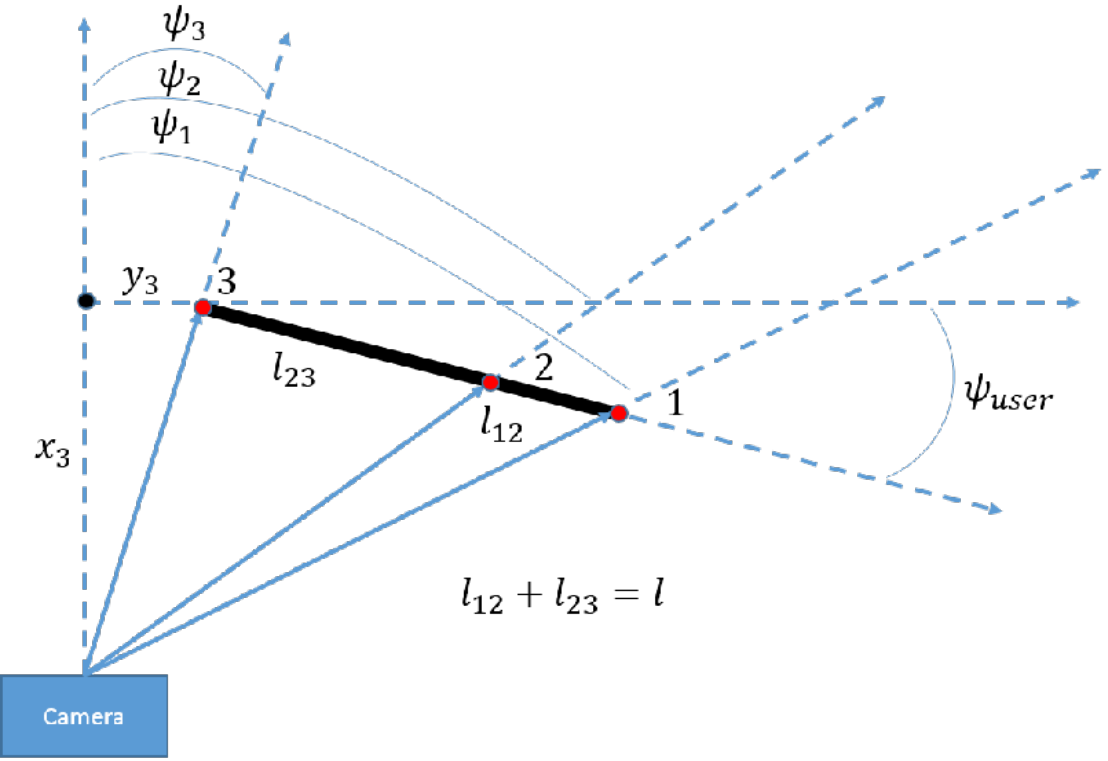
MANUAL



Headgear Design



Tracking Formula



$$\tan(\psi_3) = \frac{y_3}{x_3}$$

$$\tan(\theta_2) = \frac{y_3 + l\cos(\psi)}{x_3 - l\sin(\psi)}$$

$$\tan(\theta_3) = \frac{y_3 + m\cos(\psi)}{x_3 - m\sin(\psi)}$$

$$c = \frac{l_{23}}{l}\frac{\tan(\psi_1) - \tan(\psi_3)}{\tan(\psi_2) - \tan(\psi_3)}$$

$$a = 1 - c$$

$$b = \tan(\psi_1) - c\tan(\psi_2)$$

$$\psi_{user} = \tan^{-1}\left(\frac{-a}{b}\right)$$

$$x_3 = \frac{l(\cos(\psi_{user}) + \sin(\psi_{user})\tan(\psi_1))}{\tan(\psi_1) - \tan(\psi_3)}$$

$$y_3 = x_3\tan(\psi_3)$$

Putting It All Together

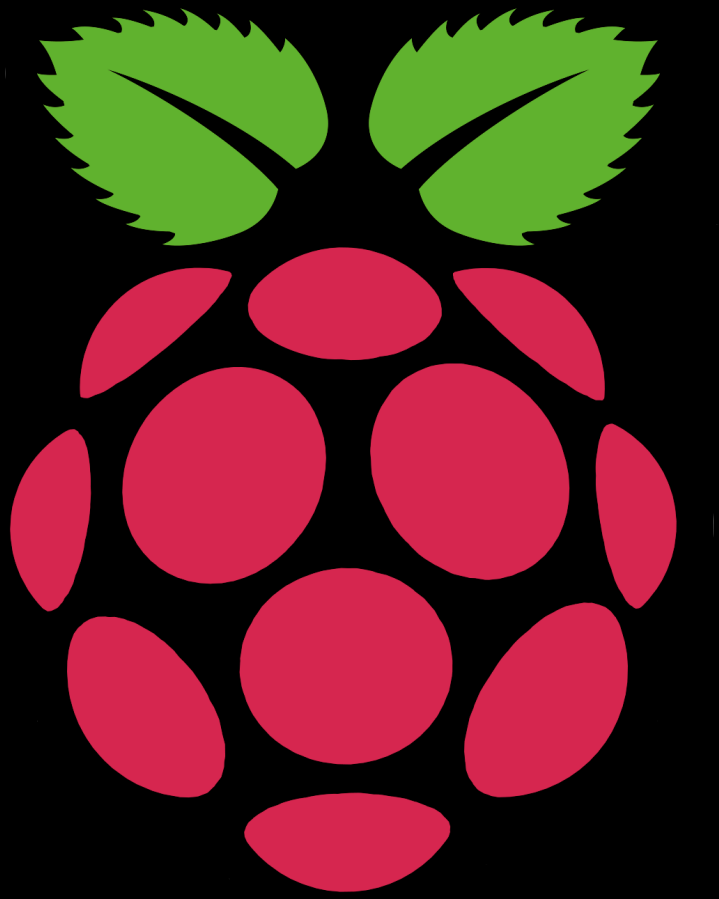
- Read data from WiiMote at fixed, repeating interval
- Use data from WiiMote to calculate user's position
- Use user's position to calculate the angle to which motors need to move

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