



Ch.3 Input and Output



Topics

- • **Introduction: input and output (I/O)**
- **Gaming devices**
 - 3.1.1: I/O device interface
 - 3.1.2: Program-controlled I/O transfer
 - 3.2: Interrupt-based I/O
 - 3.2.6: Exceptions



I/O Communication: 3 Issues



1. **What** data are communicated?
2. **How** data are communicated?
3. **When** data are communicated?



I/O Communication: What



1. What data are communicated?

1. Image (video frames)
2. Coordinates
3. Speed
4. Acceleration



I/O Communication: How



2. How data are communicated?

1. Wi-fi (Wireless Fidelity? IEEE 802.11 Standard)
2. Ethernet
3. Radio frequency RF
4. Bluetooth
5. Universal Serial Bus USB



I/O Communication: When



3. When data are communicated?

1. Periodically at regular interval
2. upon request
3. at event time (when something happens)



Leap Motion Controller (LMC)

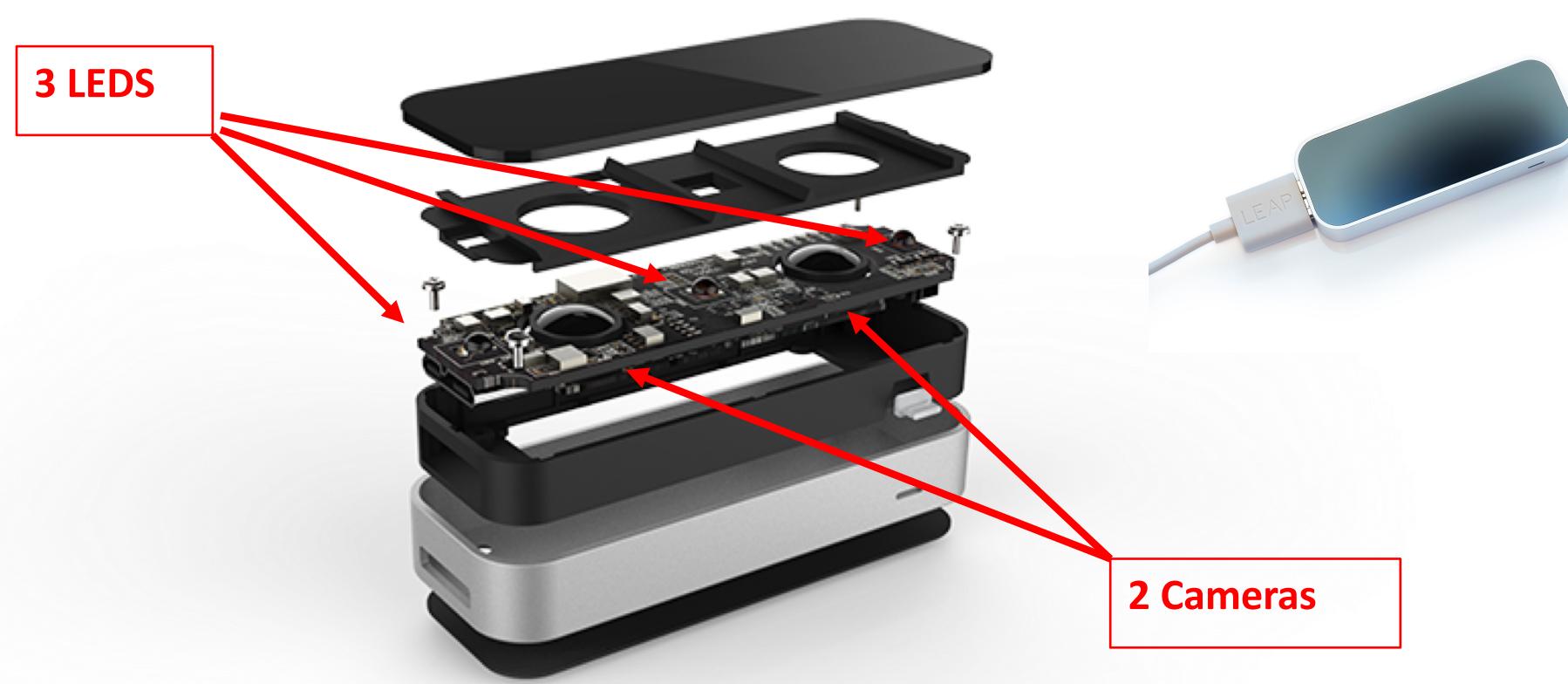


- 5 years R & D, venture capital investment
- Connected via USB
- Placed on flat surface
- Or mounted on a VR headset



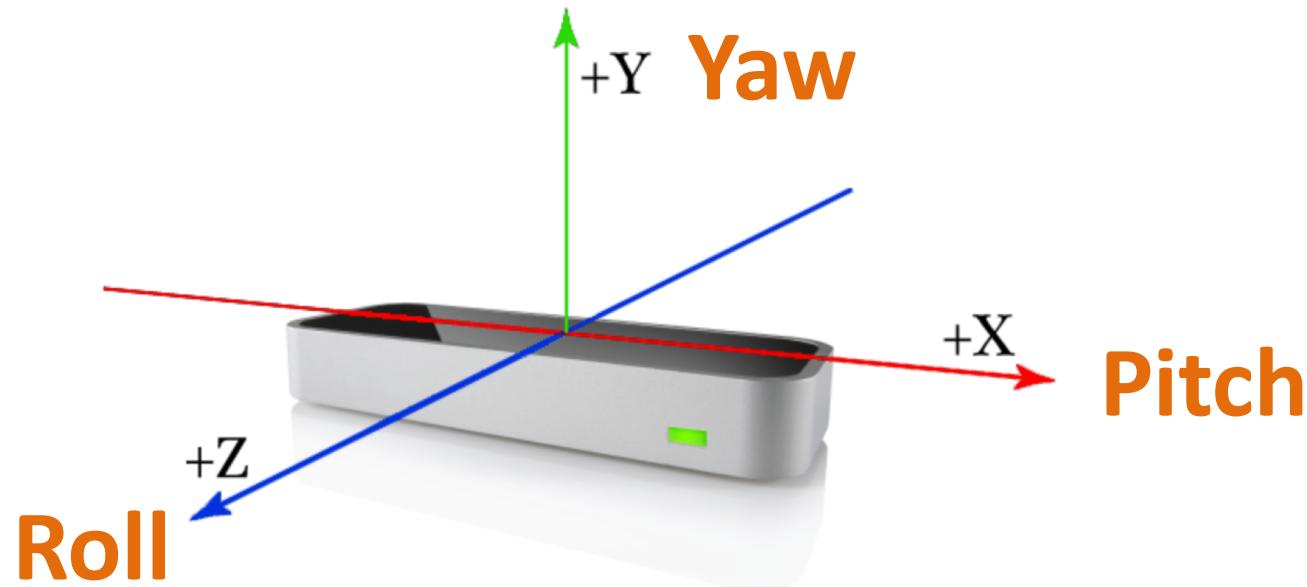


LMC Detection Technology





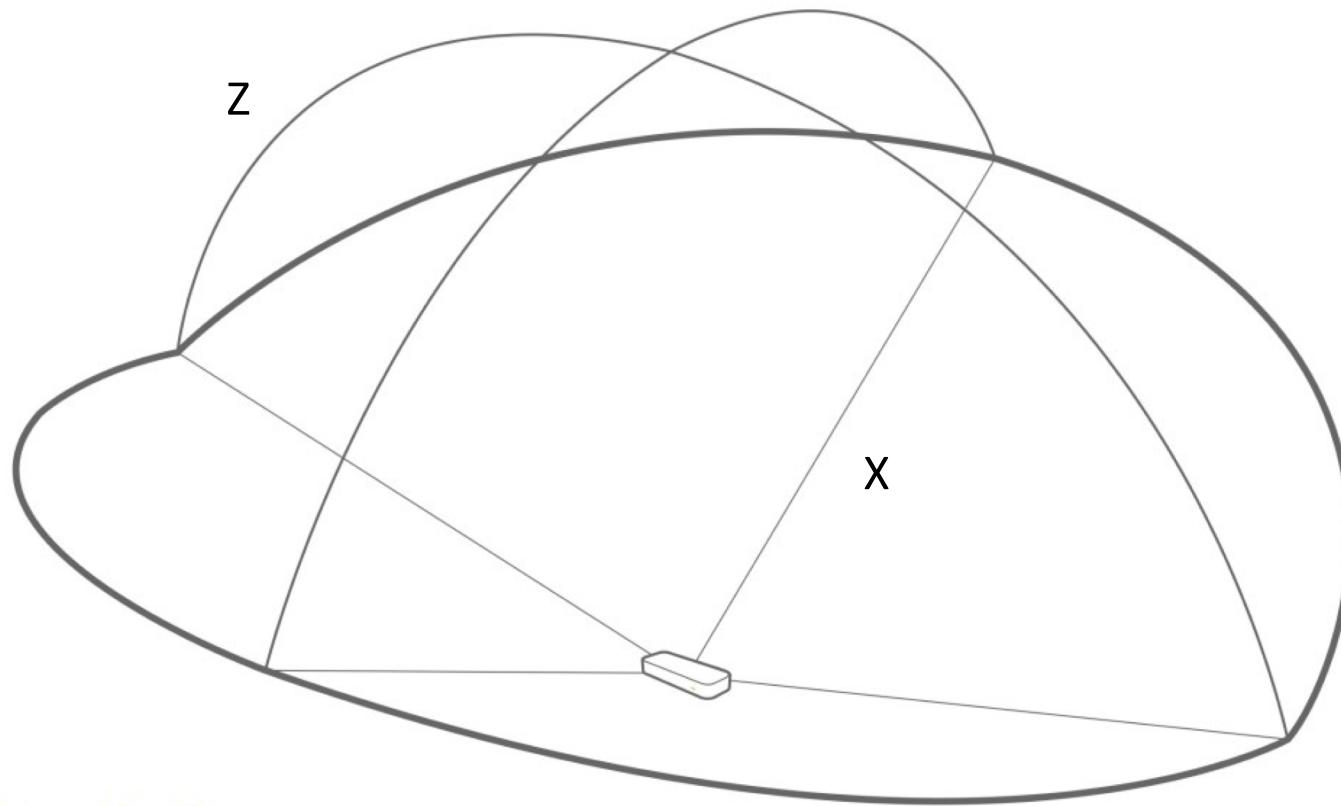
LMC Tracking



- Tracks and records movements in X, Y, Z axes
- Records time in all frames



LMC Coverage

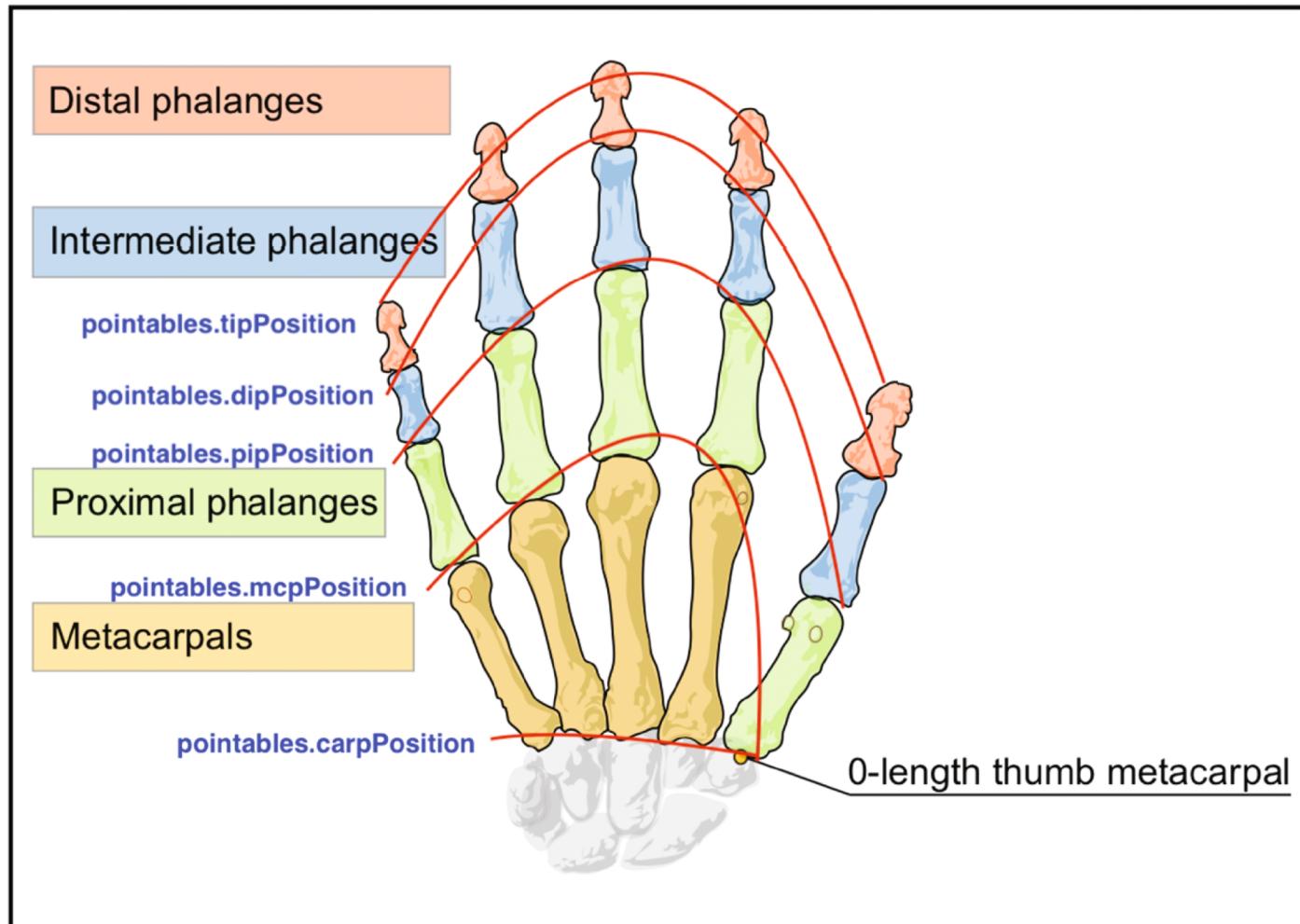


Interaction Area

2 feet above the controller, by 2 feet wide on each side
(150° angle), by 2 feet deep on each side (120° angle)



LMC: Track Points



Leapmotion.com



Gesture/Motion Detection Device



- **Gaming industry:** most cost-effective solutions

- Microsoft Xbox:

- Kinect: RGB camera



- Object recognition and detection

- Xbox Controller



- Sony PlayStation:

- Dual sense wireless controller

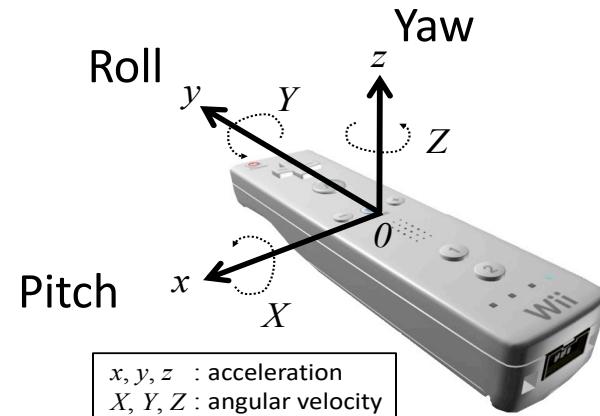




Wiimote Motion Detection



- **Nintendo Wii:**
 - Sensor Bar
 - 10 Infrared lights
 - Wiimote
 - Optical sensors for pointing position and distance
 - Bluetooth
 - Buttons
 - Accelerometer
 - » acceleration magnitude/direction

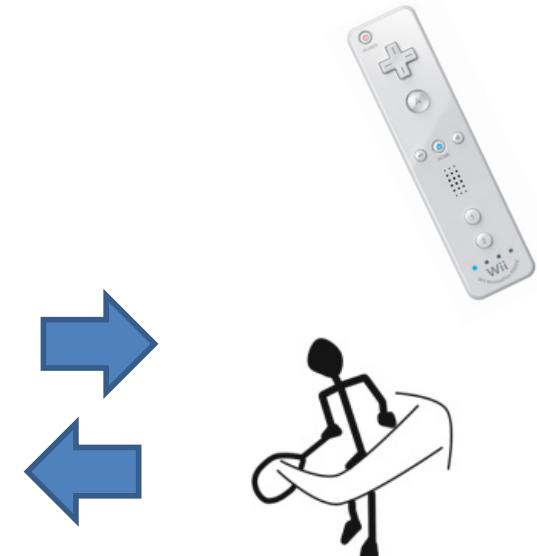
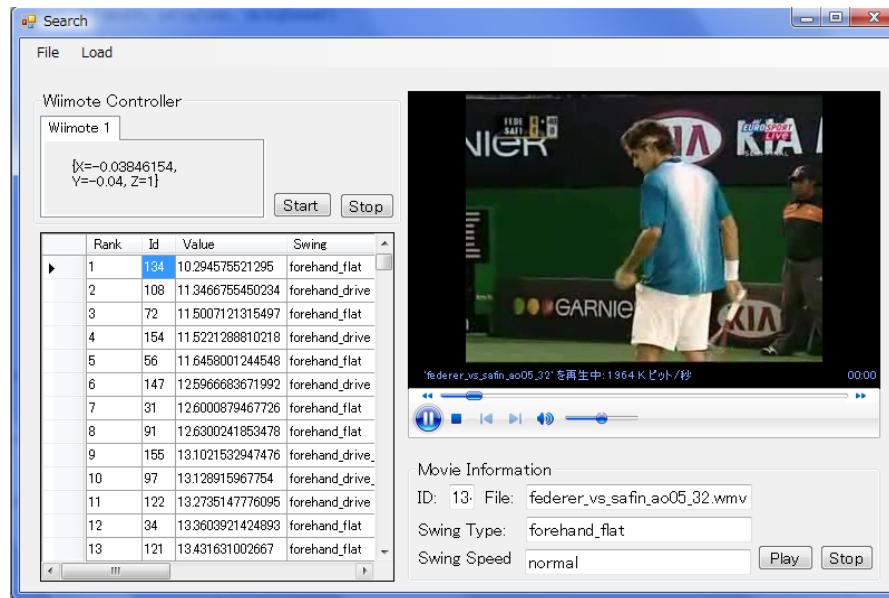




App: Tennis Instruction Project



- Learning tennis swings from video
- Matching (scoring) motion to database's baseline





Rehabilitation System Project



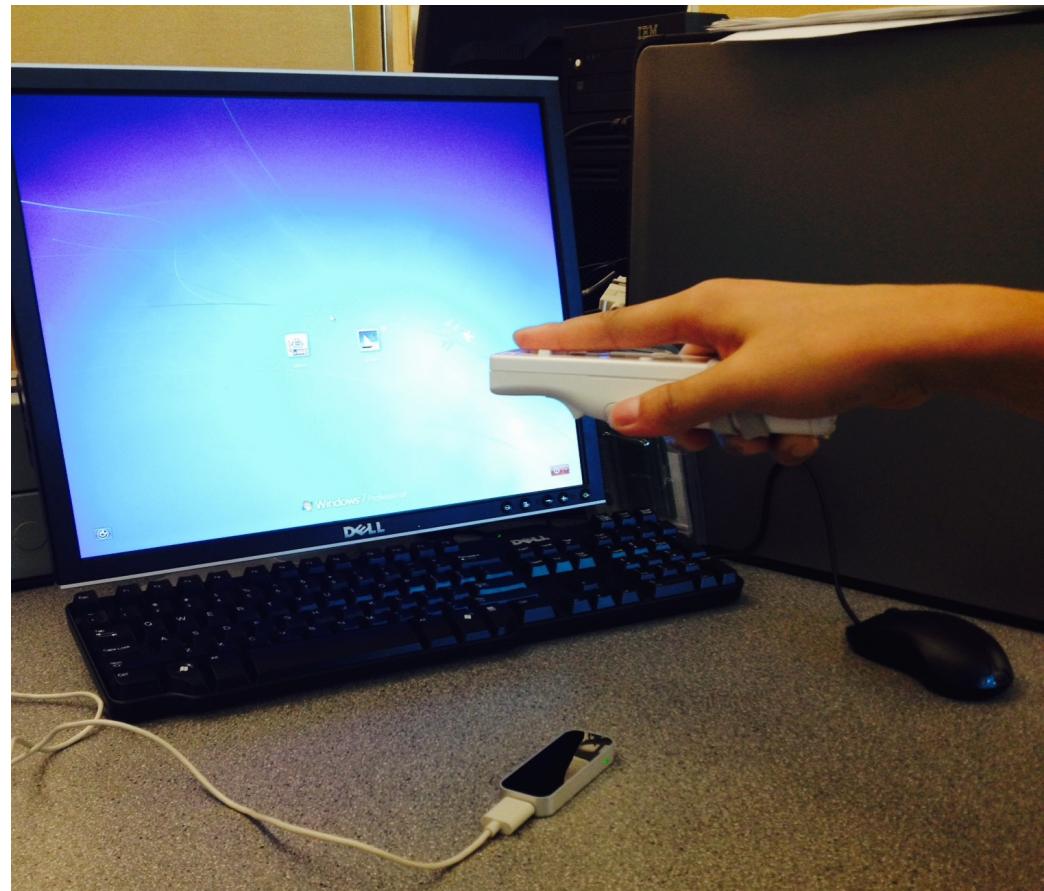
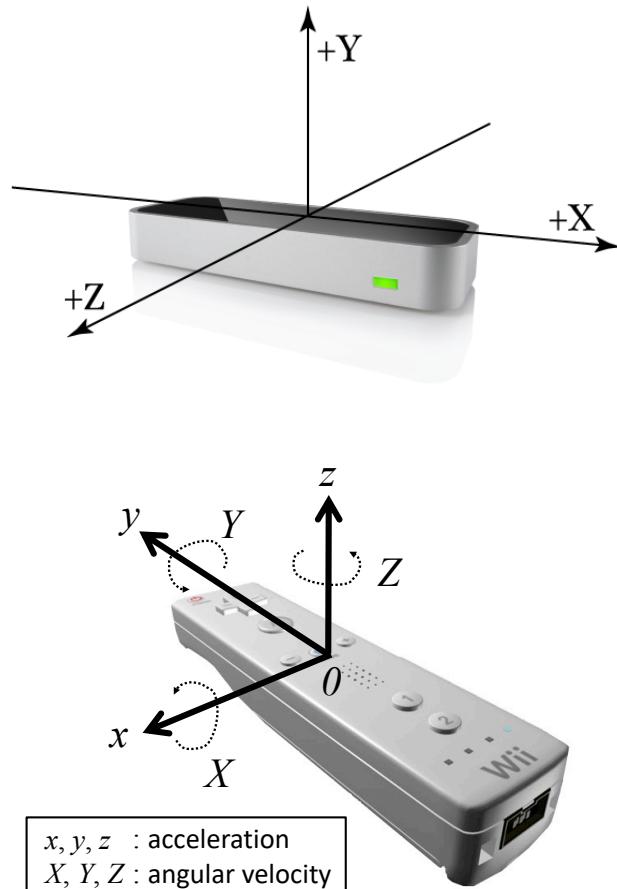
- Wrist injury recovery exercise:



- Telemedicine
 - Minimize visits to Physiotherapist
 - Remote location recovery monitoring

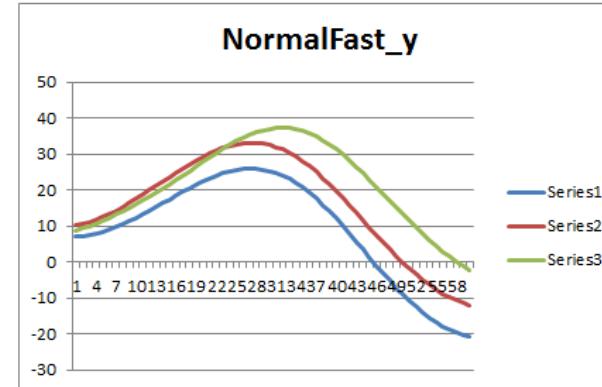


Wiimote vs Leap Motion



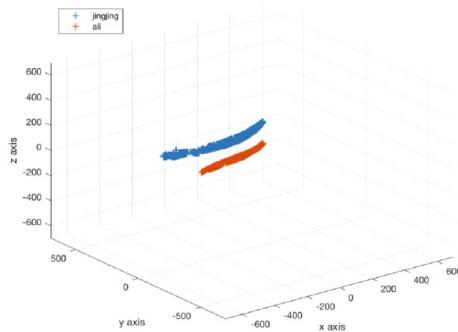


Wiimote Wrist Movement Samples

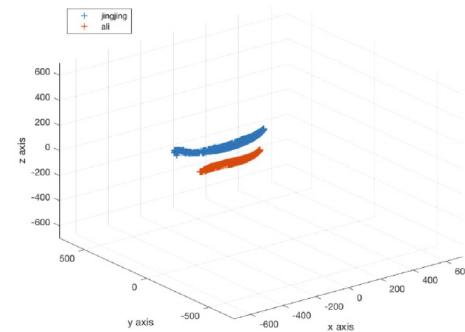




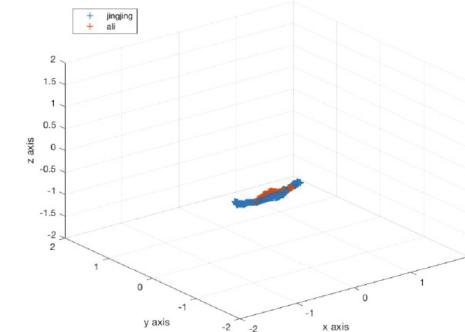
LMC: 2 People Wrist Motions



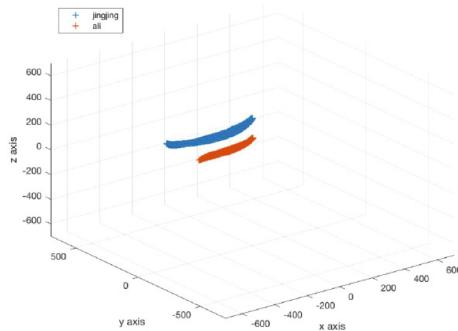
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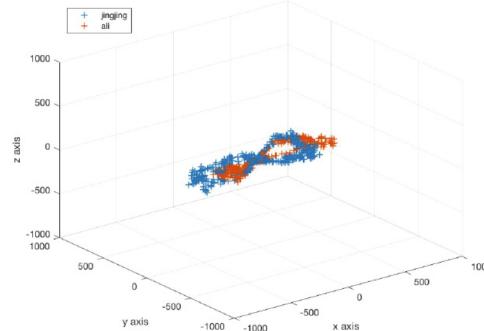
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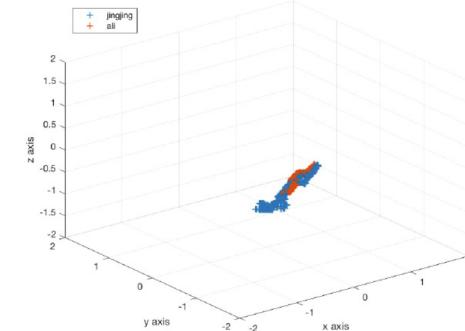
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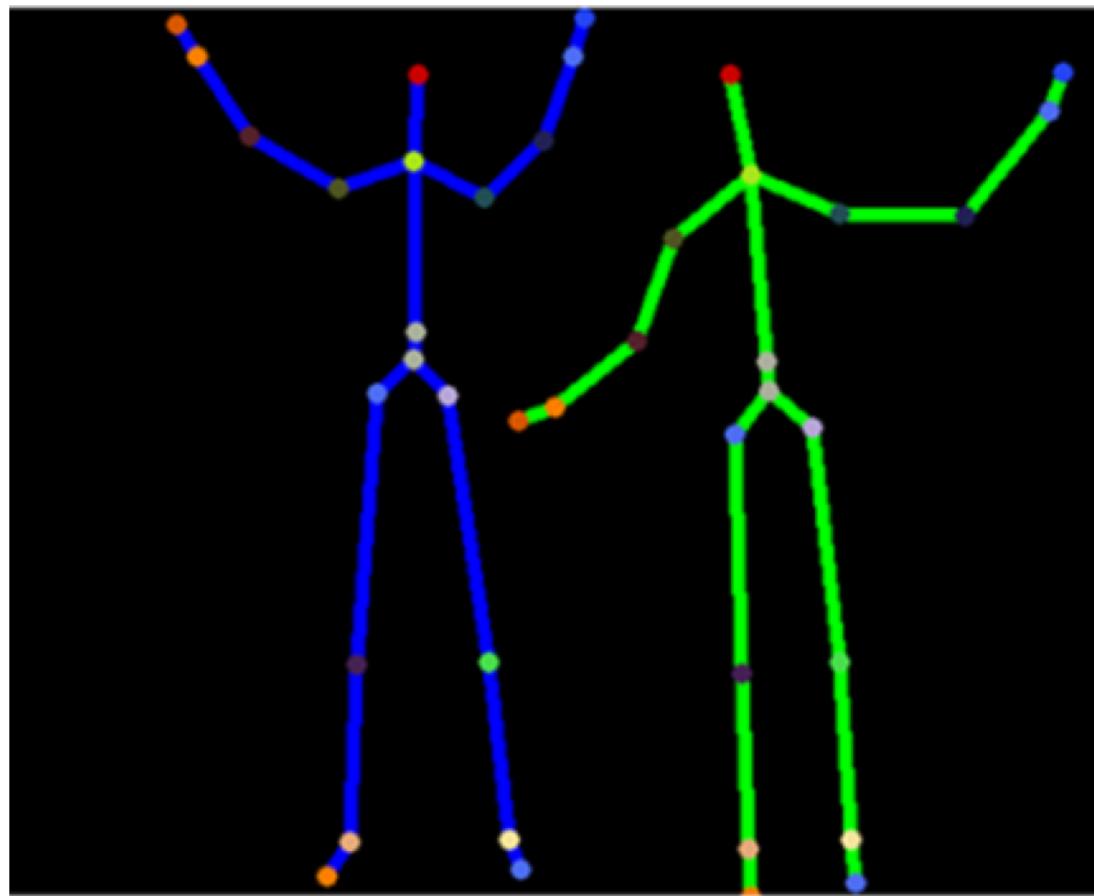
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f



Xbox Kinect Sample Data



30 FPS

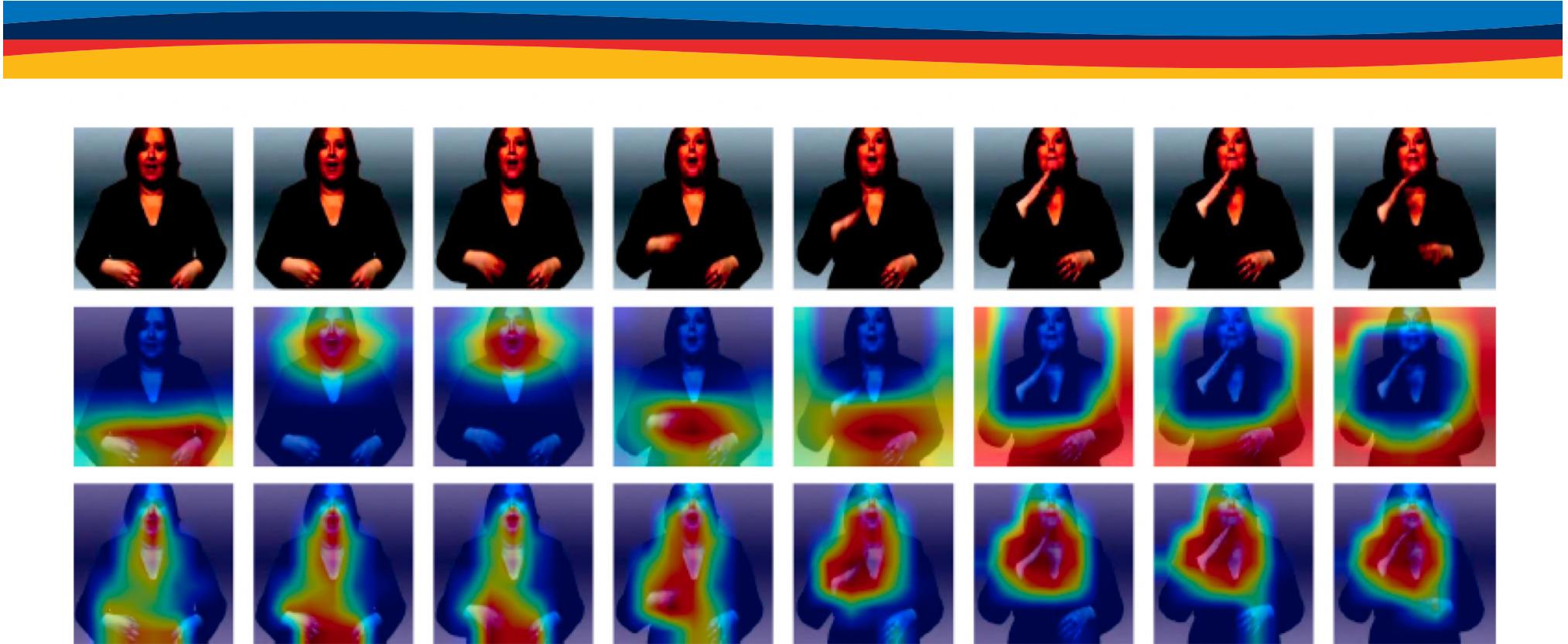
**640X480
pixels**

Y Post to set baseline

**Sign Language to
Text Project in 201x)**



Continuous Sign Language Recognition



Top: original Frames

Middle: baseline recognition

Our Model: focused areas, and filtering out background and irrelevant objects



Mediapipe Studio



- MediaPipe Studio is a web-based application for evaluating and customizing on-device ML models and pipelines for your applications. The app lets you quickly test MediaPipe solutions in your browser with your own data, and your own customized ML models.
- Sample Applications:
 - Pose Landmark Detection: https://mediapipe-studio.webapps.google.com/demo/pose_landmarker
 - Gesture Recognition: https://mediapipe-studio.webapps.google.com/demo/gesture_recognizer



1. What Data Are Communicated



- Wiimote:
 - Data: 8-bit acceleration along X, Y, and Z axes
 - Sampling Rate: 100 Hz
- Leap Motion:
 - Image: 640 by 240 pixels
 - Sampling Rate: 100 Frames per Second



2. How Data Are Communicated



- Wired:
 - USB (Leap Motion)
 - Ethernet
- Wireless:
 - Bluetooth (Wiimote)
 - Wi-Fi (IEEE 802.11x)
- Need **device interface** and **controller**



3. When Data Are Communicated



1. Program controlled (also called Polling)

- Master checks/reads interface continuously
- Hand movement with Leap Motion and Wiimote





3. When Data Are Communicated



2. Interrupts (buttons on Xbox controller)

- Slave alerts masters when ready





Terminology: Master/Slave



- First appearance, 1904, in electronic circuits and communication
- Official complaint: the term is racially biased, 2020
- Microsoft Terminology:
 - *primary/replica*
 - *principal/agent*
 - *controller/worker*
 - *parent/child*.



IEEE Terminology: Master/Slave



- IEEE Standards [IEEE 1588g-2022](#), an amendment to IEEE 1588-2019 network protocols.
- **Optional** alternative for master and slave.
 - timeTransmitter / timeReceiver
 - Leader / Follower (L / F instead of M / S)