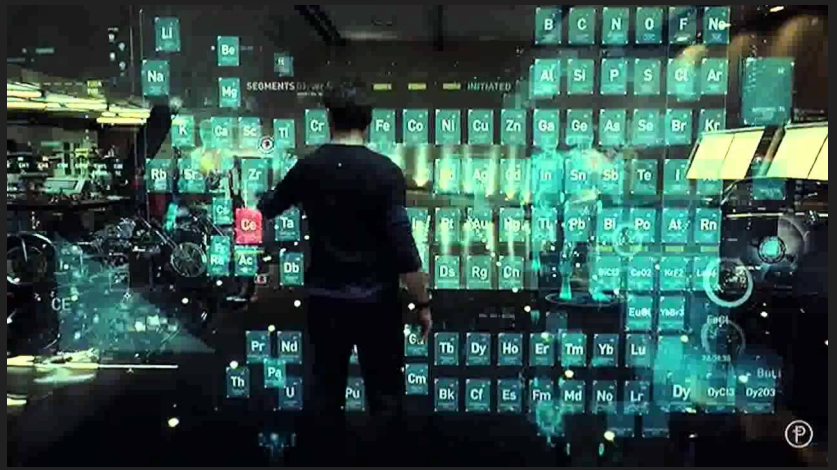
Virtual Whiteboard

Team A2

Alan Song (presenter), Brian Lane, Andrew Huang

“As a user of Virtual Whiteboard, I would like to open a web browser and navigate to several different pages”



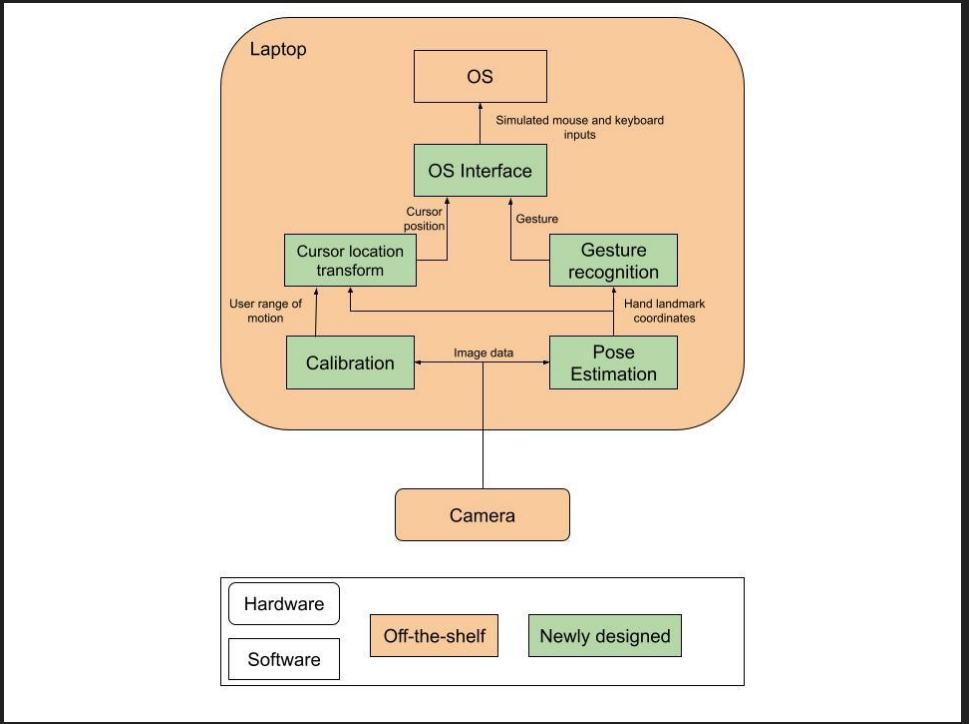
Application Area and Requirements

- Touchless touchscreen
- Computer usage from a distance
- Shifted from presentation tool to general use system for interacting with desktop
- Positive impacts for health and sanitation

- Most important is smooth user experience
- Functional from 3 to 12 feet
- 50 ms latency (20 fps)
- 90% accuracy (1 error every 10 gestures)
- 30 pixel cursor precision

Solution Approach

- Gesture recognition model now takes in hand landmark coordinates instead of image data



Complete Solution

- Fully functional system
- Cursor movement, left clicking, right clicking, holding and dragging, and scrolling
- We will demonstrate and explain how to use the system and how it works
- Showcase all the features
- Then other users can try it out!

Requirements

Latency:

- Measured for subsystems and entire system
- Measured during system execution
- 50 ms and 20 fps
- Passing test is if average latency of the system during execution is < 0.05 latency

Accuracy:

- One measure is our gesture recognition model validation accuracy
- Another measure is counting the number of missed gestures
  - We want < 10% miss rate
- Passing test is if at most 1 in every 10 gestures has to be re-done

- For cursor motion, we want accuracy to be within 30 pixels for an interactable button

Metrics - Latency and Model Accuracy

Specification	Performance
Hand Recognition Latency	Min: < 0.0001s Max: 0.0047s Mean: 0.0018s
Gesture Recognition Latency	Min: < 0.0010s Max: 0.0030s Mean: 0.0020s
Gesture Recognition Accuracy	Validation Accuracy: 88% Gesture Confidence: ~100%

Metrics - System Latency

Min: 0.016s

Max: 0.075s - 0.080s

Mean: 0.034s - 0.036s → 27.8 Hz - 29.4 Hz

- Average latency within our design review specifications of < 0.05s latency or 20 Hz by a margin of 47%

Metrics - Gesture Accuracy vs Distance

- Performed multiple clicks at various distances (100 per trail)
- Results averaged over several trials (at least 20 total)

Distance	Accuracy
3 feet	89/100 clicks
6 feet	92/100 clicks
9 feet	95/100 clicks
12 feet	71/100 clicks

Metrics - Cursor Jitter vs Distance

- Calculated average pixel distance from mean of 5 second stationary window where hand is as still as possible
- Calculated maximum pixel distance between furthest two points (diameter of jitter circle)

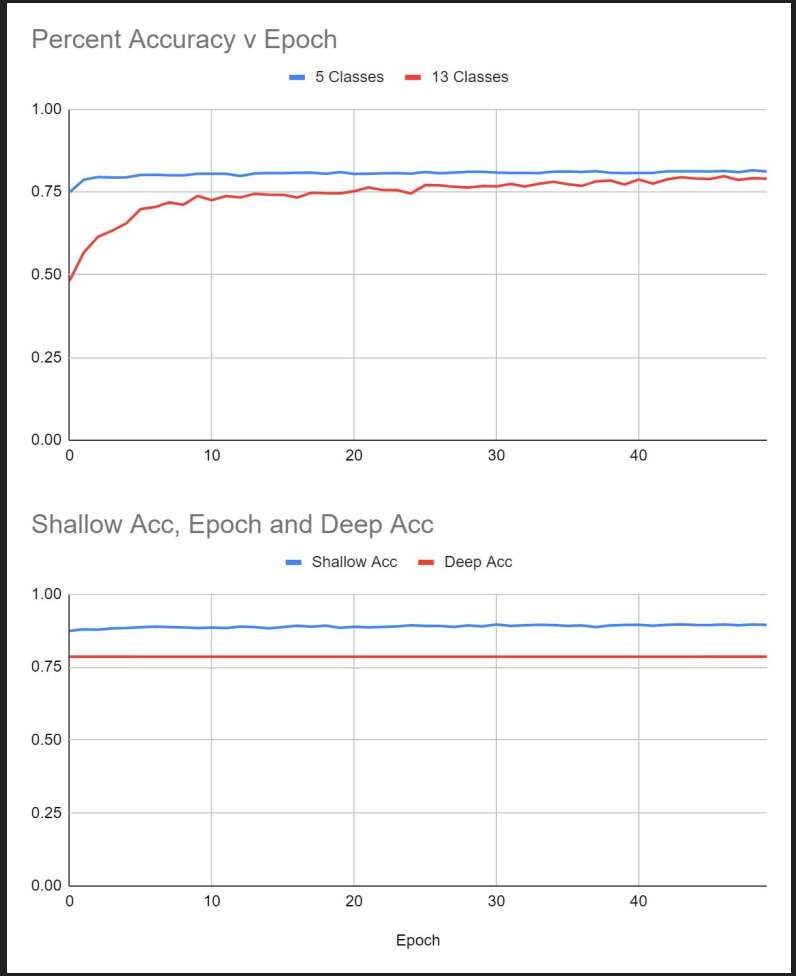
Distance	Average Pixel Jitter About Mean	Max Distance of Furthest Points
3 feet	5.76 pixels	38.6 pixels
6 feet	4.29 pixels	35.4 pixels
9 feet	3.73 pixels	25.0 pixels
12 feet	3.85 pixels	29.2 pixels

Trade-off Analysis

Gesture Recognition

- Closely Related:
  - Gesture Complexity vs Accuracy
  - Gesture Quantity vs Accuracy
- Quantity ↓ = Accuracy ↑
  - But more quantity is expandable

- Model Architecture
  - Larger = Slower
  - No noticeable difference on accuracy



User Satisfaction Survey

- User satisfaction survey (1-10)
  - “This product is a useful way to remotely control a screen.”
  - “This product is a cool way to remotely control a screen.”
  - “The cursor went where I intended.”
  - “The product clicked when I wanted.”
  - “I could use this product to do anything I could with a mouse and keyboard.”
  - “The product felt intuitive to use.”
  - “Overall, I was satisfied using this product.”

Project Management

- More detailed responsibilities
- System functional, need to refine smooth user experience
- Further testing and metrics collection, improve results