Virtual Whiteboard

Team A2

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"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 \rightarrow 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 \downarrow = Accuracy \uparrow
 - 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

	9/19 - 9/25	9/26 - 10/2	10/3 - 10/9	10/10 - 10/16	10/17 - 10/23	10/24 - 10/30	10/31 - 11/6	11/7 - 11/13	11/14 - 11/20	11/21 - 11/27	11/28 - 12/4	12/5 - 12/11
Research model/choose dataset												
Model/transfer learning research												
Pose Estimation research	1											
Gesture Dataset Adaptation												
Gesture Model Training												
Model Evaluation with dataset												
Model Testing with Pose Estimation												
Model Refinement and Improvement												
Pose Estimation Integration												
Pose Estimation Depth Transform												
Hand Detection Library Research												
Testing Using Webcam												
Matplotlib Visualization Tools												
Pose Estimation Code												
Transition to New Webcam												
ROM and Calibration												
Read library documentation												
Begin testing mouse/cursor libraries	-					177						
Create OS Interface document												
Create mouse movement module												
Add gesture inputs to mouse												
Improve smoothness of movement												
Improve functionality of mouse												
Integration/Improvements	_											
Testing/Verification (metrics)												
-												
Proposal Presentation												
Design Review Presentation	-			-								
	_											
Design Review Report												
					2							
Ethics	_					SI				_	-	
Final Presentation												
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Brian												
Andrew												
Alan												
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