TouchCU

Senior Capstone Project 2013 – 2014

The Team

- Trenton Bishop: Documentation Lead
- Yizhou Hu: Algorithm Design Lead
- Blake LaFleur: Technical Lead
- Thales Lessa: Testing Lead
- Matthew Spector: Project Lead

Project Origin

- Easy way to interact with lectures.
- Growth of touch technology integration.
- Increased demand by users ➔ new/innovative ways to interact.
- TouchCU was born.

Project Goal

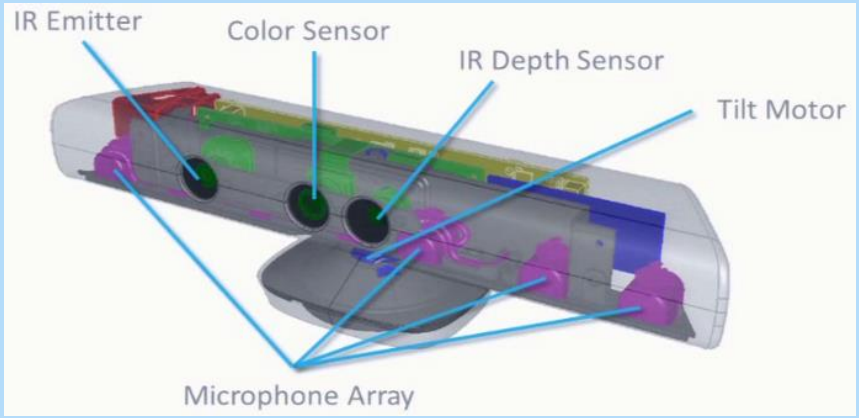
- Create a standalone application for the Windows 8 Operating System that will turn any flat surface into a multi-touch screen.

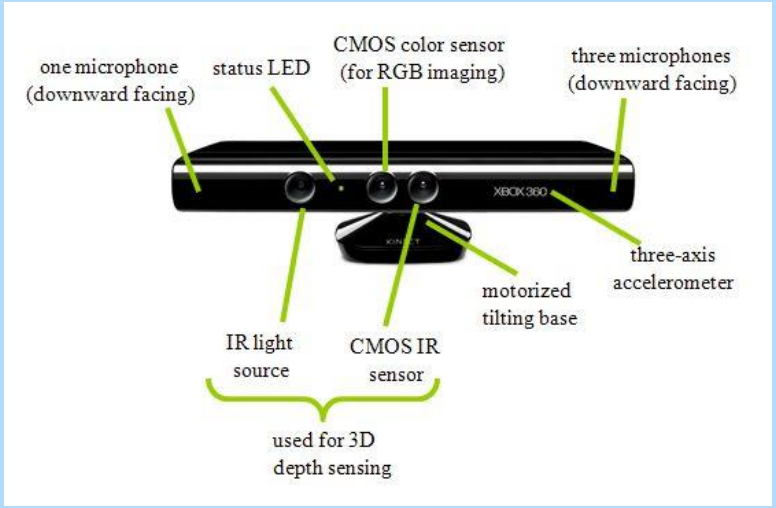
Project Goal

- Require minimal setup and hardware:
  - A projector
  - A Windows 8 PC
  - A Kinect for Windows
  - A flat, non-reflective surface
- Screen size of at least 6ft measured diagonally.
- User can setup and calibrate their own custom screen size.

Microsoft Kinect for Windows

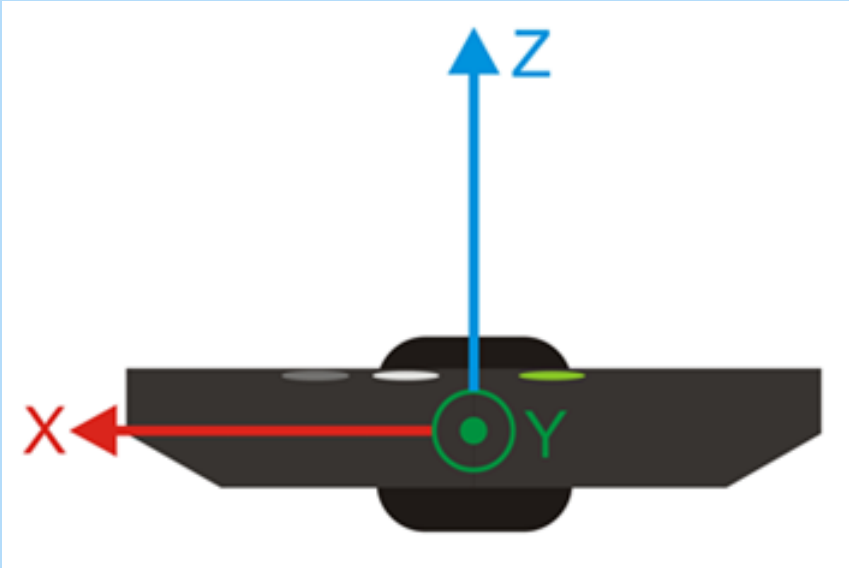
- Connects to a Windows PC
- Maximum capture rate of 30fps





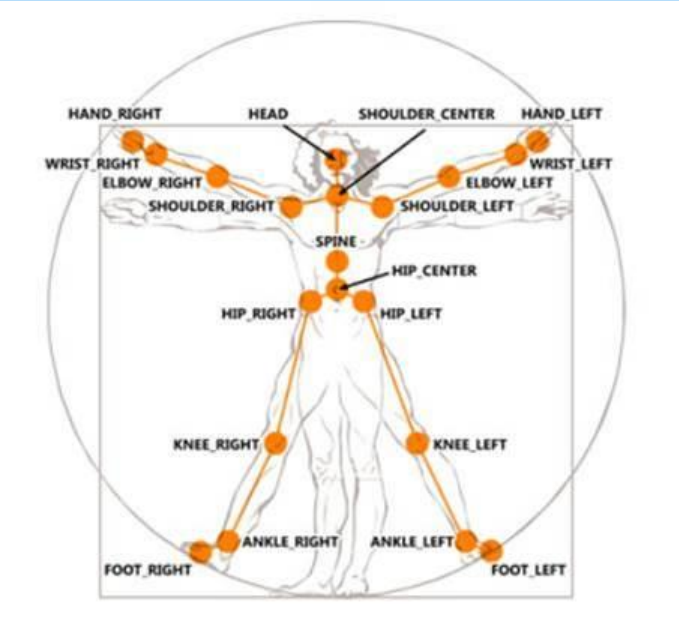
Microsoft Kinect for Windows

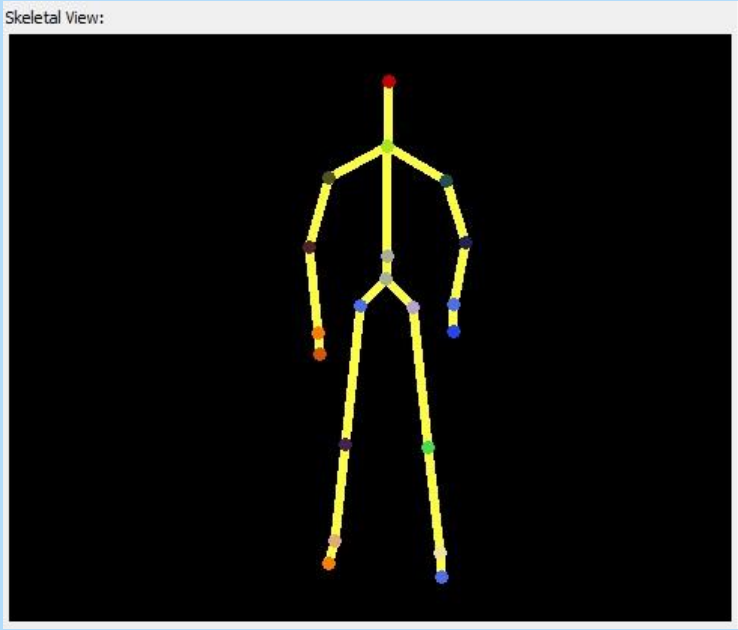
- Joint data represented as (X,Y,Z) coordinates



Microsoft Kinect for Windows

- Skeletal Stream - Tracks up to 20 joints

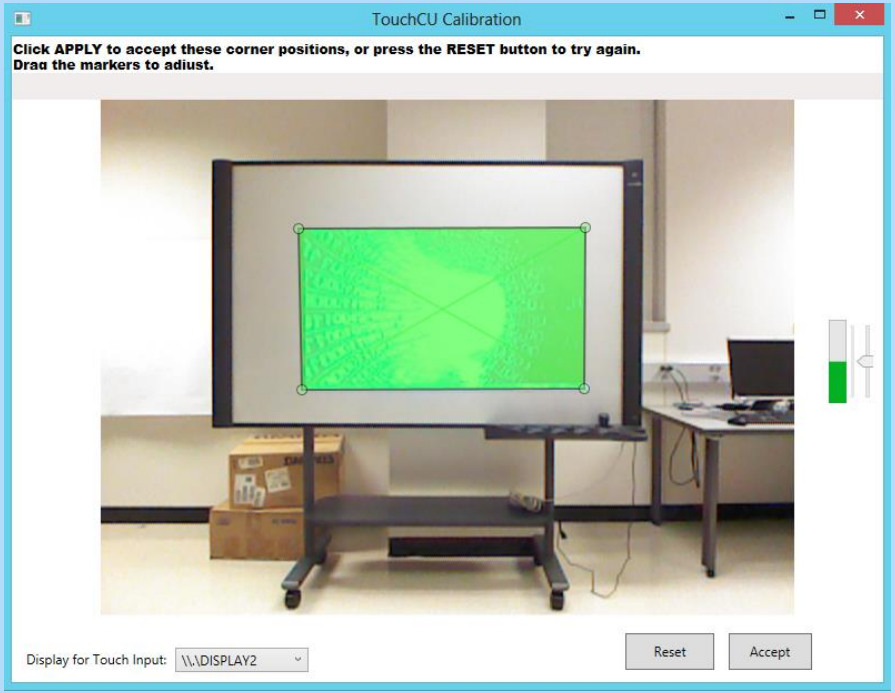




Microsoft Kinect for Windows

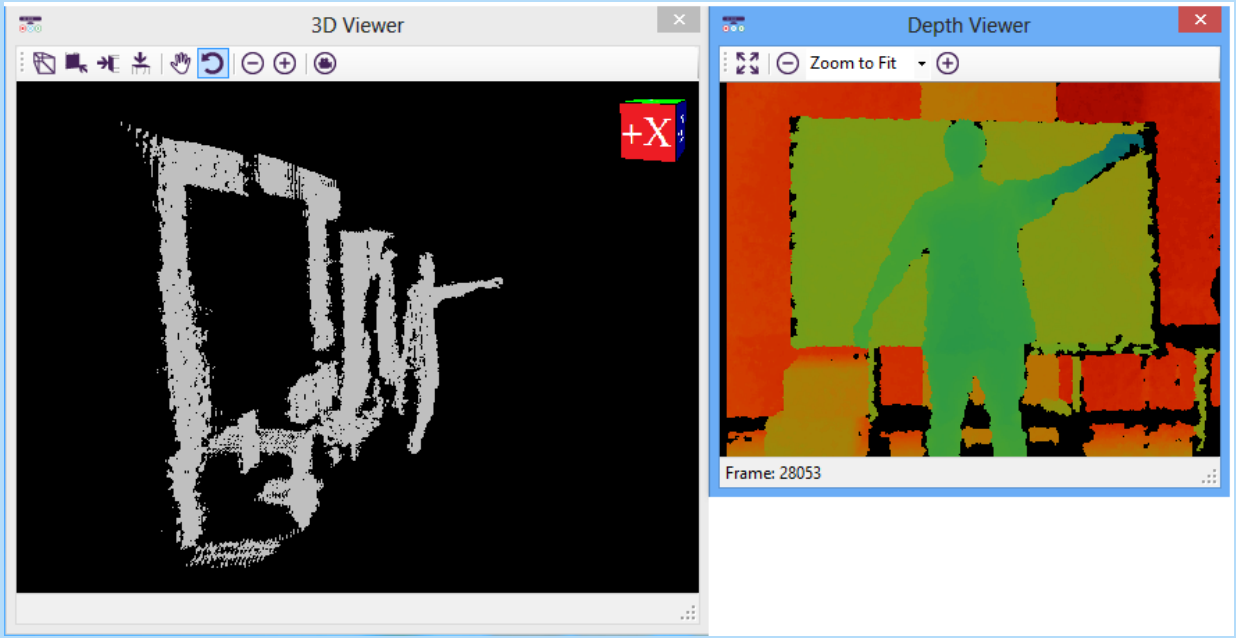
Microsoft Kinect for Windows

- Color Stream – Used for calibration

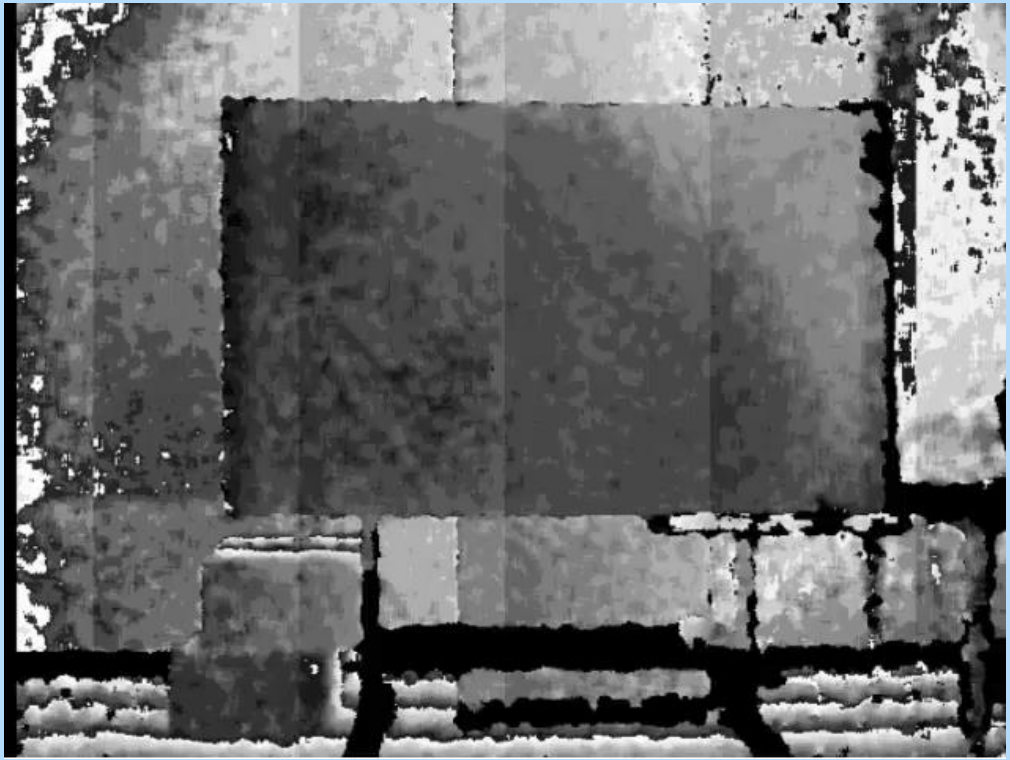


Microsoft Kinect for Windows

- Depth Stream – Used for calibration and depth tracking



Microsoft Kinect for Windows



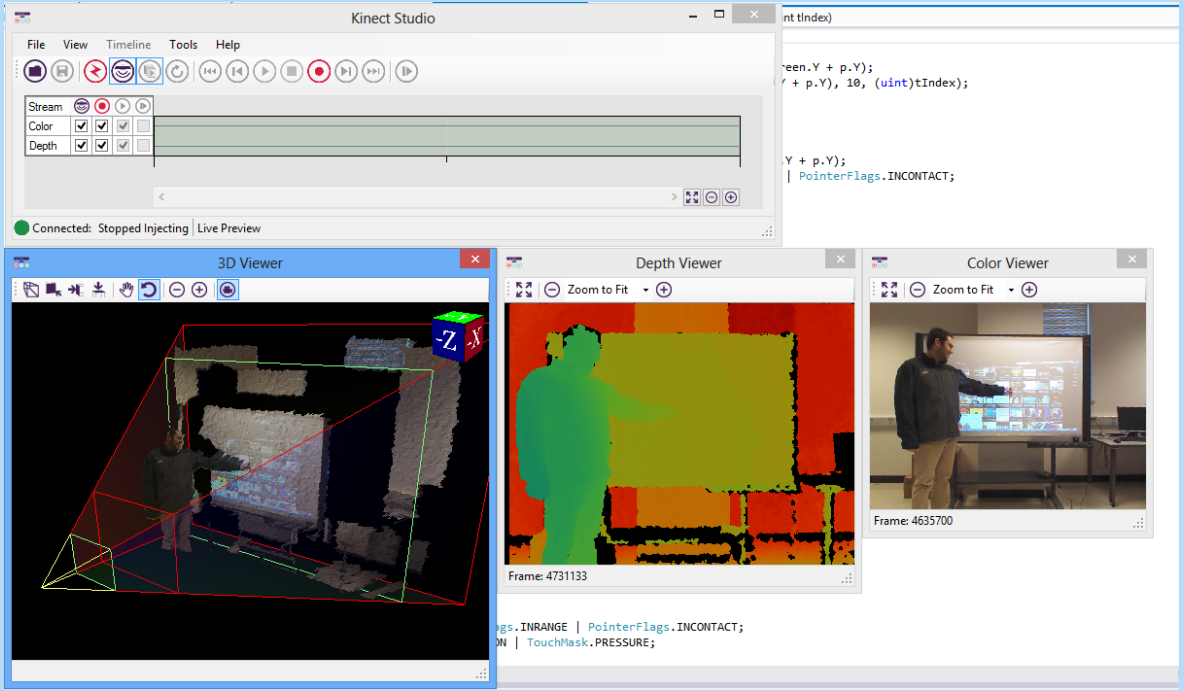
Development Environment

Programming Environment

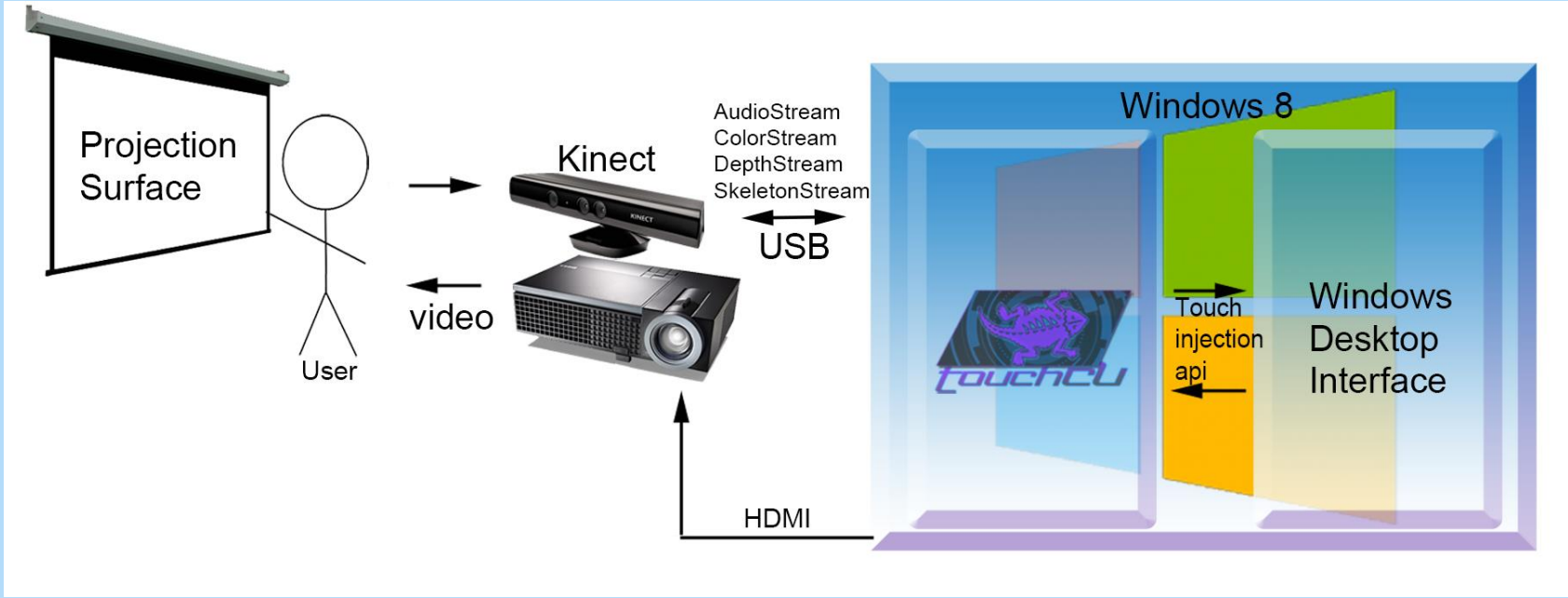
- Microsoft Windows 8 x64 Professional
- Visual Studio Pro 2012
- Kinect Studio for Windows v1.8.0
- Kinect Developer Toolkit SDK

Development Environment

- Kinect Studio



System Architecture



Gestures

Single Hand Gestures		
Name of Gesture	How it's Performed	What it's Used For
Tap (GR 1)	Tap an item on the screen once.	Simulates a left-click from a mouse.
Double-Tap (GR 2)	Tap an item on the screen twice.	Simulates a double left-click from a mouse.
Hold (GR 3)	Tap an item on the screen and hold.	Simulates a right-click from a mouse.
Drag (GR 4)	Tap and hold the screen while moving in any direction.	Simulates moving an object on the screen.

Gestures

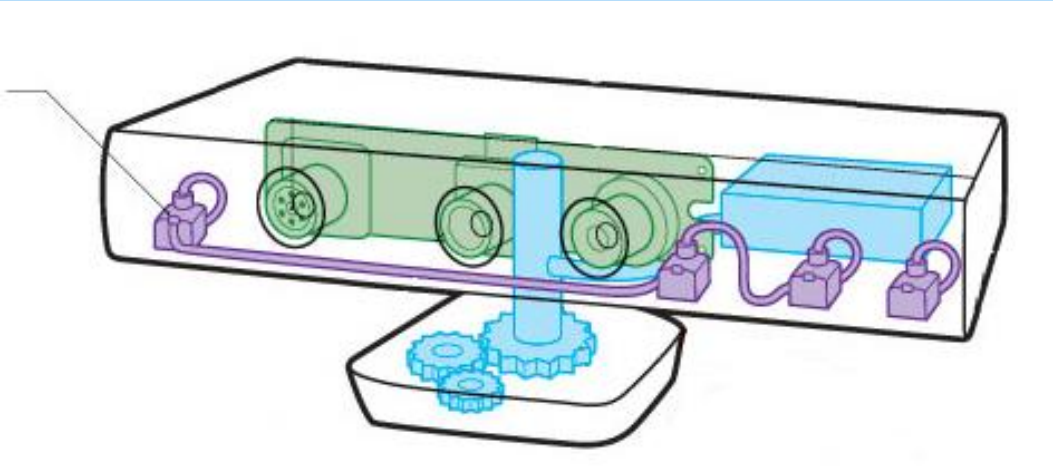
Two Hand Gestures		
Name of Gesture	How it's Performed	What it's Used For
Zoom (GR 5)	Both hands will be placed on the screen and move either farther or closer apart.	Simulates making an object larger or smaller on the screen.
Rotate (GR 6)	Both hands will be placed on the screen to emulate a clockwise or counter-clockwise motion.	Simulate moving the object around a center point.

Gestures

Air Gestures		
Name of Gesture	How it's Performed	What it's Used For
Swipe Left (GR 7)	One hand in mid-air will move a short distance to the left.	Simulates using the left arrow on the keyboard.
Swipe Right (GR 8)	One hand in mid-air will move a short distance to the right.	Simulates using the right arrow on the keyboard.

Microsoft Kinect for Windows

- Audio Stream – Used for voice commands



Voice Commands

Trigger Word		
Name of Command	How it's Performed	What it's Used For
Addie (VCR 1) **[ad-ee]**	User will say "Addie" aloud followed by a Commandword + action word.	Initiates the voice recognition process.

Voice Commands

Command Words		
Name of Command	How it's Performed	What it's Used For
Open (VCR 2) **[oh-puh n]**	User will say "Open" aloud followed by an action word.	Used to open the following action word.
Close (VCR 3) **[klohz]**	User will say "Close" aloud followed by an action word.	Used to close the following action word.

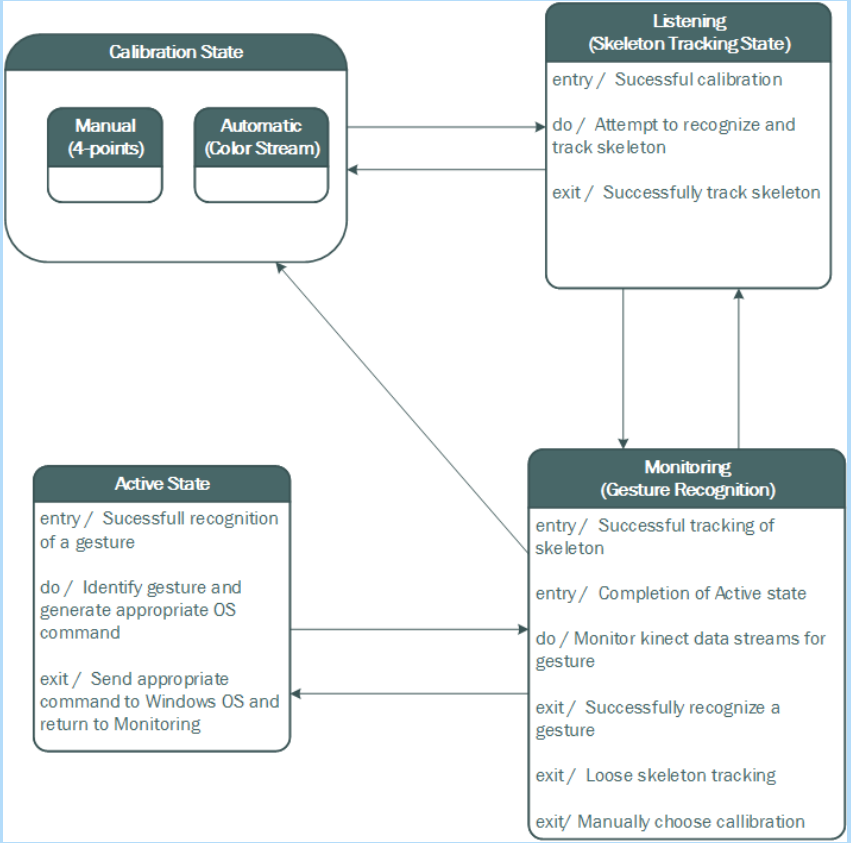
Voice Commands

Action Words		
Name of Command	How it's Performed	What it's Used For
Start Menu (VCR 4) **[stahrt men-yoo]**	User will say "Open/Close Start Menu" aloud.	Opens or closes the Windows Start Menu.
Window (VCR 5) **[win-doh]**	User will say "Close Window" aloud.	Closes the active window.
My Documents (VCR 6) **[mahy dok-yuh-muh nts]**	User will say "Open My Documents" aloud.	Opens the user's Documents folder.
Settings (VCR 7) **[set-ings]**	User will say "Open Settings" aloud.	Opens the TouchCU settings menu.
Debug (VCR 8) **[dee-buhg]**	User will say "Open/Close Debug" aloud.	Opens or closes the TouchCU debugging overlay.

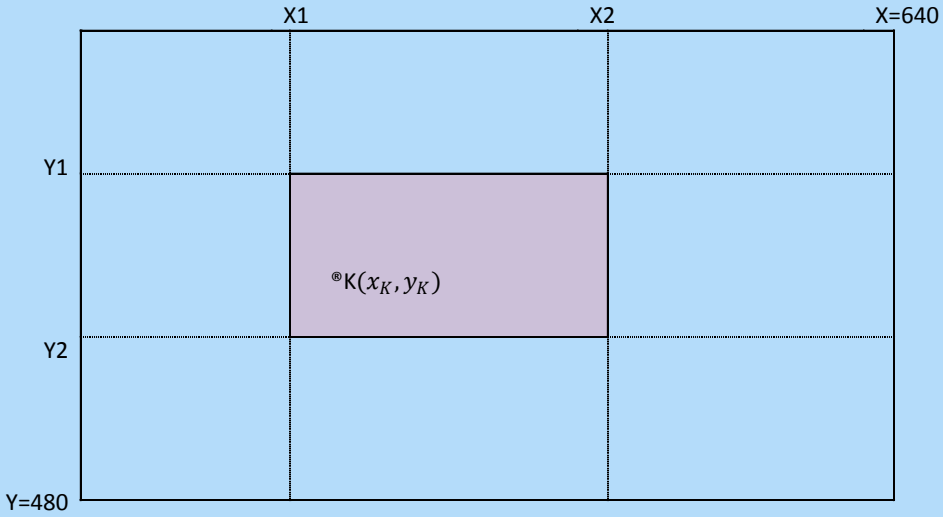
State Table

State Name	Description
Calibration	Calibrating the screen size
Listening	Looking for available skeletons to track
Monitoring	Looking for gestures
Active	Sending input to OS

State Diagram



Manual Calibration



$Skeleton(x, y, z) \quad \overrightarrow{map} \quad Image(x_K, y_K)$

[Our projector: $x_S = 1920, y_S = 1080$]

$$y_t = \frac{y_k - y_1}{y_2 - y_1} \cdot y_S \quad ,$$

$$x_t = \frac{x_k - x_1}{x_2 - x_1} \cdot x_S$$

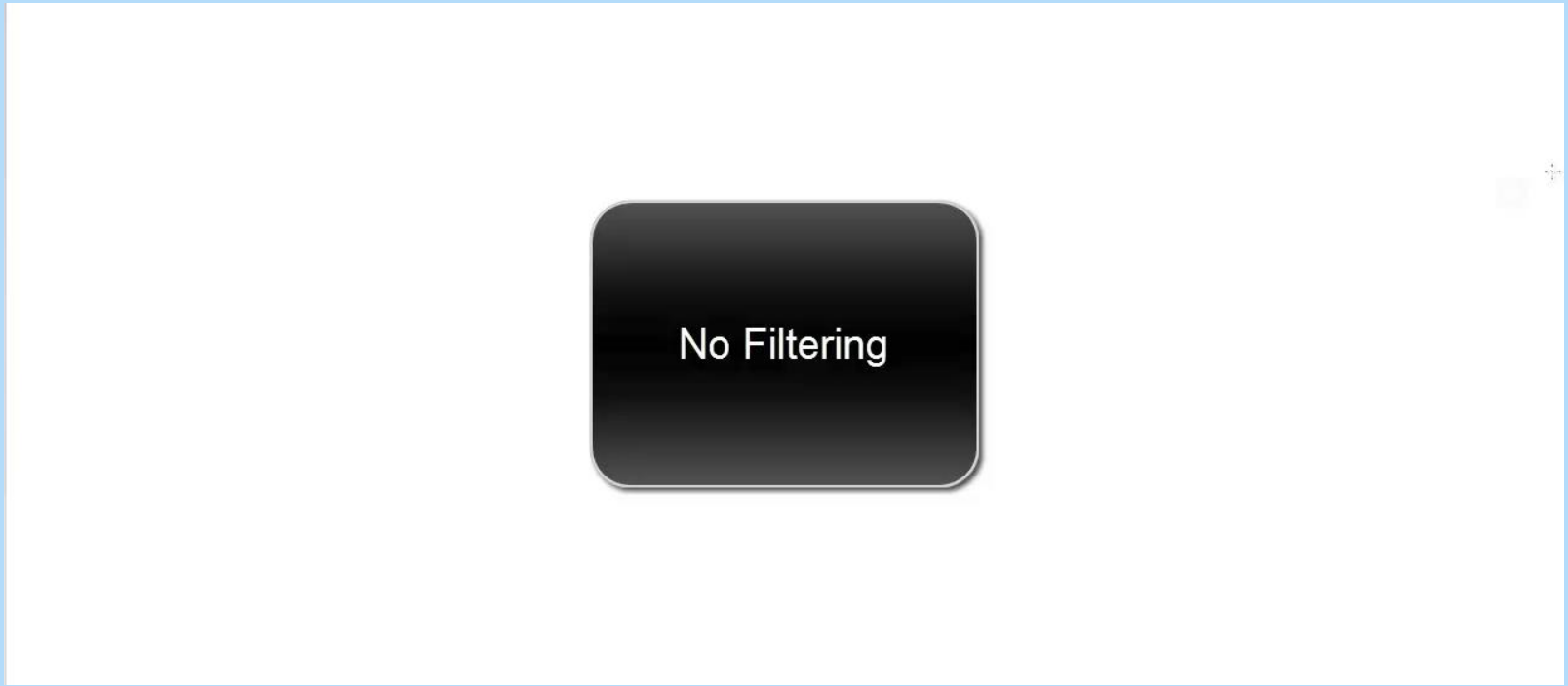
Insert gesture at (x_t, y_t)

[On a 1920*1080 scale]

Data Filtering

- Built-in Kinect filtering
  - Holt double exponential smoothing method parameters:
    - Smoothing
    - Correction
    - Prediction
    - JitterRadius
    - MaxDeviationRadius
- Low-Pass filtering
  - Binding data coordinates within a certain distance

Data Filtering



Constraints

- Time Constraints:
  - Limited by the school year (May 2014).
- Kinect Limitations:
  - Maximum Kinect capture rate of 30fps.
  - Maximum distance of 80” from the Kinect to the screen.
  - Maximum/Minimum size of the projected image. (6’/3’ diagonal screen size)
  - No objects can be in front of the screen during calibration.
- Computer Limitation:
  - Running Windows 8 or higher.

Problems Encountered

- Accuracy of Kinect
- Accuracy vs. Responsiveness
- Transparency of debug overlay
- System Tray icon disposal
- Simulate a tap

Previously Completed

- Project Plan V1.0 — 17 Oct, 2013
- Skeleton Website — 25 Oct, 2013
- Requirements Documentation V1.0 — 07 Nov, 2013
- Design Documentation V1.0 — 05 Dec, 2013
- Iteration 1 — 12 Dec, 2013
  - Test constraints on the Kinect's ability to capture the hands (i.e. time, location, left vs. right).
  - Read both hand locations from Kinect.
  - Define basic gestures:
    - Single hand.
    - Two hand.
    - Air.
  - Design two screen calibration methods:
    - Depth stream (Automated).
    - 4 points (Manual).
  - Interface the Kinect with the OS.
  - Begin implementing manual screen calibration.
  - Functional implementation of "Drag" gesture to OS.
- Iteration 2 — 30 Jan, 2014
  - Optimize manual calibration.
  - Define voice commands.
  - Implement system tray icon and right-click menu.
  - Implement application settings menu.
  - Implement debugging overlay.

Upcoming Schedule

- User Manual — 20 Feb, 2014
- Developer Guide — 20 Feb, 2014
- Iteration 3 — 28 Feb, 2014
  - Implement all cursor movements from Kinect to Windows.
  - Implement touch-specific gestures.
  - Implement voice commands.
- SRS Abstract Submission — 20 Mar, 2014
- NTASC Abstract Submission — 24 Mar, 2014
- Iteration 4 — 25 Mar, 2014
  - Implement air gestures.
  - Test integration with Windows 7.
  - Final system testing, bug fixing.
- SRS Poster Submission — 03 Apr, 2014
- NTASC — 05 Apr, 2014
- SRS — 11 Apr, 2014
- Final Presentation — 01 May, 2014
- Complete All Documents — 02 May, 2014
- Final Product DVD — 05 May, 2014

Time for a demo!

Questions?