*Florida International University*

*School of Computing and Information Sciences*

CIS 4911 - Senior Capstone Project

Software Engineering Focus

Feasibility Study and Project Plan

Multi Modal Interactive Paint

Team # X

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# Abstract

This document outlines the feasibility for developing the Multi Modal Interactive Pain application with all the devices currently available at the OpenHID lab. The devices include the Tobii EyeX, Acer Multitouch Monitor, Leap Motion Controller, and Intel Real Sense Depth Camera.

This document will cover various aspects of the product development. We will talk about how no current software solution does what is required for showcasing the smart desk, and how likely it will be to complete our given tasks. In addition we will cover the requirements for the application we are setting out to produce.

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# Introduction

New and Unique input devices are popping up all over the place. The Smart Desk hopes to create a modifiable desk that can show and teach students how to learn about and use new and unique devices. It aims to have multiple devices working at once, to operate it by performing different actions with various devices.

## 1.1 Problem definition

Currently the Smart Desk will have no easy to learn and fun application to get students used to the devices. The Smart Desk needs a software solution that can combine multiple devices such as the Leap Motion Controller, Touch Inputs, EyeX gaze Tracking, as well as the Intel Real Sense Camera.

The application should also have some control over the devices. Being able to change what a device does, and test how well it works performing different tasks will greatly benefit the Smart Desk. This means the application needs to be fun and interactive, as well as be an easy way to test new and interesting input devices on students.

## Background

The Smart Desk hopes to host various input devices.

The Leap Motion Controller is an Infrared device which can detect hand motions. It can recognize hand gestures as well as the ability to find joints in 3 dimensional space.

The Tobii EyeX has the ability to track the physical location of your eyes. In addition it can perform gaze tracking to discover where on the screen you are looking, allowing it to 'think ahead' to what you want to do, so you can pull up different menus.

The Intel Real Sense Device is a Infrared device which detects people in 3D space. Some of the interesting things it can do is facial recognition. This means you can perform facial gestures. In addition it can sense depth of your hand in 3d space.

The Smart Desk hopes to host all these devices and more.

## 1.3 Definitions, Acronyms and Abbreviations

* Leap Motion Controller - Infrared device for hand recognition.
* EyeX - Infrared device for eye tracking
* Intel Real Sense Camera - Infrared device for facial and 3d tracking.
* Multitouch - Multitouch monitor which detects finger presses.

## 1.4 Overview of document

This document will go over the feasibility of implementing a software solution that combines all of these devices. We will cover what kind of application we think it should be. We will also cover any alternative solutions for the smart desk. We will see how the alternatives rank up to our software solution.

The second half of this project will take a look at the project plan, the organization of the tasks for this project and the hardware and software requirements. Finally we will identify the tasks deliverables and milestones for the development of this solution during this semester.

# 2. Feasibility Study

This feasibility study will go over the strengths and weaknesses of the proposed system, opportunities, threats, resources and the necessary elements for the success of the system.

## 2.1 Description of Current System

Currently there is no system that combines all these devices in one location. There are however separate programs to test the devices. This means the Smart Desk can simply download many various programs to test them out individually.

## 2.2 Purpose of New System

The new system, an Interactive Paint system, hopes to remedy the situation of downloading many software solutions. It will enable the Smart Desk to not only be an end all be all solution for testing the devices, but also be a singular location where users can get used and learn about the devices. It will also give OpenHID the ability to add new devices whenever they want, as well as implement various functionality. In addition the application will be modifiable to add more devices in the future, since openHID will own the rights, it will also allow them to modify the program for future devices as well as update it for any new software or hardware updates.

## 2.3 High-level Definition of User Requirements

Multi Modal Interactive Paint Requirements

We were employed with creating a painting application that benefitted from these unique input methods

* + Touch Pad
  + Eye Tracking
  + Hand Recognition
  + Facial Expressions

Implementing basic paint functionality is crucial for the applications development. The program should be able to perform functions such as

* + Drawing
  + Changing Colors
  + Changing Shapes
  + Layer Support

An intuitive UI and control over input devices is also needed for testing these new technologies and discovering how best to use them.

## 2.4 Alternative Solutions

This section describes the alternative solutions that deal with the problem at hand. We will compare and contrast the aspects of these alternative solutions against our proposed solution to try and determine the feasibility of our solution.

### 2.4.1 Description of Alternatives

One option of an alternative as previously mentioned, is the ability to download various software solutions and test them individually. This includes downloading the leap motions basic tool kit, as well as the Intel Real Sense Tool Kit. The EyeX also has a toolkit to test the basics of the device, as well as some video game integrations to test it out in a more complicated environment.

### 2.4.2 Selection Criteria

The selection criteria that will be used in the analysis of the feasibility of our software solution are as follows:

Operational Feasibility

Functionality: A description of how well the system would work.

Technical Feasibility

Technology: An assessment of the maturity, availability (or ability to acquire), and desirability of the computer technology needed.

Expertise: An assessment to the technical expertise needed to develop, operate, and maintain the candidate system.

Economic Feasibility

Cost to develop: The cost to implement the solution.

Schedule Feasibility: An assessment of how long the solution will take to design and implement.

### 2.4.3 Analysis of Interactive Paint

Operational Feasibility:

A painting application would work wonders for both the interactive, fun, and testing portions of what the Smart Desk needs. It provides a fun way to enable students to draw, compare drawing, as well as perform funny facial expressions to change settings. In addition it will provide a great baseline to begin testing devices. Giving OpenHID complete control over what devices do will allow them to decide what portion of the devices they want to check. In addition a painting applications mends the gap between 'Complex input' and 'Simple Inputs'. It can be complicated by requiring precision to draw, as well as various simple functionality such as changing shapes or colors.

Technical Feasibility:

Implementing this software solution will be tough. Working with various devices at once is already a technical hurdle. Being able to write code for various devices and compile them into one application can definitely be a challenge. In addition the program will mostly be graphical, requiring knowledge of OpenGL and how graphics programming works. The students working on the project however promise to put forth maximum effort to be able to produce results in the very first implementation of the product.

Economic Feasibility:

The OpenHID has the budget to buy the devices separately for the developers. Since they are already implementing the entire desk, they can also afford to buy the technologies required. In addition the students will be available for the Senior Design course, allowing them to work for free.

Schedule Feasibility:

The Technical hurdles involved in an application like this are very high. The ability for students to learn OpenGL, as well as the various SDK's and combine them in a working app should be do-able within one semester. The students will have 14 weeks to learn how to code for the various devices, LibCinder (OpenGL wrapper) as well as combine them all in a singular application. The results might not be amazing, but they can get the project started and lay the ground work for future developers working on the application.

## 2.5 Recommendations

Implementing OpenHID's own program to display the Smart Desk is definitely the best route. We can build a software solution that compliments the hardware, to showcase, and test it. All with complete control over the application. We recommend beginning the application during Smart desk development so it is ready for the future, when the desk is complete and ready to showcase.

# 3. Project Plan

In this section we will review what is required of the project. We will also discuss the members working on the project. Software and Hardware requirements will also but mentioned in this section, as well as the various milestones we will show throughout the semester.

## 3.1 Project Organization

This section outlines the management and organization aspect of this project. The implementation of this project is broken down into various requirements depending on the features that this product will exhibit.

### 3.1.1 Project Personnel Organization

This semester contains two members, Garrett Lemieux as well as Andrew Mitchell. They will be practicing using an Agile Development process, using the UML standard for developing diagrams for the coding process. Each individual will work on the whole of the application, however each may be more specialized for certain devices.

### 3.1.2 Hardware and Software Resources

The implementation of Multi Modal Interactive Paint is the following:

**Hardware Resources**

* **Windows 10 PC**
  + Both computers used were laptops, with at least an intel core i5 processor and a fairly recent graphics card, such as the Geforce 940M
* **Acer Touch Screen Display**

The Touch Screen was one input for our Multi Modal Interactive Paint Application. As well as the screen used to view the app.

* **LeapMotion Input Device**
  + One of the more developed devices we used to read hand gestures.
* **Tobii EyeX**
  + Infrared camera used for gaze tracking in the application.
* **Intel Real Sense Depth Camera**
  + Depth Camera used for facial recognition and drawing with your hand

**Software Resources**

* **Windows 10**
  + Necessary for installing Visual Studio 2013
* **Visual Studio 2013**
  + Necessary IDE.
* **C++ Programming Language**
  + The language of choice by Dr. Francisco Ortega. It is also used for many of the SDK's such as the real sense, Eyex and Leap Motion Controller.
* **OpenGL Framework**
  + Used to power the API render features such as 2D shapes and 3D shapes
* **LibUSB 1.0**
  + Used to detect if devices are plugged into the PC.
* **LeapMotion SDK**
  + Used to interact with the LeapMotion device in order to program the LeapMotion gesture detection and finger drawing.
* **Intel Real Sense SDK**
  + Used to interact with the Intel Real Sense device in order to program the facial recognition and hand drawing.
* **Tobii EyeX SDK**
  + Used to interact with the EyeX device and program Gaze Tracking.
* **LibCinder**
  + an OpenGL wrapper that helps us draw primitive shapes and have control over our canvas where we can write FBO's.

## 3.2 Identification of Tasks, Milestones and Deliverables

The software development methodology used for this semester will be Agile Software Development. This will be divided into seven sprints which is an Agile method that focuses on the organizational aspects of the software engineering process. It is currently one of the most popular Agile methods.

The Milestones for this semester are as follows:

Sprint 1, **(1/18/2016 – 2/12/2016)**

Sprint 2, **(2/1/2016 – 2/12/2016)**

Sprint 3, **(2/15/2016 – 2/26/2016)**

Sprint 4, **(2/29/2016 – 3/11/2016)**

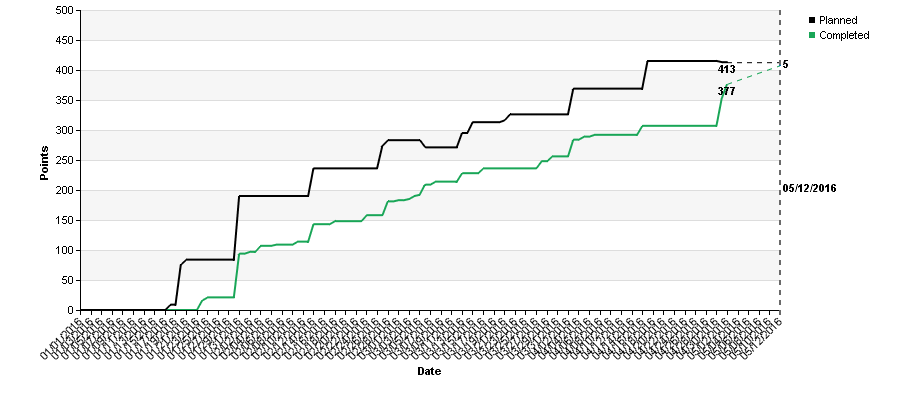
Sprint 5, **(3/21/2016 – 4/1/2016)**

Sprint 6, **(4/4/2016 – 4/15/2016)**

Sprint 7, **(4/18/2016 – 4/29/2016)**

# 4. Appendix

Here are the diagrams, images and chart that are supplementary to the Feasibility Study and Project Plan.

**4.1 Appendix A - Project Schedule (Gantt or PERT chart)** ****

## 4.4 Appendix D - Diary of Meetings

**Sprint Planning**

**Sprint Planning 1**

Date: 1/19/2016

Attendees: Garrett, Andrew, Professor Ortega

Start time: 4:30

End time: 5:30

After discussion, the velocity of the team were estimated to be ??.

The product owner chose the following user stories to be done during the next sprint. They are ordered based on their priority.

* User Story #497 up to User Story  (Learning C++, Technologies, and Magnum).

The team members indicated their willingness to work on the following user stories.

* Both Garrett and Andrew were assigned the same user stories, to learn C++, Magnum, download and play with the technology’s provided including Microsoft Kinect, Tobii eyeX, Acer Multitouch Screen, Leap Motion Controller. In addition to reviewing the previous semesters Framework and using that to test some of the technologies, so we are familiar with the environment.

**Sprint Planning 2**

Date: 1/31/2016

Attendees: Garrett, Andrew, Professor Ortega

Start time: 9:20

End time: 11:33

After discussion, the velocity of the team were estimated to be 49.

The product owner chose the following user stories to be done during the next sprint. They are ordered based on their priority. (See below for specifics)

* User Story 549
* User Story 552
* User Story 562
* User Story 563
* User Story 553
* User Story 550
* User Story 560
* User Story 548
* User Story 546
* User Story 554

The team members indicated their willingness to work on the following user stories.

Andrew :

#549 - 1 points - Change Background Color

#552 - 3 points - Create Circle Shape

#562 - 2 points - Implement Triangle Shapes.

#563 - 1 Points - Implement Rectangle Shapes.

#553 - 5 points - Smooth Lines

#550 - 8 points - Add Multiple Layers

#560 - 5 points - Read EyeX Eye Locations.

Garrett:

#548 - 8 points - Draw lines with leap motion

#546 - 8 points - Find working leap motion gestures

#554 - 8 Points - Save a File

**Sprint Planning 3**

Date: 2/14/2016

Attendees: Garrett, Andrew, Professor Ortega

Start time: 7:45

End time: 8:40

After discussion, the velocity of the team were estimated to be 46 points.

The product owner chose the following user stories to be done during the next sprint. They are ordered based on their priority. (See below for specifics)

* 558
* 590
* 591
* 592
* 548
* 546
* 554

The team members indicated their willingness to work on the following user stories.

Andrew :

#558 - 5 Points - Design Proper Feedback for Multitouch

#590 - 5 Points - Improve Performance

#591 - 5 Points - Design UI for Multitouch

#592 - 8 Points - Implement feedback for multitouch

Garrett:

#548 - 8 points - Draw lines with leap motion

#546 - 8 points - Find working leap motion gestures

#554 - 8 Points - Save a File

**Sprint Planning 4**

Date: 2/27/2016

Attendees: Garrett, Andrew, Professor Ortega

Start time: 11:15

End time: 12:45

After discussion, the velocity of the team were estimated to be 47 points.

The product owner chose the following user stories to be done during the next sprint. They are ordered based on their priority. (See below for specifics)

* #623 - 2 Points - Create Multitouch ReadMe
* #625 - 2 Points - Provide leapmotion read me for user
* #632 - 5 Points - Implementation of UI Menu
* #629 - 5 Points - Disable Gestures while drawing.
* #623 - 5 Points - Implement Double Tap Multitouch Gesture
* #634 - 3 Points - Enable device’s connection status
* #626 - 5 Points - Enable Alpha Coloring for Shapes
* #627 - 5 Points - Create layer visualization menu
* #628 - 3 Points - Design Device Modes
* #636 - 3 Points - Develop interactive paint device modes
* #633 - 2 Points - Implement icons for gestures
* #631 - 2 Points - Refactor “Touch” code
* #630 - 5 Points - Create Vertical Symmetry Line
* #635 - 3 Points - Work with intel camera

The team members indicated their willingness to work on the following user stories.

Andrew :

* #623 - 2 Points - Create Multitouch ReadMe
* #631 - 2 Points - Refactor “Touch” code
* #624 - 5 Points - Implement Double Tap Multitouch Gesture
* #626 - 5 Points - Enable Alpha Coloring for Shapes
* #627 - 5 Points - Create layer visualization menu
* #628 - 3 Points - Design Device Modes
* #630 - 5 Points - Create Vertical Symmetry Line

Garrett:

* #625 - 2 Points - Provide leapmotion read me for user
* #629 - 5 Points - Disable Gestures while drawing.
* #632 - 5 Points - Implementation of UI Menu
* #636 - 3 Points - Develop interactive paint device modes
* #634 - 3 Points - Enable device’s connection status
* #633 - 2 Points - Implement icons for gestures
* #635 - 3 Points - Work with intel camera

**Sprint Planning 5**

Date: 3/13/2016

Attendees: Garrett, Andrew, Professor Ortega

Start time: 9:55

End time: 11:05

After discussion, the velocity of the team were estimated to be 49 points.

The product owner chose the following user stories to be done during the next sprint. They are ordered based on their priority. (See below for specifics) (UPDATING DURING SPRING BREAK WITH USER STORY NUMBERS)

* Implement Override Modes
* Add layer transparency
* Proximity menu for leap motion
* LibUSB Research
* Implement Time Machine
* Transparent Eraser
* Leap Motion Shapes
* Real Sense Functionality
* Libcinder has Multitouch research
* Additional Multitouch Gestures
* Transparency on saves
* Add ‘Cool’ Shader functionality.

The team members indicated their willingness to work on the following user stories.

Andrew :

* 5 - Add Layer Transparency #662
* 5 - Implement Override Modes #678
* 3 Add Transparency on Save #664
* 3 Make eraser erase ‘transparent’ #665
* 3 Leap Motion Shapes#666
* 3 Add MultiTouch Gestures#668
* 2 ‘Research Libcinder Has Multitouch’ #667

Garrett:

* 10 - RealSense Implementation (Will be split into smaller User stories before end spring break)
* 5 - Create Shader
* 5 - Proximity Menu for Leap Motion
* 2 - LibUSB Brainstorm
* 3 - Set up time machine functionality or “undo” functionality

**Sprint Planning 6**

Date: 4/2/2016

Attendees: Garrett, Andrew, Professor Ortega

Start time: 2:55

End time: 3:30

After discussion, the velocity of the team were estimated to be 45 points.

The product owner chose the following user stories to be done during the next sprint. They are ordered based on their priority. (See below for specifics)

* 3 - Add Realsense to Override Mode - #700
* 10 - Add additional functionality for Real Sense - #708
* 3 - Implement Additional Gestures for Real Sense - #703
* 2 - Add Chrono to Device Detection - #699
* 2 - Find Icons - # 701
* 5 - Implement Solid Background - #702
* 10 - Implement Basic Text - #698
* 3 - Integrate Real Sense into Default Mode - #707
* 2 - Integrate Real Sense into Devicehandler - #706
* 2 - Design Start up Image - #649
* 3 - Reset Default Mode on Device Disconnect - #559

The team members indicated their willingness to work on the following user stories.

Andrew :

* 5 - Implement Solid Background - #702
* 2 - Find Icons - # 701
* 3 - Add Realsense to Override Mode - #700
* 2 - Add Chrono to Device Detection - #699
* 10 - Implement Basic Text - #698

Garrett:

* 10 - Add additional functionality for Real Sense - #708
* 3 - Integrate Real Sense into Default Mode - #707
* 2 - Integrate Real Sense into Devicehandler - #706
* 3 - Implement Additional Gestures for Real Sense - #703
* 2 - Design Start up Image - #649
* 3 - Reset Default Mode on Device Disconnect - #559

**Sprint Planning 7**

Date: 4/17/2016

Attendees: Garrett, Andrew, Professor Ortega

Start time: 11:10

End time: 11:40

After discussion, the velocity of the team were estimated to be 45 points.

The product owner chose the following user stories to be done during the next sprint. They are ordered based on their priority. (See below for specifics)

* 3 Icons Implemented
* 2 Draw UI Improvements
* 3 Compress Brush Buttons
* 1 Add Frames Per Second Counter
* 3 Add Start Up Image
* Develop Leap Motion and Real Sense User Guide - 10
* Develop Multitouch and EyeX User Guide - 10
* Ensure Bugless Leap Motion and Real Sense Interaction  - 5
* Ensure Bugless Multitouch and EyeX Interaction - 5

The team members indicated their willingness to work on the following user stories.

Andrew :

* 3 Draw UI Improvements - #731
* 3 Icons Implemented - #730
* 2 Add Frames Per second counter- #733
* 10 Develop Multitouch and EyeX User Guide - #734
* 5 Ensure Bugless Multitouch and EyeX Interaction - #736

Garrett:

* 5 Compress Brush Buttons - #732
* 3 Add Start up Image - #735
* 10 Develop Leap Motion and Real Sense User Guide - #737
* 5 Ensure Bugless Leap Motion and Real Sense Interaction - #738

**Sprint Planning - For Product Backlog**

Date: 5/1/2016

Attendees: Garrett, Andrew, Professor Ortega

Start time: 12:45

End time: 1:30

After discussion, the velocity of the team were estimated to be NO points.

The product owner chose the following user stories to be done during the next sprint. They are ordered based on their priority. (See below for specifics)

* #753 Implement Threading
* #754 Add Active Pen Support
* #755 Implement Speech Recognition
* Implement Gamified Tutorial

The team members indicated their willingness to work on the following user stories.

Andrew :

* N/a

Garrett:

* N/a

**Sprint Review**

**Sprint Retrospective 1**

Date: 1/31/2016

Attendees:Garrett, Andrew, Francisco Ortega

Start time:9:00

End time:9:20

What went wrong?

* Did we do a good job estimating our team's velocity?
  + No. We only did 20 points.
* Did we do a good job estimating the points (time required) for each user story?
  + After setting up libcinder and getting our first user story completed we estimated the other user story fairly well, but still not great.
* Did each team member work as scheduled?
  + Yes we worked as scheduled, including over time!
  + We had a small hiccup for our sprint planning meetings, started later than planned.
* Magnum
  + Failed as a good development environment.
  + Spent many hours working on compiling
  + Spent even more hours trying to get working samples
  + Spent some time on working examples.
  + Eventually it was scrapped for libcinder.

What went right?

* After switching to libcinder our velocity skyrocketed. After looking at a few examples we managed to get our user stories completed in a great amount of time.
* We did learn a lot about C++ and the various devices from Professor Ortega and online videos.
* Great communication between product owner and developers.
* All team members are working hard and on time, very easy to get a hold of.

How to address the issues in the next sprint?

* How to improve the process?
  + Sprint planning with real user stories from day 1.
  + Already have a dev environment set in stone (no magnum, switched to lib cinder), so it should be easier to develop user stories.
  + Point Estimation - Longer Sprint planning II and doing it properly with correct user stories.
* How to improve the product?
  + Smooth the larger lines.
  + Implement LeapMotion Device.

**Sprint Retrospective 2**

Date: 02/14/2016

Attendees:Garrett, Andrew, Francisco Ortega

Start time:7:30

End time:7:45

What went wrong?

* Did we do a good job estimating our team's velocity?
  + Estimations were fairly accurate, but,  Sunday, the last day of the sprint,  we spent a little more time than anticipated finishing our work before the meeting.
* Did we do a good job estimating the points (time required) for each user story?
  + Andrew - Underestimated the line smooth functionality. Took a bit longer than anticipated.
  + Garrett - Underestimated drawing a smooth line. Took extra time fixing performance issue.
* Did each team member work as scheduled?
  + Yes!
* Design philosophy meeting got pushed back.
* Performance issues with drawing lines (multitouch).
* EyeX is not as precise as previously thought.
* Worked separately on different devices.

What went right?

* Got the devices to work.
* Got our user stories completed.
* Product owner was impressed by how much we got done.

How to address the issues in the next sprint?

* How to improve the process?
  + More meetings between Garrett and Andrew to structure the code better for the multiple devices
* How to improve the product?
  + Need to improve performance issues (Andrew)
  + Implement a good user Interface.
  + Implement Shape Inheritance

**Sprint Retrospective 3**

Date: 02/27/2016

Attendees:Garrett, Andrew

Start time:10:55

End time: 11:15

What went wrong?

* Did we do a good job estimating our team's velocity?
  + We got everything done, maybe have worked a bit extra to account for unexpected meetings.
* Did we do a good job estimating the points (time required) for each user story?
  + Feedback implementation took a bit longer than anticipated.
* Did each team member work as scheduled?
  + We had a few hiccups the days where we had meetings. We worked later a lot later in the day when the meetings got pushed back.
  + Sprint review got slightly postponed.

What went right?

* Code integration went well.
* Finally learned a few core components of framebuffers which will surely help in the following sprints.
* Much better time estimations.
* Git integration is a lot more smooth now.

How to address the issues in the next sprint?

* How to improve the process?
  + Try to get all our meetings scheduled ahead of time. They need to be at least known at the start of the sprint, even if the schedule is slightly malleable.
  + Should have design meetings in previous sprints.
* How to improve the product?
  + Implement alpha shading to our shape colors.
  + Get icons for our buttons and feedback popups.
  + Improve device status so it can be dynamic (currently only leap is dynamic)
  + Turn off gestures while drawing with leap.
  + Add UI for Layering
  + Implement ‘Modes’ for using specific devices a certain way.

**Sprint Retrospective 4**

Date: 3/13/2016

Attendees:Garrett, Andrew

Start time: 9:40

End time:9:55

What went wrong?

* Did we do a good job estimating our team's velocity?
  + Yes
* Did we do a good job estimating the points (time required) for each user story?
  + Yes.
  + LibUSB provided a couple of unsuspecting hiccups. Won’t be our end all be all solution.
* Did each team member work as scheduled?
  + Yes.
* Lib USB caused a lot of performance issues.

What went right?

* Our presentations went well
* Completed all of our user stories on time, even with the event of our checkpoint I

How to address the issues in the next sprint?

* How to improve the process?
  + Try to find a way to better communicate with the OpenHID Lab.
  + Continuously refactor code.
    - Ensure code is as separate as possible
    - This should be an ongoing process.
* How to improve the product?
  + Refactor / Separate out code.
  + Draw shapes with leap motion.
  + Gamification elements for kids?
  + Add RealSense Device.
  + Continue searching for good ‘device detection’ paths.
  + Interactive UI for Leap Motion
  + Continue working on the user guide.
  + Improve LIBUSB Performance Issues.

**Sprint Retrospective 5**

Date: 4/2/2016

Attendees:Garrett, Andrew, Francisco Ortega

Start time: 2:20 PM

End time: 2:55 PM

What went wrong?

* Did we do a good job estimating our team's velocity?
  + Yes, some slight overtime due handling new device.
* Did we do a good job estimating the points (time required) for each user story?
  + Fairly well.
    - User Story 670 Implement Undo Button took a bit longer than expected.
    - Some overtime with setting up real sense.
* Did each team member work as scheduled?
  + Yes.
* Again the product owner had to push back the meeting despite sending out a message and Gmail meeting early in the sprint. The product owner did get sick however, so this may have been the cause for the postponement. Hopefully it doesn’t continue to happen.

What went right?

* We finished everything on time despite some very interesting bugs that popped up (With some slight overtime)
* We Integrated a new device into the program (Intel RealSense Camera)
* Cleaned up how devices are handled.

How to address the issues in the next sprint?

* How to improve the process?
  + We should write the User Guide before writing the code (So we know what exactly the user should experience). We should update it after completion still to ensure that it turned out as planned.
* How to improve the product?
  + Continue working on the user guide.
  + Improve LIBUSB Performance Issues (Add Chrono).
  + Better Icons for Buttons
  + Improve how UI is drawn (performance wise) - Low priority.
  + RealSense - Additional Functionality
  + Program Startup Display Image

**Sprint Retrospective 6**

Date: 4/17/2016

Attendees:Garrett, Andrew, Francisco Ortega

Start time:10:55

End time: 11:10

What went wrong?

* Did we do a good job estimating our team's velocity?
  + Yes. We estimated perfectly this time. We finished on time.
* Did we do a good job estimating the points (time required) for each user story?
  + Yes. All went about the correct time.
* Did each team member work as scheduled?
  + Yes.
* Again the product owner had to push back the meeting due to being out of town this week. Had to postpone to Saturday.

What went right?

* We finished everything on time (no real overtime except a video the product owner wanted us to do).
* Added more functionality for new real sense device.
* Improved performance dramatically by reducing the amount of device checks.

How to address the issues in the next sprint?

* How to improve the process?
  + We should change our sprint review schedule because the product owner seems to have problems arriving on fridays.
* How to improve the product?
  + Continue working on the user guide.
  + Better Icons for Buttons (found Icons, need to implement them now).
  + Improve how UI is drawn (performance wise, draw into frame buffers once) - Low priority.
  + Program Startup Display Image
  + Refactor some more code
    - Leap Motion and EyeX out of Touch Points
    - Ensure that ‘Update’ does all the updates and ‘Draw’ does our ui and canvas drawing.
  + Real Sense ‘Asynchronous’ Implementation (May improve real sense performance).
  + Buffer Multitouch input.

**Sprint Retrospective 7**

Date: 5/1/2016

Attendees:Garrett, Andrew, Francisco Ortega

Start time:12:10

End time: 12:45

What went wrong?

* Did we do a good job estimating our team's velocity?
  + Yes. We managed to finish our tasks early and had enough time to finish touching up our user guides as well as old documentation.
* Did we do a good job estimating the points (time required) for each user story?
  + Yes.
* Did each team member work as scheduled?
  + Yes.
* This sprint we decided to set the EoS Meetings to sunday at noon. This means we didn’t wait up friday for our product owner because he is normally available sundays. Worked much better!

What went right?

* Setting up the meeting on sunday.
* Our Testing was good. Retesting old features, most of them seemed to work as intended but we did find a few bugs that we managed to fix.
* New documentation is looking good!

How to address the issues in the next sprint?

* How to improve the process?
  + Continue to change day for our EoS Meetings.
  + Do documentation right the first time!
* How to improve the product?
  + Refactor more code. Move Leap Motion, EyeX, and Multitouch out of TouchPointsapp.
  + Buffer Multitouch Input.
  + Implement Threading
  + Gamification elements added into a tutorial system.
  + How to improve it for multi modal ouputs (iPad, VR, etc).
  + Speach recognition
  + Active Pen.

**Sprint Review**

**Sprint 1**

Date: 1/31/2016

Attendees:Garrett, Andrew, Francisco Ortega

Start time: 8:53PM

End time: 9:00PM

After a show and tell presentation, the implementation of the following user stories were accepted by the product owners: All.

* User Story #538 - Change Line Size
* User Story #537 - Implement Random Color Mode
* User Story #498 - Change Line Color
* User Story #??  - Eraser Mode

The following ones were rejected and moved back to the product backlog to be assigned to a future sprint at a future Spring Planning meeting.

* N/A
  + N/a
  + How this should be reflected on the user story definition in Mingle:
    - N/A
* …

**Sprint 2**

Date: 02/14/2016

Attendees:Garrett, Andrew, Francisco Ortega

Start time: 7:15

End time: 7:30

After a show and tell presentation, the implementation of the following user stories were accepted by the product owners: All.

* User Story 549
* User Story 552
* User Story 562
* User Story 563
* User Story 553
* User Story 550
* User Story 560
* User Story 548
* User Story 546
* User Story 554

The following ones were rejected and moved back to the product backlog to be assigned to a future sprint at a future Spring Planning meeting.

N/a. All Accepted.

* User Story #???
  + N/a
  + How this should be reflected on the user story definition in Mingle:
* …

**Sprint 3**

Date:2/27/2016

Attendees:Garrett, Andrew, Francisco Ortega

Start time: 10:40

End time:10 : 55

After a show and tell presentation, the implementation of the following user stories were accepted by the product owners: All.

* User Story #623
* User Story #624
* User Story #625
* User Story #626
* User Story #629
* User Story #630
* User Story #631
* User Story #633
* User Story #627
* User Story #628
* User Story #632
* User Story #634
* User Story #635
* User Story #636

The following ones were rejected and moved back to the product backlog to be assigned to a future sprint at a future Spring Planning meeting.

* User Story #???
  + N/a
  + How this should be reflected on the user story definition in Mingle:
* …

**Sprint 4**

Date: 3/13/2016

Attendees:Garrett, Andrew, Francisco Ortega

Start time: 9:25

End time: 9:40

After a show and tell presentation, the implementation of the following user stories were accepted by the product owners: All were completed to his specifications.

* User Story #627
* User Story #623
* User Story #630
* User Story #628
* User Story #624
* User Story #636
* User Story #629
* User Story #626
* User Story #634
* User Story #633
* User Story #632
* User Story #625
* User Story #631
* User Story #635

The following ones were rejected and moved back to the product backlog to be assigned to a future sprint at a future Spring Planning meeting.

* User Story #???
  + N/a
  + How this should be reflected on the user story definition in Mingle:

**Sprint 5**

Date: 4/2/2016

Attendees:Garrett, Andrew, Francisco Ortega

Start time: 2:00

End time: 2:25

After a show and tell presentation, the implementation of the following user stories were accepted by the product owners: All were completed to his specifications.

* User Story #675
* User Story #671
* User Story #670
* User Story #669
* User Story #667
* User Story #678
* User Story #668
* User Story #666
* User Story #665
* User Story #664
* User Story #662

The following ones were rejected and moved back to the product backlog to be assigned to a future sprint at a future Sprint Planning meeting.

* User Story #672
  + Was rejected because developer found that it cannot yet be integrated. The Orion update for the leap motion device is currently only available in the unity engine.
  + How this should be reflected on the user story definition in Mingle:
    - The acceptance criteria is updated to “Update to new Orion API and SDK when it is released for C++”

**Sprint 6**

Date: 4/17/2016

Attendees:Garrett, Andrew, Francisco Ortega

Start time:10:30

End time: 10:55

After a show and tell presentation, the implementation of the following user stories were accepted by the product owners: All.

* User Story #559
* User Story #649
* User Story #698
* User Story #699
* User Story #700
* User Story #701
* User Story #702
* User Story #703
* User Story #706
* User Story #707
* User Story #708

The following ones were rejected and moved back to the product backlog to be assigned to a future sprint at a future Spring Planning meeting.

N/a. All Accepted.

* User Story #???
  + N/a
  + How this should be reflected on the user story definition in Mingle:
* …

**Sprint 7**

Date: 5/1/2016

Attendees:Garrett, Andrew, Francisco Ortega

Start time:11:55

End time: 12:10

After a show and tell presentation, the implementation of the following user stories were accepted by the product owners: All.

* User Story #701
* User Story #700
* User Story #699
* User Story #698
* User Story #702
* User Story #708
* User Story #707
* User Story #706
* User Story #703
* User Story #649
* User Story #559

The following ones were rejected and moved back to the product backlog to be assigned to a future sprint at a future Spring Planning meeting.

N/a. All Accepted.

* User Story #???
  + N/a
  + How this should be reflected on the user story definition in Mingle:
* …