

LOCKHEED MARTIN



Virtual Reality Tracking and Haptic Feedback Gloves



Team 513



Team Introductions



Alexandra Hollabaugh
Project Manager

Jonathan Roberts
Hardware Engineer

Alex Erven
Systems Engineer

Jake Kennedy
Test Engineer

Kevin Lindquist
Software Engineer

Sponsor and Advisor



Engineering Mentor
Jeffrey Payne, PE
Staff Mechanical Engineer



Academic Advisor
Jerris Hooker, Ph.D
Teaching Faculty / Senior Design Coordinator

Project Background

Jake Kennedy

Objective

The objective of the project is to make a pair of gloves for Lockheed Martin that allow for the user to train in a virtual reality Abrams tank. The design will reduce the cost and size of current simulation systems while still providing feedback to the user.



Figure 1: A Lockheed Martin F-35 Flight Simulator

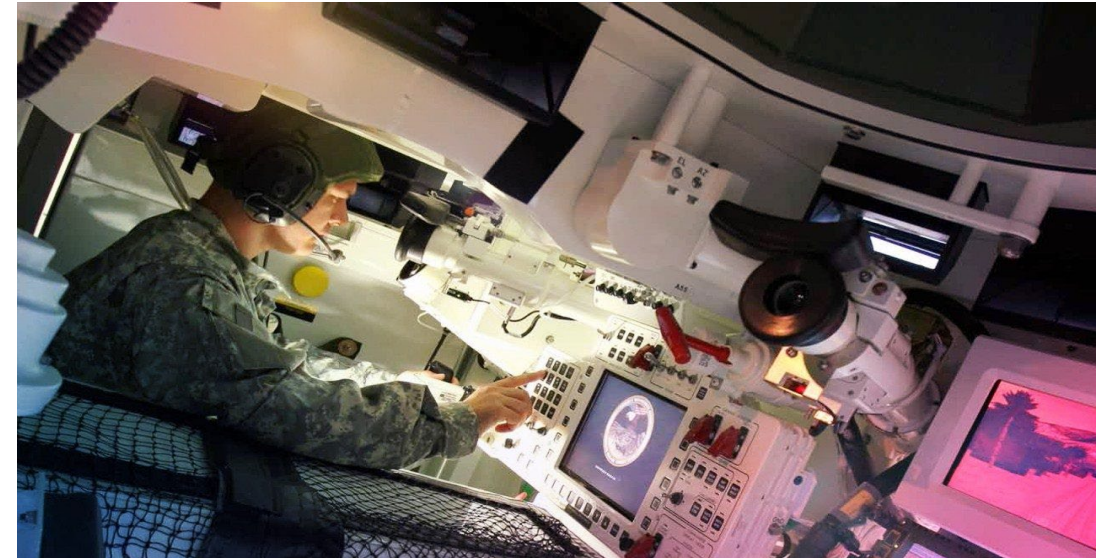


Figure 2: A Lockheed Martin M1A2 Tank Simulator

Current VR Systems

- VR stands for virtual reality and is a relatively new technology.
- A headset allows for full emersion into a virtual world.
- Wands are used as controllers to interact with the environment while providing limited feedback.
- Current gloves are bulky and limit the user's ability to interact with the real-world.



Figure 3: HTC VIVE Pro Headset and Controller

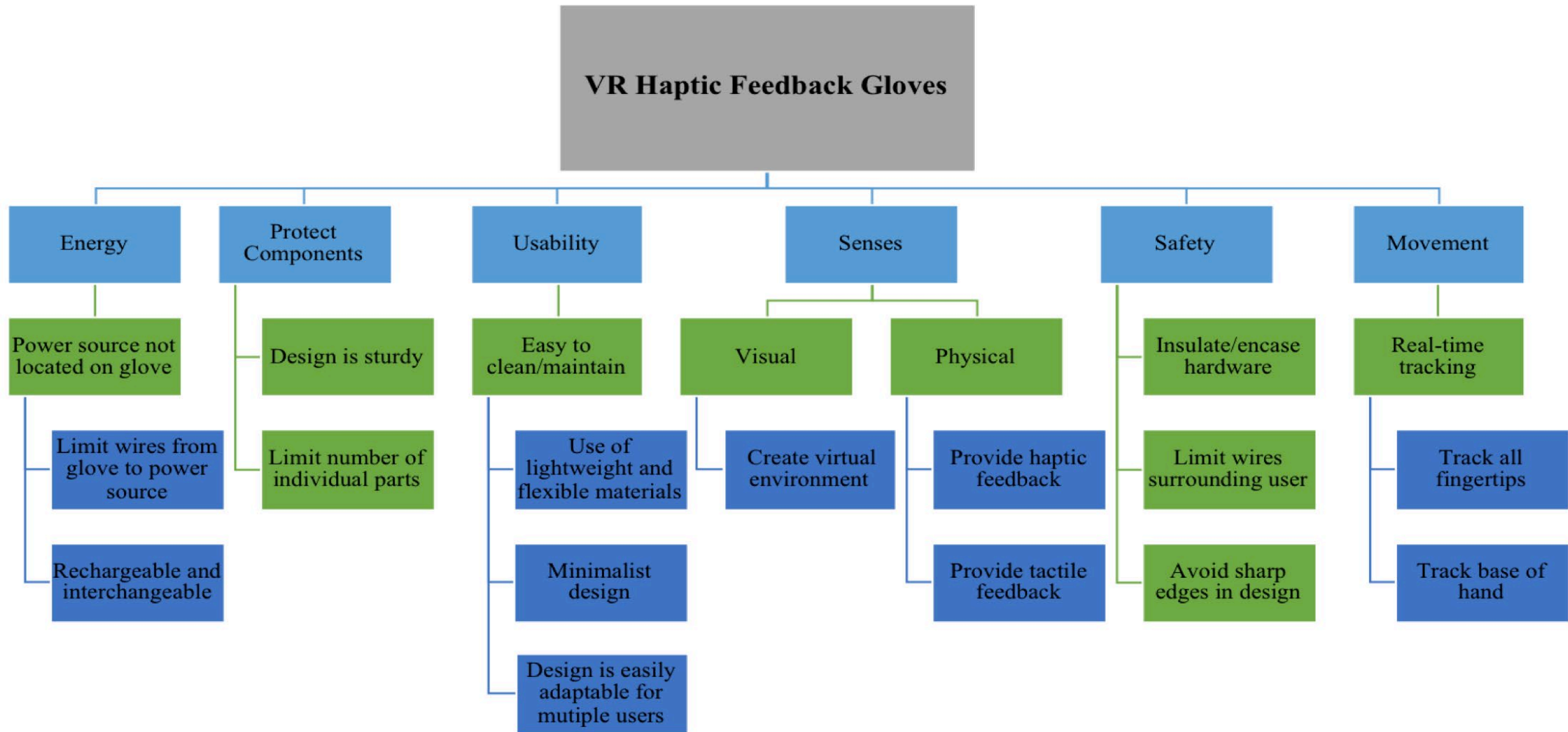


Figure 4: Example of current Haptic Feedback Glove (HaptX glove)

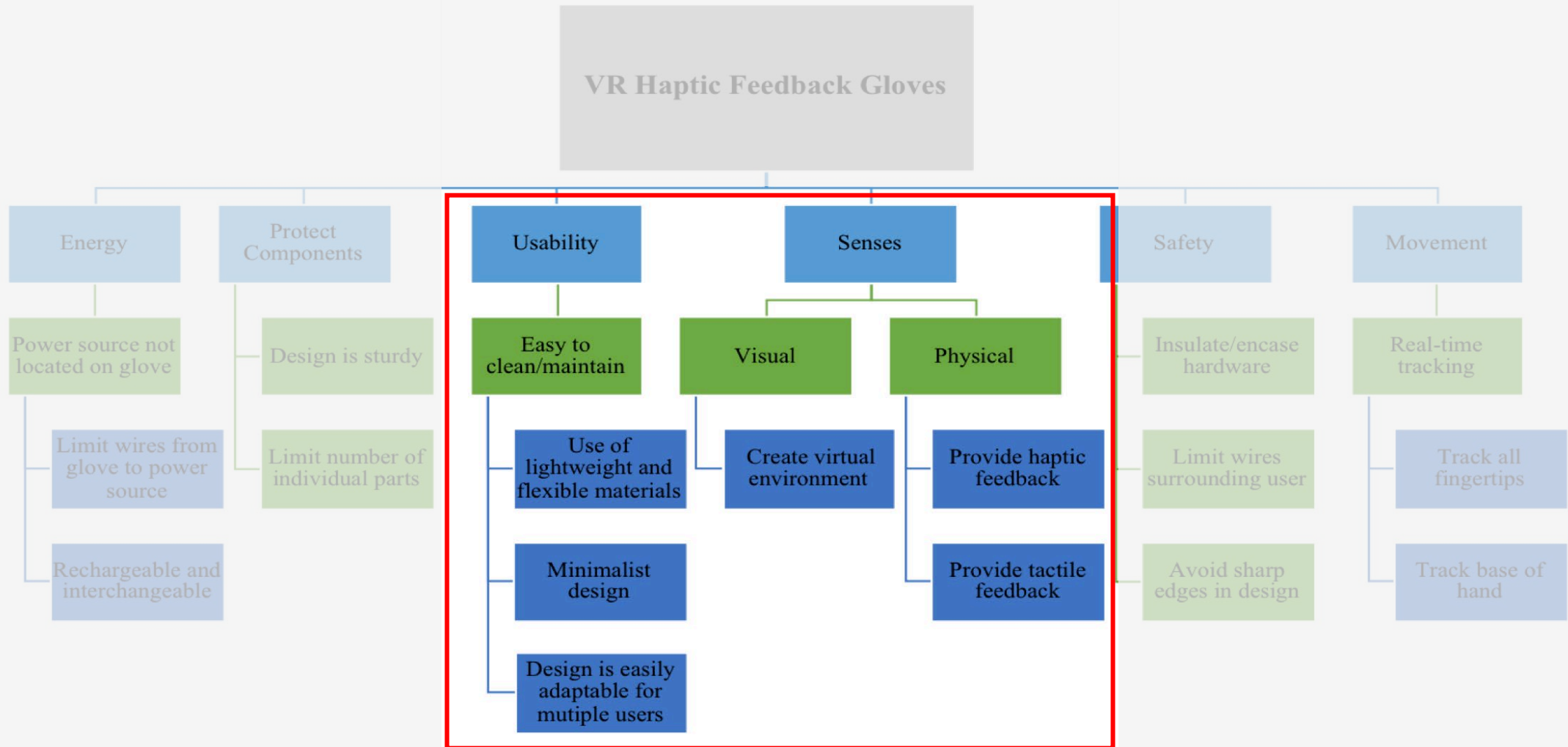
Customer Needs

- Provide haptic feedback when interacting with the virtual environment.
- Provide tactile feedback when interacting with the real world.
- Durable design while maintaining a low profile.
- Be able to easily transfer from one user to the next.
- They allow for uninhibited range of motion.
- The gloves are hypoallergenic and easily sanitized.

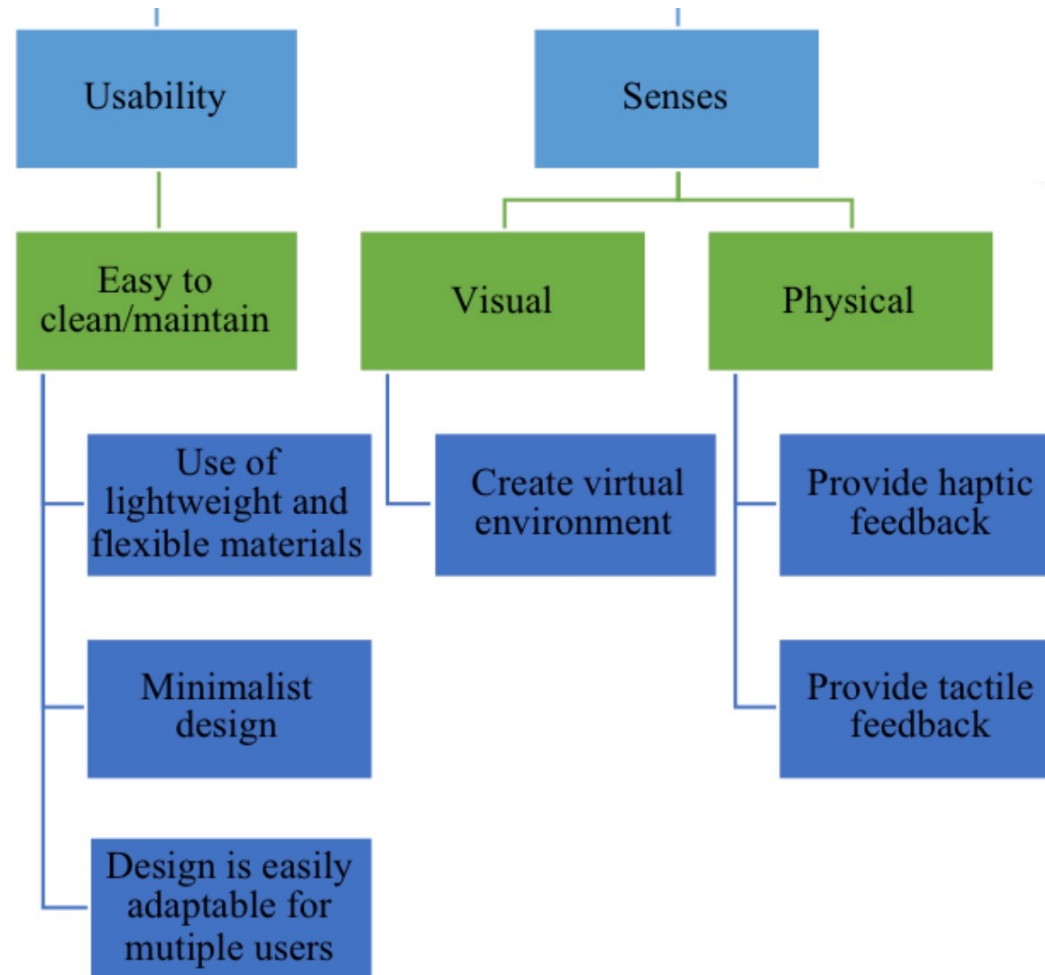
Functional Decomp



Functional Decomp



Functional Decomp



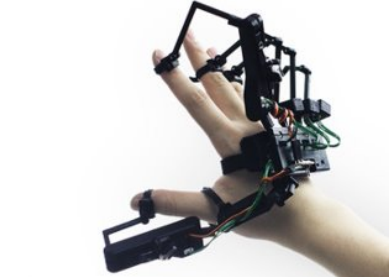
Concept Development and Testing

Alex Erven



Concept Generation

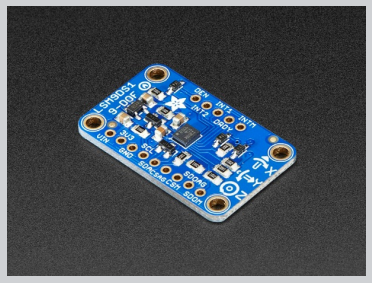
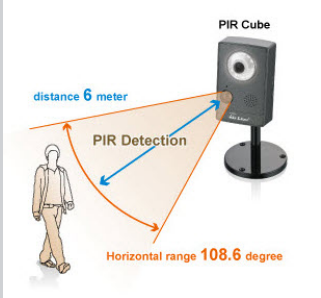
Haptic Feedback



Gloves

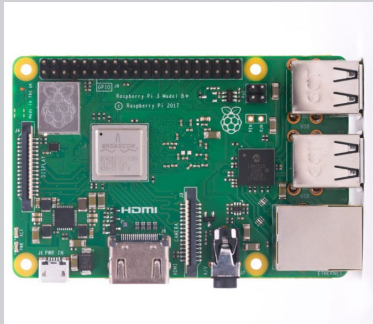
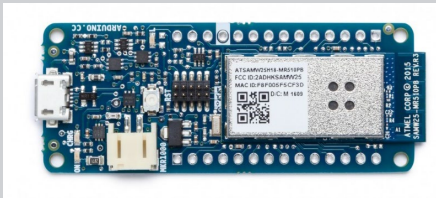
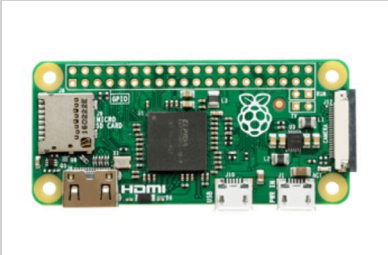
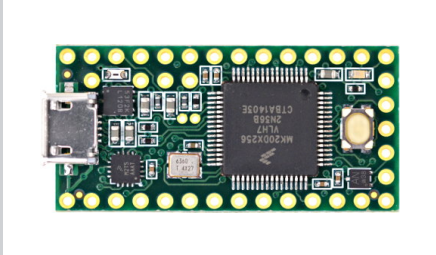


Tracking



Concept Generation

Microcontroller



Power Supply



Concept Selection

Table 1: Parts Breakdown

| Part # | Subsystem | Final Selection | Placement | Quantity (Total) |
|--------|------------------------|---------------------------------|--|------------------|
| 1 | Haptic Feedback | Linear Resonant Actuators (LRA) | 1 on inside of each finger and thumb | 10 |
| 2 | Gloves | Fingerless gloves | -- | 1 (pair) |
| 3 | Tracking | Flex Sensors | 1 on the back of each finger and thumb | 10 |
| 4 | Microcontroller | Teensy 3.2 | 1 on the back of each hand | 2 |
| 5 | Power Supply | Removable, Rechargeable Battery | 1 on the back of each hand | 2 |
| 6 | Wireless Communication | Bluetooth RN-42 Module | 1 on the back of each hand | 2 |

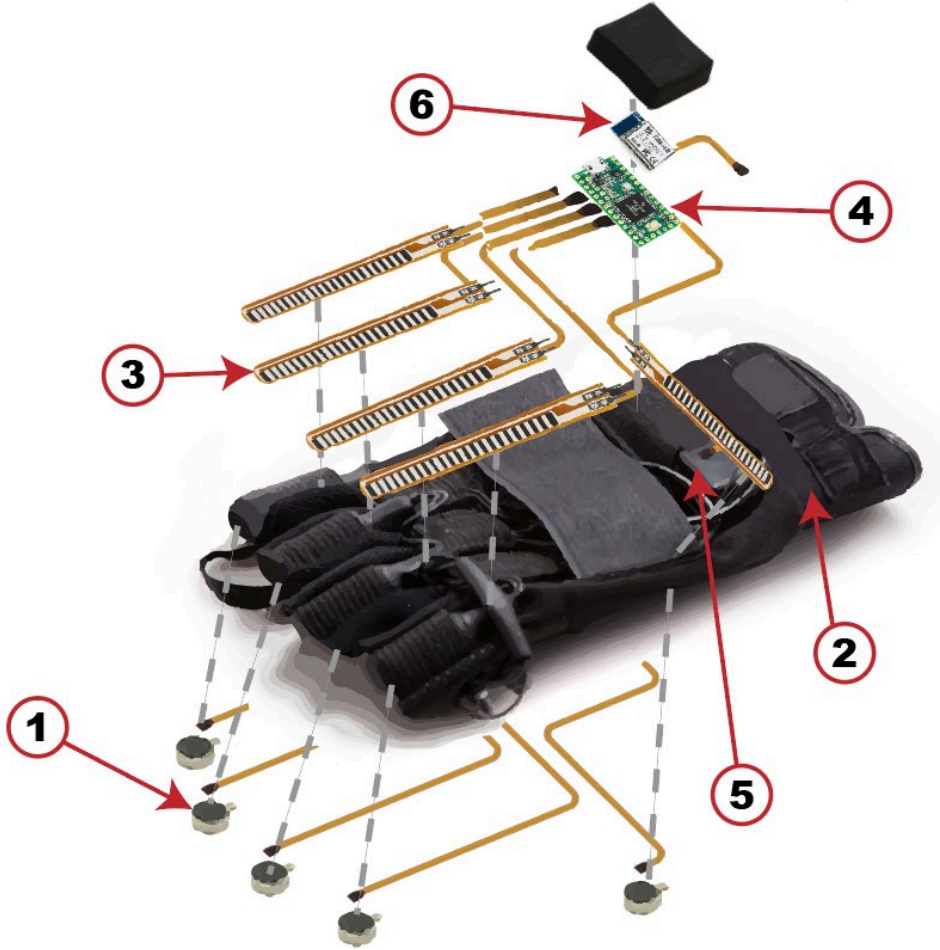


Figure 5: Modified concept design with numbered parts

Hardware Mounting

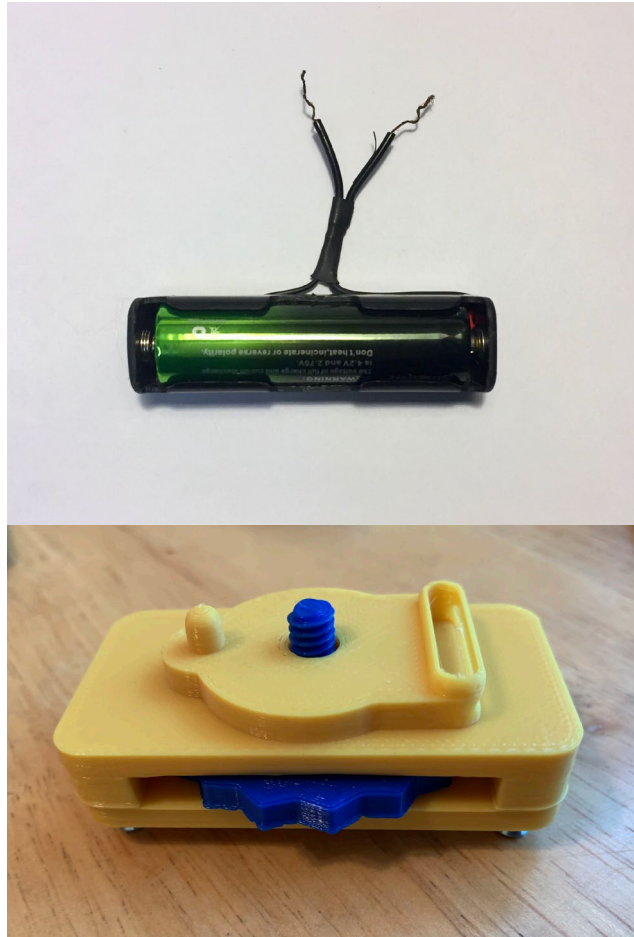
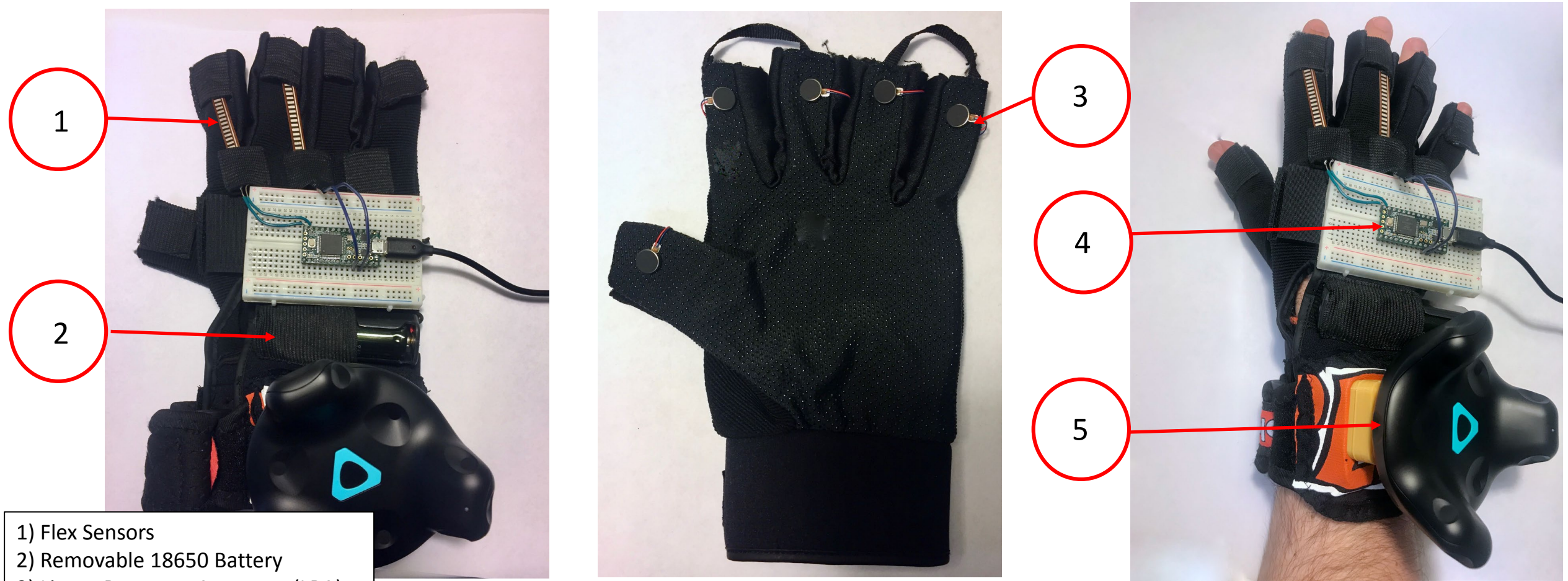


Figure 6: Hardware components for glove design

Component Layout Testing



- 1) Flex Sensors
- 2) Removable 18650 Battery
- 3) Linear Resonant Actuators (LRA)
- 4) Teensy 3.2 Microcontroller
- 5) Vive Tracker

Figure 7: Layout of components for glove design

Sensor & Unity Testing

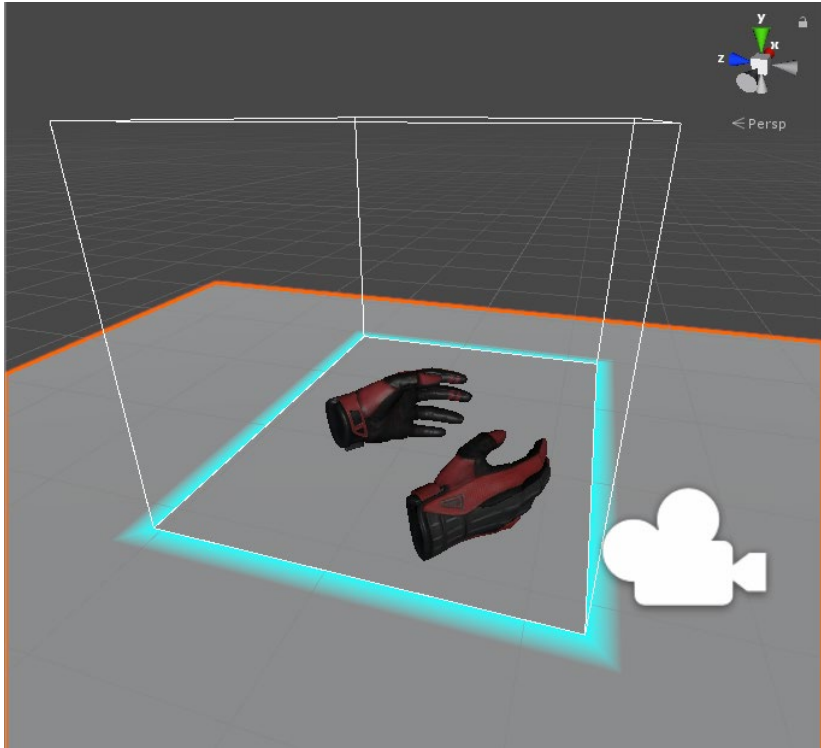


Figure 8: Hands In Unity VR Environment



Figure 9: Tank With Hands In Unity VR Environment

Project Management

Kevin Lindquist

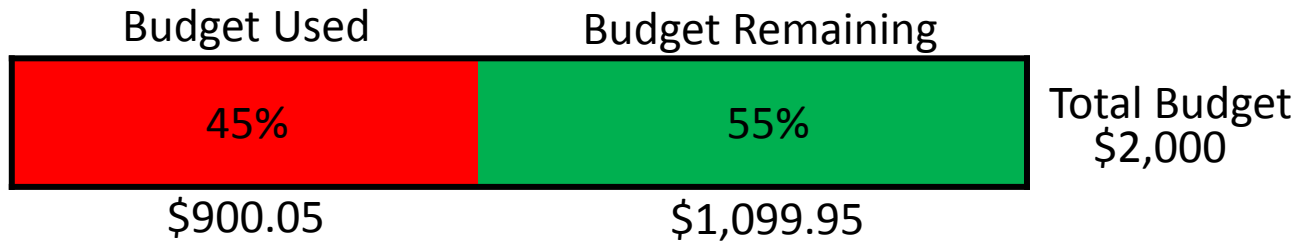
Targets

- From the customer needs the following targets were determined.

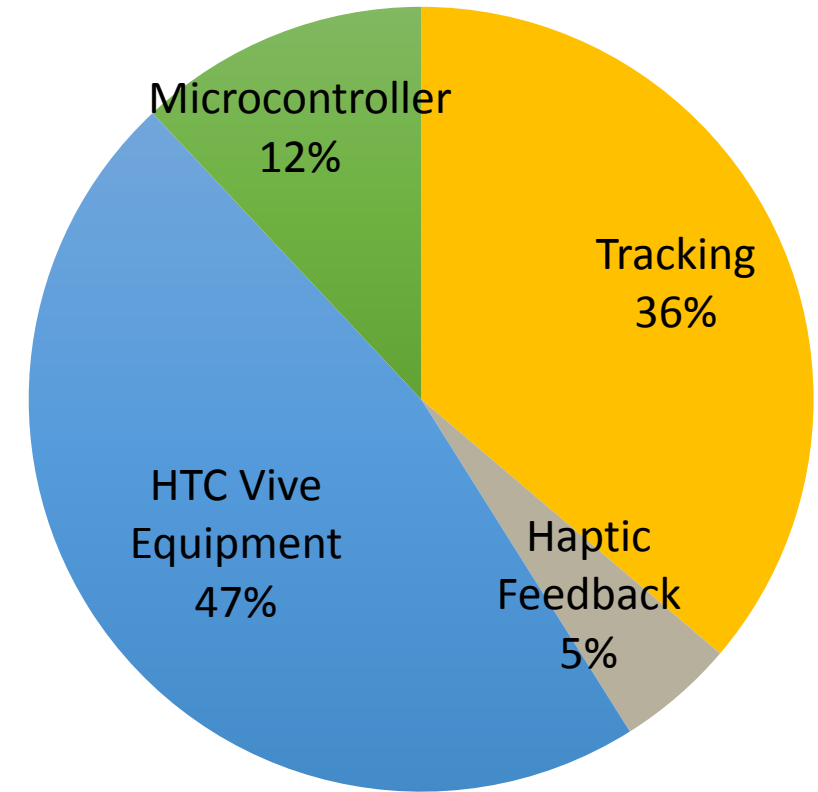
Table 2: Most Important Targets and Metrics

| Metric | Target |
|------------------|---|
| System latency | 20 milliseconds |
| Tactile feedback | Sensation of touch retained |
| Haptic feedback | Physical response to interaction with virtual environment |

Budget Report



Budget Breakdown



- Tracking
- Haptic Feedback
- Power Supply
- Gloves
- HTC Vive Equipment
- Microcontroller

Timeline



| | | February | | | | March | | | | April | | | | May | | |
|-------------|---|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|------------|-------------|-------------|-------------|-------------|-------------|
| Major Tasks | | 10th | 18th | 22nd | 28th | 2nd | 6th | 10th | 12th | 18th | 22nd | 30th | 12th | 18th | 29th | 5th |
| | Read data from single IMU & flex sensor | Completed | | | | | | | | | | | | | | |
| | Build hands in VR environment | | Completed | | | | | | | | | | | | | |
| | Incorporate Vive tracker in VR environment | | Completed | | | | | | | | | | | | | |
| | Test LRA vibrations on gloves | | Completed | Completed | | | | | | | | | | | | |
| | 3D scan Vive tracker to make mounting device | | Completed | Completed | | | | | | | | | | | | |
| | Establish bluetooth communications from microcontroller to computer | | Completed | Completed | Completed | | | | | | | | | | | |
| | Connect single IMU to the VR hand | | | Completed | Completed | | | | | | | | | | | |
| | Connect single flex sensor to the VR hand | | | Completed | Completed | | | | | | | | | | | |
| | Connect sensor network to microcontroller | | | | | Completed | | | | | | | | | | |
| | Read data from multiple sensors in a network | | | | | Completed | Completed | | | | | | | | | |
| | Manipulate raw data into usable data | | | | | Completed | Completed | | | | | | | | | |
| | Order parts last needed parts for prototype | | | | | Completed | Completed | | | | | | | | | |
| | Connect sensor network to the VR hand | | | | | | | | Completed | | | | | | | |
| | Mount sensors/LRA's on one glove | | | | | | | | Completed | | | | | | | |
| | Mount tracker and MCU on one glove | | | | | | | | Completed | | | | | | | |
| | Duplicate one hand into two hands in VR | | | | | | | | Completed | Completed | | | | | | |
| | Make wiring low profile | | | | | | | Completed | Completed | Completed | | | | | | |
| | Working intial prototype but not final one | | | | | | | | | | Started On | Started On | Started On | | | |
| | Mount sensors/LRA's on the other glove | | | | | | | | | | | Future Work | Future Work | | | |
| | Mount tracker and MCU on other glove | | | | | | | | | | | Future Work | Future Work | | | |
| | Testing | | | | | | | | | | | Future Work | Future Work | | | |
| | Debugging | | | | | | | | | | | Future Work | Future Work | | | |
| | Testing | | | | | | | | | | | Future Work | Future Work | | | |
| | Finished Prototype | | | | | | | | | | | Future Work | Future Work | | | |
| | Engineering Design Day | | | | | | | | | | | | Future Work | Future Work | | |
| | Finals | | | | | | | | | | | | | Future Work | Future Work | |
| | Graduation | | | | | | | | | | | | | | | Future Work |

Completed

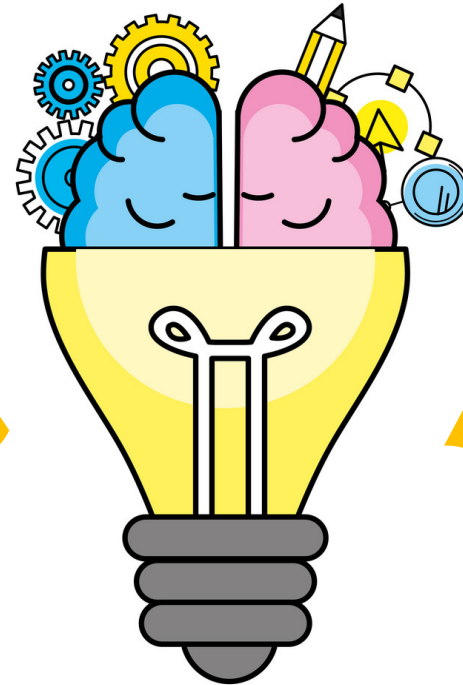
Started On

Future Work



Lessons Learned

Develop small, reasonably attainable tasks.



Order key parts quickly to expedite prototyping.

Maintain flexibility during the design process.

Everything costs more and takes longer.

Questions



References

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