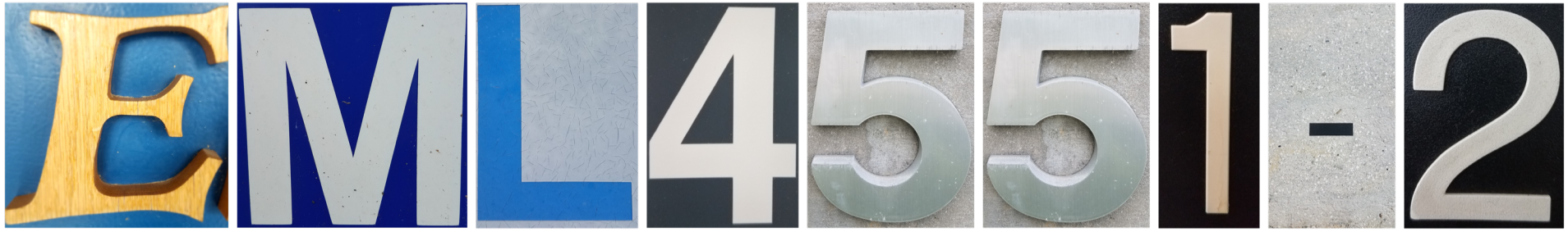
LOCKHEED MARTIN



Virtual Reality Tracking and Haptic Feedback Gloves

Team Introductions

Alexandra Hollabaugh
Project Manager

Jonathan Roberts
Hardware Engineer

Alex Erven
Systems Engineer

Jake Kennedy
Test Engineer

Kevin Lindquist
Software Engineer

Project Background

- Sponsor: Lockheed Martin
- The purpose of this project is to improve current virtual training systems at Lockheed Martin through the design of Virtual Reality gloves that 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

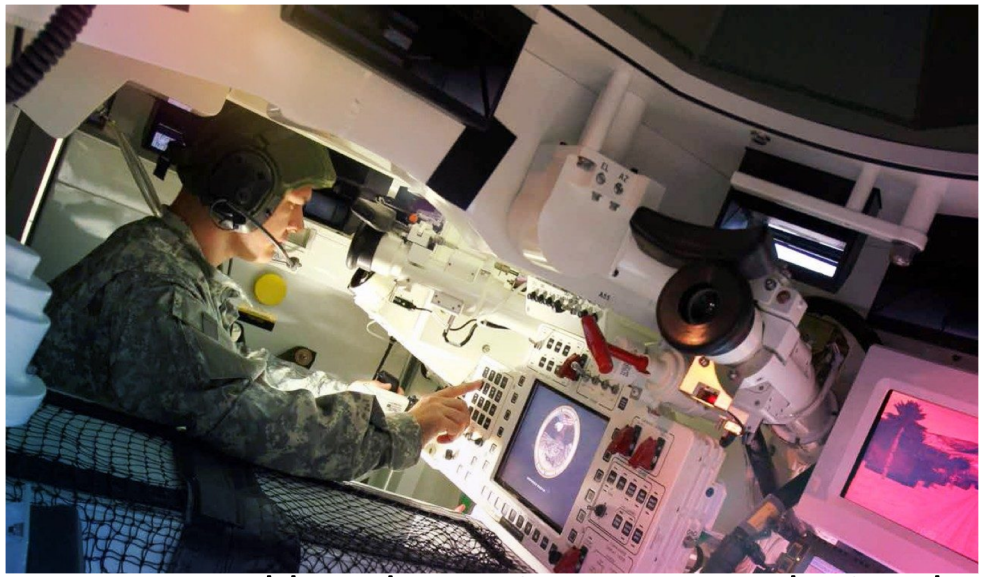


Figure 2: A Lockheed Martin M1A2 Tank Simulator

Important Terms and Acronyms

- Haptic feedback: Feedback provided by the gloves in response to interaction with the virtual environment
- Tactile feedback: Feedback provided by interaction with the real world environment
- IMU: Inertial measurement unit
- LRA: Linear resonant actuators

Alexandra Hollabaugh

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
- Able to easily transfer from one user to the next
- Allows for uninhibited range of motion
- Hypoallergenic and easily sanitized

What is VR?

- 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

Figure 3: Example of an HTC VIVE Pro Headset and Controller

Jake Kennedy

Drawbacks of Existing VR Gloves

LOCKHEED MARTIN

- Current examples are expensive
- Have numerous wires and tubes connected to the base
- Do not retain the ability to feel interactions with a non-virtual environment
- Use bulky tracking systems

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

Jake Kennedy

Project Goals

LOCKHEED MARTIN

- Design a pair of gloves that are portable, lightweight, and durable
- Provide haptic feedback for the palms of both hands and all ten fingers
- Track both hands and all ten fingers in real time in the Unity environment
- Overall design compatible with the HTC Vive VR system

Jake Kennedy

Targets

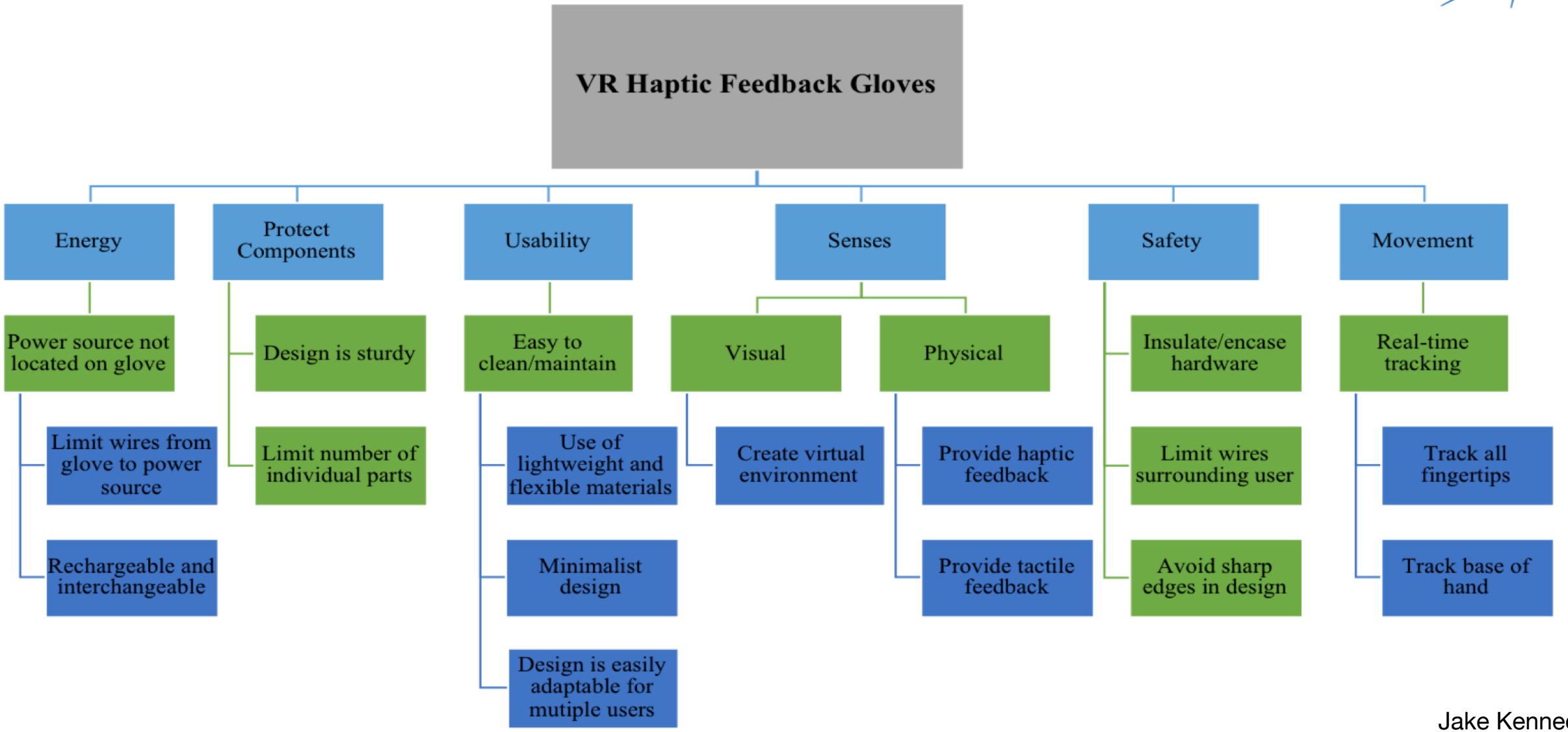
Table 1: Most Important Targets and Metrics

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

- From the customer needs the following targets were determined
- These were then used to determine the engineering characteristics

Jake Kennedy

Functional Decomposition



Jake Kennedy

Functional Decomposition (cont'd)

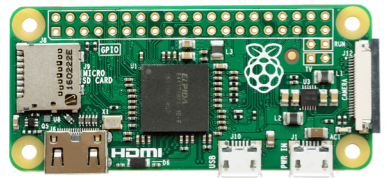
LOCKHEED MARTIN

- Track the movement of hands and fingers in real time
- Provide haptic and tactile feedback for the hands
- Allow design to be easily adaptable for multiple users

Jake Kennedy

Design Concept

- Fingerless gloves
- 12 LRAs, 1 on each palm and front of each finger
- Removable rechargeable battery on back of each hand
- Raspberry Pi Zero on the back of each hand
- 12 9-axis IMUs, 1 on the back of each finger and hand

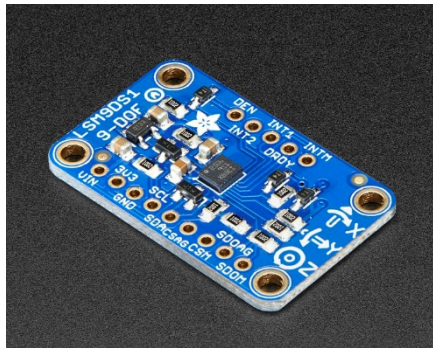
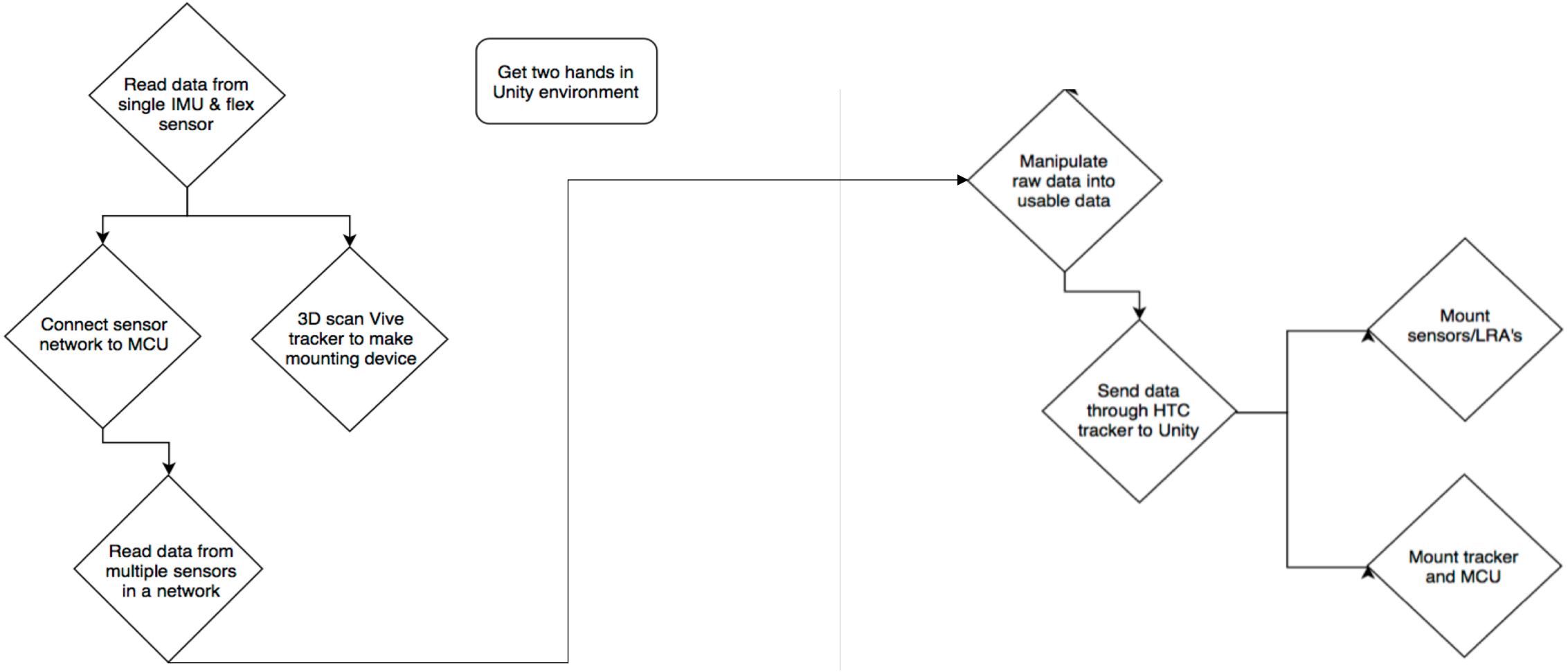



Figure 5: Final concept components

Jonathan Roberts

Moving Forward



Jonathan Roberts

Challenges Moving Forward

- Mount electronic hardware
- Connect sensor network to microcontroller
- Integrate hardware with virtual environment
- Making wiring low profile (i.e. conductive thread, etc.)

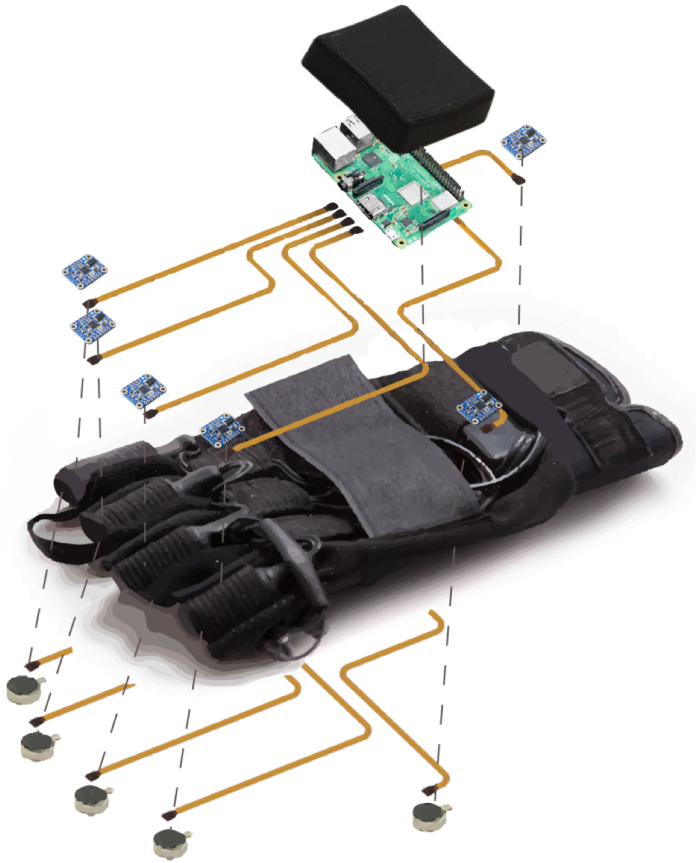


Figure 6: Layout of components for glove design

Prototyping and Testing

Figure 7: IMU's with Raspberry Pi Zero

Figure 8: LRA's with Raspberry Pi Zero

Figure 9: Flex Sensors, IMU's, Raspberry Pi Zero

Acknowledgments

- Thank you to Lockheed Martin for their sponsorship
- Thank you to Jeff Payne and Adam Bojanowski of Lockheed Martin for their guidance and direction
- Thank you to Dr. Hooker for his expertise on our project

References

Burnett, Richard. “Lockheed F-35 Training Work Gets Big Boost.” *OrlandoSentinel.com*, 18 Aug. 2014, www.orlandosentinel.com/news/os-lockheed-f35-simulator-contract-20140818-story.html.

Catanzarite, M. (n.d.). Lockheed Martin displays fighter jet simulator for Arconic employees, Rep. Walorski. Retrieved from https://www.wndu.com/content/news/Lockheed-Martin-displays-F-35-simulator-for-Arconic-employees-Rep-Walorski-489797411.html

Lee, N. (2017, November 20). HaptX promises to make your virtual hands feel like real ones. Retrieved from https://www.engadget.com/2017/11/20/haptx-gloves-vr/

Horsey, J. (2018). *HTC Vive Pro Headset Unveiled Offering Improved Audio And Higher Resolution - Geeky Gadgets*. [online] Geeky Gadgets. Available at: https://www.geeky-gadgets.com/htc-vive-pro-headset-09-01-2018.eky-gadgets.com/htc-vive-pro-headset-09-01-2018/

Horsey, J. (2014). *Dexmo Exoskeleton Provides Touch Feedback In Virtual Worlds.* [online] *Geeky Gadgets*. Retrieved from https://www.geeky-gadgets.com/dexmo-exoskeleton-provides-touch-feedback-in-virtual-worlds-27-10-2014/

Holley, R. (2017). *The least painful way to set up HTC Vive Lighthouses.* [online] *VR Heads.* https://www.vrheads.com/least-painful-way-set-htc-vive-lighthouses

Senso Glove. (n.d.). Retrieved from https://senso.me/