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Introduction

- Elbow stiffness after surgery is a common and debilitating problem caused by the accumulation of fibrous tissue in the joint and surrounding structures during the healing process. It is made worse by the rigid postoperative bracing used to stabilize the elbow after surgery. It is commonly treated with range of motion exercises performed daily, but they can be painful and are often ineffective.
- The goal of this project is to design and create a motor-hinged elbow orthosis activated by an iOS application. The iOS app will initiate exercises to regain as much range of motion in the joint during the healing process while simultaneously breaking down scar tissue in the joint.

Methods and Materials

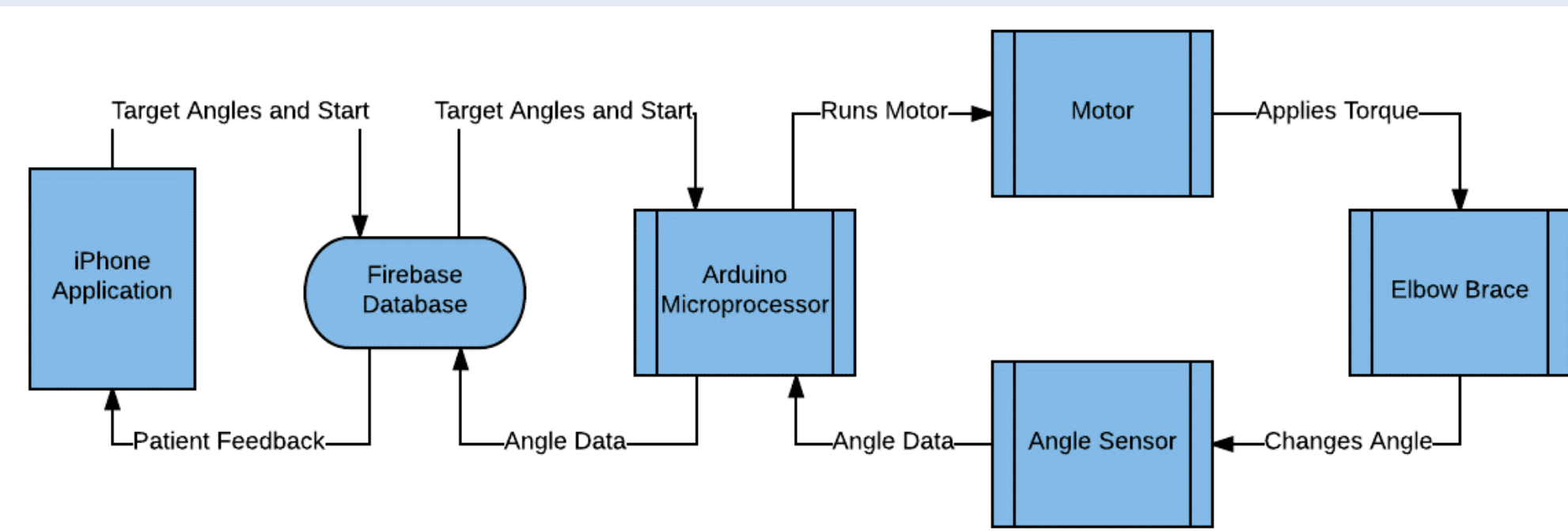


Figure 1: Logistic Flow Diagram

Interface between the iPhone application illustrated along with each component of the AEO

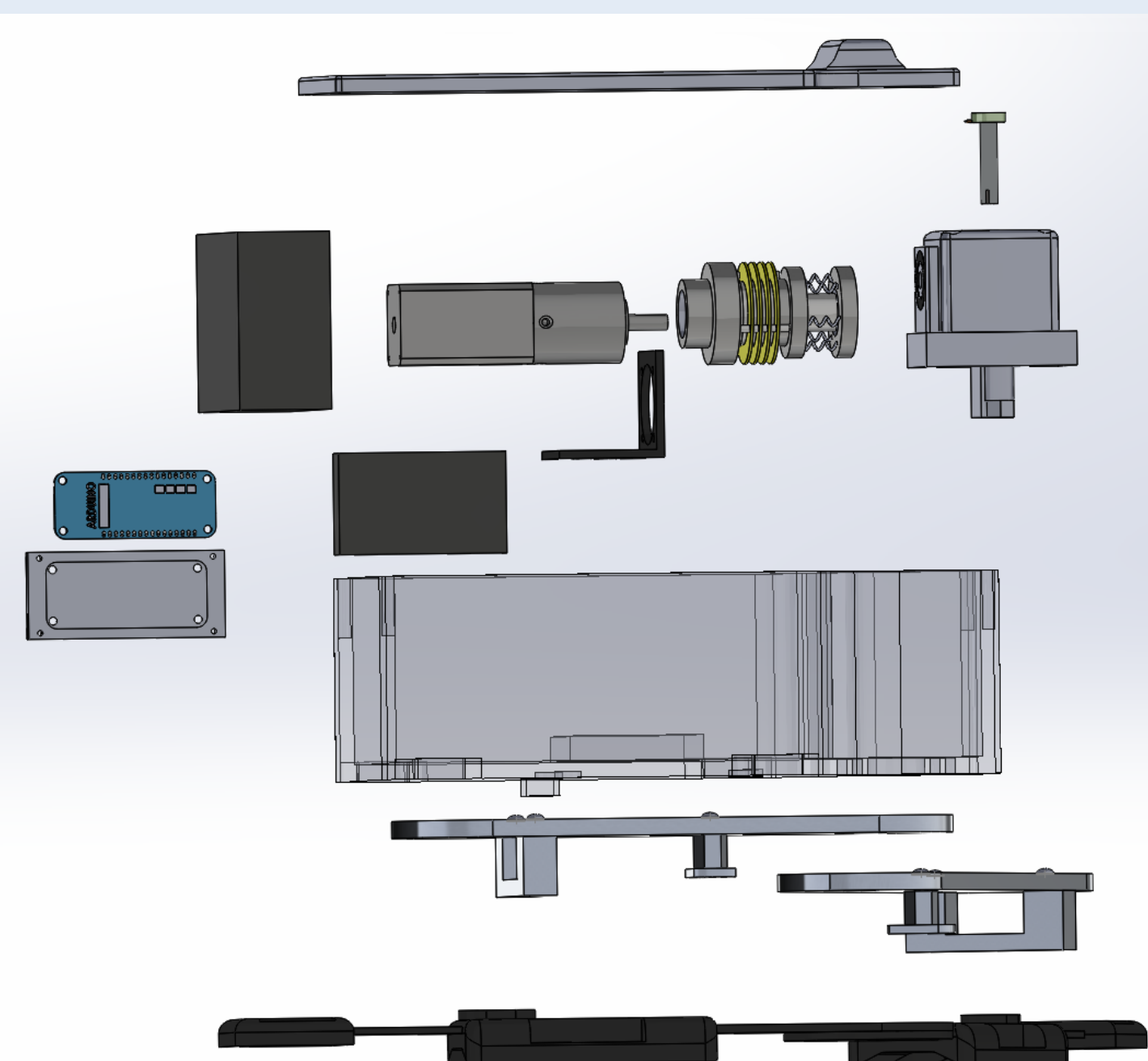


Figure 2:
SolidWorks Exploded
Assembly
Individual parts of the
assembly and each
approximate location
inside the case

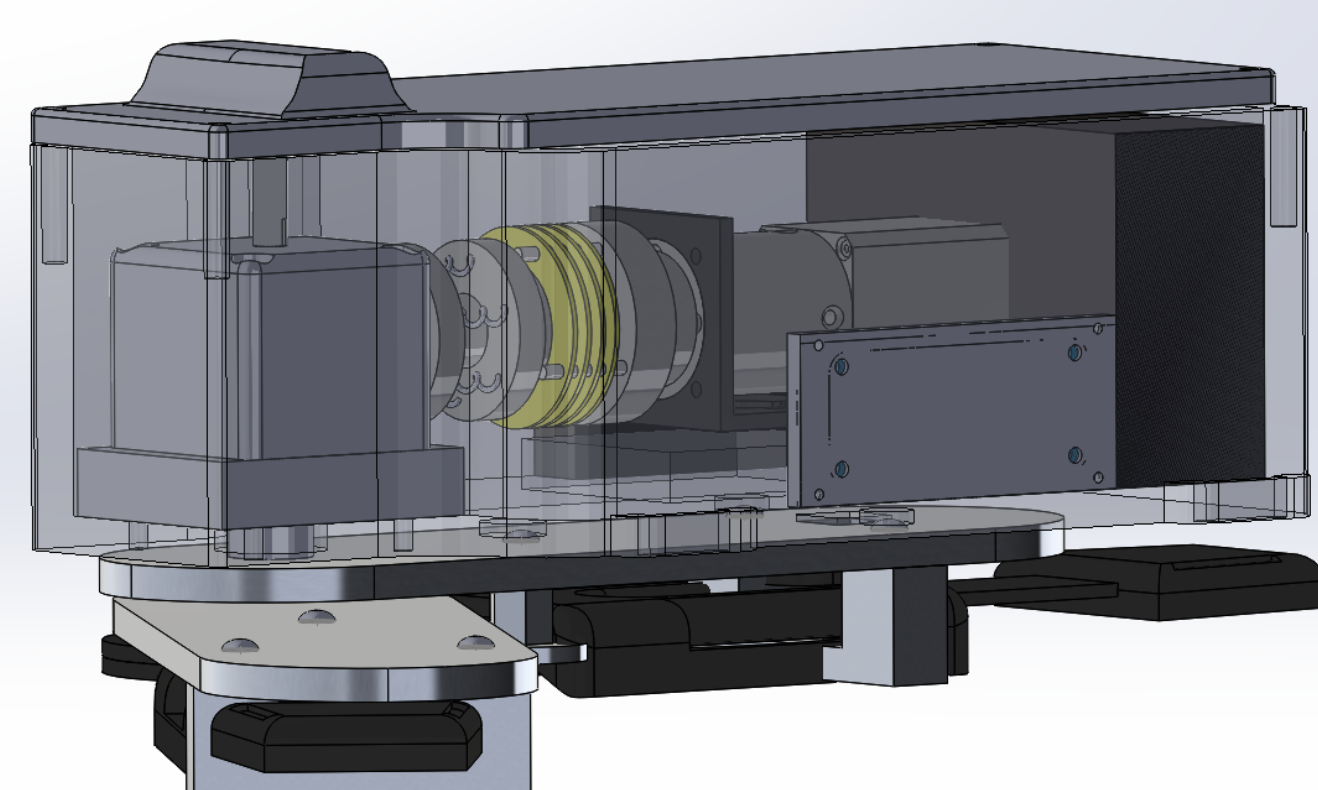


Figure 3:
SolidWorks Isometric
View (Transparent
case)
This view shows the
articulation of all the
assembly pieces inside
the case

Analysis and Test Results

Table 1: AEO device testing

Test	Requirement	Pass/Fail
Test 1.0 AEO Lock	Lock shall hold a 30 lb. weight	Pass
Test 2.0 Motor Torque	AEO shall move 15 sec each way with no weight, 1kg, 4kg	a-b: Pass c-f: Fail
Test 3.0 Position Tolerance	AEO shall move to desired angle	Pass
Test 4.0 AEO Sensor	Sensor shall measure within 2.5° of actual angle	Pass
Test 5.0 Angular Speed	AEO shall move less than 10°/sec	Pass
Test 6.0 Sensor App Accuracy	App shall move brace to desired angle < 2.5°	Pass
Test 7.0 Temperature Range	AEO shall move in 104°F heat and 32°F cold	Pass
Test 8.0 Weather	AEO shall move after lightly sprayed with water	Pass
Test 9.0 Battery Life	Battery shall last > 20 cycles continuously	Pass
Test 10.0 Battery Recharge	Battery shall take < 12 hrs. to recharge fully	Pass

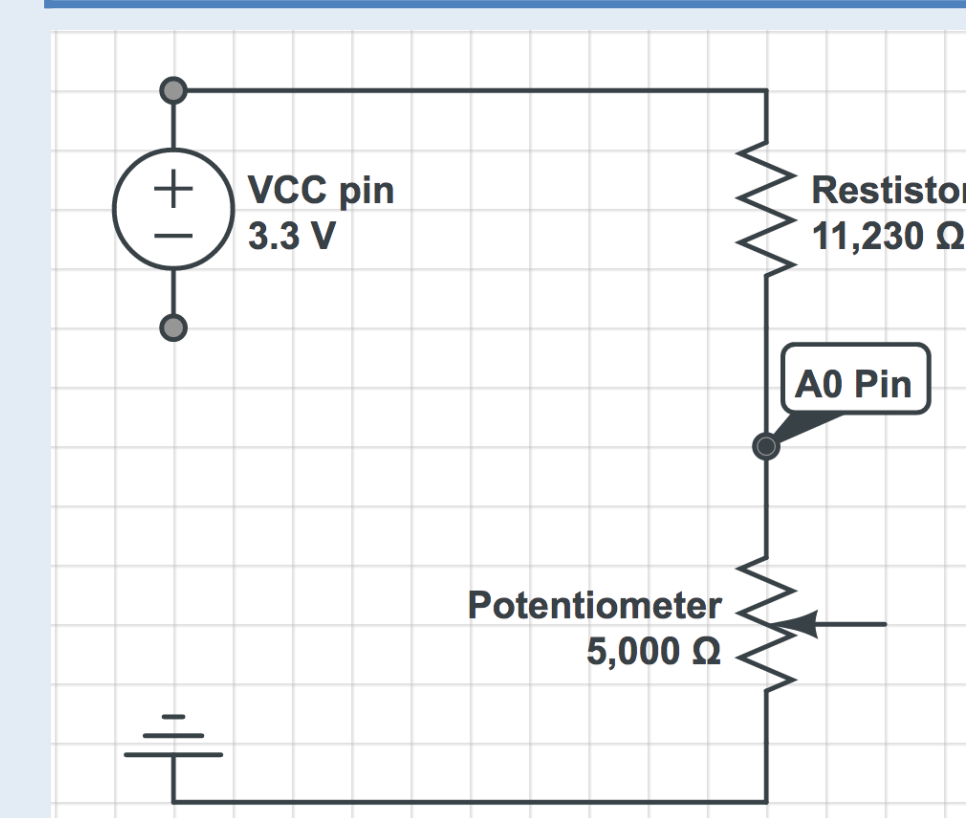


Figure 4: Sensor Circuit Diagram

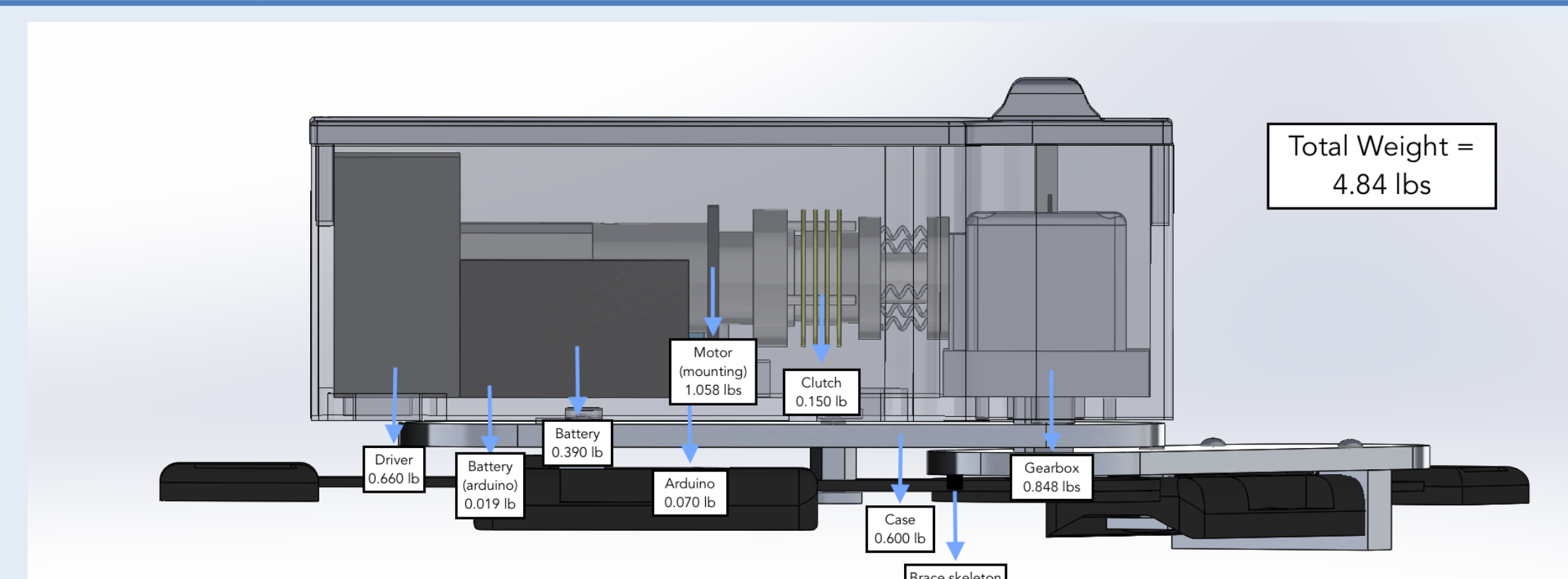


Figure 5: Weight Analysis (lbs.)

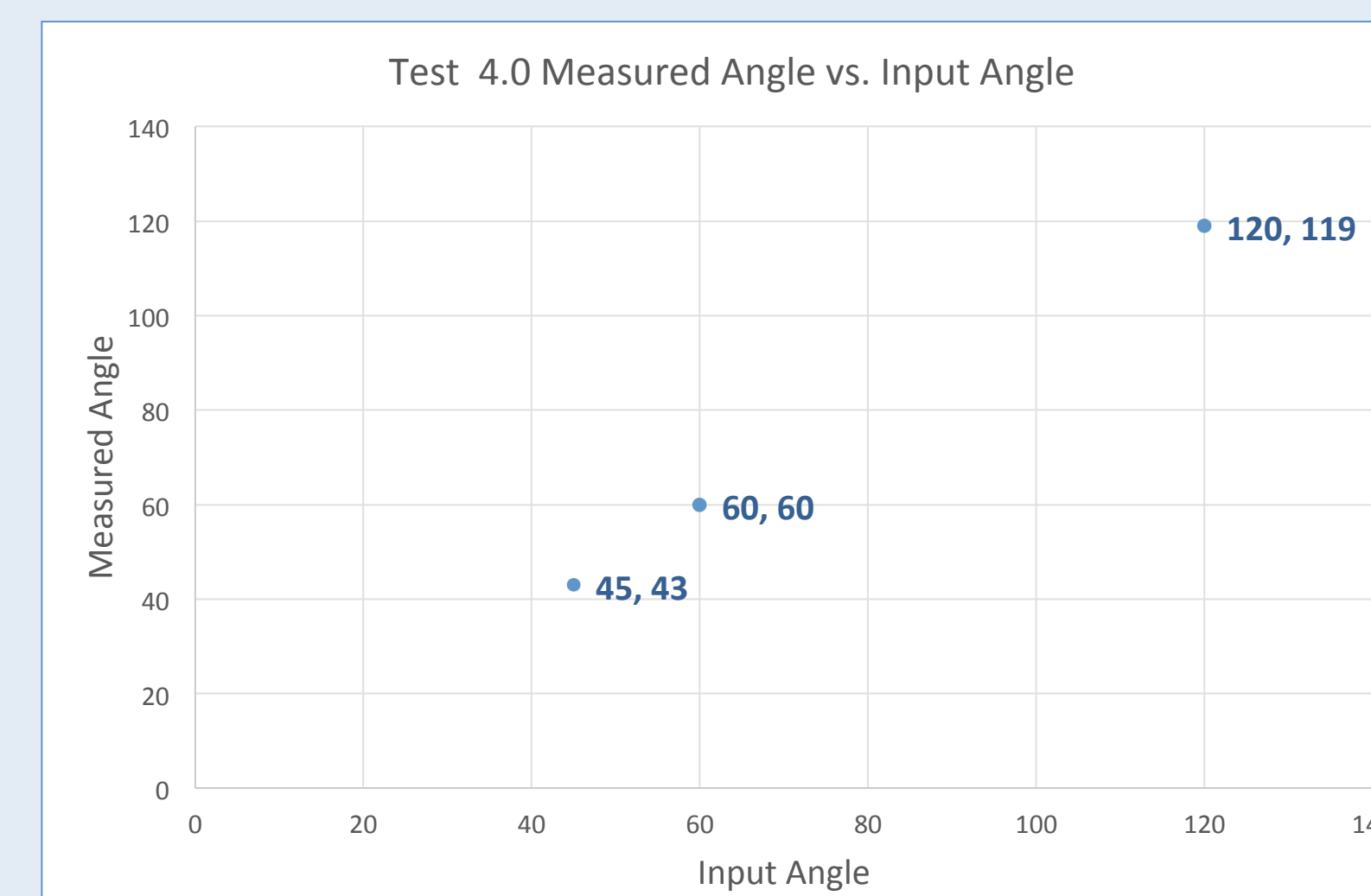


Figure 6: Test Four
Repeated twice with the same values
acquired both times

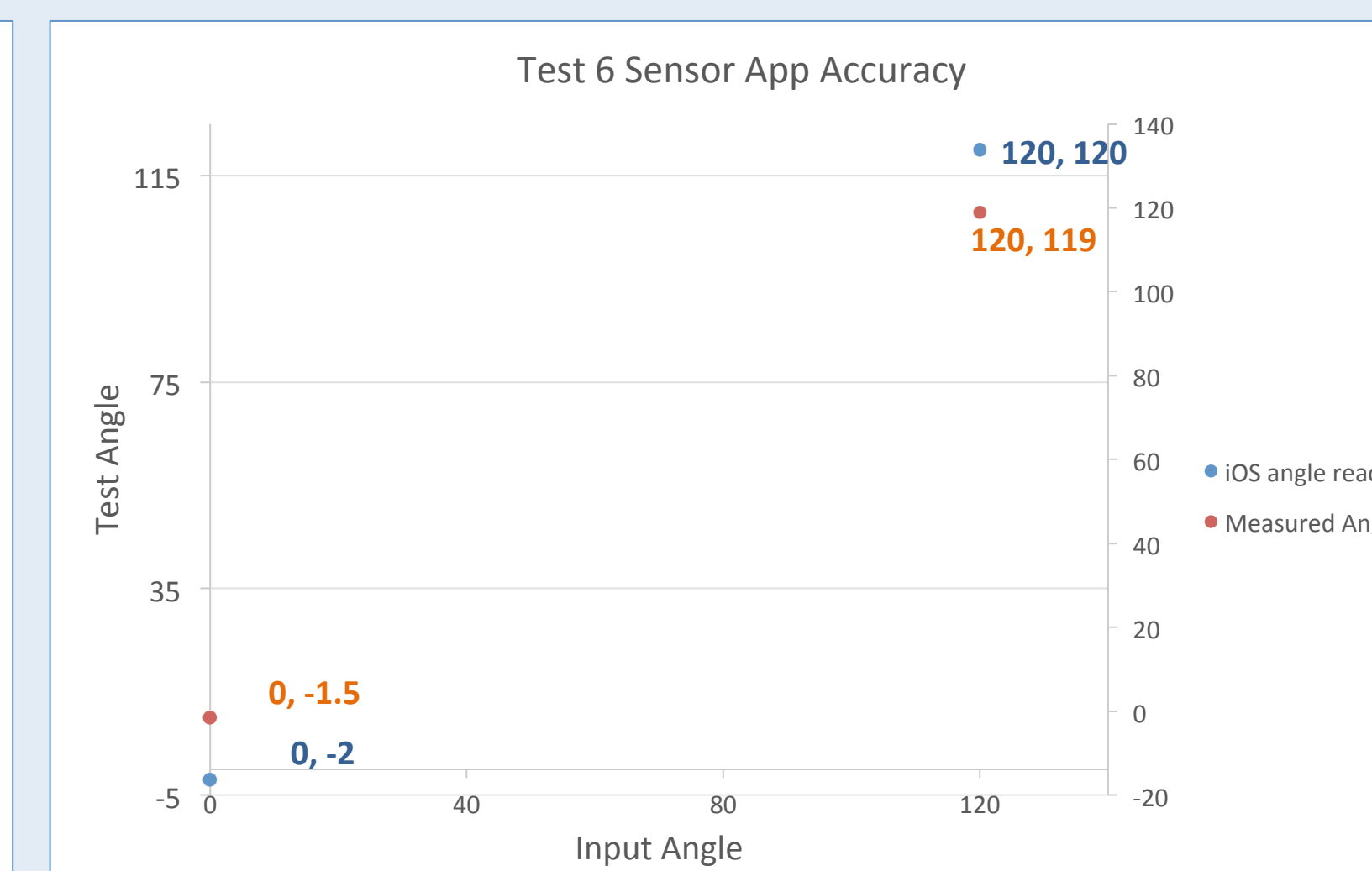


Figure 7: Test Six
Angle measured at full flexion and extension;
Measured both iOS angle feedback and
goniometer angle

Table 2: Test Five
Measured angular speed

Flexion Time (s)	Extension Time (s)	Flexion Speed $\omega = 120/t$ (degrees/second)	Extension Speed $\omega = 120/t$ (degrees/second)
12.61	12.25	9.516	9.795

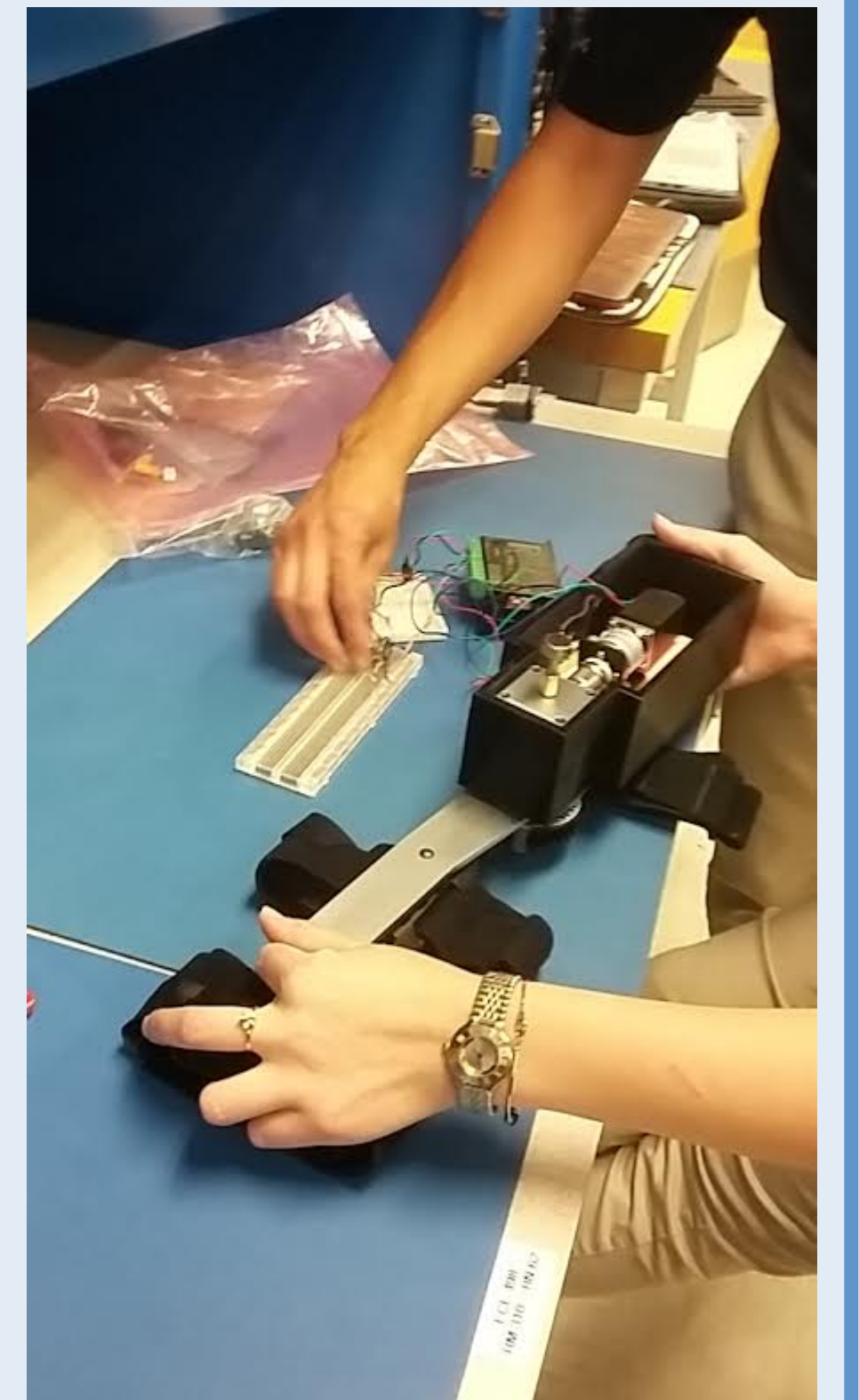
Mitigation Plan/Conclusion

Overcoming Risks

- Weight of the brace
- Heat from the system
- Maintaining active assist
- Locking mechanism

Lessons Learned

- Use of resources/expertise
- Plan for setbacks
- Maintain deadlines
- Reduce assumptions



Conclusion

- The first prototype has been developed and is operating according to expectation. The brace moves at a rate of approximately 10°/sec while the sensor detects accurate movement of the elbow angle within 2.5°.
- The AEO device actively assists patients in therapy post elbow surgery in the comfort of their own home due to its portability and implementation of an easy-to-use iOS application.

Team Members

- Michael Sveiven— Team Lead, BME
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Acknowledgements

- Mario Hernandez— Software Consultant
- Justin Peery— Gearbox Consultant
- AME Machine Shop
- TechLaunch Arizona