**3.6 GRIPPER SUBSYSTEM**

The gripper was designed to be able to accommodate a wide variety of tools. To achieve this, a two jaw design was created, similar to how a human hand opens and closes around a tool. The main mechanism for the gripper was designed to move in two discrete motions, opening and closing the jaws, and raising and lowering the tool. Another main goal of the design was to include the least number of parts possible and simplify the design down to its core functions. By simplifying the design, we were able to reduce the time spent prototyping each iteration, problem solve over the course of more iterations, and reduce the overall cost of the assembly with less off the shelf parts., this was due to budget constraints, materials available for use and the ability for easier assembly. Due to the motions of opening and closing the jaws of the gripper being separate from each other, two servos must be used instead of one; each with their own inputs coming from the User Interface. Each servo is paired with a set of gears that rotate either the lower half of the assembly raising and lowering the tool, or the jaws to open and close, clamping onto the tool. In order to meet the tight time constraint, To solve the need of building the gripper quickly and efficiently, rapid prototyping by 3D printing was used which in turn helped solve many of the design challenges as they came up.

**3.6.1 Design**

As part of the first design iteration a large piece of bent sheet metal was used as the center cradle to hold all of the adjoining parts together. As we began building the first prototype we realized that the sheet metal part was too complicated to make with the tools and skills available to us. To solve this issue, we adapted the design from a sheet metal part into a 3D printable part. Once the design was reinterpreted, we were able to quickly modify and reprint the part to test its strength and fitment with the other parts. One of the main design changes that came about through testing was the addition of a support at the top of the jaws. The original thickness of the jaw layers combined with the overall height of the jaw assembly meant that the 3D printed parts were bending under load and not providing sufficient grip strength on the tool. By increasing the thickness of each jaw layer and mirroring the design of the bottom jaw on the top of the assembly, rigidity of the assembly and overall grip strength, were greatly increased as a result. As an extra precaution to increase grip strength rubberized heat shrink was added to the ends of the jaw layers to prevent the tool from sliding vertically in the jaws.

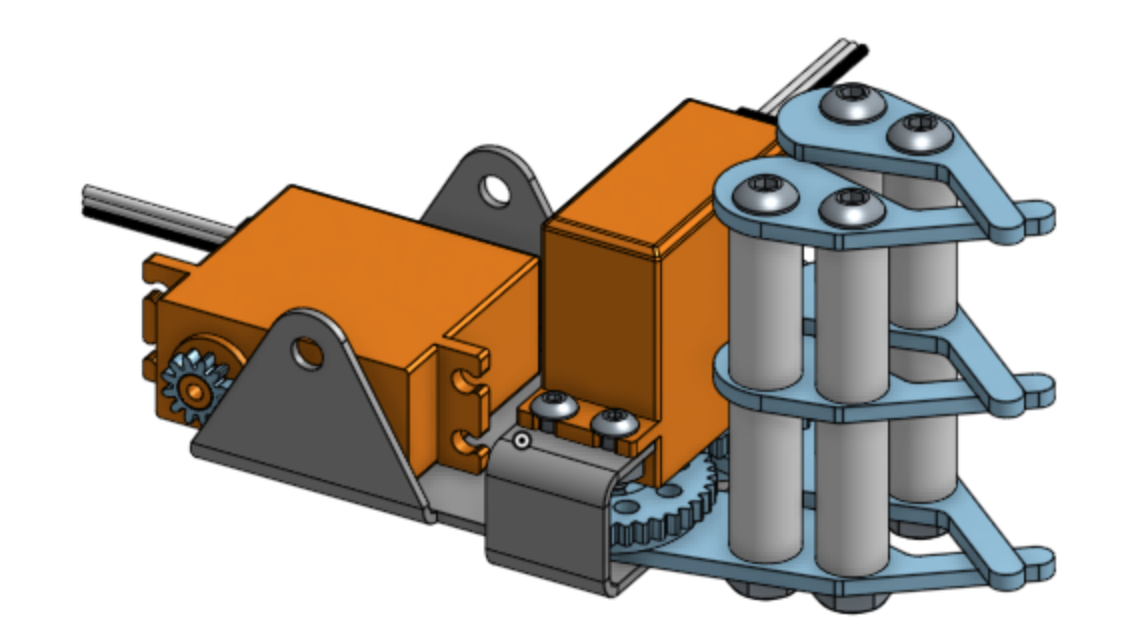


Figure 3.6.1.1: Shows the first design iteration of the Gripper assembly using a mix of sheet metal parts shown in dark grey, 3D printed parts shown in blue, and hardware shown in grey.

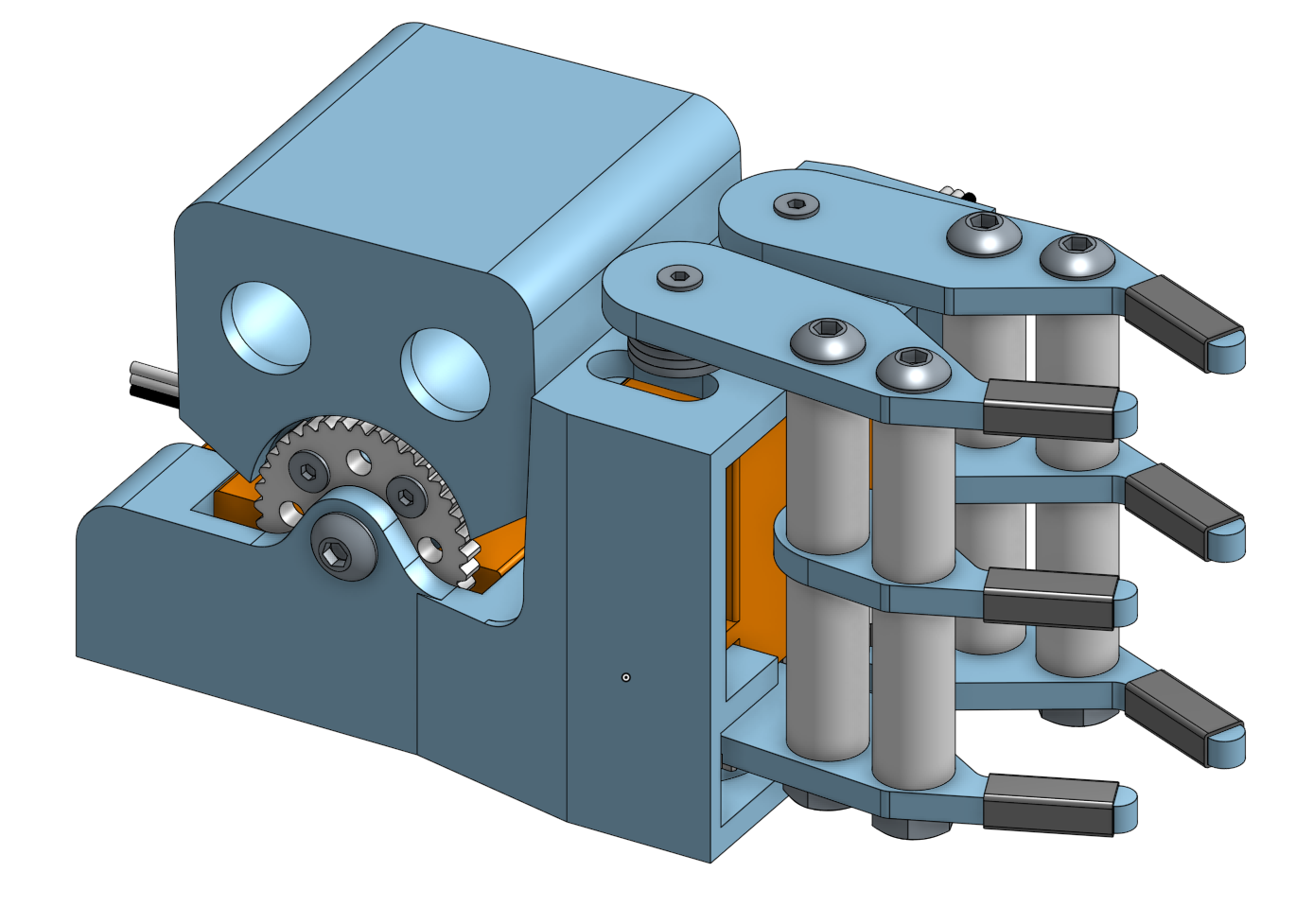


Figure 3.6.1.2: Shows the final iteration of the Gripper assembly using 3D printed parts shown in blue, two servos shown in orange, and hardware shown in grey.

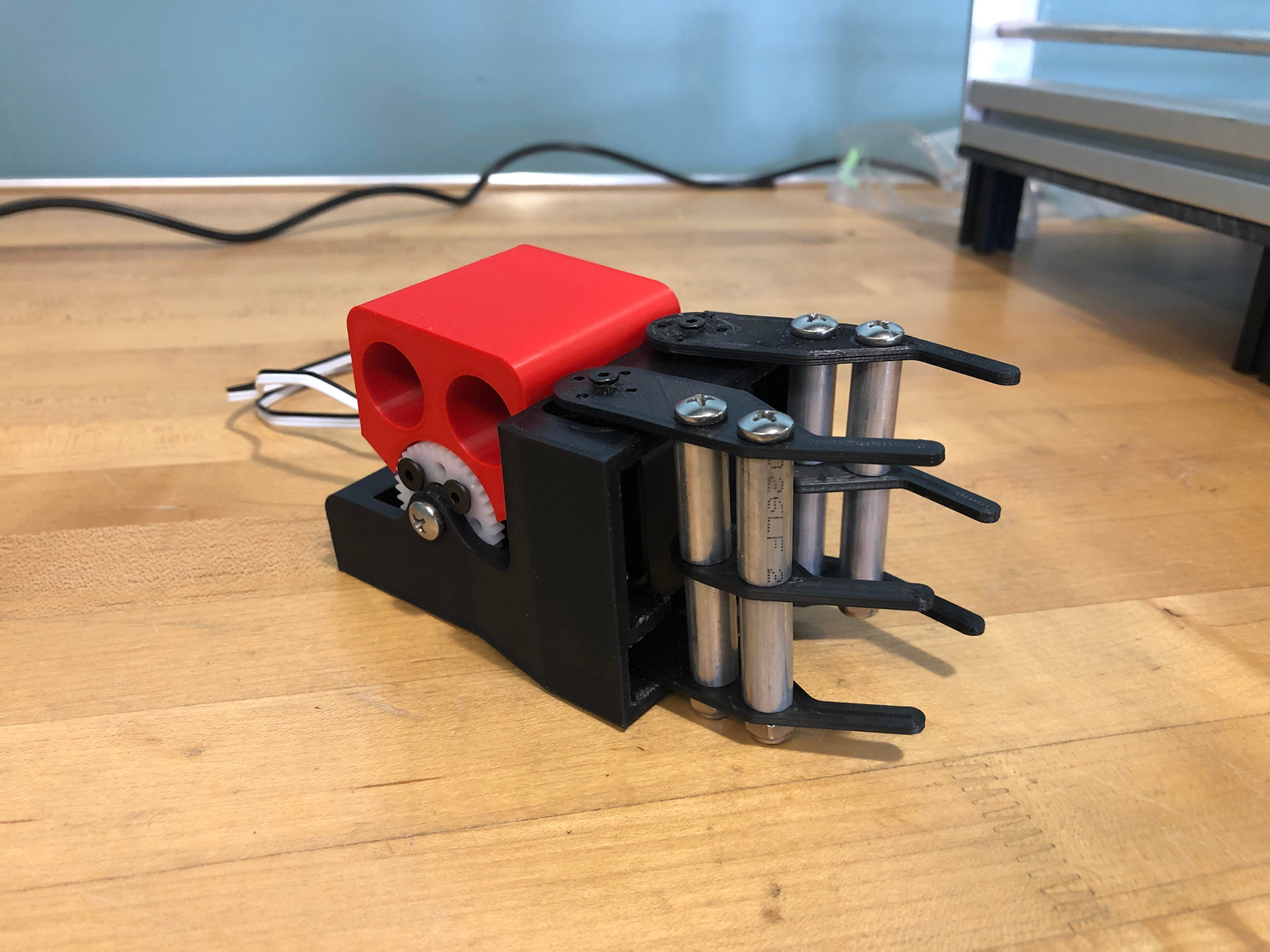


Figure 3.6.1.3: Shows a picture of the final Gripper assembly as used on the VanGoBOT machine. **REPLACE PICTURE WITH FINAL PART**

**3.6.2 Safety**

Because the gripper is one of the most accessible parts of the machine, mitigating safety concerns is an important aspect of the design. The biggest risk of injury would be the number of pinch points between moving parts and gears. This risk is mitigated by enclosing all of the moving parts to locations in the assembly deeper in the assembly where one could not reach their hand or finger into. The grip strength of the jaws has shown to be strong enough to firmly grasp tools, but not strong enough to cause pain if someone were to close the jaws around their finger.

**3.6.3 Integration**

Integrating the Gripper assembly into the machine at large was straightforward given the small amount of mechanical interaction between the Gripper and the rest of the VanGoBOT. The Gripper gets its information and power supply from the User Interface through a wired connection protected by a flexible conduit allowing the Gripper to move freely without damaging the wires. The main mechanical connection between the GRipper and the VanGoBOT is the connections to the Belt and Framework subsystems using low friction bushings to slide across smooth rails.