1/14 - Turntable and Servo Signoff

Friday, January 14, 2022 3:39 PM

During the competition, nets will be placed randomly along either side of the track. Because of
necessary that the robot be able to aim its shooting mechanism in either direction. Early in the
process, it was decided that the robot will utilize a turntable in order to accomplish this. The tu
will be responsible for turning the upper chassis (which contains the shooting mechanism) in ei
direction.

The turntable will need to be able to support the weight of the upper chassis. A breakdown of t
weight is shown below.

Motors x4	**1.65 lbs**
All Controllers/Sensors	**Approx 0.5 lbs**
Shooting Mechanism	**Approx 2 lbs**
Wheels x4	**0.5 lbs**
Battery	**Approx 1.1 lbs**
Robotic Arm	**Approx 2 lbs**
Acrylic Chassis	**2.5 lbs**
Turntable	**Approx 0.2 lb**
Total	**11.25 lbs**

Being that the turntable only needs to support the weight of the upper chassis, the drivetrain n
wheels, ½ of the acyllic chassis, and the turntable itself can be subtracted. It is not yet known tl
layout of all other components, but it is reasonable to assume that the turntable will need to su
least 7 lbs. In addition, these turntables contain bearings that help reduce the overall load of th

The turntable that I would like to purchase can be found at:
https://www.robotshop.com/en/lynxmotion-base-rotate-kit-no-servo.html.

The product info for this turntable says that it can "easily support 10 pounds".

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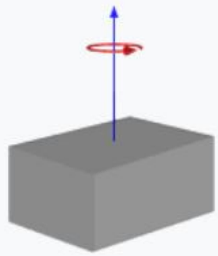
In addition to the turntable, we will also need a servo motor to drive the rotation. Calculating t
the servo is a matter of calculating the torque required to rotate a rectangle (the chassis volun
around its height axis. This torque is equal to the moment of inertia multiplied by the angular acceleration. The equation for moment of inertia is shown below.

Solid cuboid of height *h*, width *w*, and depth *d*, and mass *m*. For a similarly oriented cube with sides of length s, $I_{\mathrm{CM}} = \frac{1}{6} m s^2$		$I_h = \frac{1}{12} m \left(w^2 + d^2\right)$ $I_w = \frac{1}{12} m \left(d^2 + h^2\right)$ $I_d = \frac{1}{12} m \left(w^2 + h^2\right)$

$$Ih = \frac{1}{12} * 3.2 * (0.3^2 + 0.23^2)$$

This gives the moment of intertia at approximately 0.0381 kg*m^2.

The desired acceleration of the servo is 2*pi radians/s^2.

Thus, multiplying these values gives a resultant torque of 0.2394 N*m.

Converting to kg*cm gives 2.44 kg*cm, which is the minimum torque requirement of the moto

The article mentioned above regarding the turntable also lists some compatible servo motors.
list and the torque requirement above, it is clear to see that any of them will meet the requirer
Since they are all similarly priced, I think the highest torque servo would be a sensible option.

The servo motor can be found here https://www.robotshop.com/en/hitec-hs-645mg-servo-mc

This servo requires 4.8-6 V. Our design already includes step down circuitry that outputs 5 V, sc
be able to meet this voltage requirement.

The servo will be controlled using the Adafruit servo shield that we purchased for the robot arr
servo shield will allow us to control the servo from the microcontroller via PWM. A wiring diagr
shown below.

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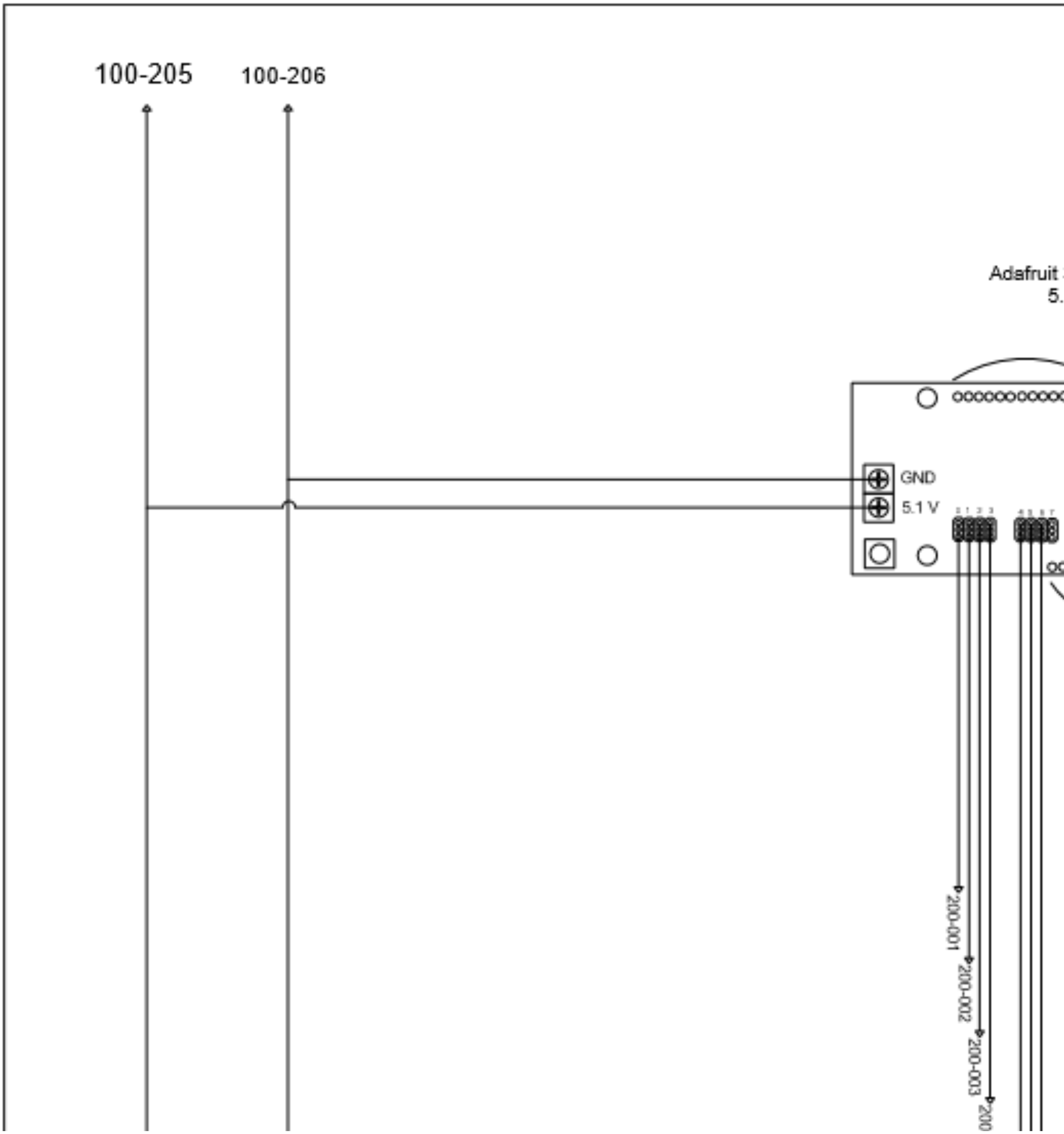
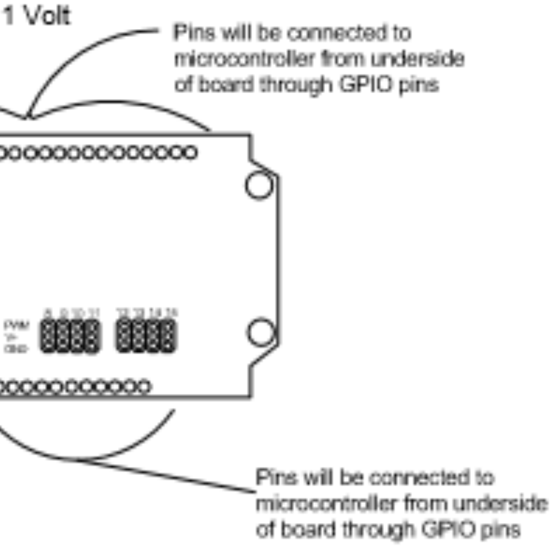

100-205
100-206
Adafruit
GND
5.1 V
200-001
200-002
200-003

6-1
Servo Shield
1 Volt



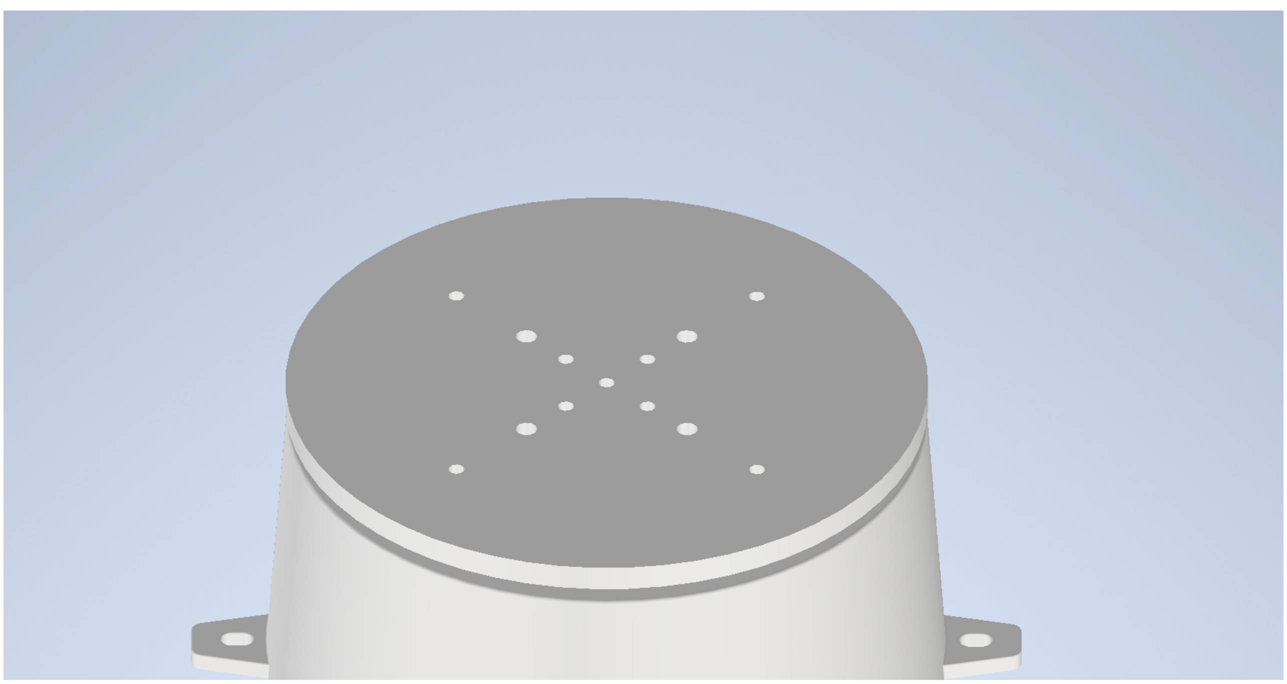
Wire numbers 200-001 through 200-006 will control the servo motors on the robotic arm as follows:
200-001: Turn Table
200-002: Shoulder Joint
200-003: Elbow Joint
200-004: Wrist Joint
200-005: Wrist Turn Joint
200-006: End Effector Grab

200-007: Chassis Turntable

Assembling the turntable and mounting the servo will require specific screws. I was able to finc exact screws mentioned from the same manufacturer at this link https://www.robotshop.com/en/lynxmotion-phillips-tapping-screws-phts-04.html. They are so quantites of 100.

Below are the CAD drawings of the turntable as well as the physical layout of the robot. The tur small form factor means that we will have to have a custom base to mount it in order to achiev correct height, but this should not be an issue.

Turntable CAD Model



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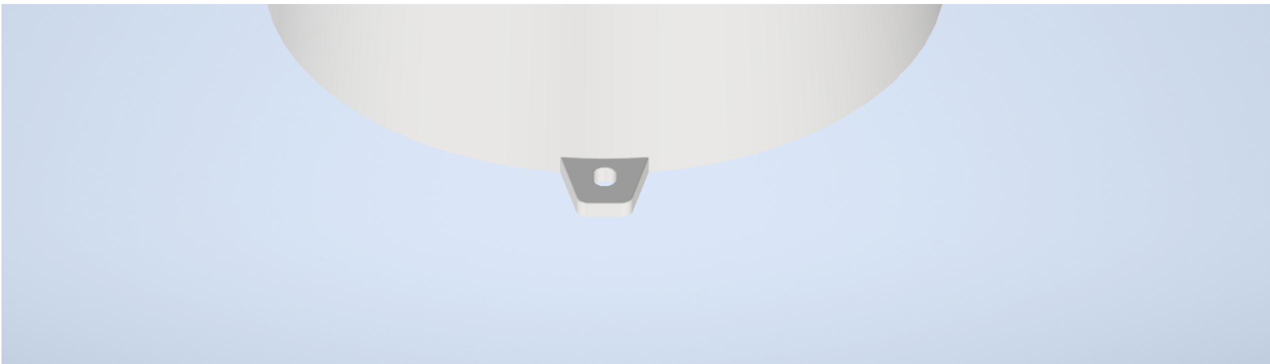
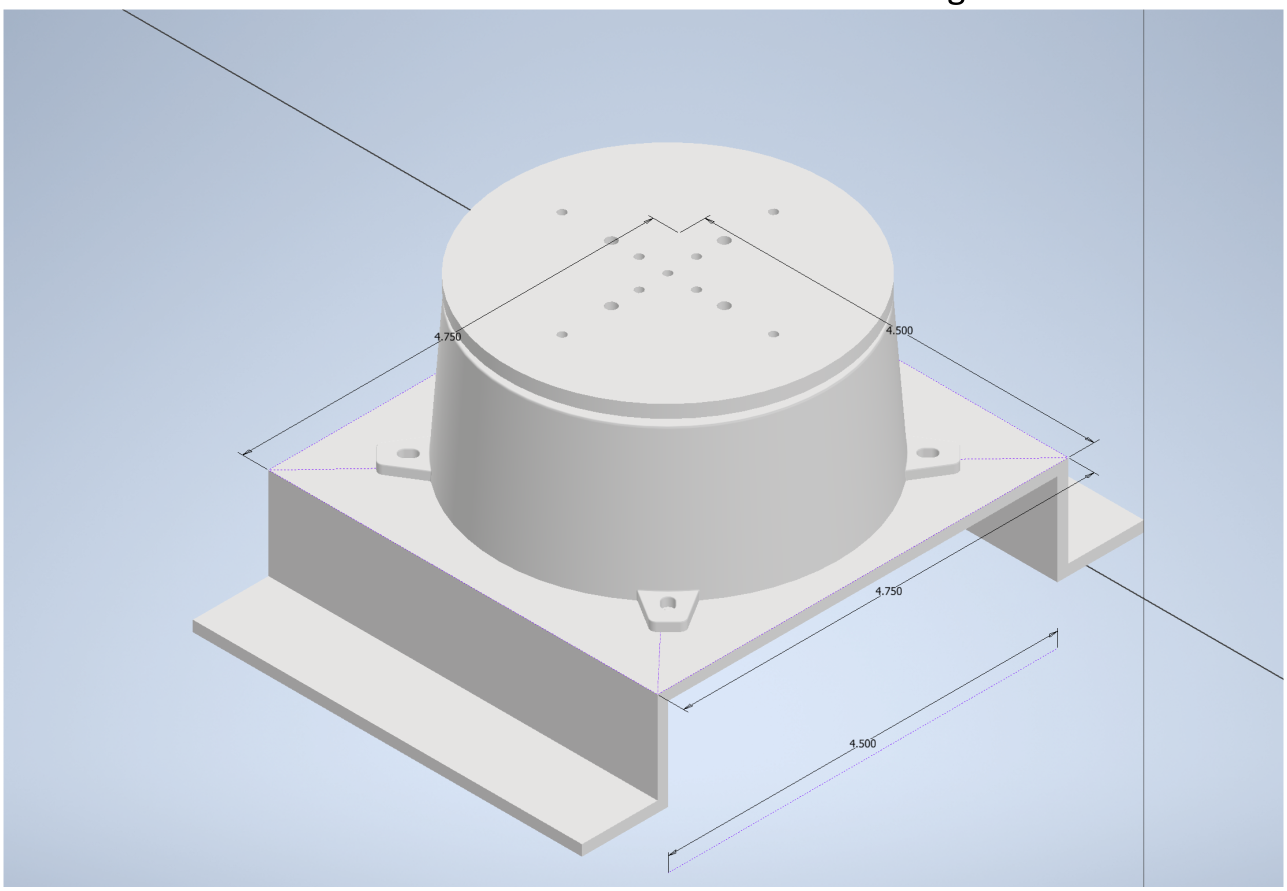
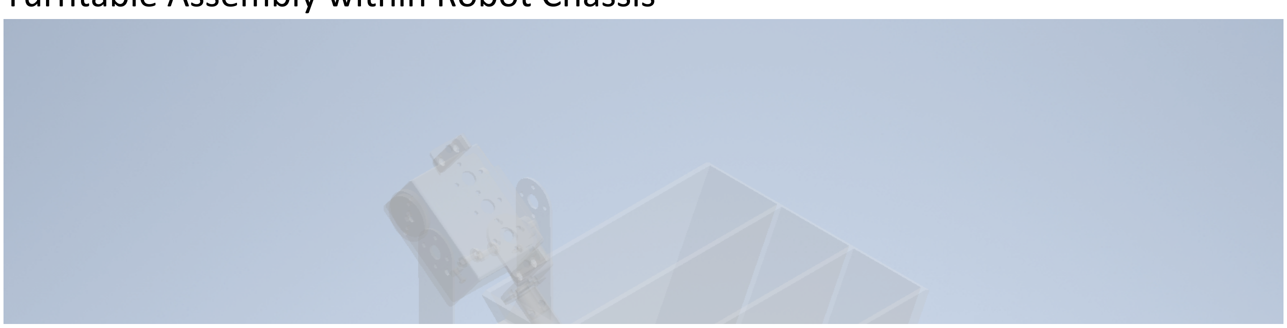
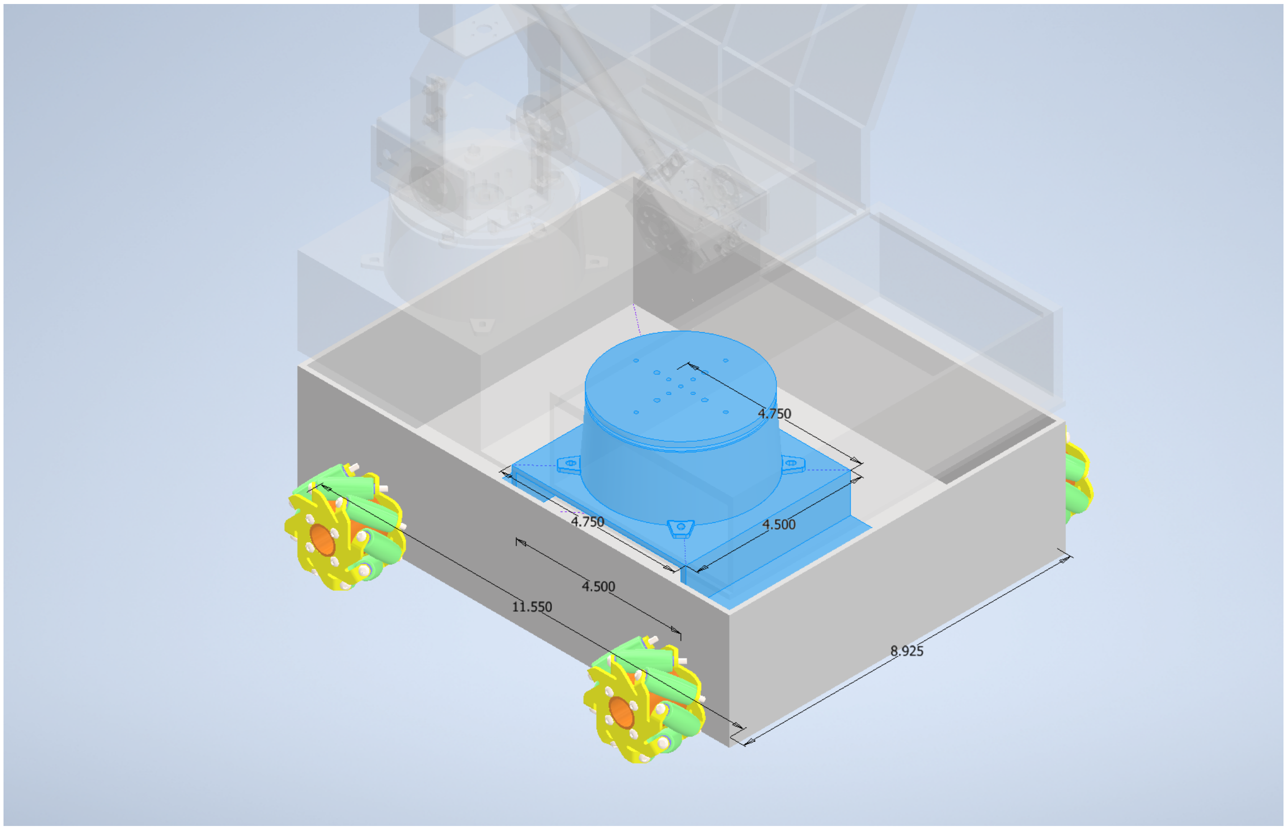


Turntable With Custom Base to Achieve Correct Chassis Height

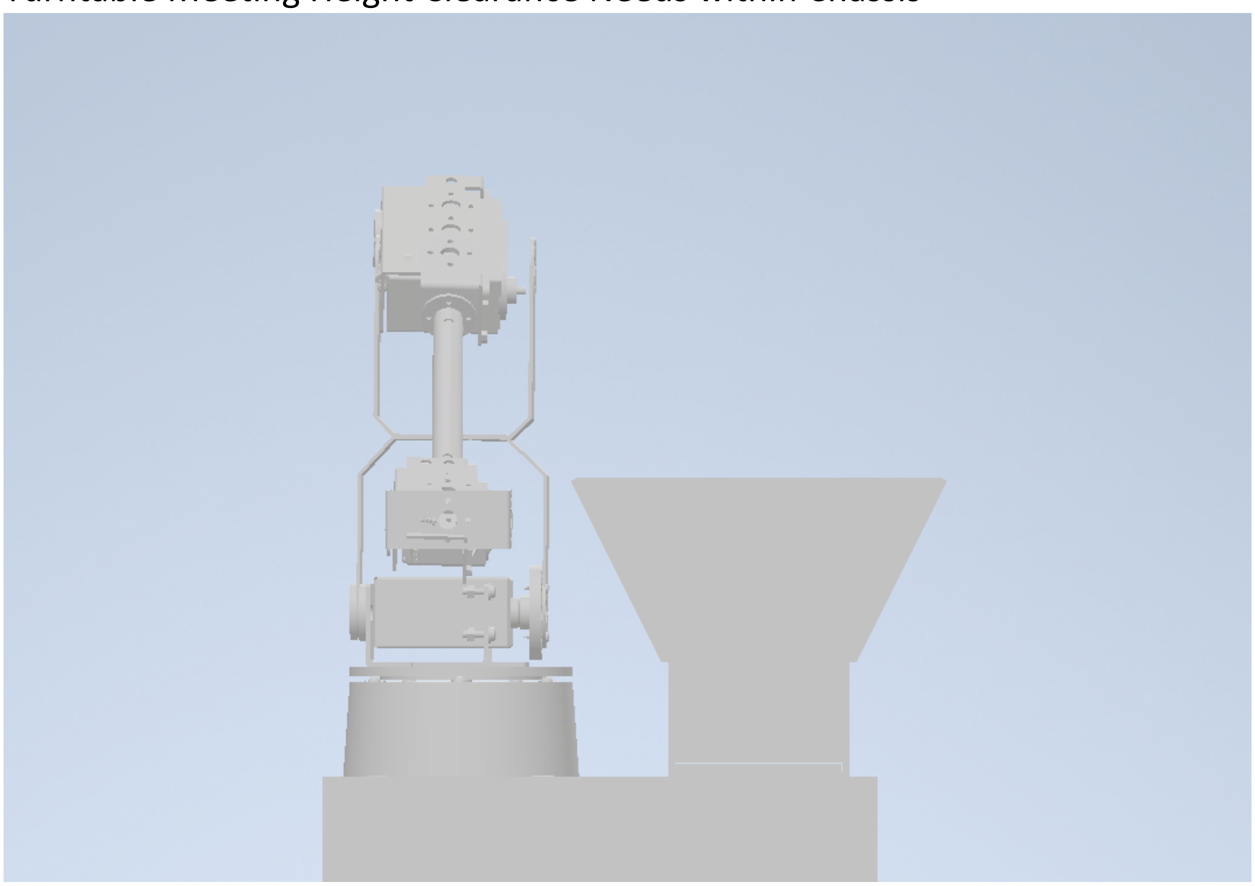


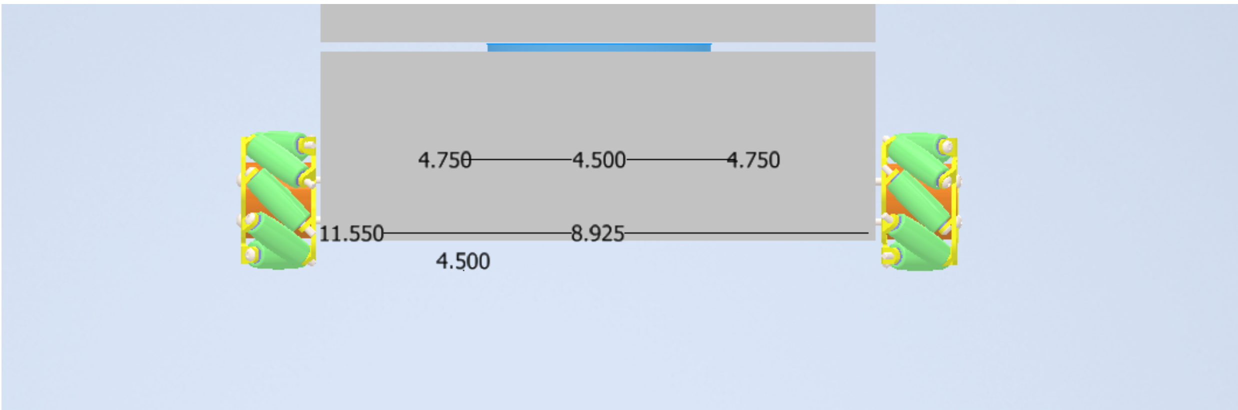
Turntable Assembly within Robot Chassis





Turntable Meeting Height Clearance Needs within Chassis




4.750
4.500
4.750
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