MECE 4611 - ROBOTICS STUDIO

Name & Uni: Aatir Fayyaz - af3252

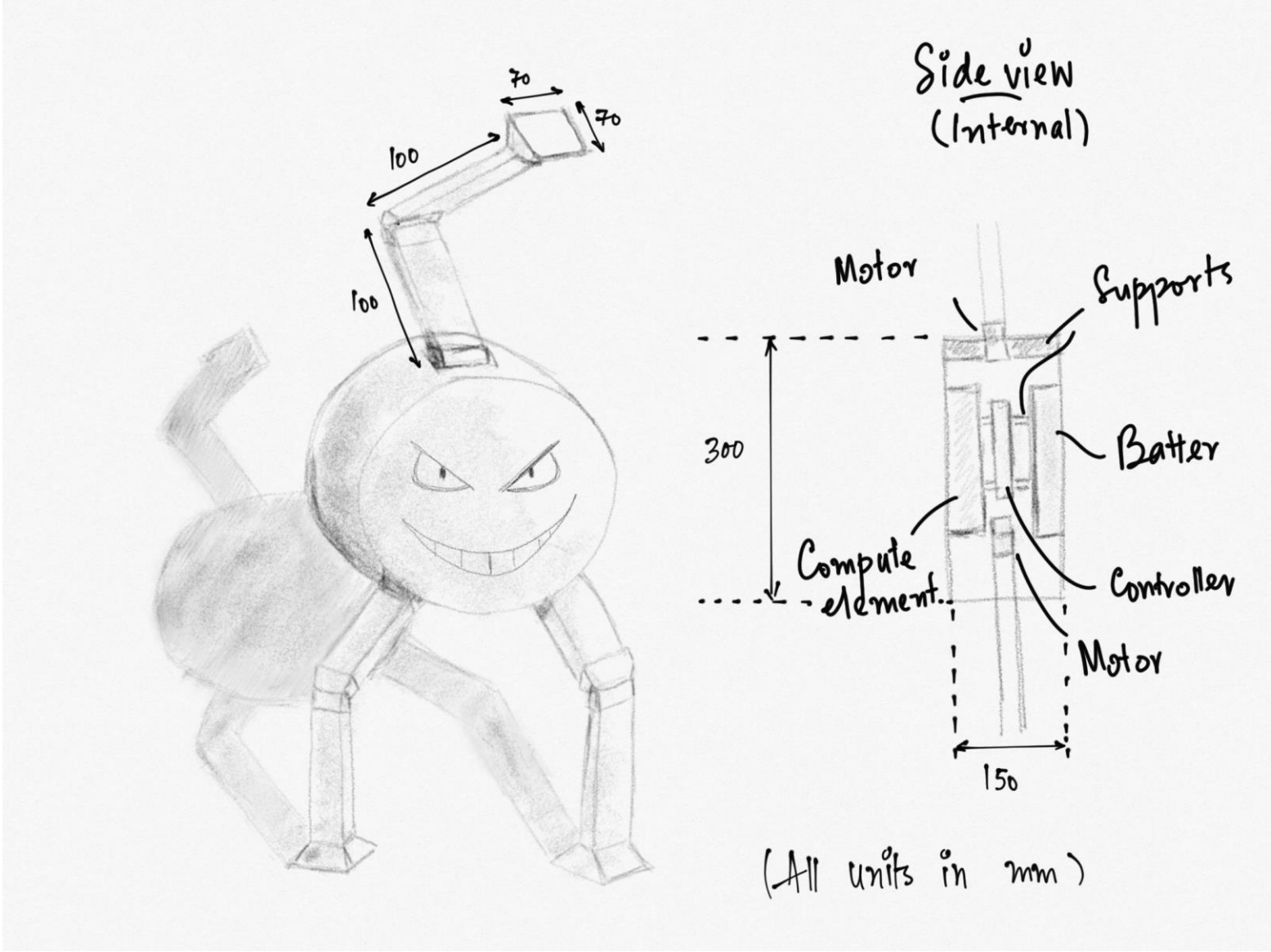
Date/Time Submitted: 09/13/2022 @ 2230hrs

Grace Hours: 96hrs + 13.5hrs (gained) = 109.5hrs

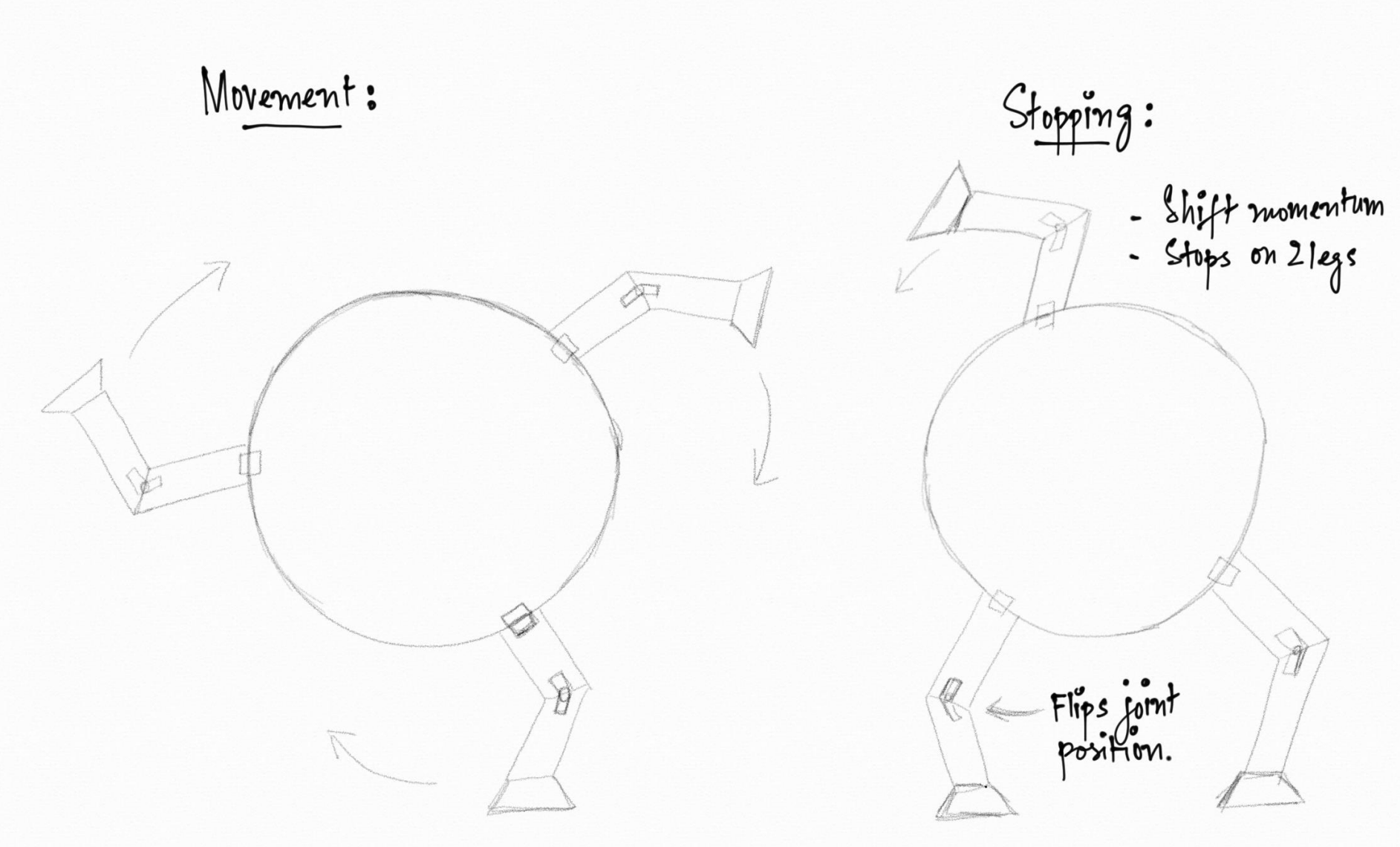
CONCEPT 1: TRI-BOT

Inspired by various tri-pedal robots portrayed in movies and TV and more specifically, *War of the Worlds*. This may not be the most pragmatic solution since the kinematics and movement is rather complicated to perfect.

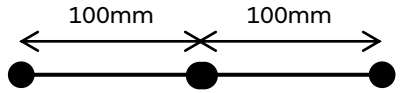
TRI-BOT SKETCH #1



TRI-BOT SKETCH #2



CALCULATED PROPERTIES



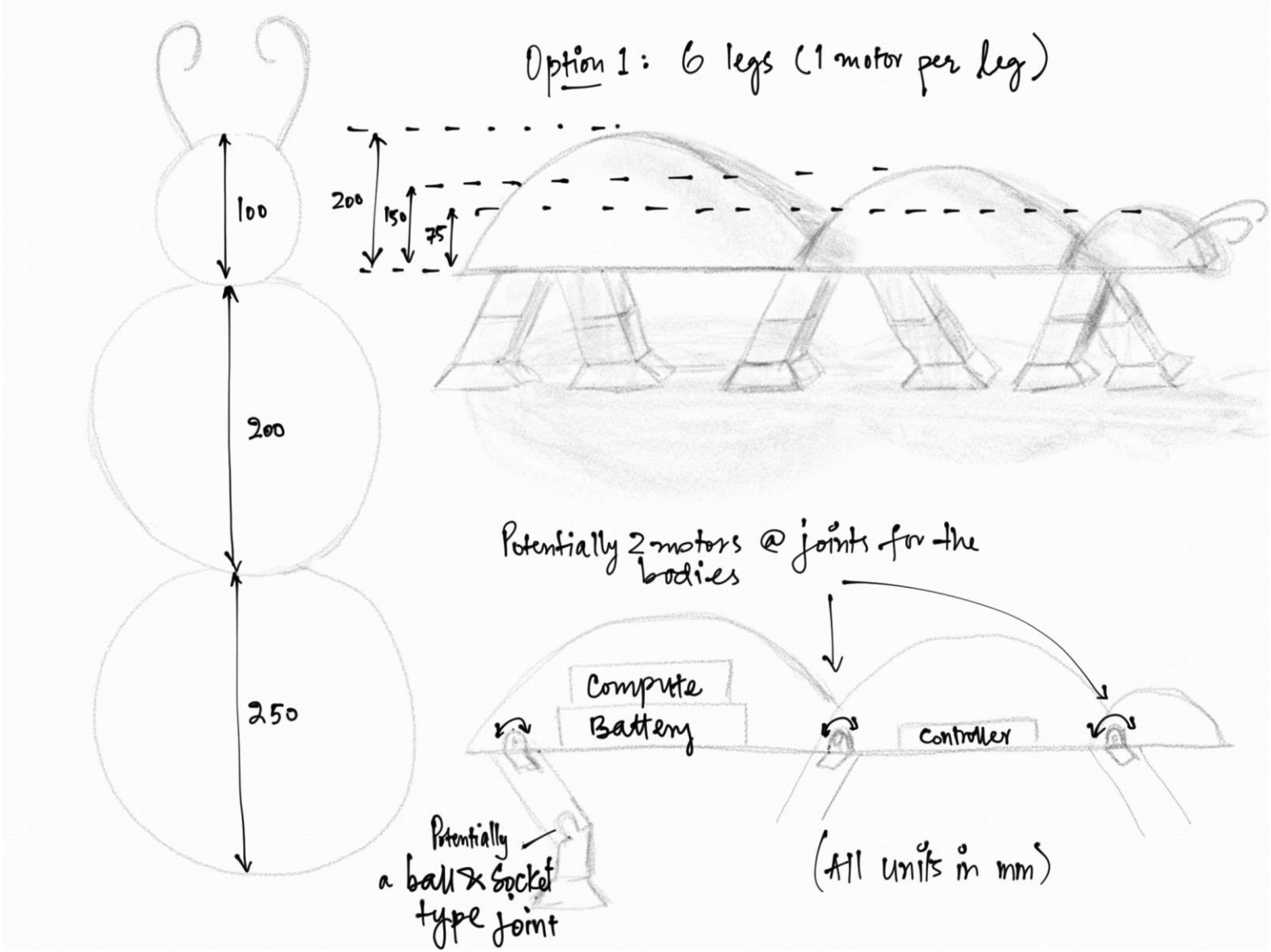
Max torque observed at max length

	MASS	WEIGHT	MAX TORQUE REQD.	MAX POWER
One leg (incl. motors)	($1.24g/cm^3$*0.1*$100cm^3$) + 52g*2motors = 116.4g	1.1 N	20 N.cm	12 W
All legs (incl. motors)	116.4g * 3 = 349.2g	3.4 N	40 N.cm	24 W (Max 4 motors /time)
Body (incl. components) @ Thickness = 5mm	$V = \pi(R_i^2 - r_i^2)h$ ($1.24*0.1*1025.3cm^3$) + 190g+150g+60g = 527.1g	5.2 N	N/A	N/A
Total	876.3g	8.6 N	*Below motor specs of 166.7N.cm* 40 N.cm peak	*Below battery peak supply of 30W* 24 W peak. *Estimated run time: ~8 mins*
	$m = \rho * Infill\% * V$	$W = m * g$	$\tau = L * W$	$P = I * V$

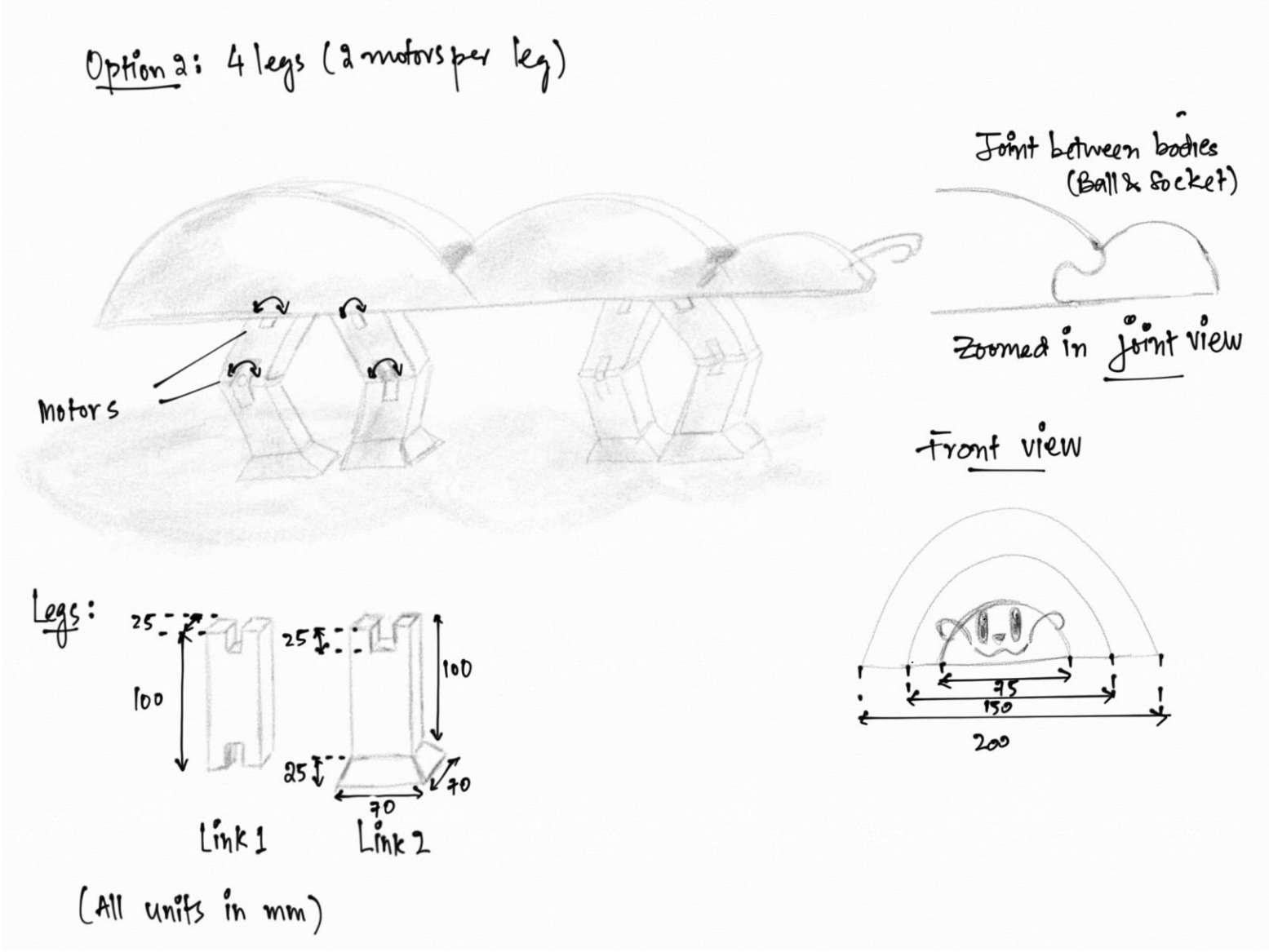
CONCEPT 2: ROBO-ANT

With some inspiration stemming from *A Bug's Life* and *Antz*, the Robo-Ant is a more pragmatic approach to robot locomotion. As a preliminary concept, two options were considered – one with 6 legs and another with 4.

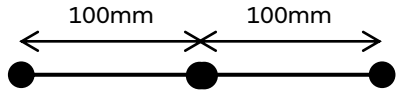
ROBO-ANT SKETCH #1



ROBO-ANT SKETCH #2



CALCULATED PROPERTIES (OPTION 2 – 4 LEGS)



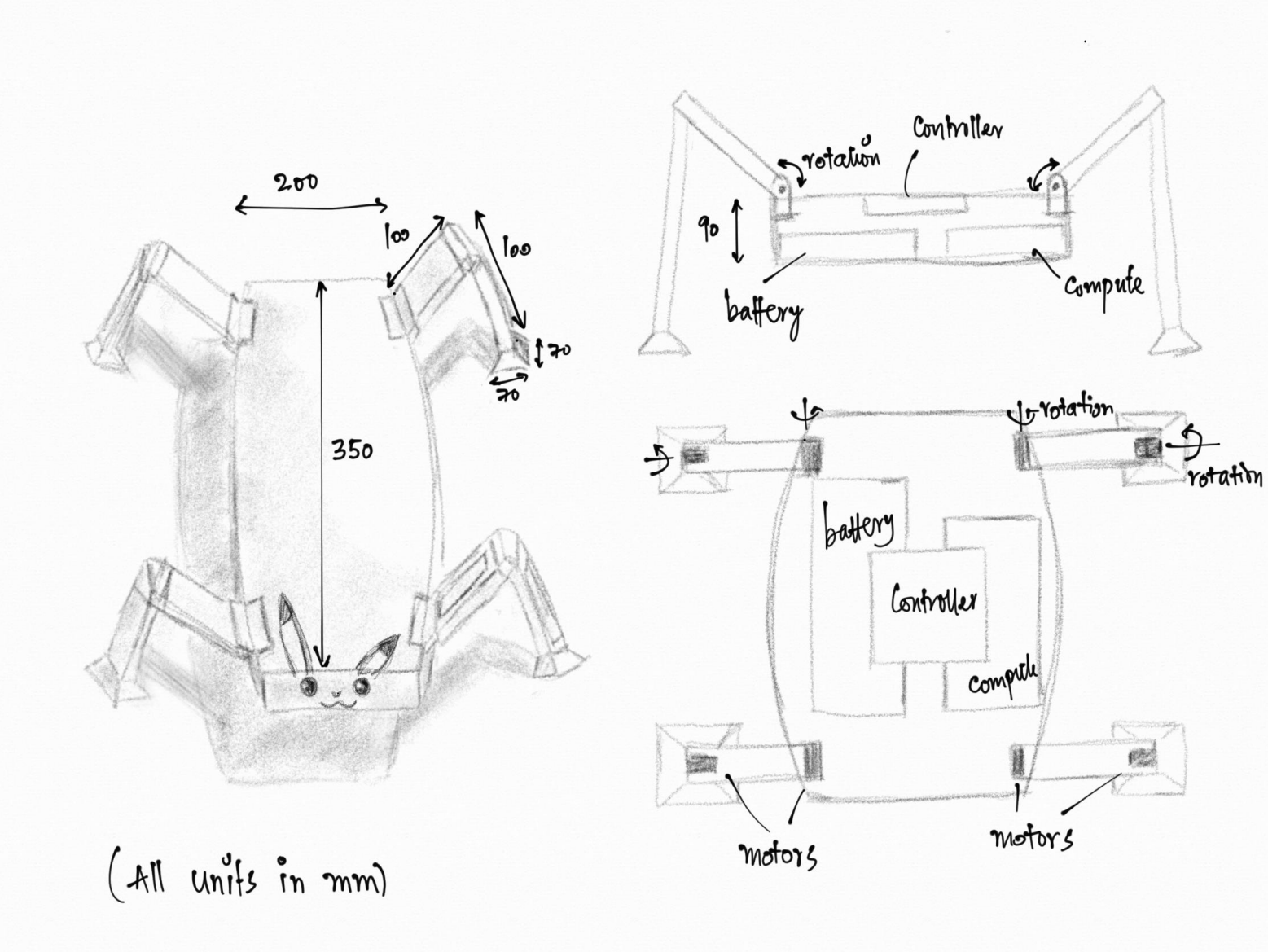
Max torque observed at max length

	MASS	WEIGHT	MAX TORQUE REQD.	MAX POWER
One leg (incl. motors)	(1.24g/cm^3*0.1*100cm^3) + 52g*2motors = 116.4g	1.1 N	20 N.cm	12 W
All legs (incl. motors)	116.4g * 4 = 465.6g	4.6 N	40 N.cm	12 W (Max 2 motors /time)
Body (incl. components) @ Thickness = 5mm	$V = \frac{2}{3}\pi \sum_{i=1}^{3}(R_i^3 - r_i^3)$ (1.24*0.1*2074.2cm^3) + 190g+150g+60g= 657.2g	6.4 N	N/A	N/A
Total	1122.8g	11.0 N	*Below motor specs of 166.7N.cm* 40 N.cm peak	*Below battery peak supply of 30W* 12 W peak. *Estimated run time: ~10 mins*
	$m = \rho * Infill\% * V$	$W = m * g$	$\tau = L * W$	$P = I * V$

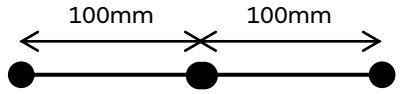
CONCEPT 3: STANDRONE

The idea stems from drone housings (hence the name). The housing is essentially like a drone except instead of being a quad-copter, it is a quad-pedal robot!

STANDRONE SKETCHES



CALCULATED PROPERTIES



Max torque observed at max length

	MASS	WEIGHT	MAX TORQUE REQD.	MAX POWER
One leg (incl. motors)	(1.24g/cm^3*0.1*100cm^3) + 52g*2motors = 116.4g	1.1 N	20 N.cm	12 W
All legs (incl. motors)	116.4g * 4 = 465.6g	4.6 N	40 N.cm	12 W (Max 2 motors /time)
Body (incl. components) @ Thickness = 5mm	(1.24*0.1*1332cm^3) + 190g+150g+60g= 565.1g	51.7 N	N/A	N/A
Total	1030.8g	55.1 N	*Below motor specs of 166.7N.cm* 40 N.cm peak	*Below battery peak supply of 30W* 12 W peak. *Estimated run time: ~12 mins*
	$m = \rho * Infill\% * V$	$W = m * g$	$\tau = L * W$	$P = I * V$

SUMMARY

5 Points Title slide complete

5 Points overall aesthetics, layout and formatting of the slides

5 Points posting some sketch of your robot on the discussion board at least 24h in advance of the deadline, and commenting constructively and positively on at least three other's postings – **SHOWN ON NEXT SLIDE**

Following are point rubrics you can receive for each of the three concepts:

5 Points 3D sketch, with key dimensions and labels – **(SLIDES 3,4,7,8,11)**

5 Points shading and shadows – **(SLIDES 3,4,7,8,11)**

5 Points weight estimate, gait and stability analysis – **(SLIDES 5,9,12)**

5 Points power estimates (including estimated run time) – **(SLIDES 5,9,12)**

5 Points including Computer, controller, battery labels – **(SLIDES 3,4,7,8,11)**

5 Points showing in multiple poses – **(SLIDES 3,4,7,8,11)**

5 Points showing "Zoom in" of some feature – **(SLIDES 3,4,7,8,11)**

ED DISCUSSION SCREENSHOTS

Rough Concept Sketches #24

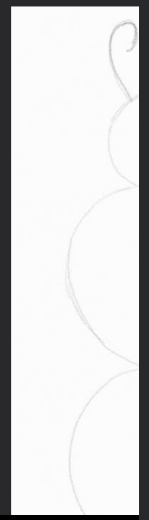
Aatir Fayyaz
5 hours ago in Assignments – A1

STAR WATCHING 30 VIEWS

Hi everyone, here are two of my concept sketches. Any feedback would be appreciated.

Concept 1: The Robo-Ant

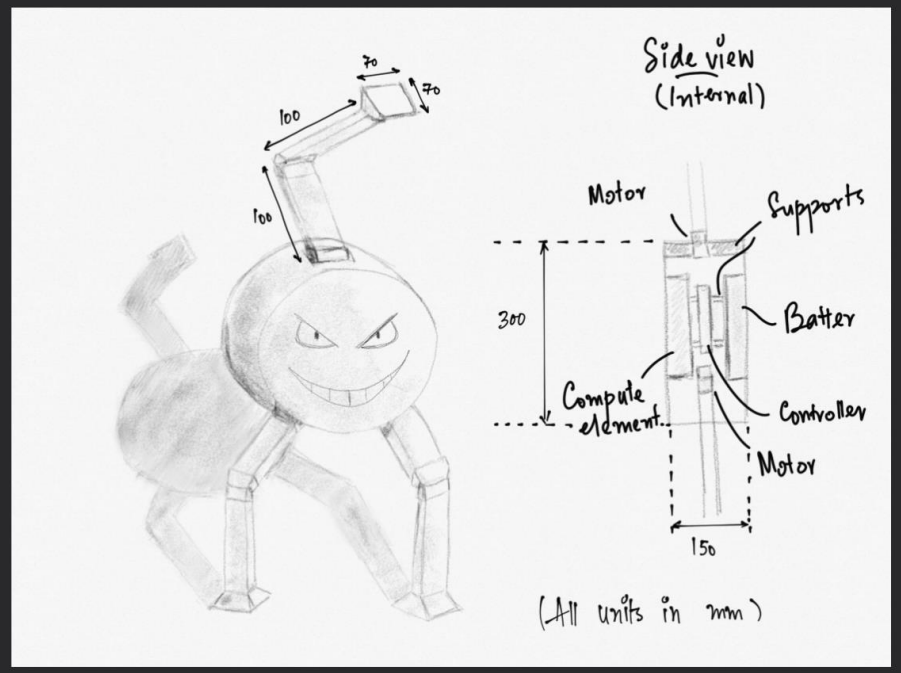
The name says it all. A robot trying to make it as an ant. I am conflicted on whether I could make the legs work with 1 motor or not, so I have two cases shown.



Concept 2: The Tri-bot

This is definitely more of a stretch in terms of mobility. The initial idea was to possible have it move by rotating itself but the stability is going to be an issue. The other movement option is to move using one leg at a time alternative legs.

I'd love if I could make either of these ideas work but it'll be tricky.



Concept Sketch #16

Jenny Shan
23 hours ago in General

Aatir Fayyaz
7 hours ago

Very creative naming and a pretty neat concept. Good sketches too. I agree with Amr that the zoomed in sketches are also very well done.! Would be exciting to see the v-alker walking about.

Comment Edit Delete •••

Concept 1: Turtle-Bot and Concept 2: R4D4 #23

Danish Rahman
6 hours ago in General

Aatir Fayyaz 5h

Good sketches and very nicely detailed. I like the turtle shell design and the shell opening is a nice addition. Loving the R4D4! Hoping to see it come to life.

Reply Edit Delete •••

Concept Sketch #16

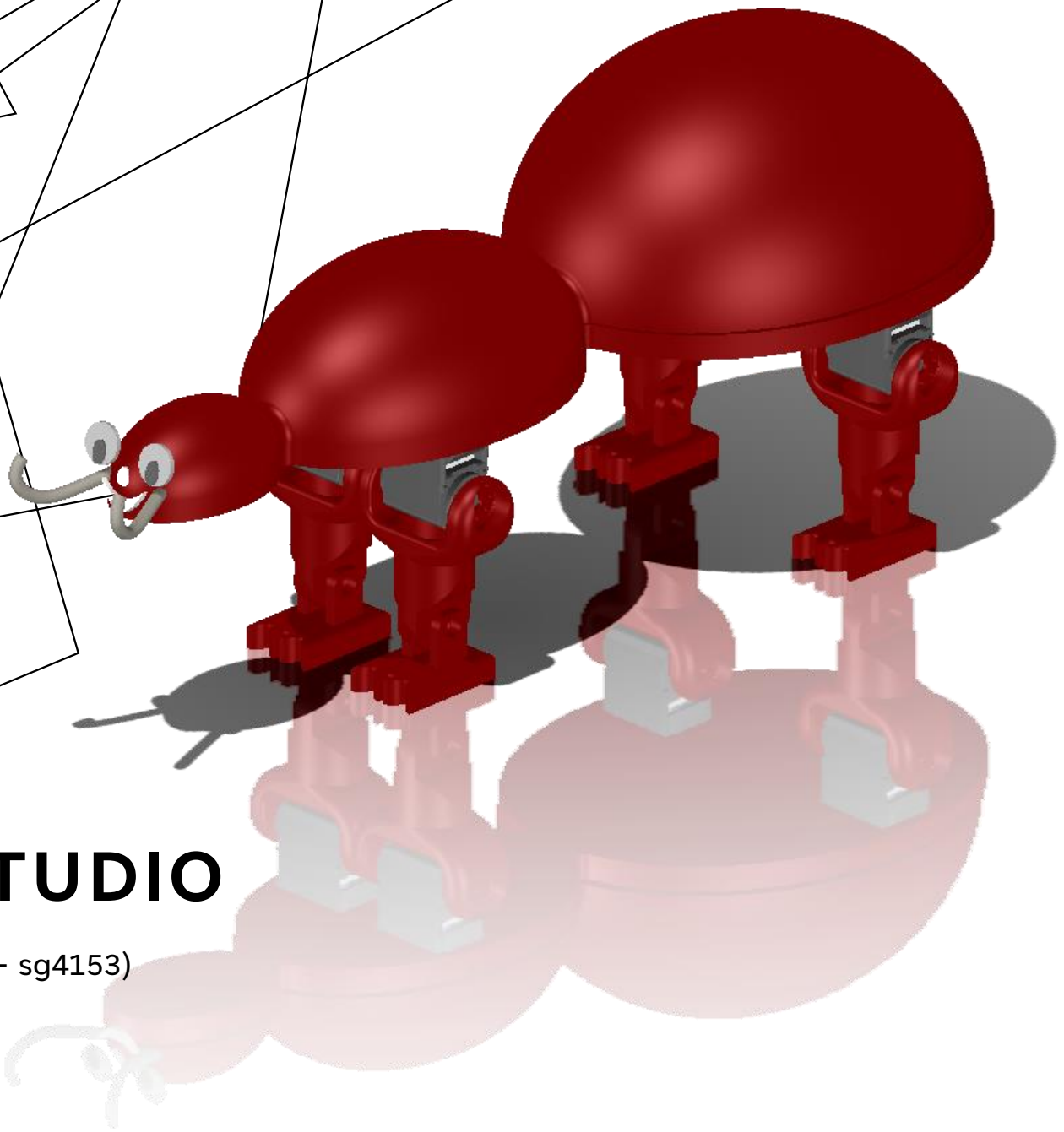
Jenny Shan
23 hours ago in General

Add comment

Aatir Fayyaz 3m

Looks pretty interesting Zeren. Are you using a motor just at the base of the leg for feet actuation? I think that's an interesting and unique idea. I like the parallel linkage for better control and stability as well. Good luck making this come to life!

Reply Edit Delete •••



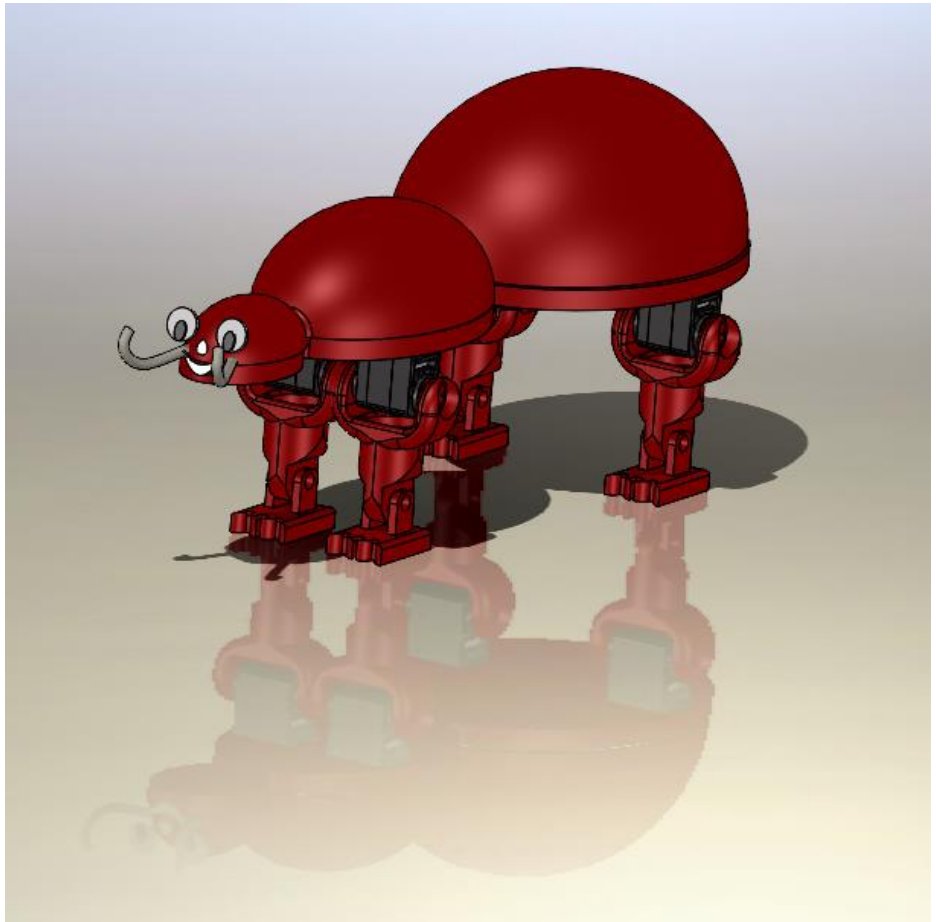
MECE 4611 - ROBOTICS STUDIO

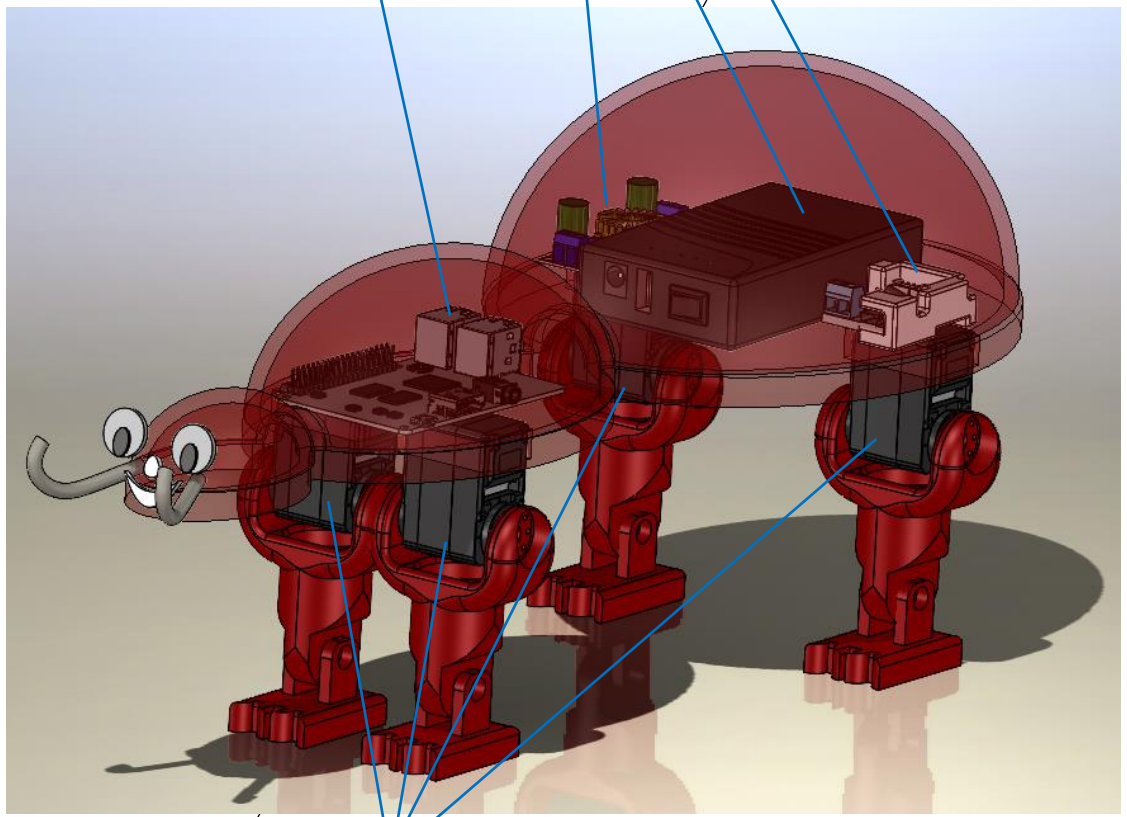
Names & Unis: Group 2 (Aatir Fayyaz - af3252, Sumedha Gudipati - sg4153)

Date/Time Submitted: 09/19/2022 @ 1500hrs

Grace Hours: 107 + 109hrs (total of the group) + 66hrs = 282hrs

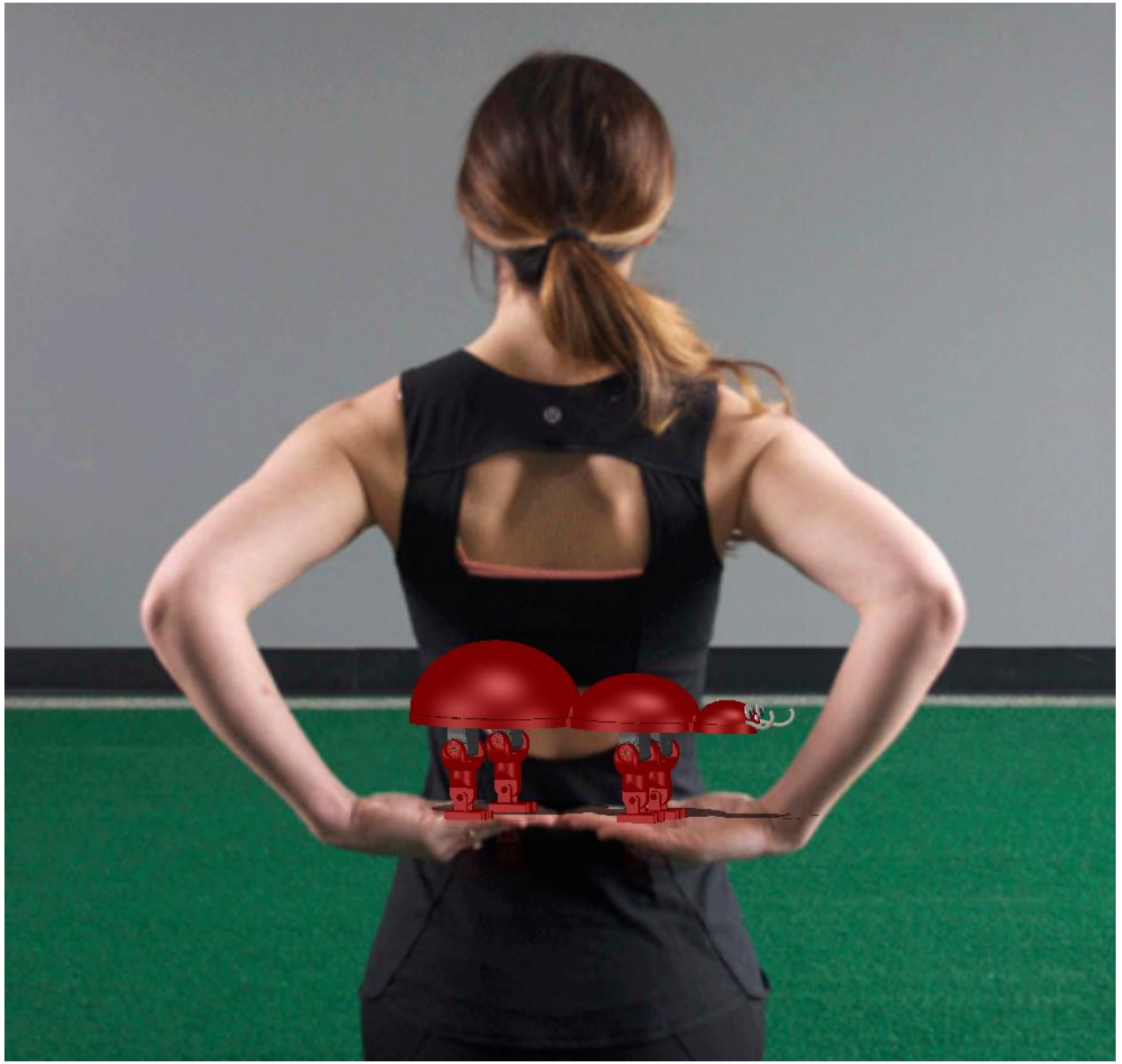
ROBO-ANT



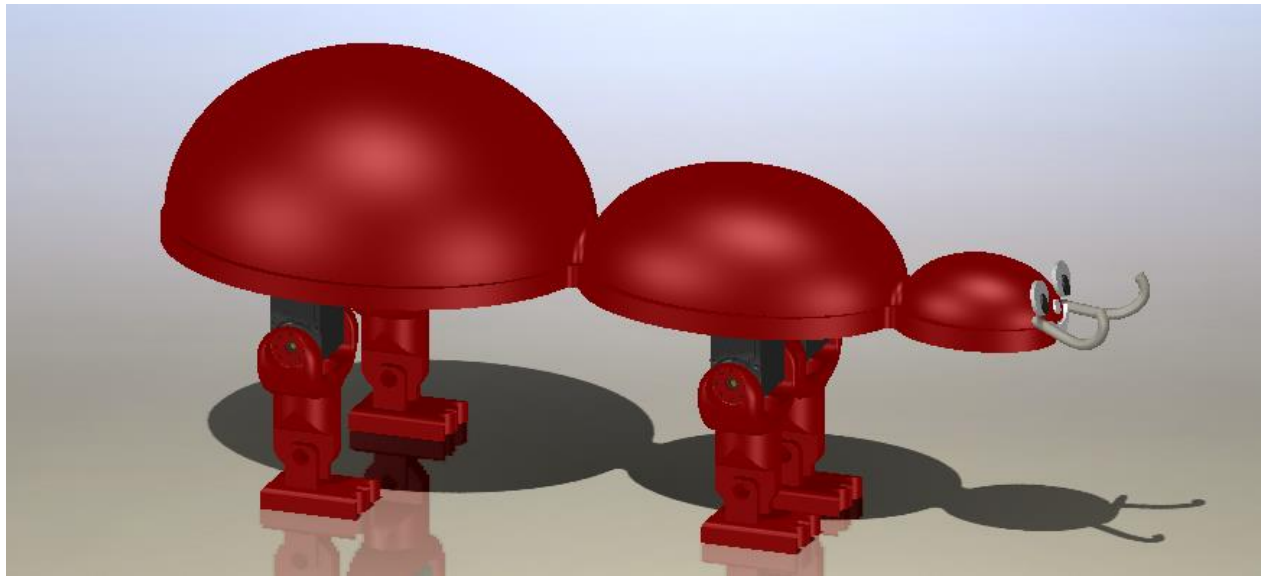

Controller Board with Case
Battery Pack
Power Converter
AML-S905X-CC (Le Potato)
LX-16A Servo Motors

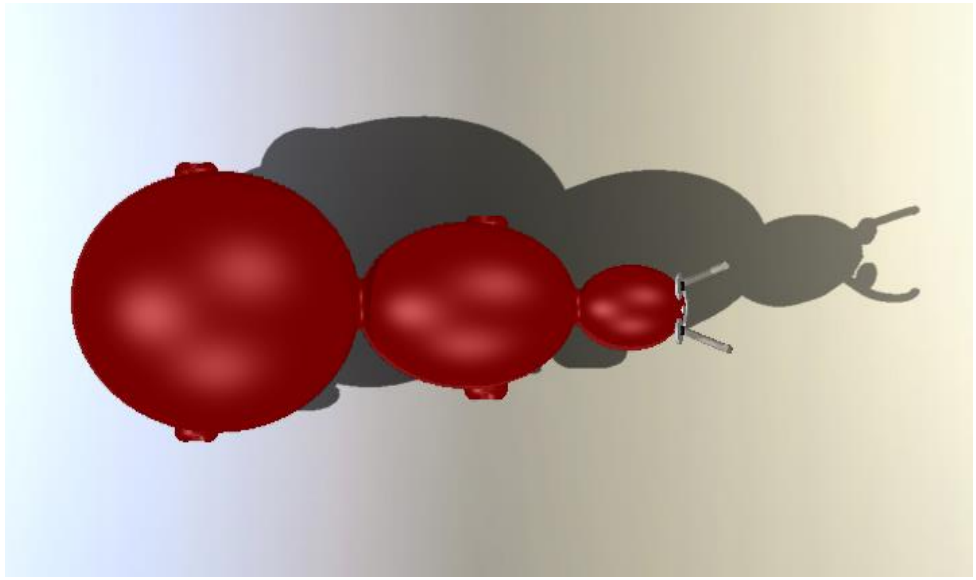
PHOTOREALISTIC RENDERING

CONTEXT RENDERING



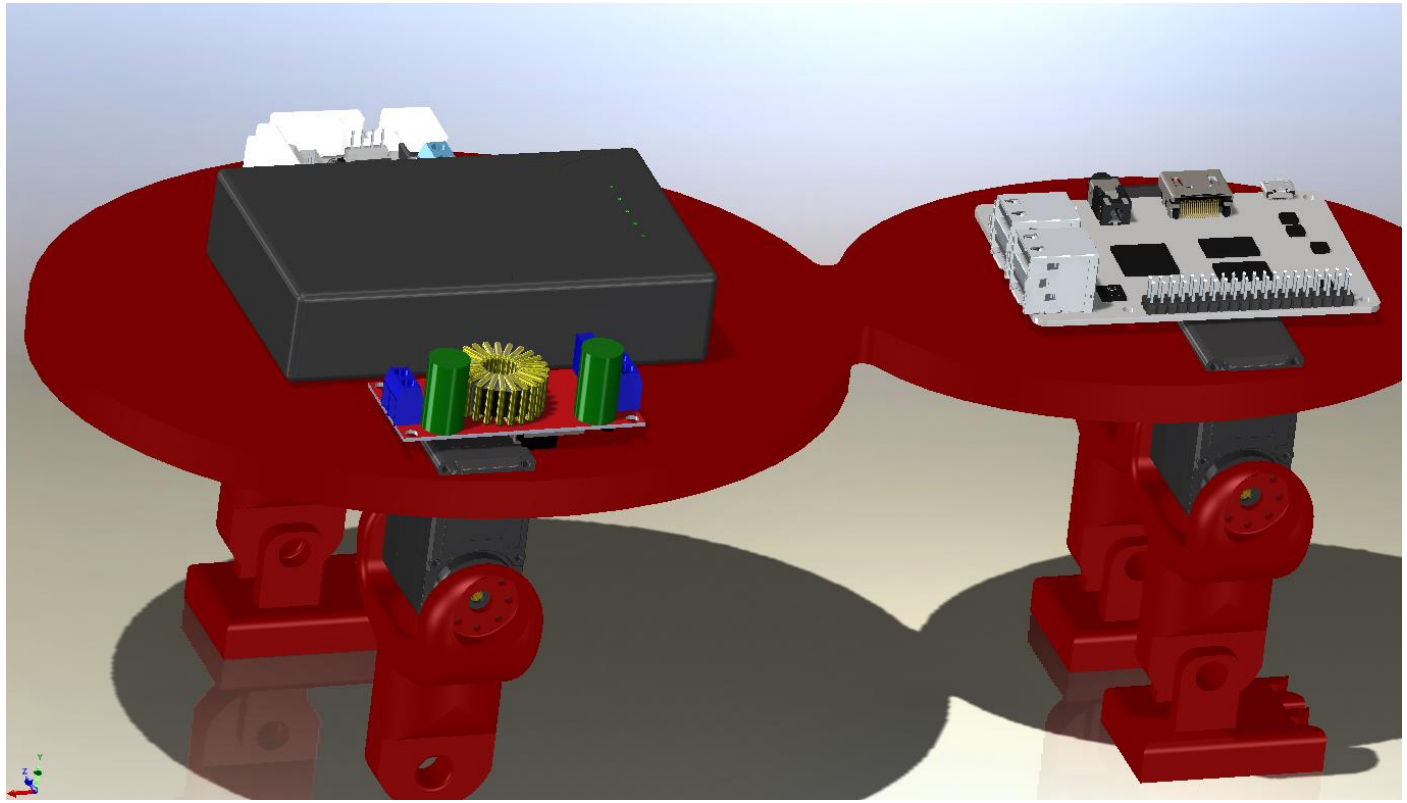
VARIOUS VIEWS OF THE BOT



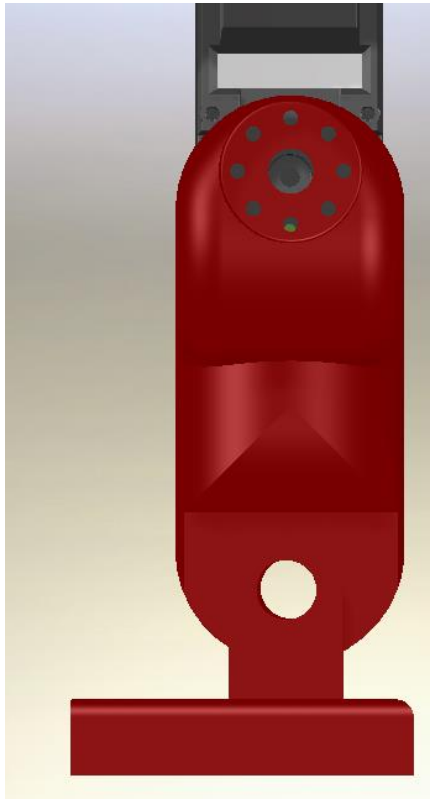


DETAILED CLOSE-UP

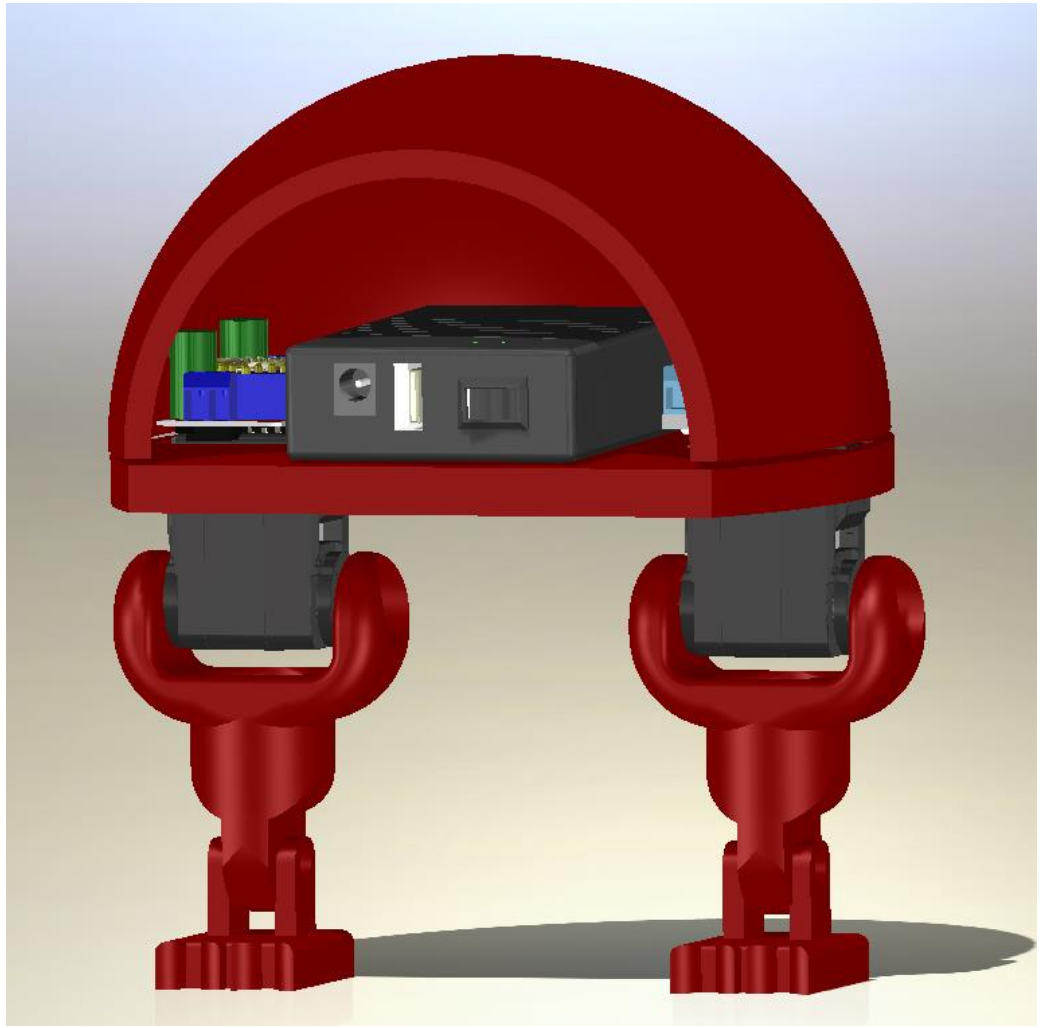
Internal Components

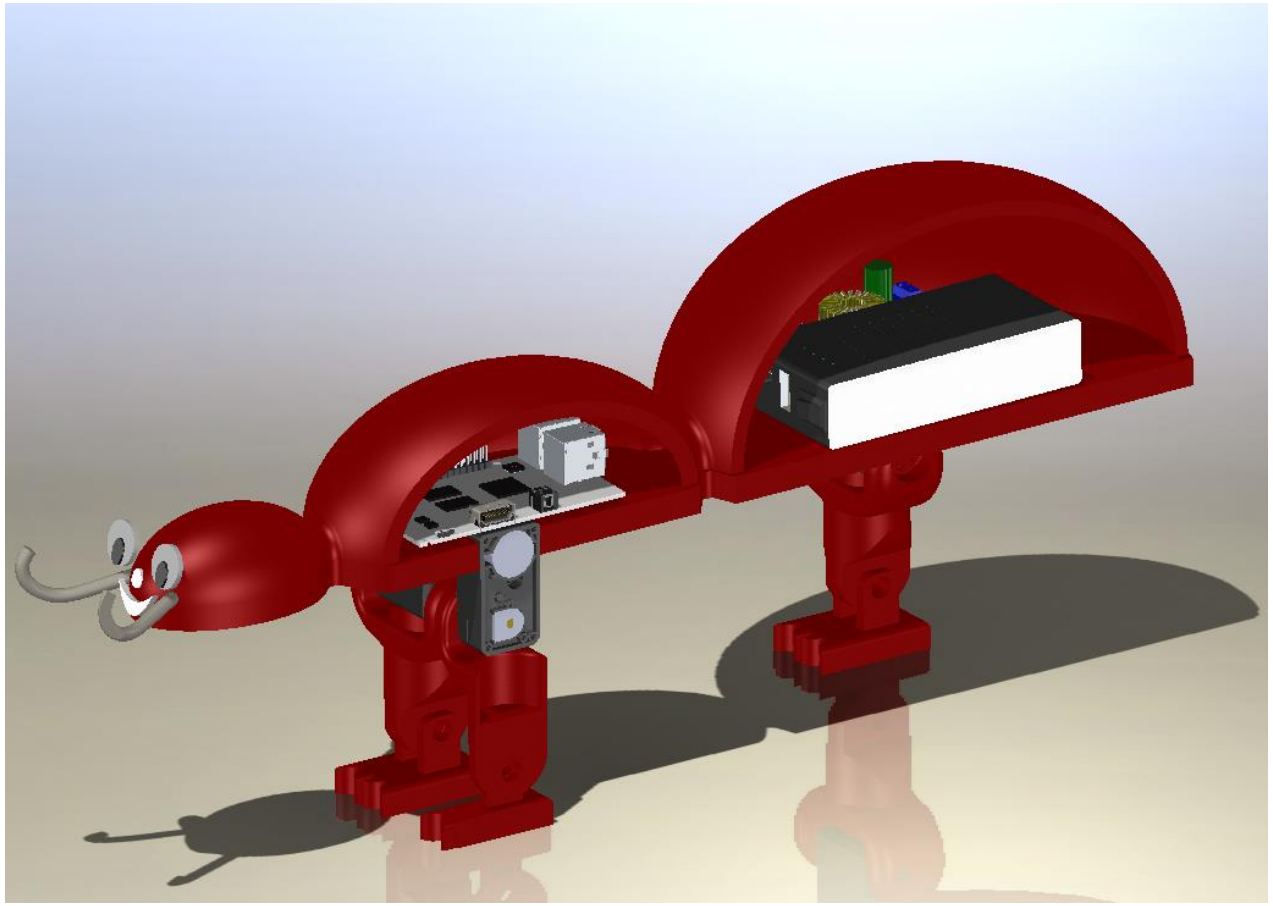


Leg showing Servo and Foot connection points

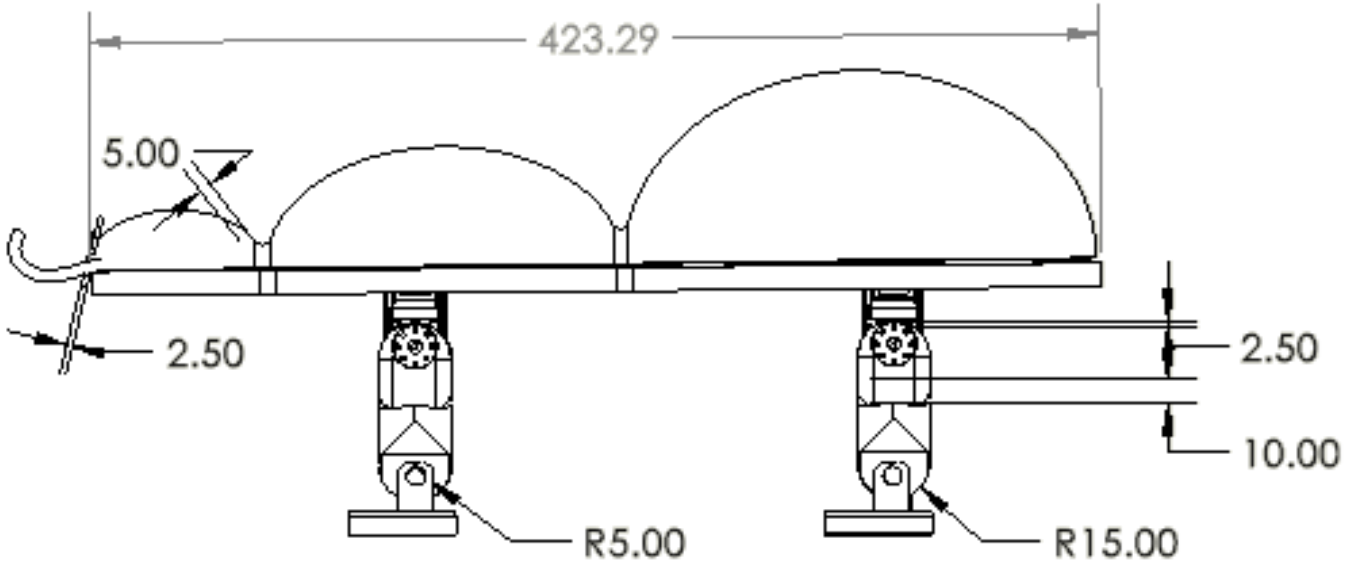


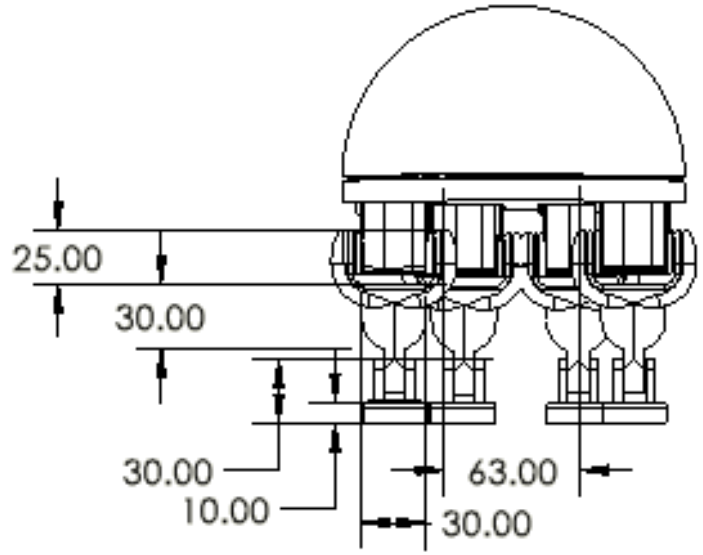
CROSS-SECTIONAL VIEWS

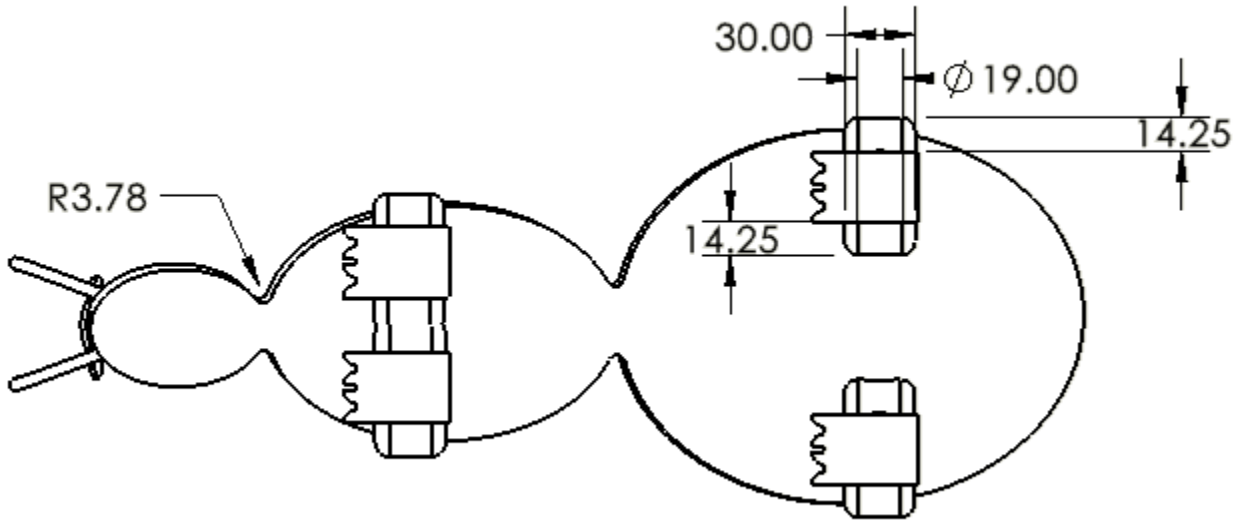




VIEWS WITH MAIN DIMENSIONS

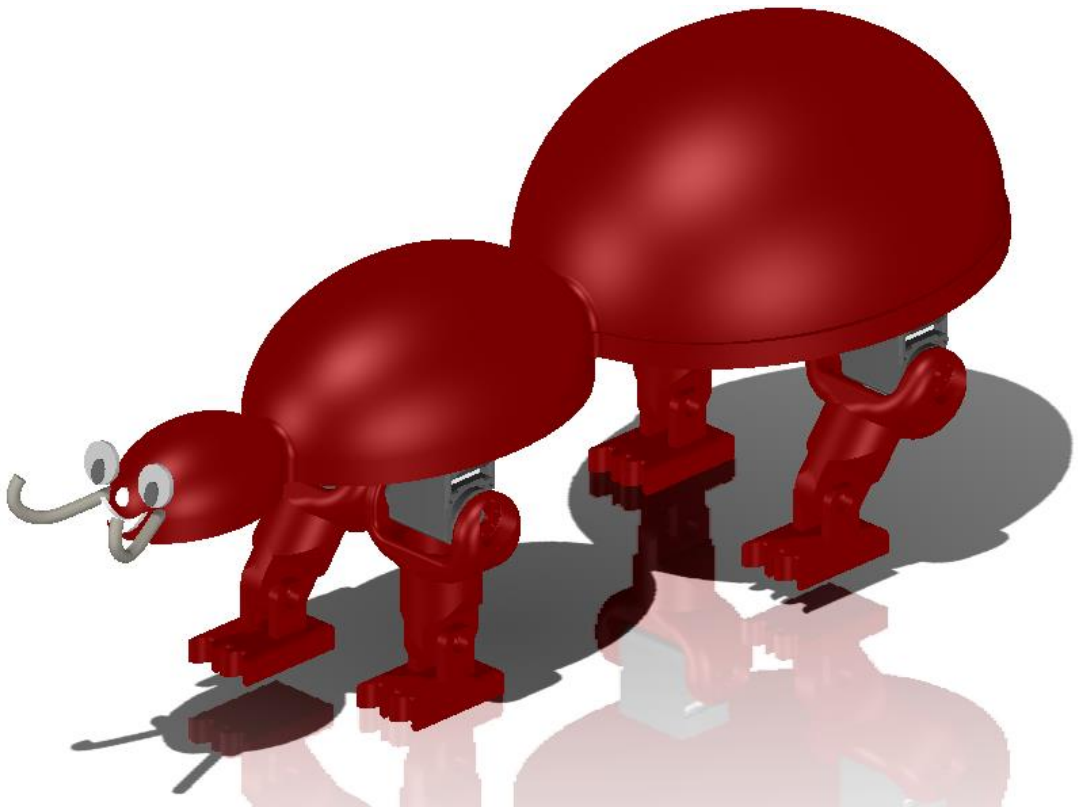


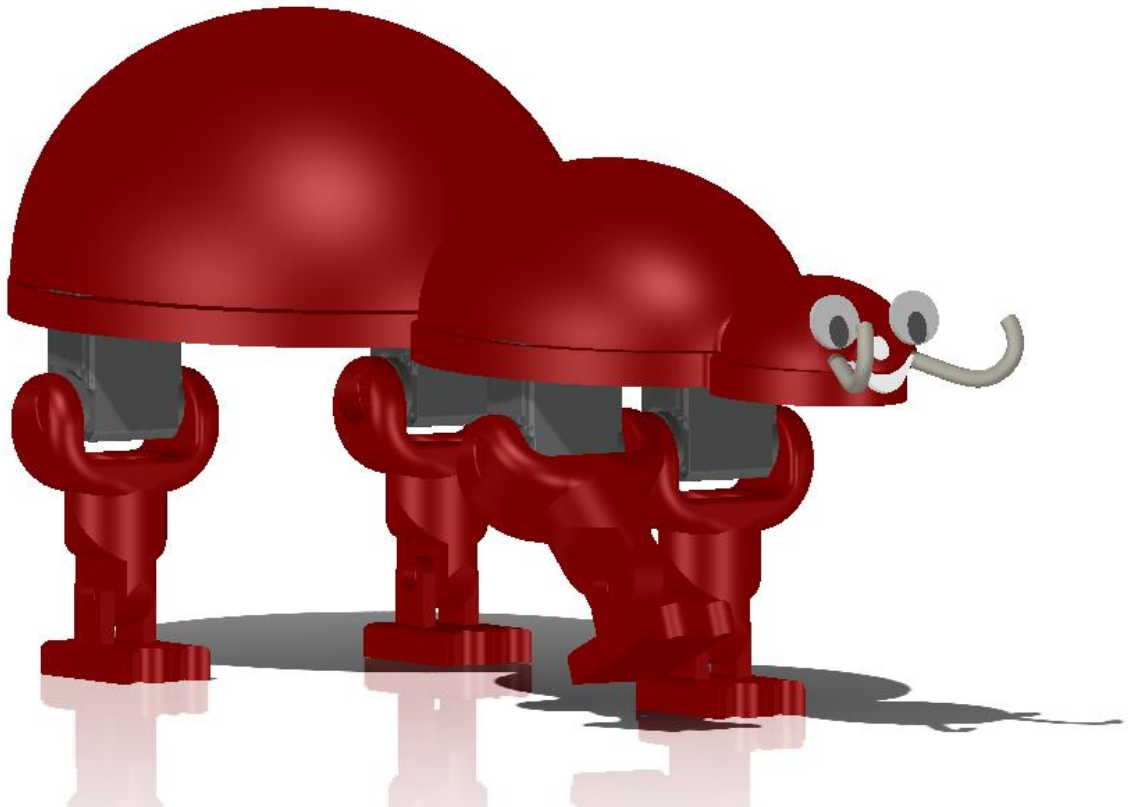




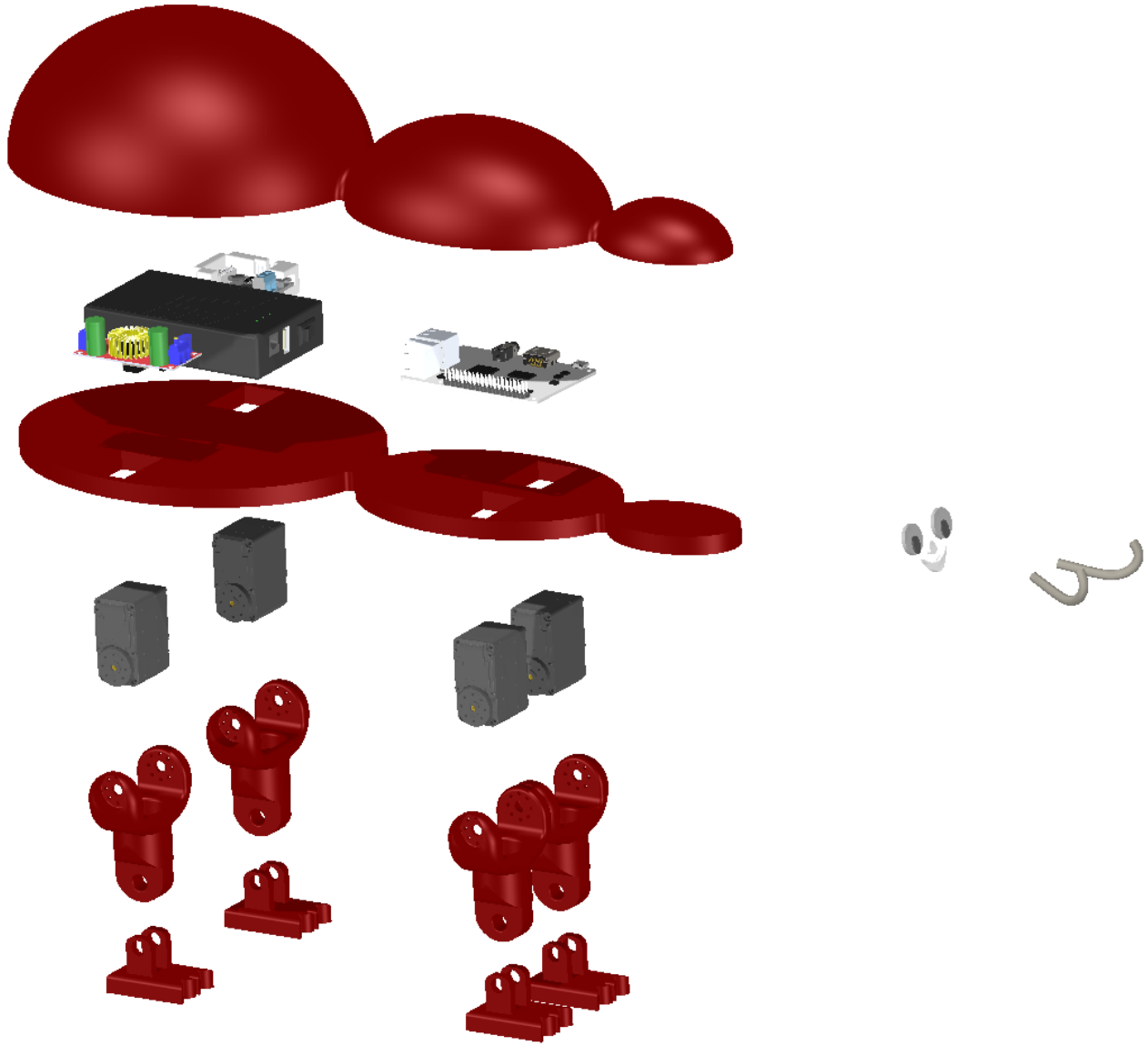
All dimensions in mm

DIFFERENT WALKING POSES

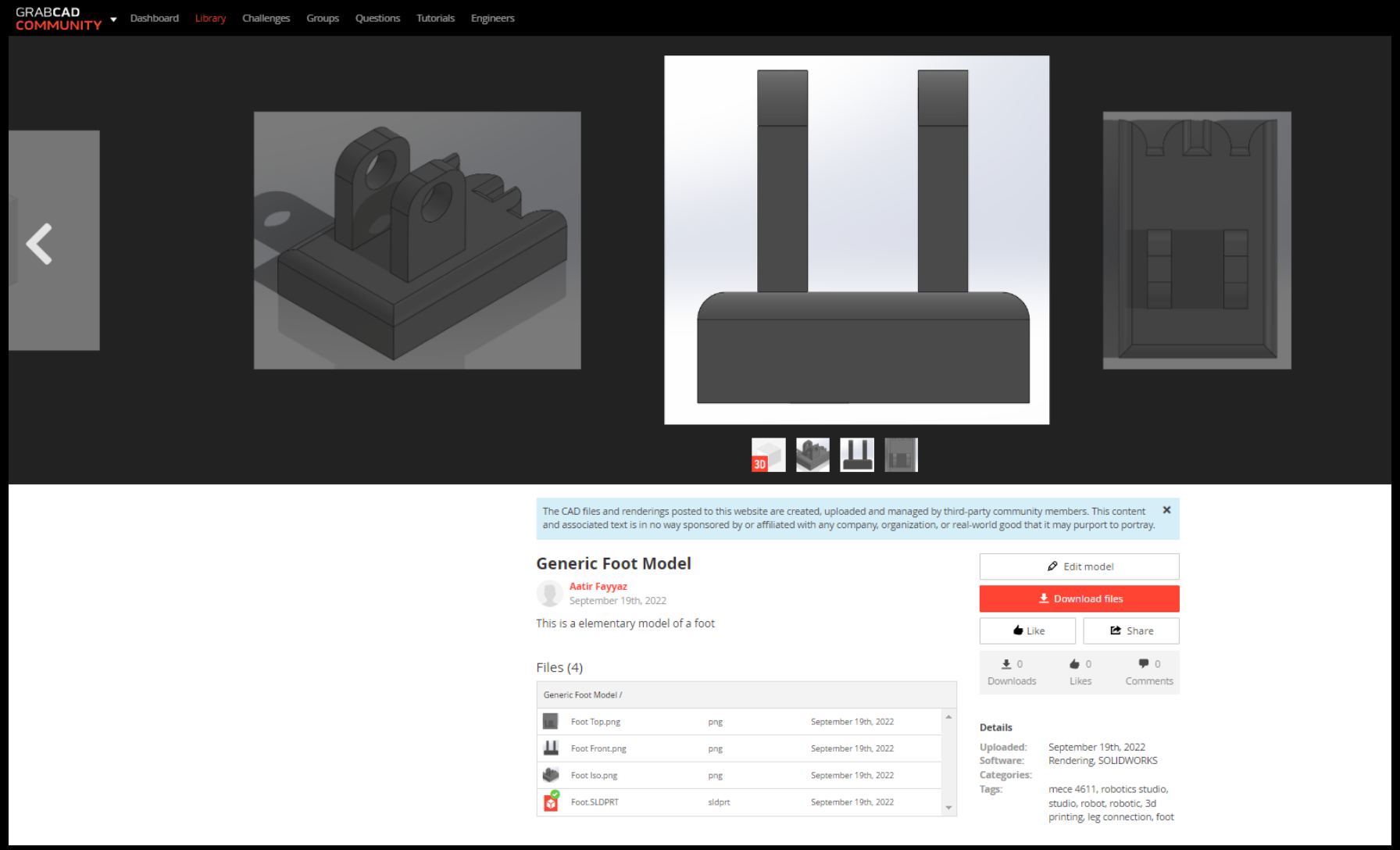




EXPLODED VIEW



UPLOAD TO GRABCAD



URL: https://grabcad.com/library/generic-foot-model-1

CALCULATED PROPERTIES OF ROBO-ANT

Mass = 1298.47 grams = ~1.3 kg

Volume = 1133979.36 cubic millimeters = ~0.001133979 m^3

Surface area = 457426.55 square millimeters

Center of mass: (millimeters)
X = -402.41
Y = -77.45
Z = 2.03

Principal axes of inertia and principal moments of inertia: (grams * square millimeters)
Taken at the center of mass.

Ix = (1.00, 0.08, 0.02)	Px = 3672375.46
Iy = (-0.08, 0.99, 0.11)	Py = 15727144.18
Iz = (-0.01, -0.11, 0.99)	Pz = 15904811.67

Weight (assuming density of PLA @ 1240kg/m^3 and an infill of 10%) = 1.83 N

Per step (assume 60° rotation per movement) = 0.38 s
Gait length = 60 * sin (60°) = 51.9 mm = ~5.2 cm

Estimated Speed = 5.2/0.38 = 13.7 cm/s

ED DISCUSSION SCREENSHOTS

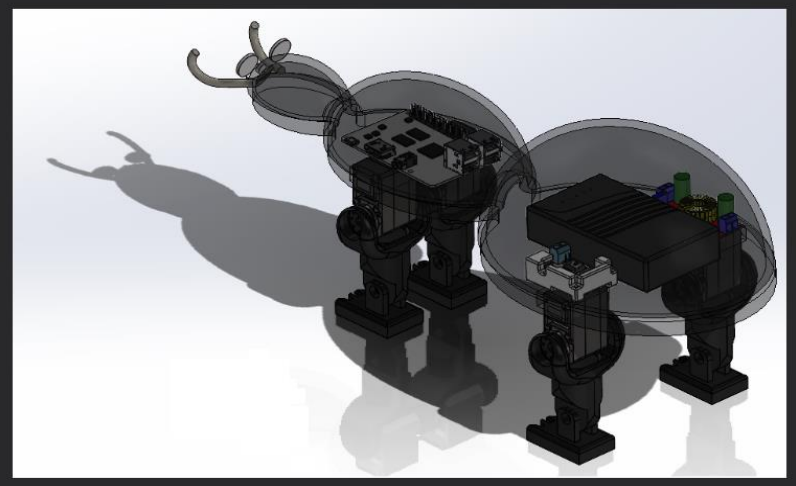
Preliminary CAD - Robo-Ant #36

Aatir Fayyaz
5 minutes ago in Assignments – A2

STAR WATCHING 3 VIEWS

Hello all,

We are Group 2 (Aati
Any suggestions will



Preliminary CAD! #34

Jiong Lin
20 hours ago in General

Aatir Fayyaz
18 hours ago

Wow - this is pretty nice. I really like the AR model! I'm going to try to learn how to do that too

1 Comment Edit Delete ···

Preliminary CAD #35

Yuzhe Wang
13 hours ago in Assignments – A2

Sumedha Gudipati 51m

The design looks very well thought out - really like the shell design. Design of the bot works well with the transformers theme and the logo looks great!

Reply ···

Preliminary CAD #37

Hazel Zhu
2 hours ago in Assignments – A2

Aatir Fayyaz
Now

The placement of the servos will allow really good movement ability for this bipedal humanoid robot! Love the dancing maneuver in the last picture

Comment Edit Delete ···

SUMMARY

5 Points Title slide complete – **(SLIDE 15)**

5 Points overall aesthetics, layout and formatting of the slides

10 Points posting some rendering of your robot on the discussion board at least 24h in advance of deadline, and commenting constructively and positively on at least three other's postings (show screenshots) – **(SLIDE 27)**

10 Points 3D Renderings in perspective – **(SLIDE 16)**

10 Points Key components included – **(SLIDE 16)**

10 Points organic shape (no/few straight edges) – **(Almost no straight edges as shown)**

10 Points photorealistic rendering – **(SLIDES 17, 18)**

10 Points context rendering – **(SLIDES 18)**

10 Points animation

10 Points exploded view – **(SLIDES 24)**

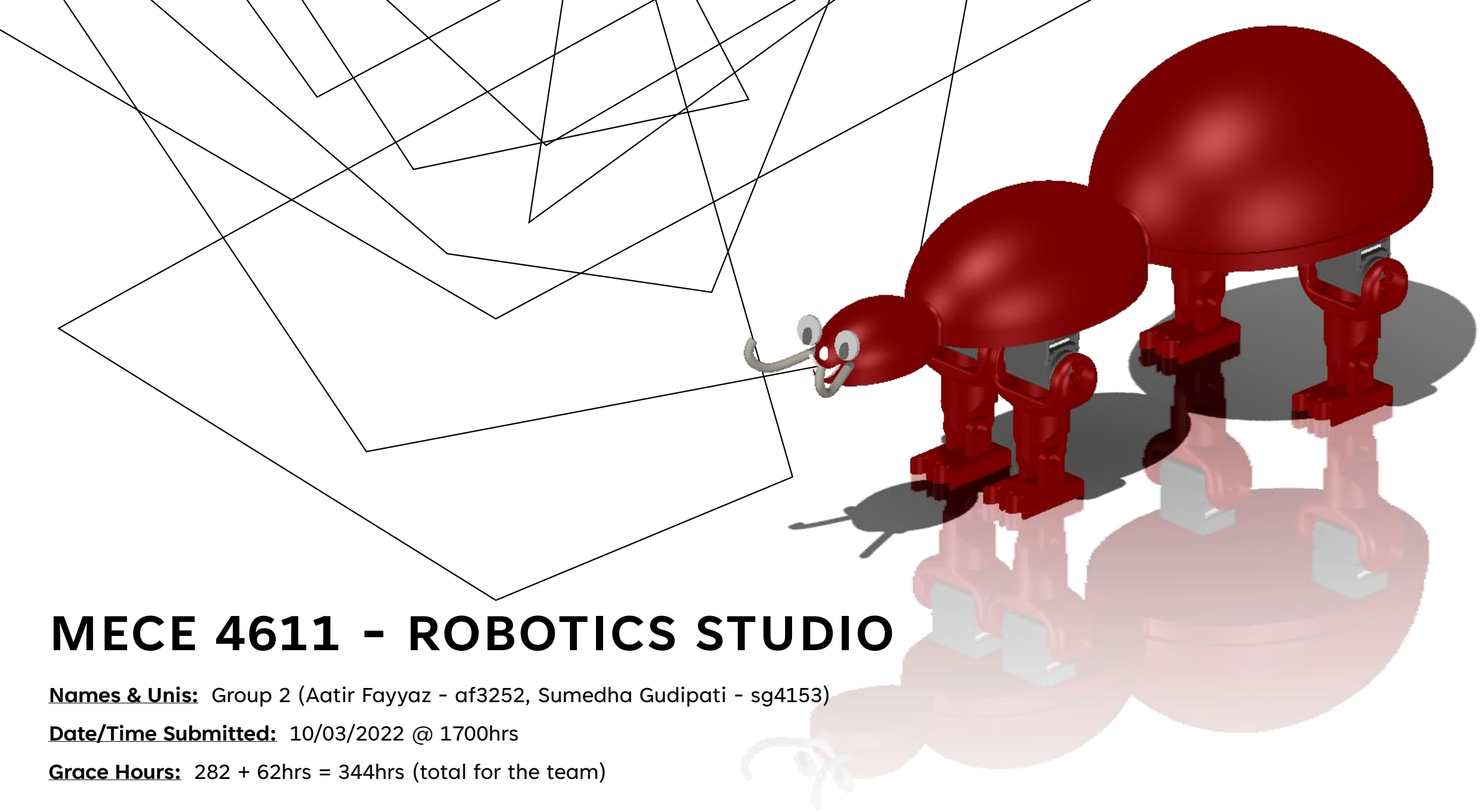
10 Points key specs listed including speed – **(SLIDES 26)**

10 Points multiple poses shown – **(SLIDES 23)**

10 Points detail close-up shown – **(SLIDES 20, 21)**

10 Points side views with main dimensions – **(SLIDE 22)**

10 Points sharing a relevant CAD component on GrabCAD or Thingiverse (show screenshot) – **(SLIDE 25)**



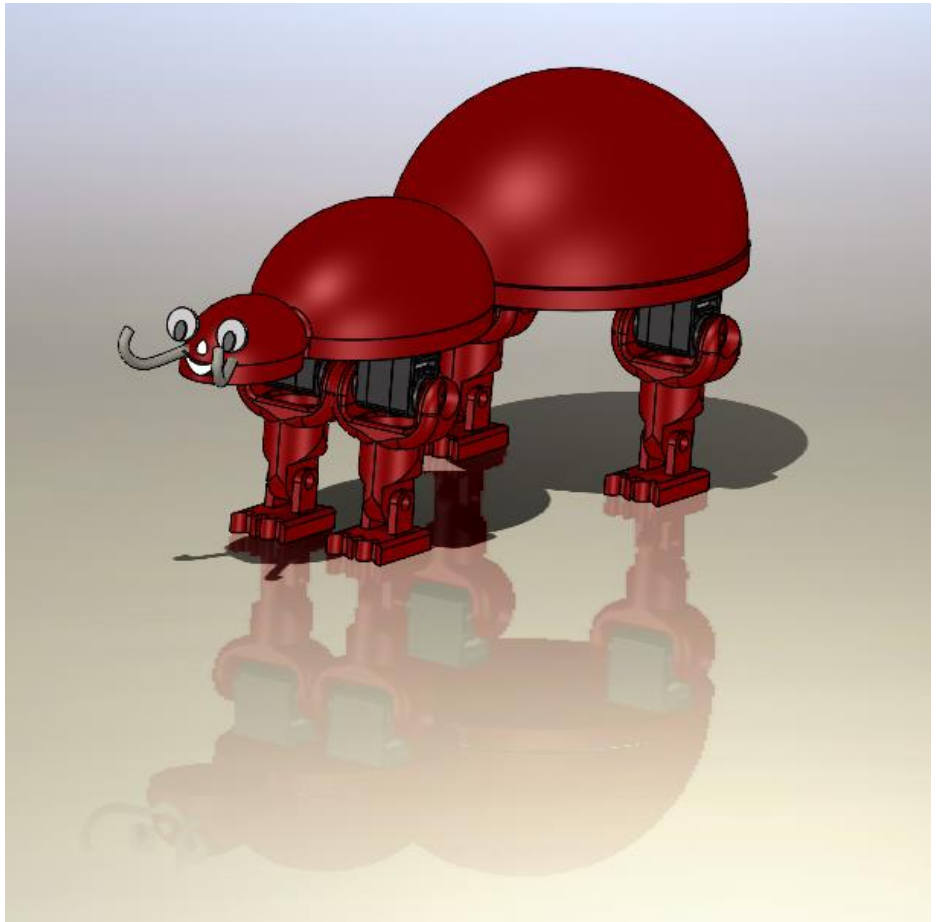
MECE 4611 - ROBOTICS STUDIO

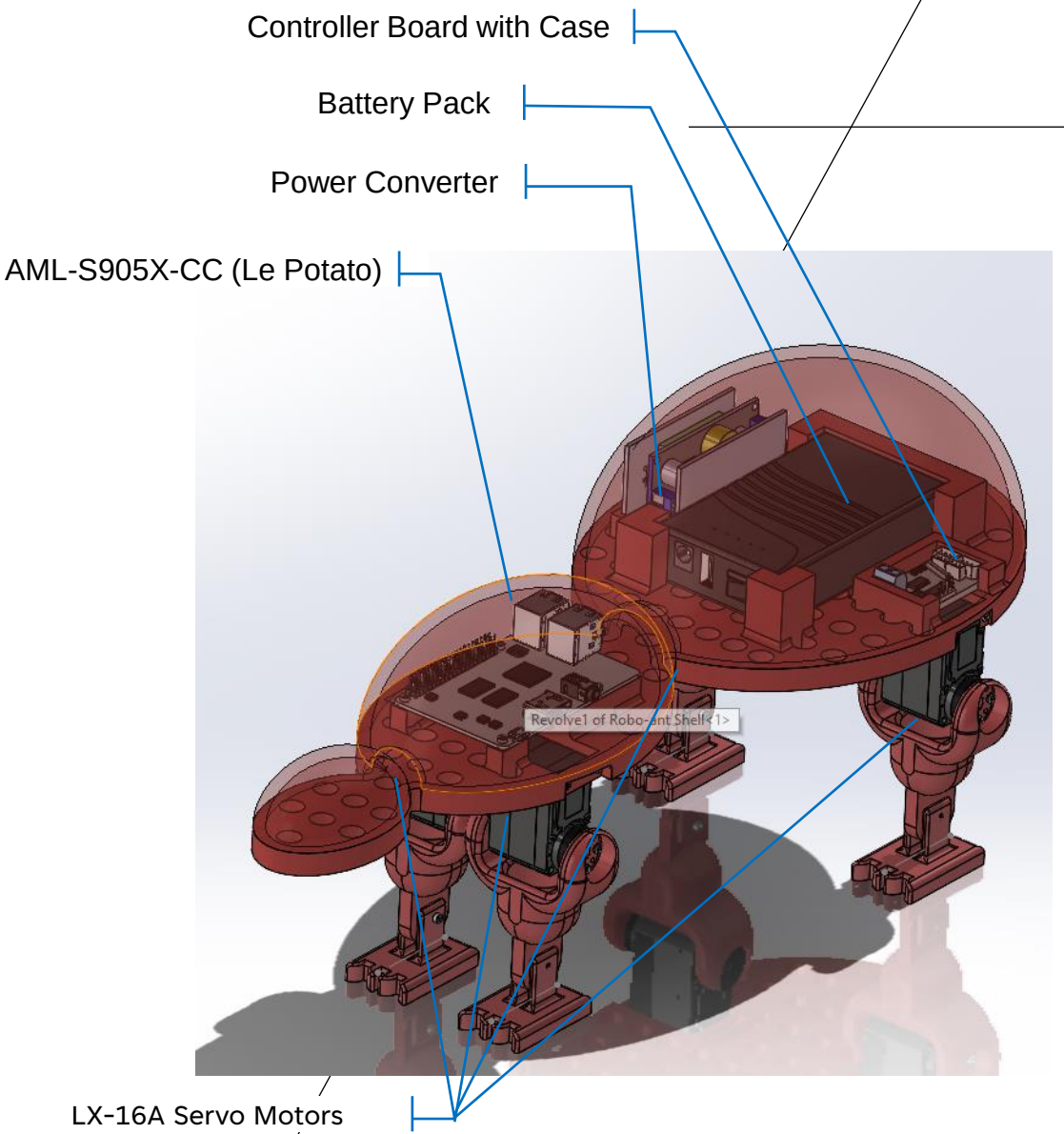
Names & Unis: Group 2 (Aatir Fayyaz - af3252, Sumedha Gudipati - sg4153)

Date/Time Submitted: 10/03/2022 @ 1700hrs

Grace Hours: 282 + 62hrs = 344hrs (total for the team)

ROBO-ANT




Controller Board with Case
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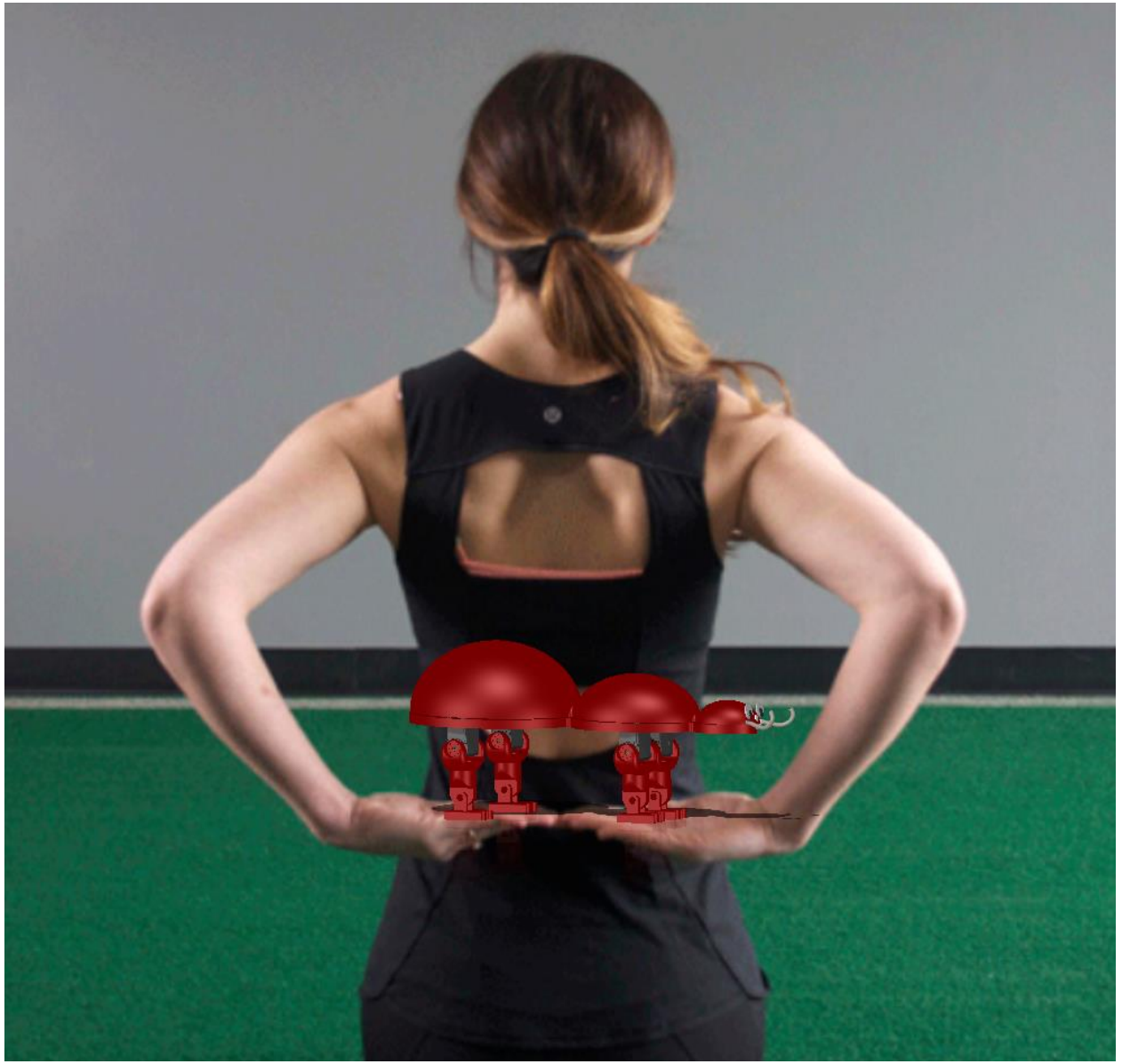
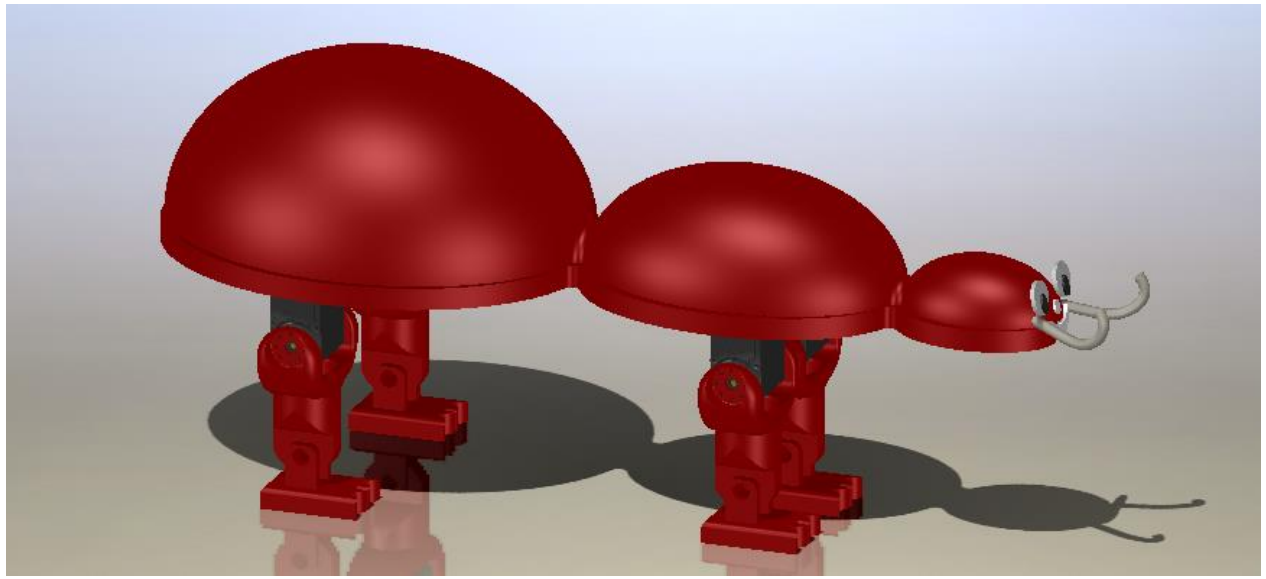
LX-16A Servo Motors

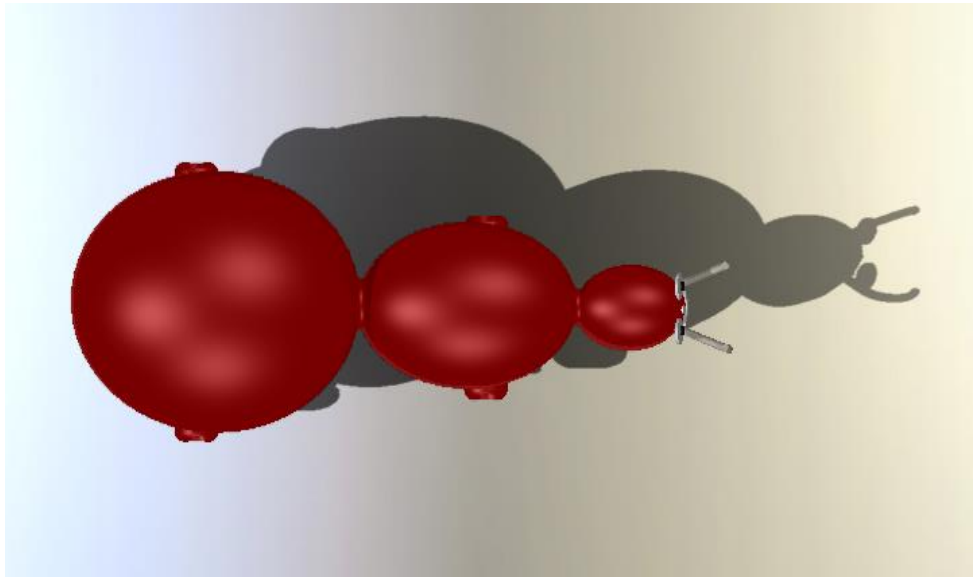
PHOTOREALISTIC RENDERING

CONTEXT RENDERING



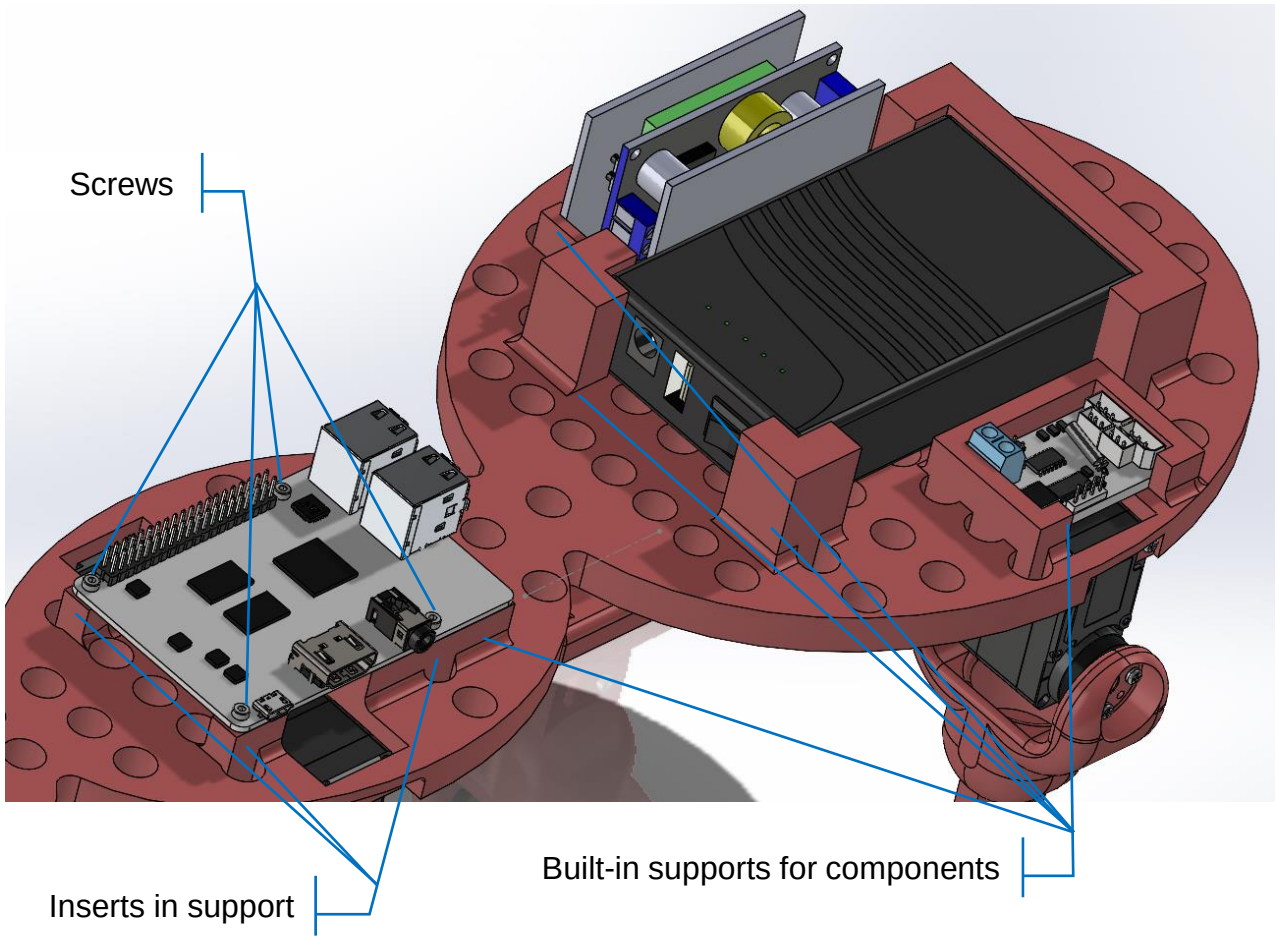
VARIOUS VIEWS OF THE BOT



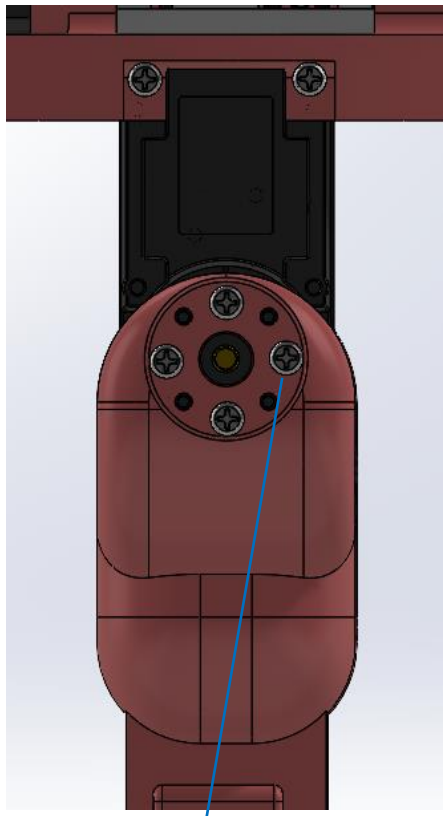


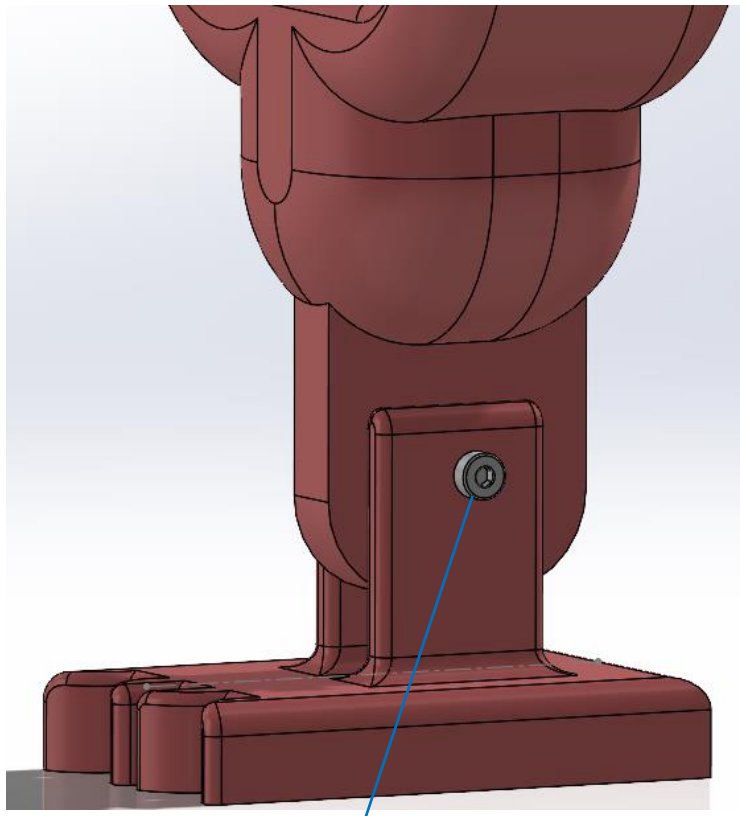
DETAILED CLOSE-UP

Internal Components

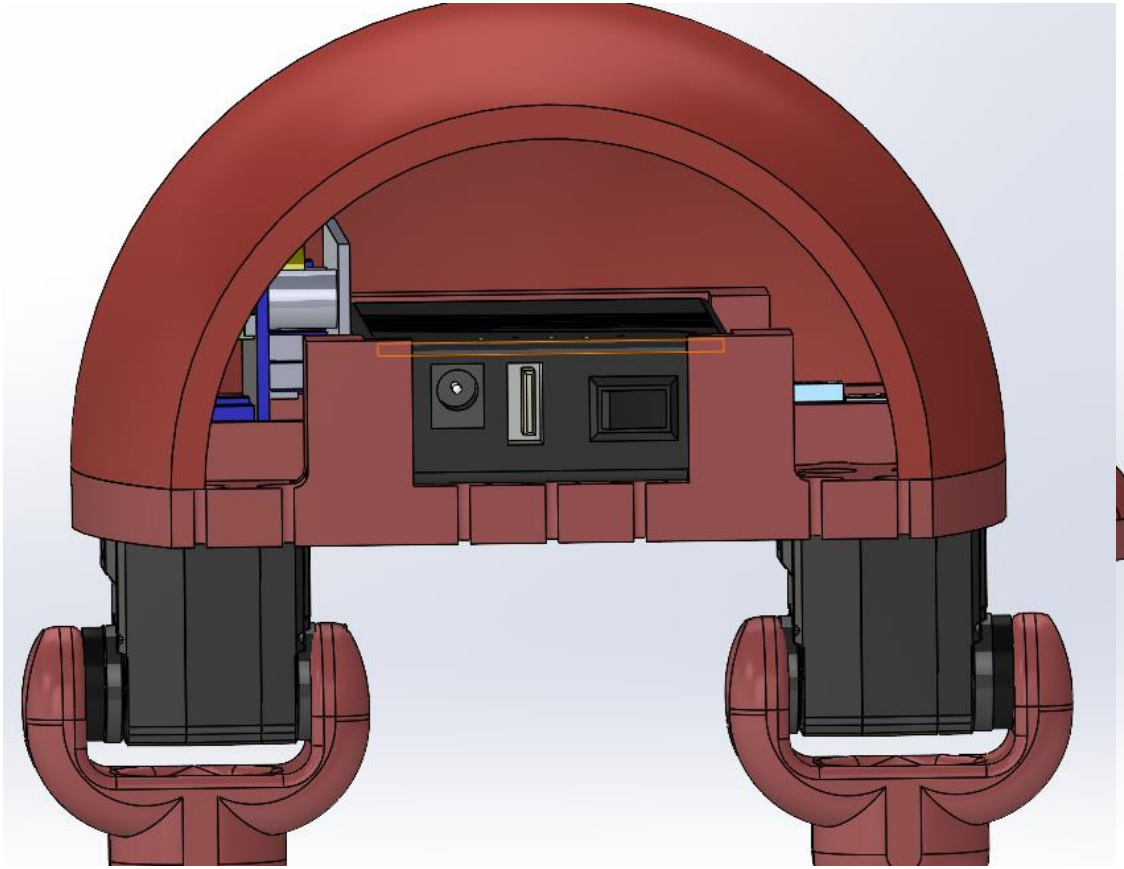


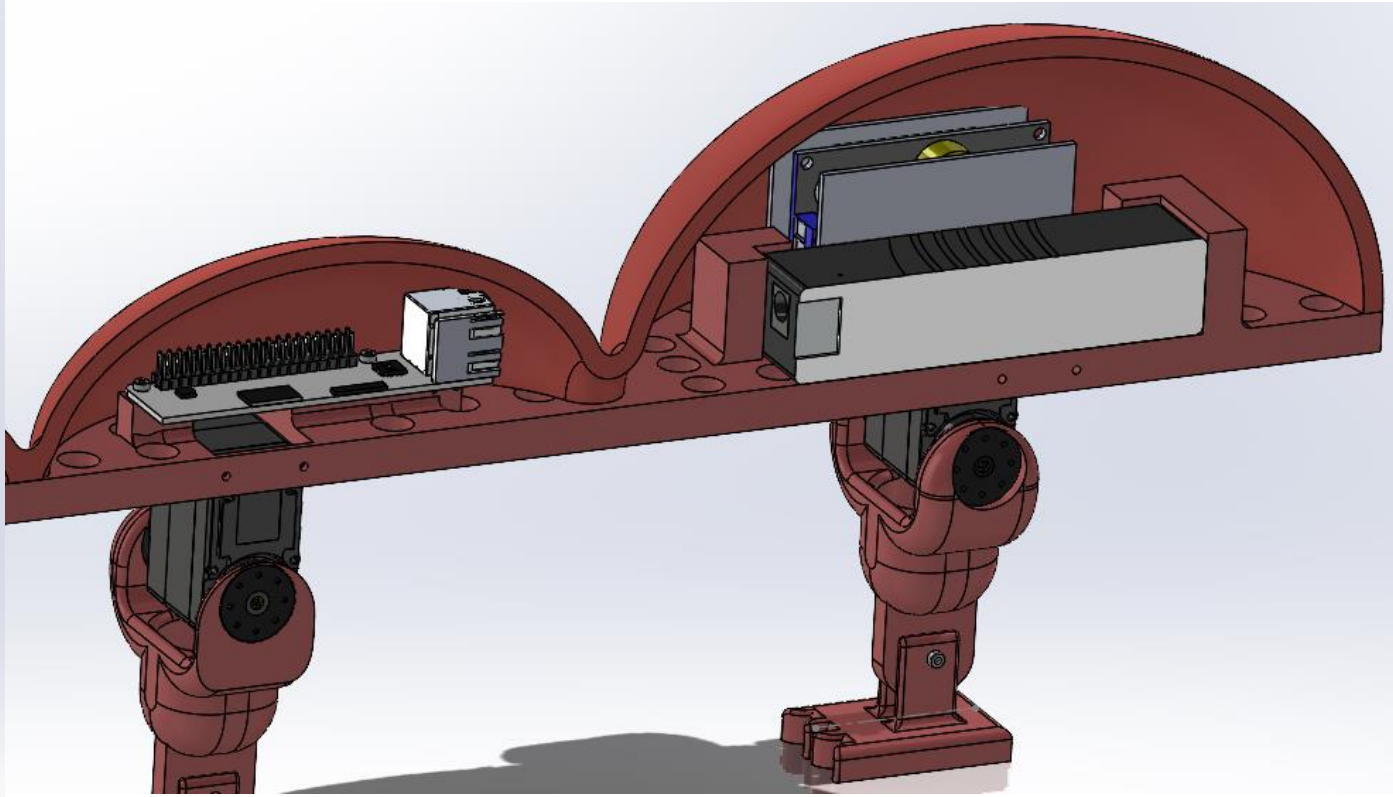
Leg showing Servo and Foot connection points





CROSS-SECTIONAL VIEWS

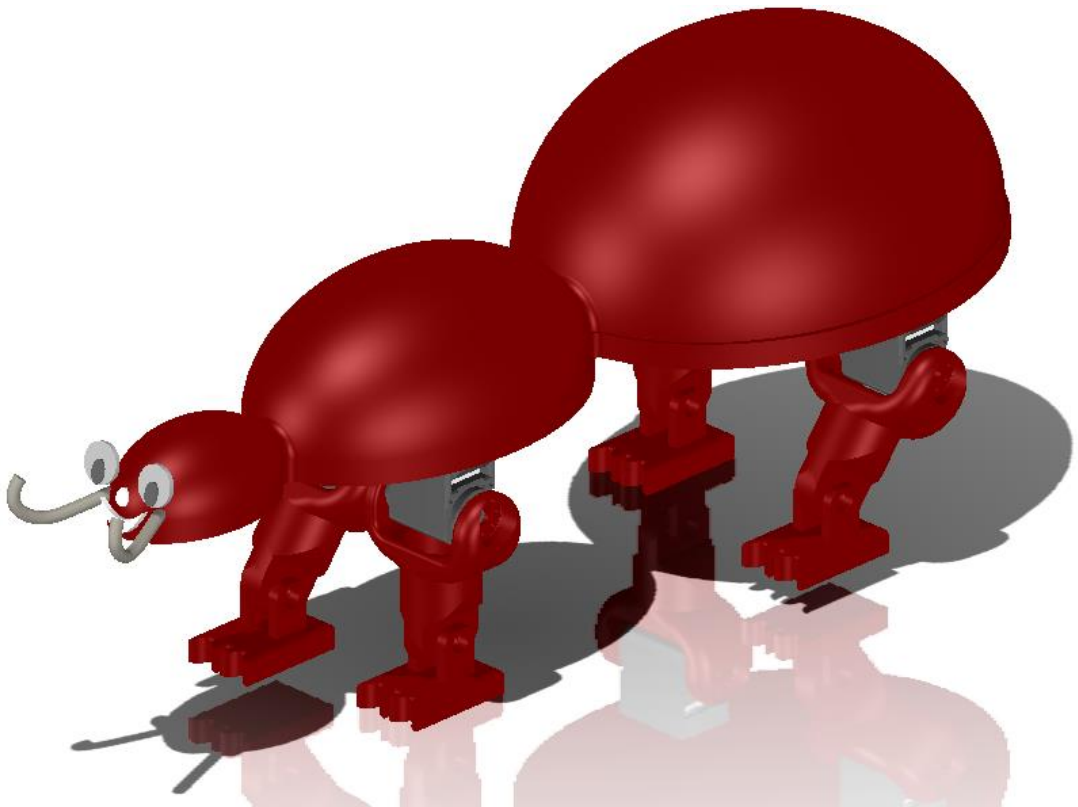


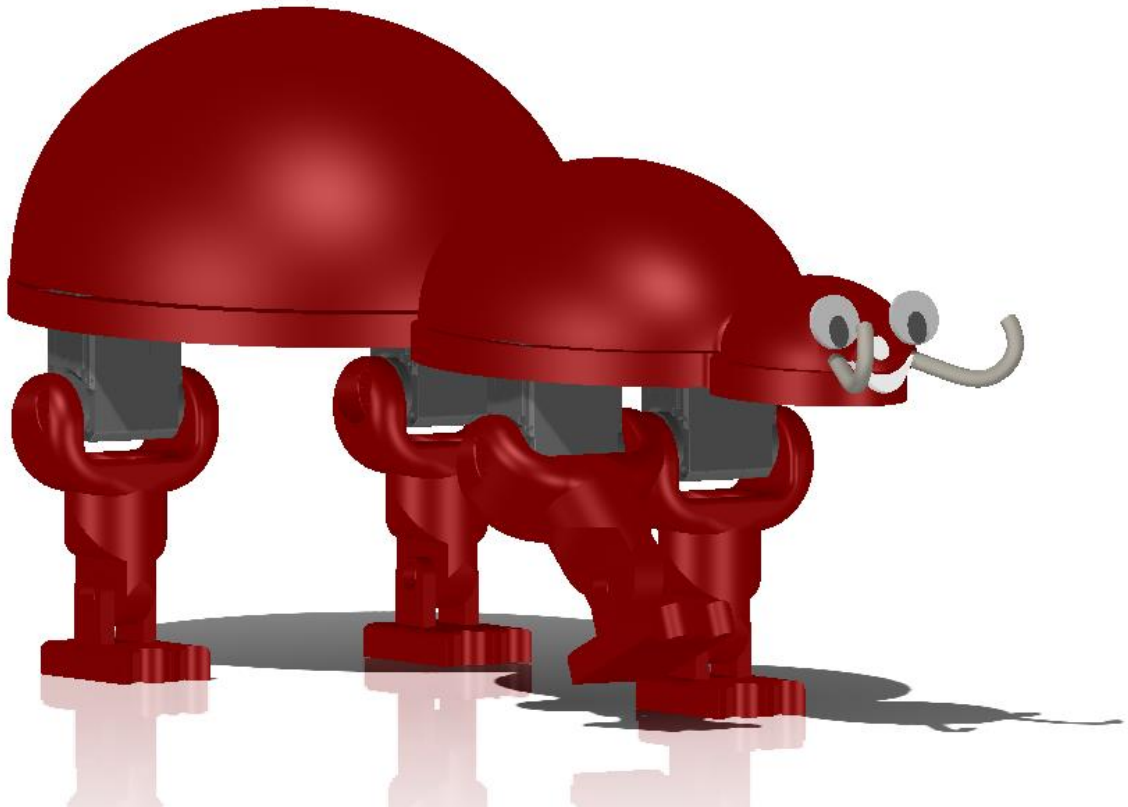


BILL OF MATERIALS (BOM)

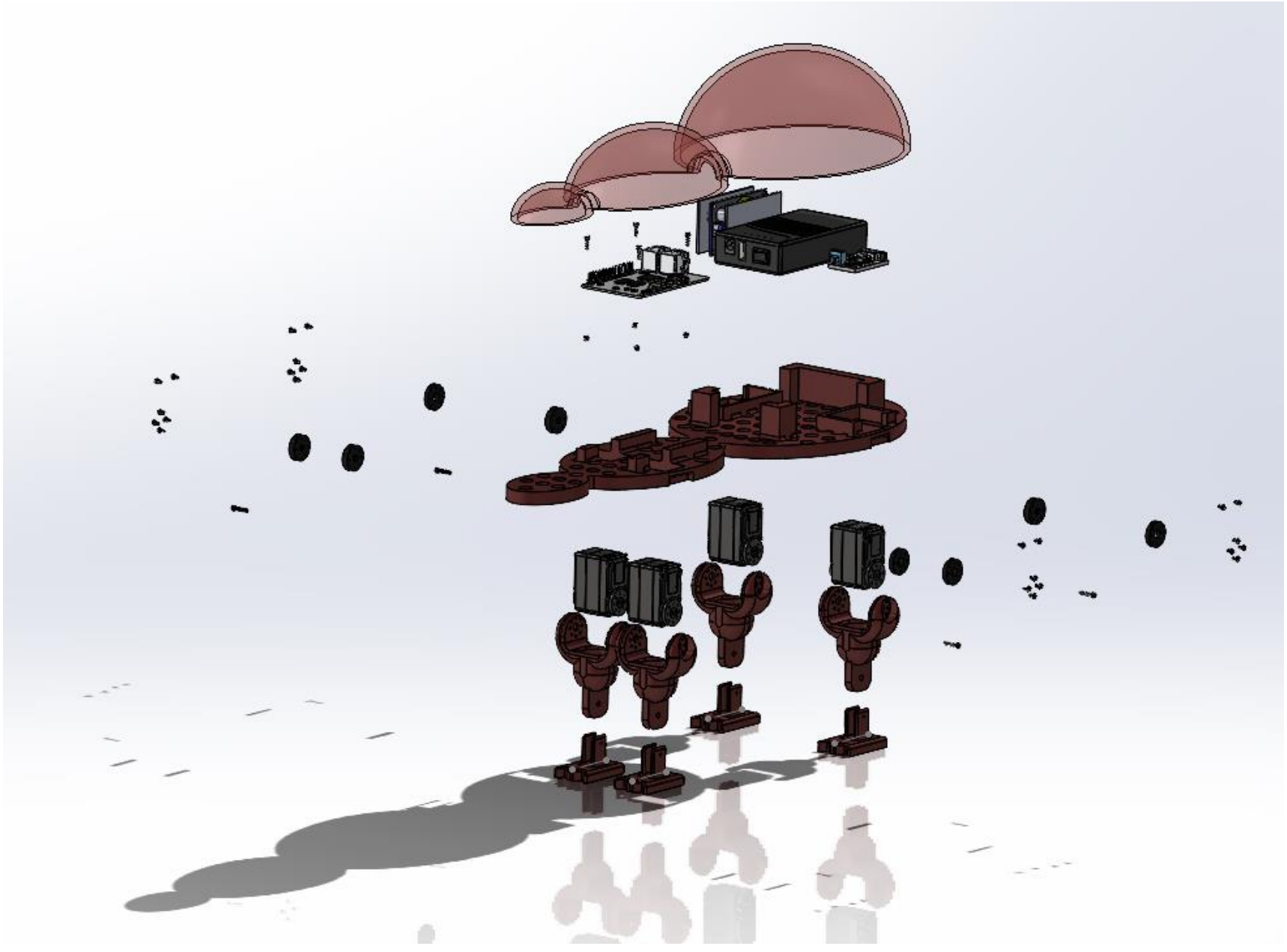
ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	Robo-ant Base		1
2	TalentCell Battery		1
3	DC Power Converter		1
4	Servo Controller Board		1
5	Computer (Le Potato)		1
6	Servo (LX-16A)		4
7	Motor Adapter (LX-16A)		4
8	Shaft Adapter (LX-16A)		4
9	Robo-ant Leg		4
10	M2.2-4mm	Phillips Rounded Head Thread-Forming Screws	24
11	M2x0.4-2.9mm - Insert	Tapered Heat-Set Inserts for Plastic	4
12	M2x0.4-8mm	18-8 Stainless Steel Socket Head Screw	4
13	Robo-ant Foot		4
14	M2x0.4-12mm	18-8 Stainless Steel Socket Head Screw	4
15	Robo-ant Shell		1

DIFFERENT WALKING POSES

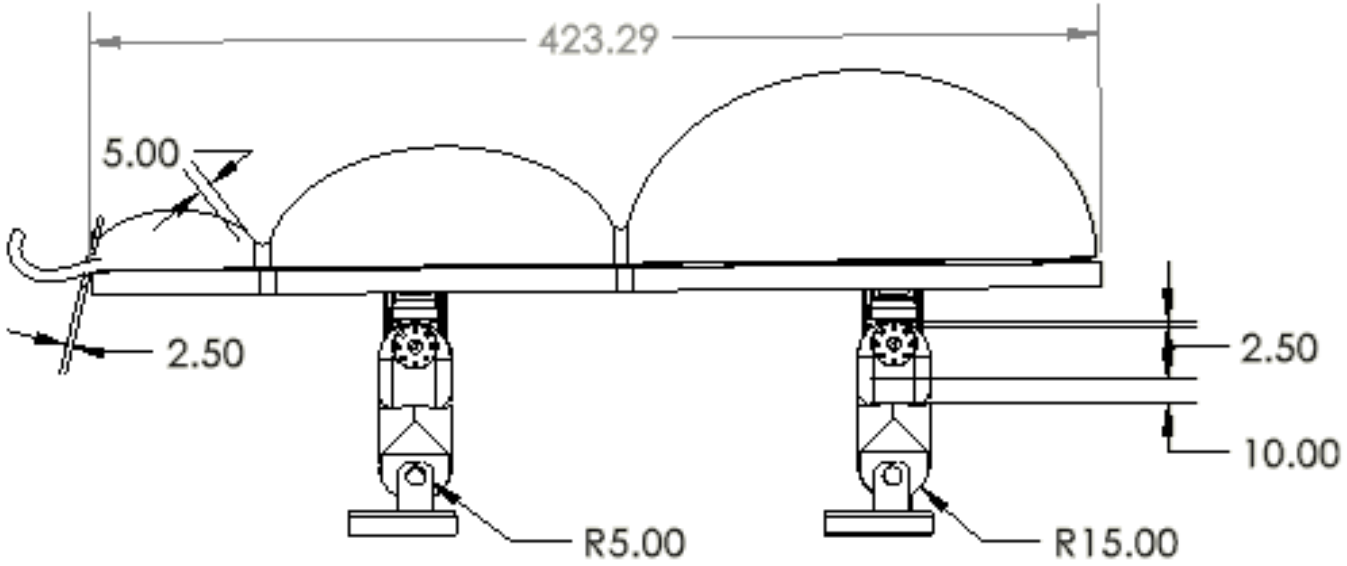


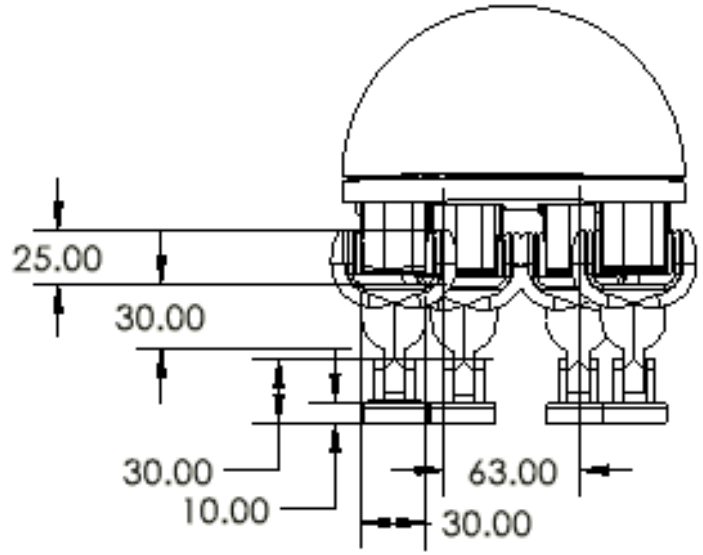


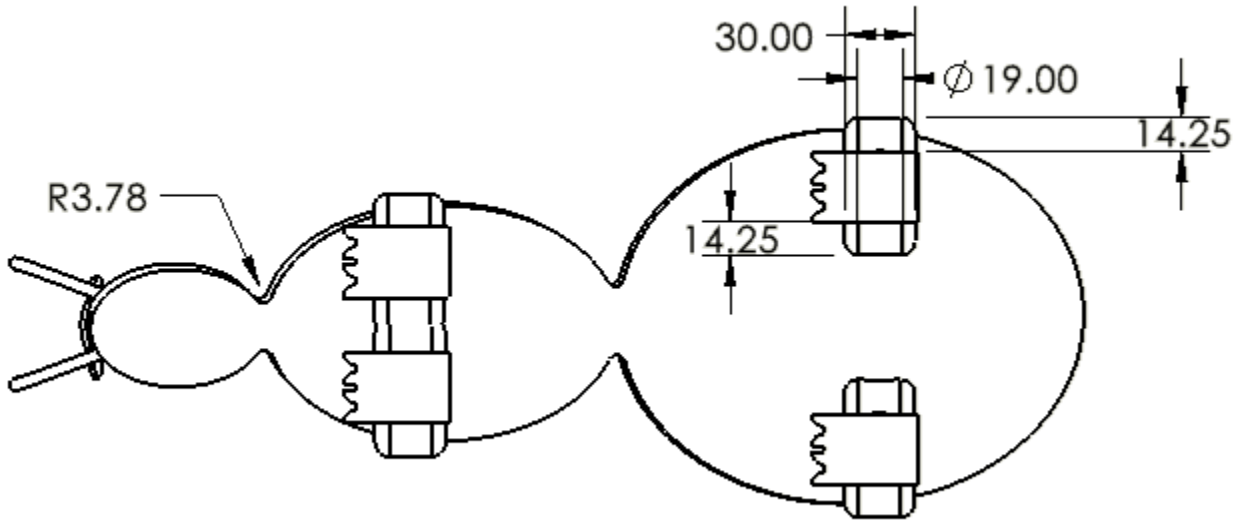
EXPLODED VIEW



VIEWS WITH MAIN DIMENSIONS







All dimensions in mm

CALCULATED PROPERTIES OF ROBO-ANT

Mass = 1266.21 grams = ~1.3 kg (includes screws and estimated component weights)

Volume = 1109353.9 cubic millimeters = ~0.001109353 m^3

Surface area = 502161.85 square millimeters

Center of mass: (millimeters)
X = 292.08
Y = 222.53
Z = 262.92

Principal axes of inertia and principal moments of inertia: (grams * square millimeters)
Taken at the center of mass.

Ix = (1, 0.08, 0)	Px = 3591566.82
Iy = (-0.07, 0.91, -0.41)	Py = 14865153.62
Iz = (-0.03, 0.41, 0.91)	Pz = 14955434.58

Weight = 12.753 N

Per step (assume 60° rotation per movement) = 0.38 s
Gait length = 60 * sin (60°) = 51.9 mm = ~5.2 cm

Estimated Speed = 5.2/0.38 = 13.7 cm/s

Mass properties of Ant Assembly_final
Configuration: Default
Coordinate system: -- default --

Mass = 1266.21 grams

Volume = 1109353.9 cubic millimeters

Surface area = 502161.85 square millimeters

Center of mass: (millimeters)
X = 292.08
Y = 222.53
Z = 262.92

Principal axes of inertia and principal moments of inertia: (grams * square r
Taken at the center of mass.

Ix = (1, 0.08, 0)	Px = 3591566.82
Iy = (-0.07, 0.91, -0.41)	Py = 14865153.62
Iz = (-0.03, 0.41, 0.91)	Pz = 14955434.58

Moments of inertia: (grams * square millimeters)
Taken at the center of mass and aligned with the output coordinate system

Lxx = 3662611.57	Lxy = 892693.22	Lxz = -6367.72
Lyx = 892693.22	Lyy = 14809616.21	Lyz = -34660.03
Lzx = -6367.72	Lzy = -34660.03	Lzz = 14939927.2

Moments of inertia: (grams * square millimeters)
Taken at the output coordinate system. (Using positive tensor notation.)

Ixx = 153894013.24	Ixy = 83193329.07	Ixz = 97231844
Iyx = 83193329.07	Iyy = 210363045.17	Iyz = 74048259.92
Izx = 97231844	Izy = 74048259.92	Izz = 185666799.1

ED DISCUSSION SCREENSHOTS

Detailed CAD - Group 2 #76

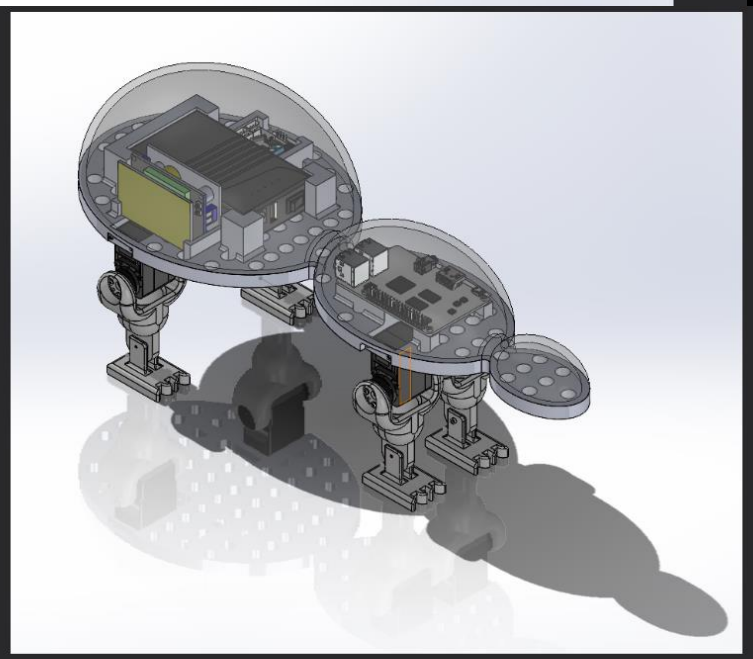
Aatir Fayyaz
49 minutes ago in General

STAR WATCHING 6 VIEWS

Hello,

Please see our detailed CADs below. For printing we will slice the base and the shell in 3 parts so that we can easily print it in the 3D printers. They will be connected via inserts and screws.

Please let us know if you have any thoughts!



Thank you,

Aatir Fayyaz and Sumedha Gudipati

Comment Edit Delete ···

Detailed cad #73

Bo Lan
16 hours ago in Assignments – A2

Aatir Fayyaz
49 minutes ago

Very organic looking leg design and I like the secondary linkage. Good shell design as well to hold all the components!

Comment Edit Delete ···

detailed CAD - Bob #72

Matthieu Gros
21 hours ago in General

Aatir Fayyaz
45 minutes ago

Love the shell design. Looks very sleek and not bulky with those legs and the servos at the top.

Comment Edit Delete ···

Detailed CAD - Toothless.. #71

Natalia Harguindeguy
22 hours ago in General

Aatir Fayyaz
48 minutes ago

Very intricate leg design - is there going to be a shell for this?

Also, really cool name. If only we could give it wings.

Comment Edit Delete ···

SUMMARY

5 Points Title slide complete **(SLIDE 29)**

5 Points overall aesthetics, layout and formatting of the slides

10 Points posting some rendering of your robot on the discussion board at least 24h in advance of deadline, and commenting constructively and positively on at least three other's postings (show screenshots) **(SLIDE 41)**

10 Points 3D Renderings in perspective **(SLIDE 30-33)**

10 Points all key components included and labeled **(SLIDE 30, 34)**

10 Points organic shape (no straight edges) **(Almost no straight edges as shown)**

10 Points photorealistic rendering **(SLIDE 31)**

10 Points animation **(N/A)**

10 Points exploded view **(SLIDE 38)**

10 Points key specs listed including speed, weight **(SLIDE 40)**

10 Points multiple poses shown **(SLIDE 30-33, 37)**

10 Points detail close-up shown **(SLIDE 34, 35)**

10 Points side views with main dimensions **(SLIDE 39)**

10 Points Bill of materials **(SLIDE 36)**

MECE 4611 - ROBOTICS STUDIO

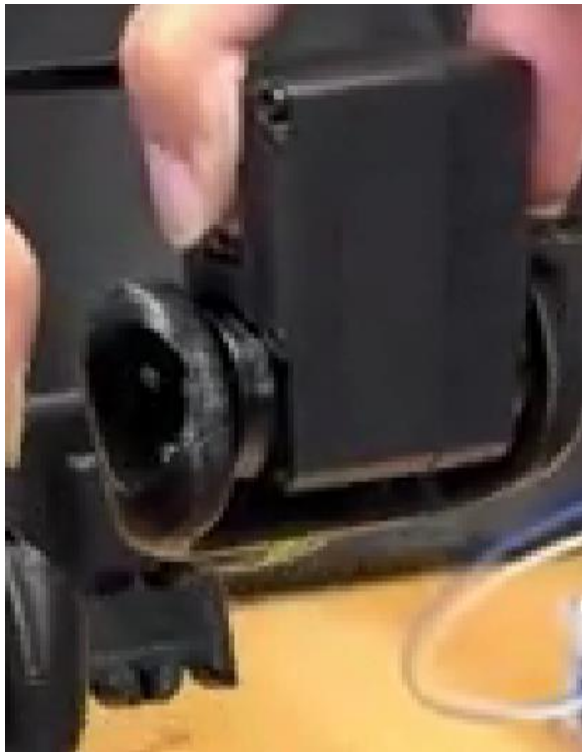
Names & Unis: Group 2 (Aatir Fayyaz - af3252, Sumedha Gudipati - sg4153)

Date/Time Submitted: 10/17/2022 @ 1700hrs

Grace Hours: 344hrs + 62hrs = 406hrs (total for the team)

LEG IN MOTION

EXTREME LEG POSITIONS TESTED AND MEASURED



Checked max and min angle:

- Min angle = ~18deg
- Max angle = ~228deg

- Checked in servo_test.py to get extreme positions

- Max range of motion = 228 - 18 = 210deg

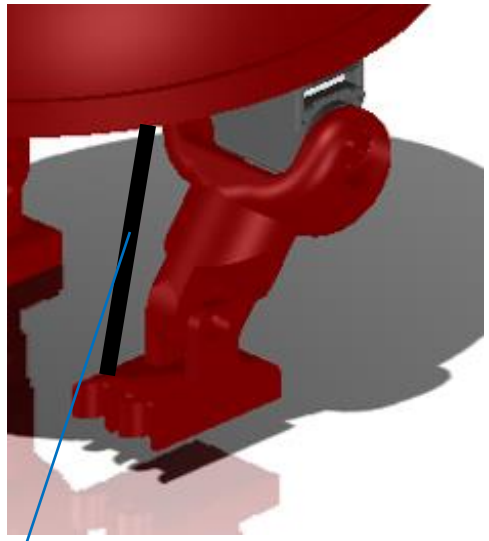
FORM/FIT ISSUES LISTED AND ADDRESSED

Issue Identified:

- Feet hole wasn't completely drilled through (support structure in hole)
- For better movement, would need a link to the feet to keep it parallel to the ground

Addressed by:

- Drilled through the foot to get the required hole dimensions
- Decided to add a link to the design to address the issue



COMPONENTS PROPERLY BOLTED AND CONNECTED

3D-PRINT QUALITY- SUPPORT STRUCTURE REMOVED

Removing support structure

DIFFERENT LEG MOTION PATTERNS EXPLORED

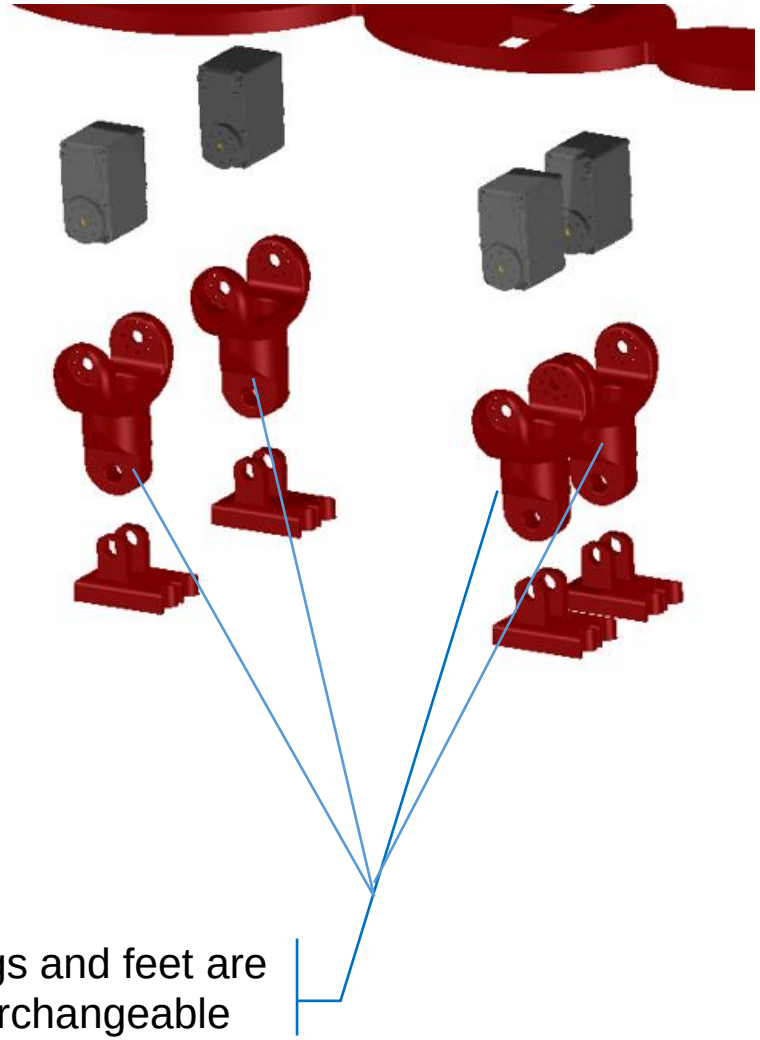
Explored different walking patterns:

- Used various sine/cosine functions including:

- Started off with default values as (sin(t)/cos(t) * 60 + 60) as servo motor angles (amplitude and shift)
- Set amplitude and offset as variables: A & B
- Tested a combination of values for A & B ranging from [0, 30, 60, 90, 120] and [0, 30, 60, 90, 120]

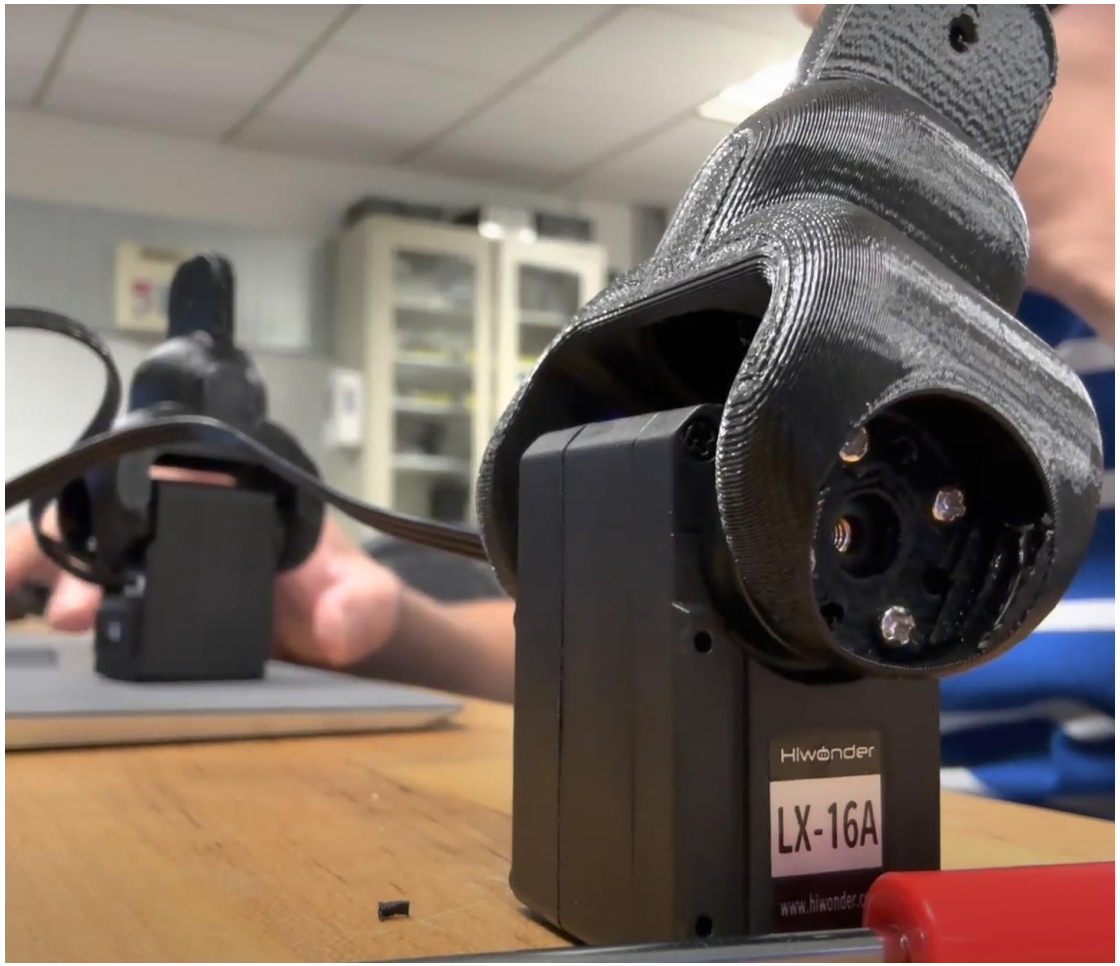
- Found the optimum values thus far as (sin(t)/cos(t) * 120 + 60)

HIGHLY MODULAR DESIGN



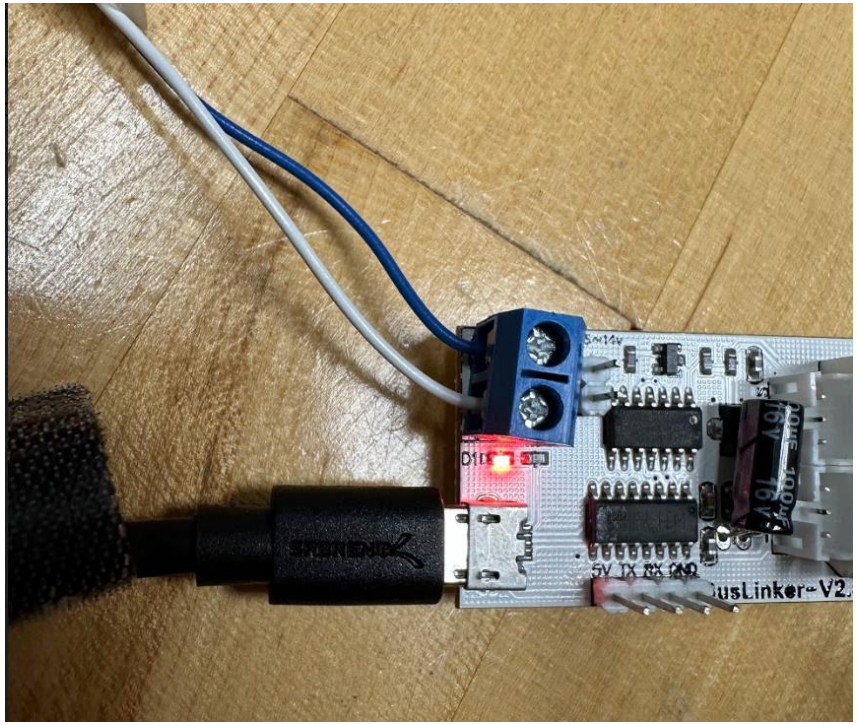
All legs and feet are interchangeable

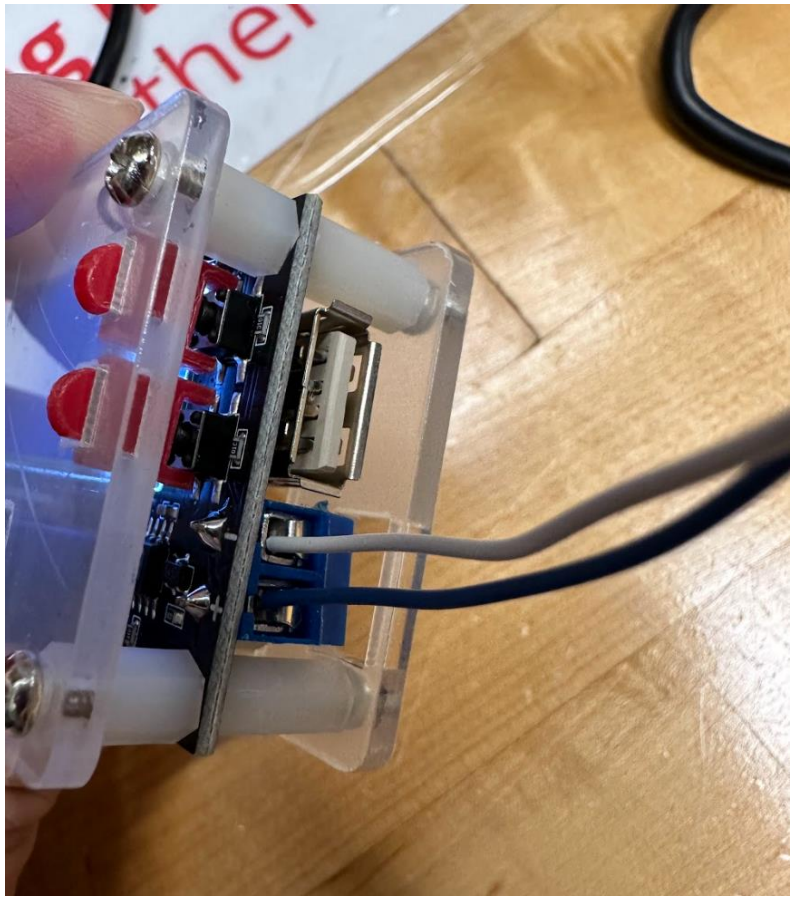
TWO LEGS TESTED IN TANDEM



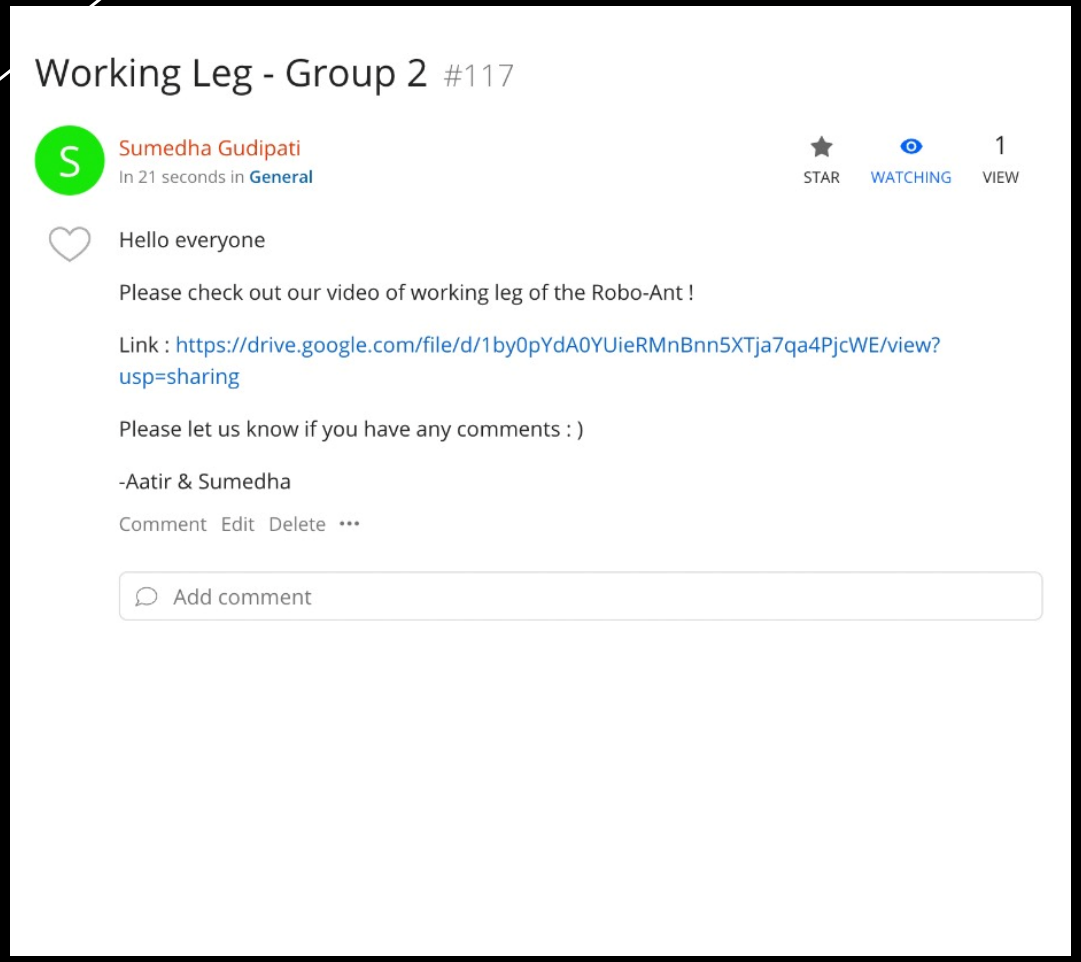
[Video of testing two legs in tandem]

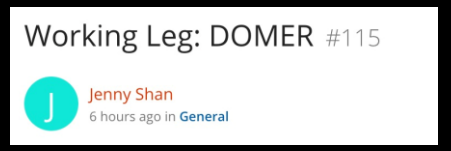
CABLES CONNECTED SECURELY

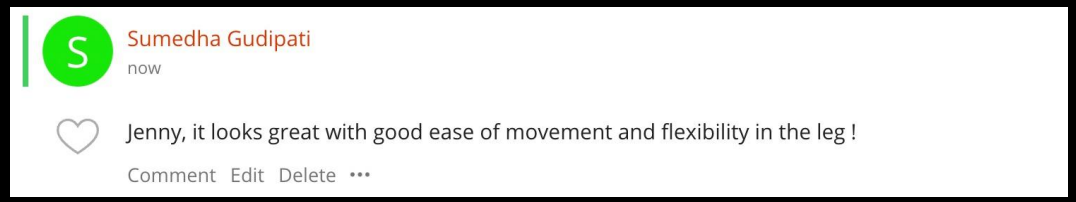


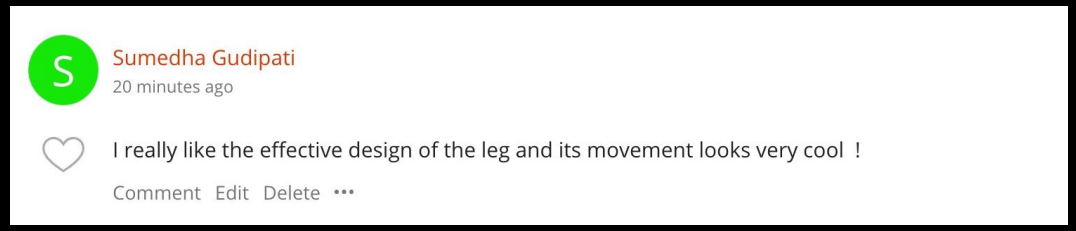


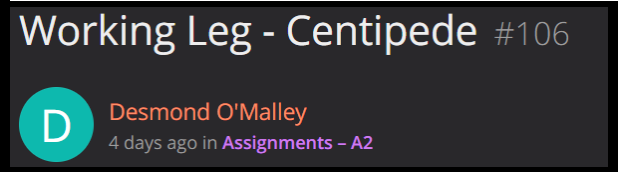
ED DISCUSSION SCREENSHOTS

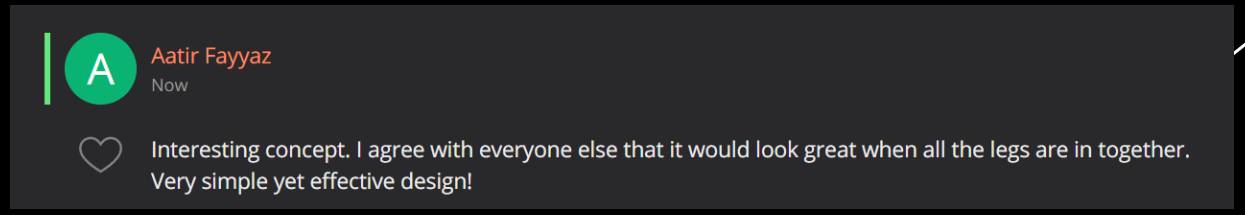












SUMMARY

5 Points Title slide complete **(SLIDE 43)**

5 Points overall aesthetics, layout and formatting of the slides

10 Points Sequence of photos showing leg in motion **(SLIDE 44)**

10 Points posting video of moving leg on the discussion board at least 24h in advance of deadline, and commenting constructively and positively on at least three other's postings (show screenshots) **(SLIDE 53)**

10 Points extreme leg positions tested and measured **(SLIDE 45)**

10 Points form/fit issues identified, listed and addressed (show how) **(SLIDE 46)**

10 Points all components properly bolted and connected (with inserts) **(SLIDE 47)**

10 Points 3D-print quality, support structure removed **(SLIDE 48)**

10 Points Different leg motion patterns explored **(SLIDE 49)**

10 Points Leg Modularity demonstrated **(SLIDE 50)**

10 Points Two or more legs tested in tandem **(SLIDE 51)**

10 Points Cables routed properly and securely **(SLIDE 52)**

10 Points Exception handling in code catches motor disconnect **– N/A**

MECE 4611 - ROBOTICS STUDIO

Names & Unis: Group 2 (Aatir Fayyaz - af3252, Sumedha Gudipati - sg4153)

Date/Time Submitted: 11/03/2022 @ 2359hrs

Grace Hours: 406hrs - 48hrs used = 358hrs (total for the team)

GLAMOUR PHOTOS OF PRINTED ROBOT

ED DISCUSSION SCREENSHOTS

Assembled Robot - RoboAnt #143

Aatir Fayyaz
47 minutes ago in General

STAR WATCH 4 VIEWS

Hello all,

Please see pictures of our assembled robot below! Please let us know if you have any comments.

Assembled Robot - Jiong

Jiong Lin
2 days ago in General

Sumedha Gudipati
36 seconds ago

Hi Yuzhe, the idea of foldable components is cool ! Looking forward to see it in motion :)

Comment Edit Delete •••

Pranav Jhunjhunwala
2 days ago in General

Aatir Fayyaz 22m

Very well designed and implemented. Impressive leg design and reminds me a lot of Atlas from BostonDynamics. Well done making this in the time we had

Reply •••

Assembled Robot-

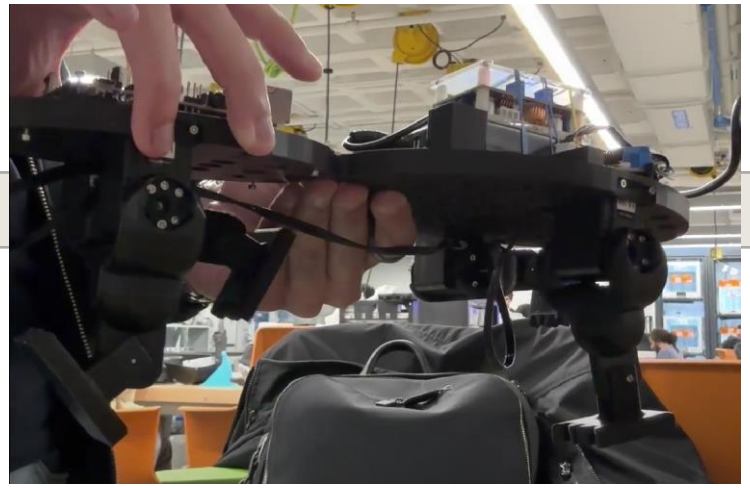
Yuzhe Wang
2 days ago in General

Sumedha Gudipati
9 minutes ago

Hi Yuzhe, the idea of foldable components is cool ! Looking forward to see it in motion :)

Comment Edit Delete •••

ROBOT LEGS IN MOTION



[Video of robot legs in motion]

FORM/FIT ISSUES LISTED AND ADDRESSED

Issue Identified:

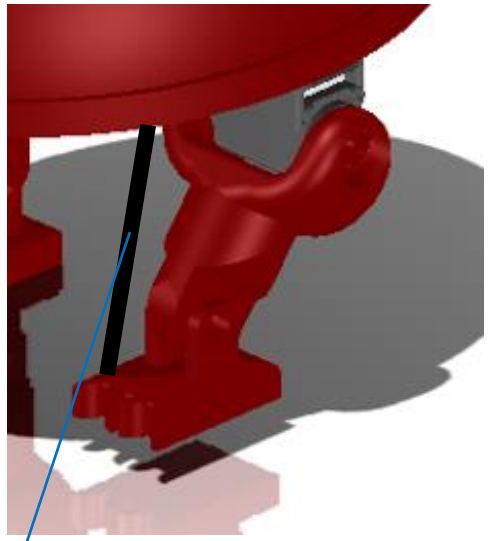
- 1. Feet hole wasn't completely drilled through (support structure in hole)

  For better movement, would need a link to the feet to keep it parallel to the ground
- 2. Front two legs of the bot almost collided with no space in between them restricting the movement
- 3. LePotato ports were slightly taller than designed resulting in not enough space for the shell

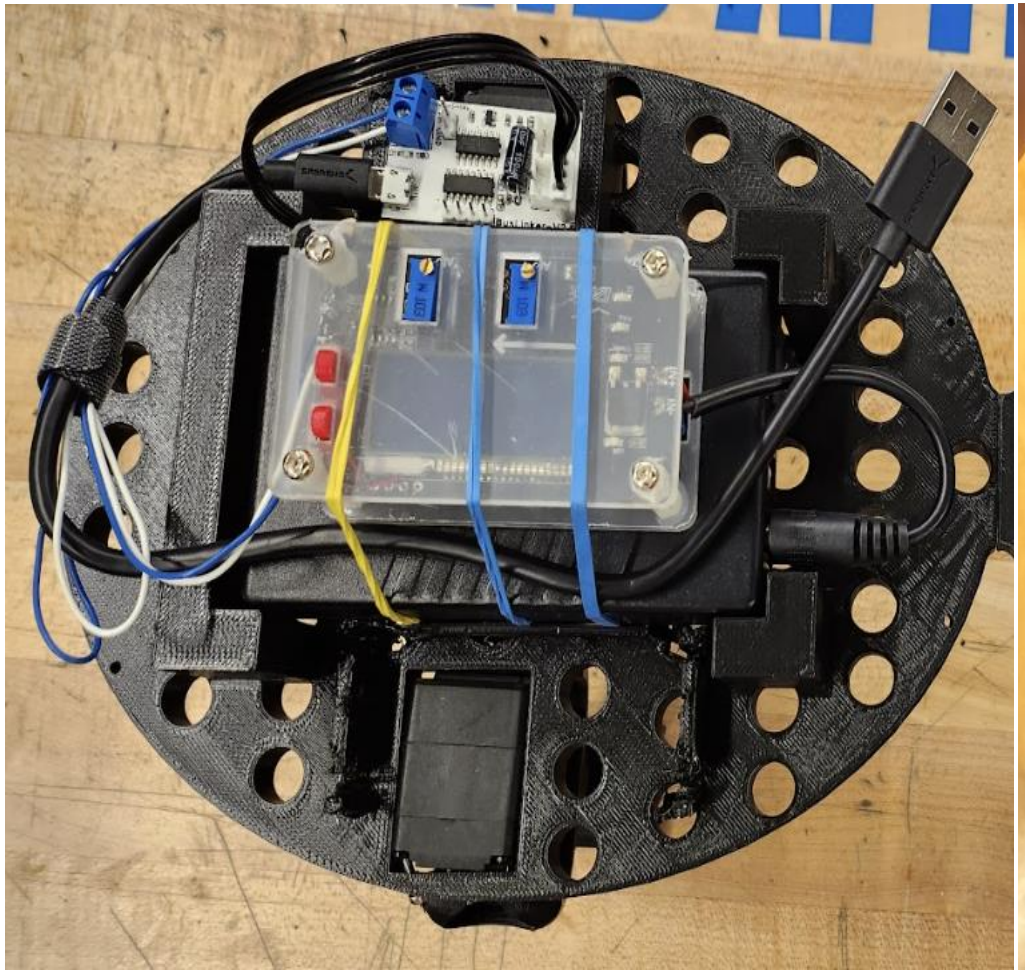
Addressed by:

- 1. Drilled through the foot to get the required hole dimensions

  Decided to add a link to the design to address the issue
- 2. Reduced the thickness of the leg without any negative effects
- 3. Sanded the supports to allow enough space



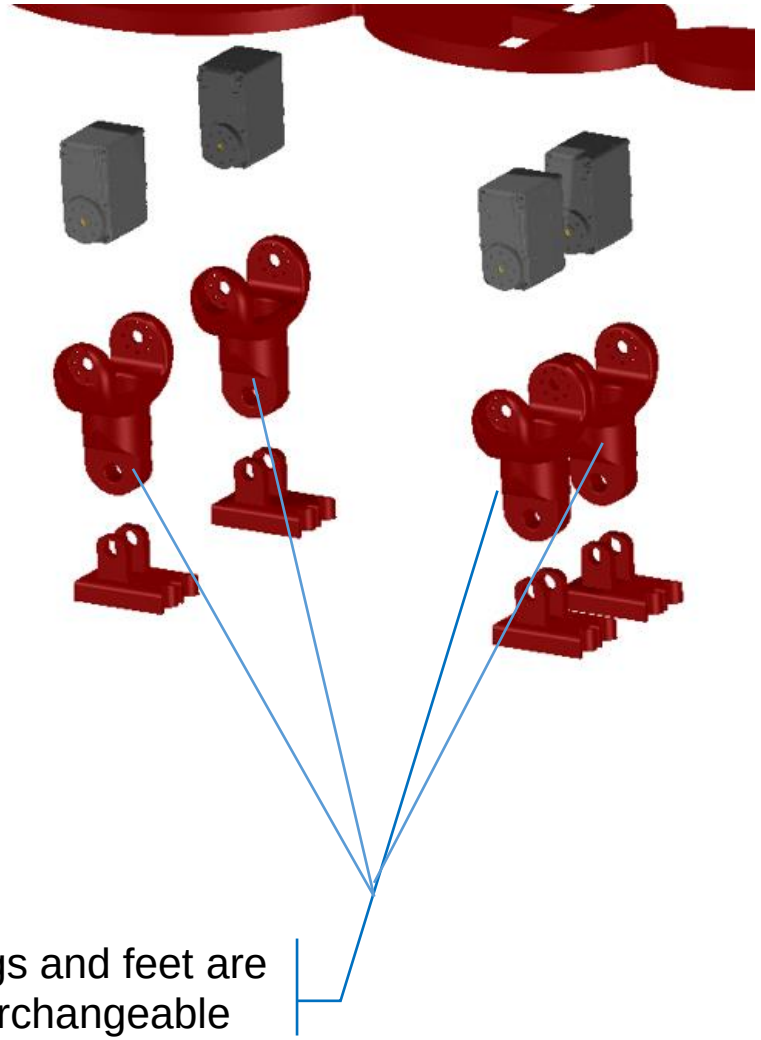
COMPONENTS PROPERLY BOLTED AND CONNECTED



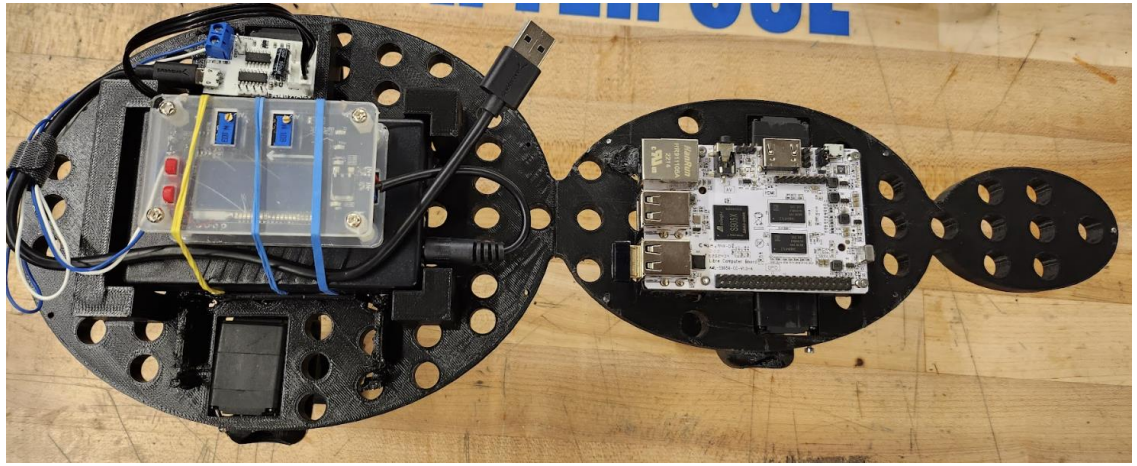
SUPPORT STRUCTURE REMOVED & SANDED

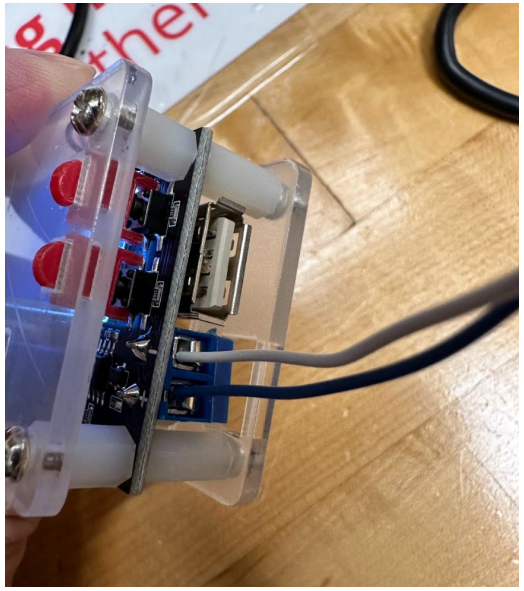
Removing support structure & sanding

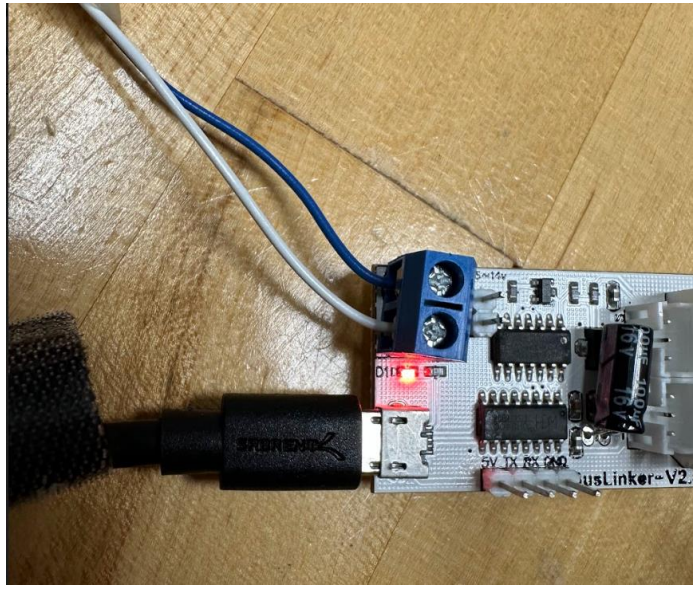
HIGHLY MODULAR DESIGN



CABLES ROUTED PROPERLY AND SECURELY







EXTREME LEG INTERFERENCE TESTED & MEASURED

Video of extreme leg positions

- Lowest angle achievable = 25deg
- Highest angle achievable = 155deg

SUMMARY

1.5 Points Title slide complete - (slide 55)

2.5 Points overall aesthetics, layout and formatting of the slides – (overall)

3.10 Points glamour photo of printed robot - (slide 56)

4.10 Points posting some rendering of your robot on the discussion board at least 24h in advance of deadline, and commenting constructively and positively on at least three other's postings (show screenshots) - (slide 57)

5.10 Points robot legs moving (frames shown + link to video) – (slide 58)

6.10 Points extreme leg interference tested and measured – (slide 64)

7.10 Points stability verified in various configurations

8.10 Points form/fit issues identified and addressed – (slide 59)

9.10 Points all components properly bolted and connected –(slide 60)

10.10 Points 3D-print quality, support structure cleanly removed. - (slide 61)

11.10 Points parts sanded and painted – (slide 65)

12.10 Points Robot modularity demonstrated - (slide 62)

13.10 Points Multiple configurations tested

14.10 Points Cables routed properly and securely – (slide 63)

15.10 Points motors controlled directly from Raspberry Pi

16.10 Points motors powered using battery – (slide 58/64)

17.10 Points overall aesthetics of the presentation – (overall)

18.10 Points Robot boot test routine implemented

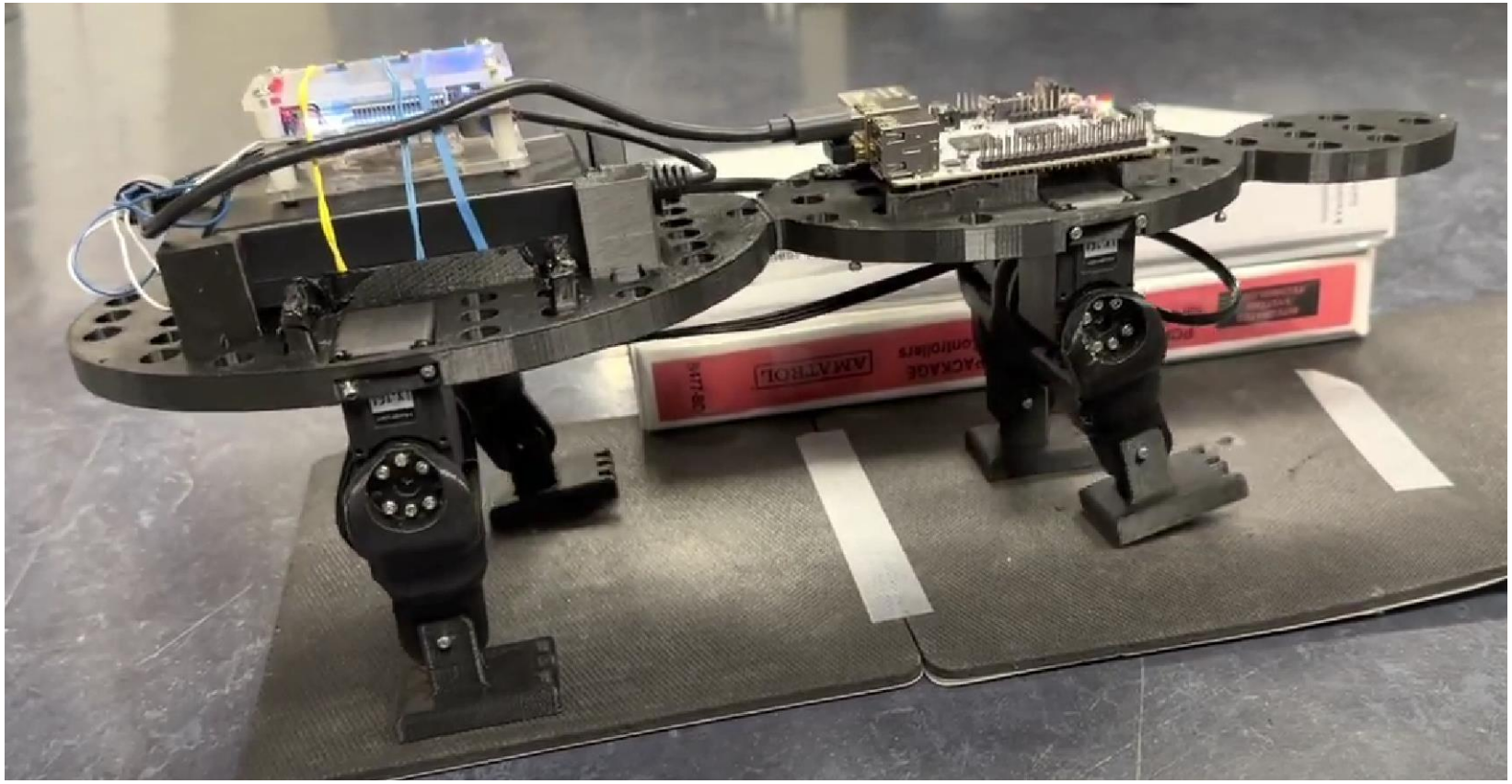
MECE 4611 - ROBOTICS STUDIO

Names & Unis: Group 2 (Aatir Fayyaz - af3252, Sumedha Gudipati - sg4153)

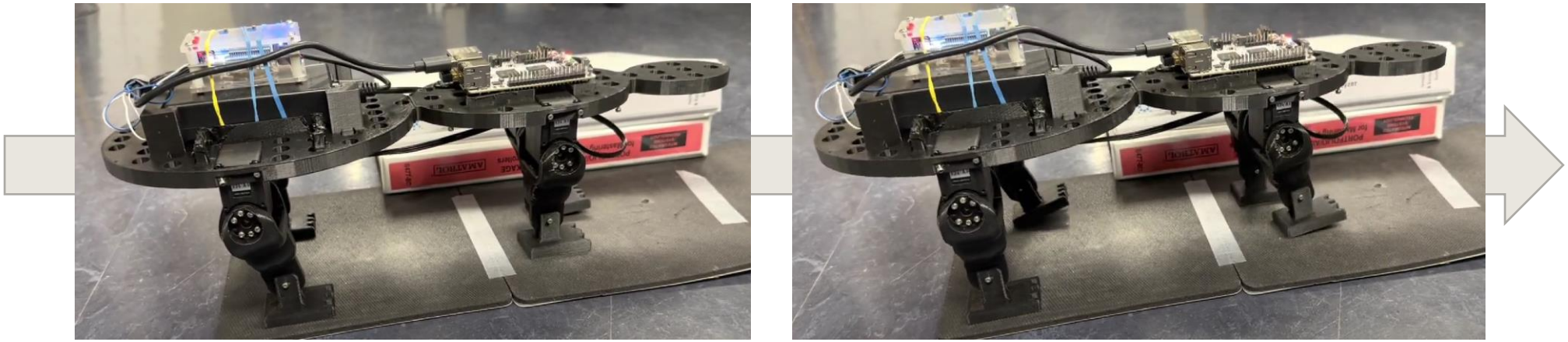
Date/Time Submitted: 11/15/2022 @ 1400hrs

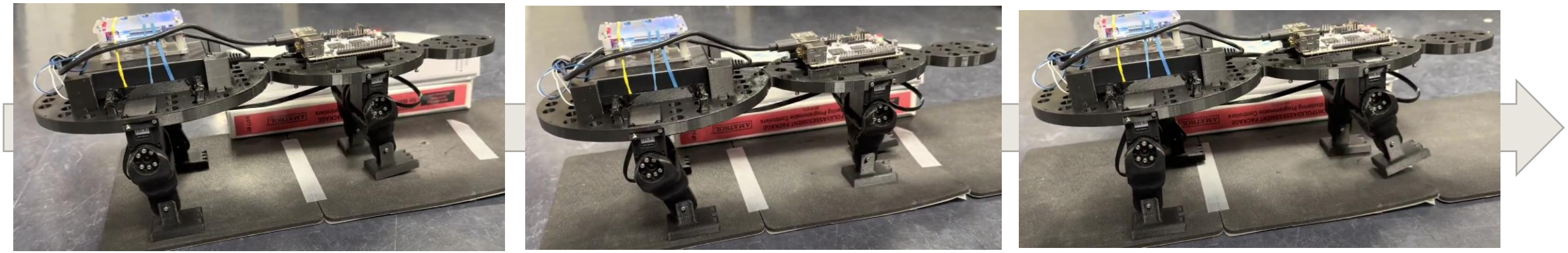
Grace Hours: 358hrs + 20hrs gained = 378hrs (total for the team)

GLAMOUR PHOTOS OF WALKING ROBOT



ROBOT IN MOTION





[Video of robot in motion]

MOTOR ANGLES AS FUNCTION OF TIME

Each motor's home angle was slightly different due to construction. The following represents the robot walking methodology:

Shifting weight to diagonal legs and moving the diagonals together.

We used a 5th-order polynomial trajectory to make sure that all movement was smooth.

$q(t) = A*(t**5) + B*(t**4) + C*(t**3) + D*(t**2) + E*t + F$

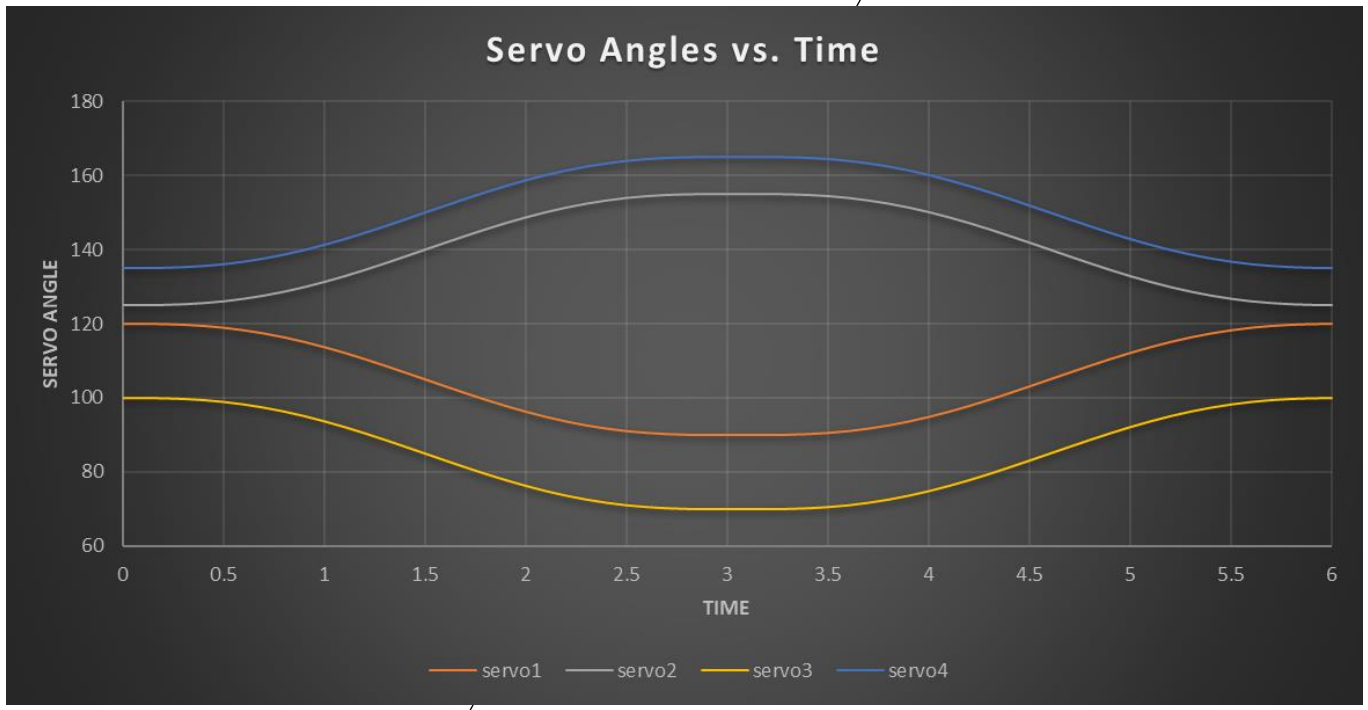
$q'(t) = d/dt(q(t)) = 5*A*(t**4) + 4*B*(t**3) + 3*C*(t**2) + 2*D*t + E$

$q''(t) = d/dt(q'(t)) = 20*A*(t**3) + 12*B*(t**2) + 6*C*(t) + 2*D$

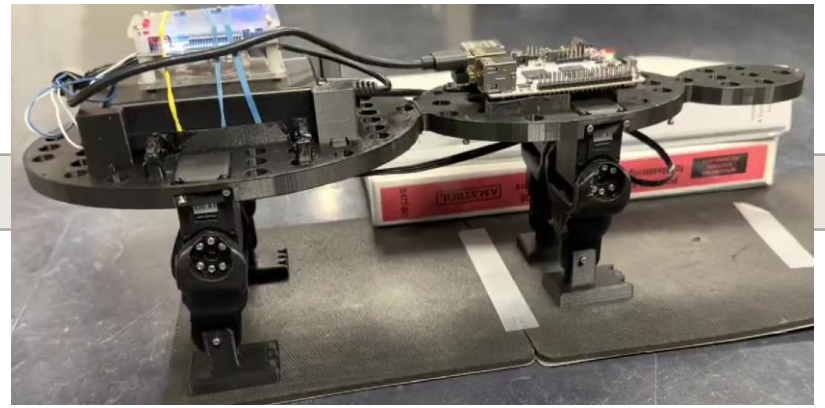
with boundary conditions:

At time t = 0; q(t) = servoHome, q'(t) = 0, q''(t) = 0

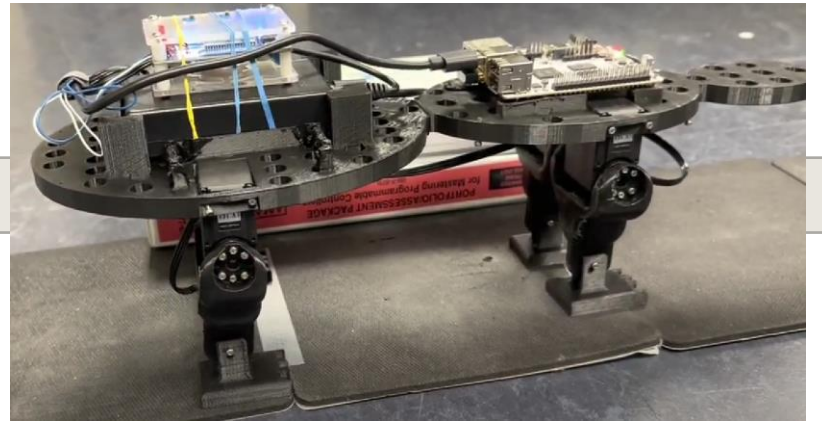
At time t = T; q(T) = servoHome + angleChange, q'(T) = 0, q''(T) = 0



ROBOT SPEED MEASUREMENT



START

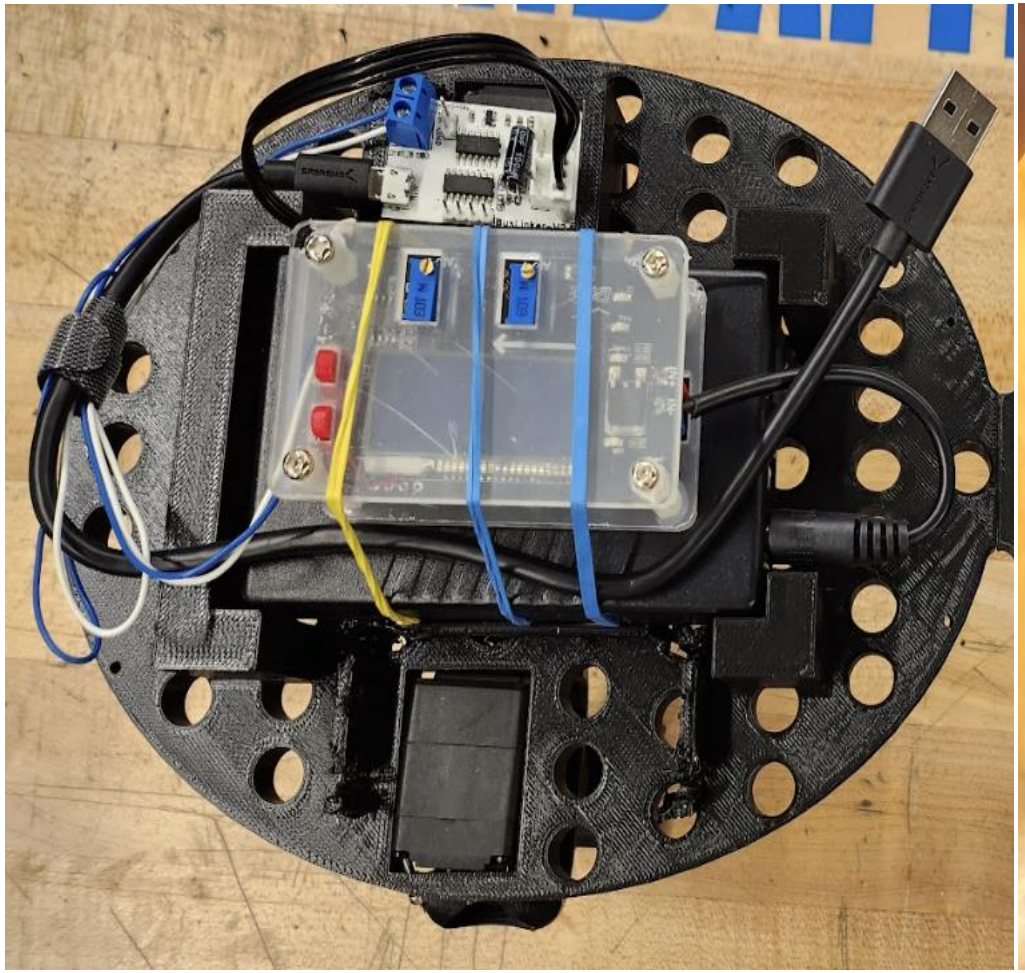


END

Distance travelled: ~8 inches = 20.32cm
Time taken to reach end: ~14 seconds

Robot speed = ~1.45 cm/s

COMPONENTS PROPERLY BOLTED AND CONNECTED



SUPPORT STRUCTURE REMOVED & SANDED

Removing support structure & sanding

MULTIPLE WALKING PATTERNS TESTED

Multiple patterns were tried to achieve the desired walking motion.

Best movement achieved at:

Time per cycle = 3 seconds

Change in angle per cycle = 30degrees

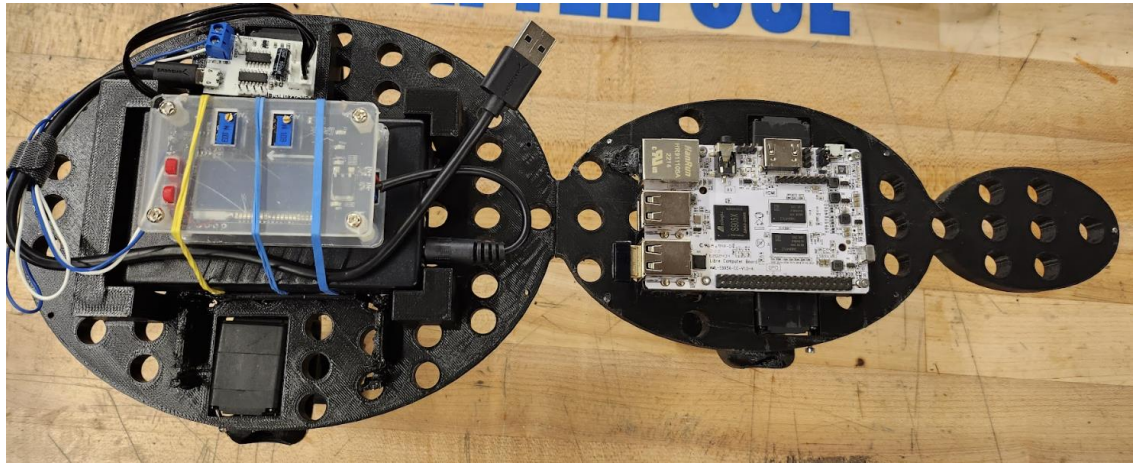
Other patterns tested:

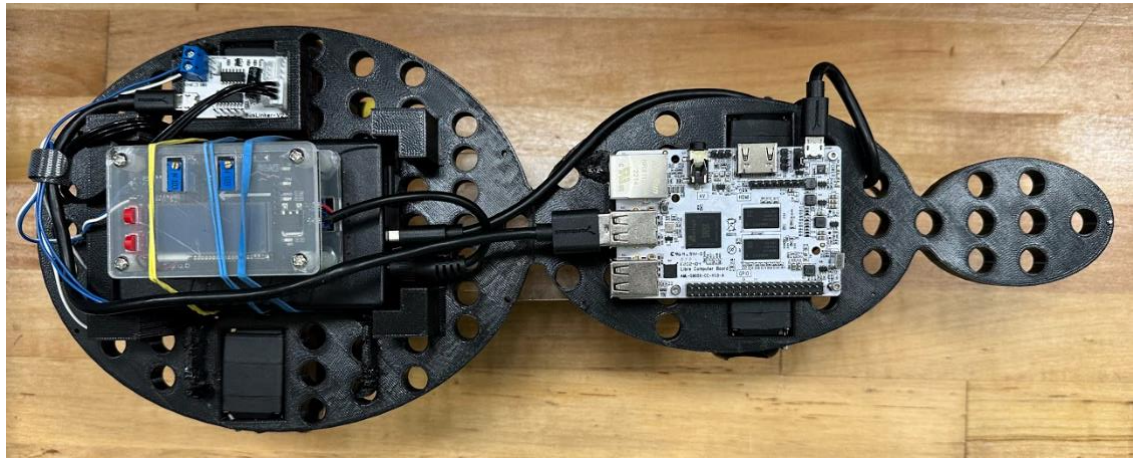
Time per cycle = 3 seconds & 2 seconds

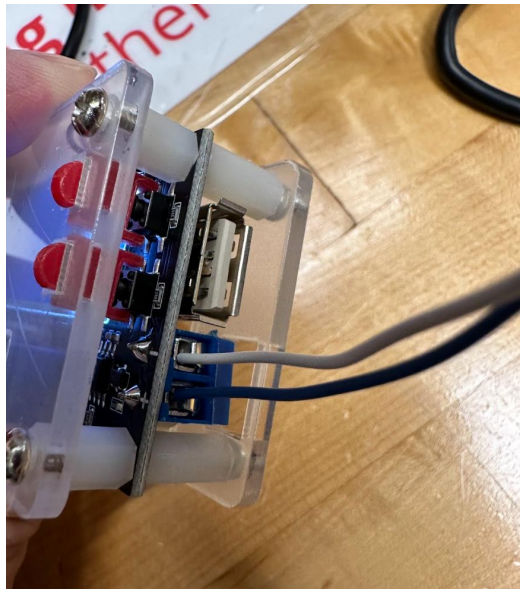
Change in angle per cycle = 50degrees, 40degrees, 30degrees

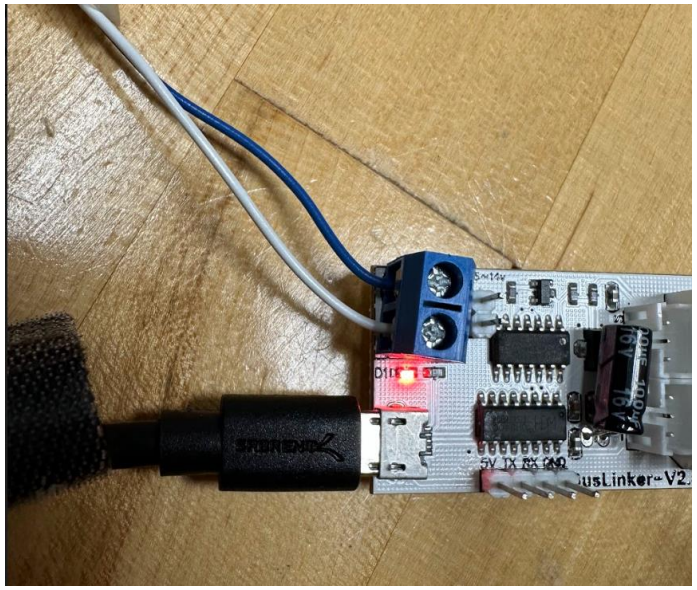
```
angleChange = 30
timeEnd = 2
timeSleep = 0.03

servo1Final = servo1Home - angleChange
servo2Final = servo2Home + angleChange
servo3Final = servo3Home - angleChange
servo4Final = servo4Home + angleChange

# For angleChange = 30 degrees, timeEnd = 3
# coeffA = 0.7407
# coeffB = 5.5556
# coeffC = 11.1111

# For angleChange = 40 degrees, timeEnd = 3
# coeffA = 0.9877
# coeffB = 7.4074
# coeffC = 14.8148

# For angleChange = 30 degrees, timeEnd = 2
coeffA = 5.625
coeffB = 28.1250
coeffC = 37.5
```

CABLES ROUTED PROPERLY AND SECURELY









ED DISCUSSION SCREENSHOTS

https://edstem.org/us/courses/28588/discussion/2162747

Baby Steps: RoboAnt #166

A Aatir Fayyaz
1 hour ago in General

STAR WATCHING 7 VIEWS

Hello all!

We would like to share the video of our RoboAnt taking its first few steps. Its always a great moment for the parent to see your little one start to move. I'm sure you all have similar feelings.

https://drive.google.com/file/d/1sccXYRyOEezNj-dLqqFmt861Xh4Qxyqp/view?usp=sharing

Please let us know what you all think

Thank you,

Aatir Fayyaz / Sumedha Gudipati

Comment Edit Delete •••

Baby Steps - Walkberto #160

B Benjamin Santos
Yesterday in General

A Aatir Fayyaz now
Its really amazing to see all the robots move. This is a really good result for the baby steps!
Reply Edit Delete •••

Baby step - Jiong #158

J Jiong Lin
2 days ago in General

A Aatir Fayyaz
Now

Really like the parallel design - and wow it walks so well! Great job!

Comment Edit Delete •••

ROBOT SHUTDOWN SEQUENCE IMPLEMENTED

The shutdown sequence runs through each of the motors and check if the angle is offset from it's home position.

If so, an error message is printed prompting the user to troubleshoot any problems that may indicate.

If no issues are found, the torque is disabled so that the user may move the legs manually if needed.

```
163    shutDown = True
164
165    if shutDown:
166        try:
167            error = servo1.get_angle_offset(servo1Home)
168            time.sleep(0.2)
169            if error > 0.25:
170                print("Servo 1 off it's home angle")
171            servo1.disable_torque()
172
173        except:
174            print("Servo 1 error during shutdown sequence")
175            quit()
176
```

SUMMARY

1.5 Points Title slide complete **(SLIDE 66)**

2.5 Points overall aesthetics, layout and formatting of the slides

3.10 Points glamour photo of working robot **(SLIDE 67)**

4.10 Points robot moving (frames shown + link to video) **(SLIDE 68)**

5.10 Points Plotted motor angles as function of time. **(SLIDE 69)**

6.10 Points Robot speed measured (cm per sec) **(SLIDE 70)**

7.10 Points Robot stability verified in various locomotion configurations

8.10 Points all components properly bolted and connected **(SLIDE 71)**

9.10 Points 3D-print quality, support structure removed **(SLIDE 72)**

10.10 Points Robot sanded and painted **(SLIDE 72)**

11.10 Points Multiple walking patterns tested **(SLIDE 73)**

12.10 Points Cables routed properly and securely **(SLIDE 74)**

13.10 Points motors controlled directly from Raspberry Pi **(SLIDE 68)**

14.10 Points motors powered using battery **(SLIDE 68)**

15.10 Points post some video of the walking robot on Discussion Board **(SLIDE 75)**

16.10 Points post video of your robot on your online portfolio

17.10 Points Robot ongoing health test routine implemented

18.10 Points Robot shutdown routine implemented **(SLIDE 76)**

FINAL PERFORMANCE EVALUATION – ROBO-ANT

MECE 4611 - ROBOTICS STUDIO – FALL 2022

Names & Unis: Group 2 (Aatir Fayyaz - af3252, Sumedha Gudipati - sg4153)

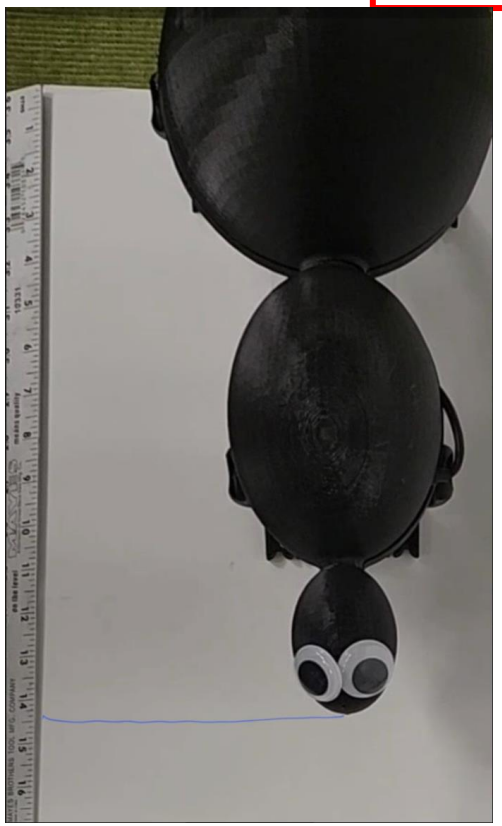
Date/Time Submitted: 12/13/2022 @ 2100hrs

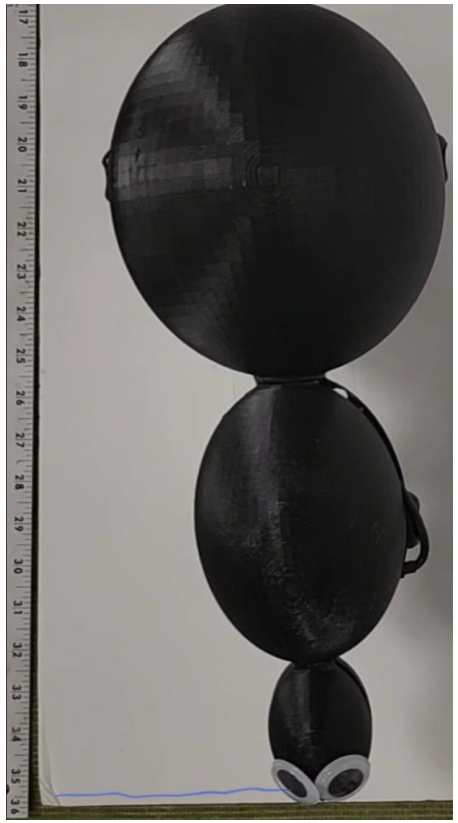
Grace Hours Left: 358hrs + 6hrs (gained) = 364hrs (total for the team)

FASTEST SPEED OF THE ROBO-ANT

Speed = (35-15) inches / 3 s

MAX SPEED ACHIEVED: 16.933 cm/s (~17 cm/s)





Link to Video:
https://drive.google.com/file/d/1uEpZVLA0rmnCR5T4x302WSCpgIzOkTnc/view?usp=sharing

ROBO-ANT – JOURNEY VIDEO

Journey Video Link:

https://drive.google.com/file/d/1_JFrSG2I9TEpSMAHltw-zbPpe_HjEnDu/view?usp=sharing