Robotics Studio MECE 4611 Final Report

Xingsheng Wei Wenjie Lin
UNI: xw2815 UNI: wl2789

Robot: Birdman, LarvaBot

Semester: Fall 2021

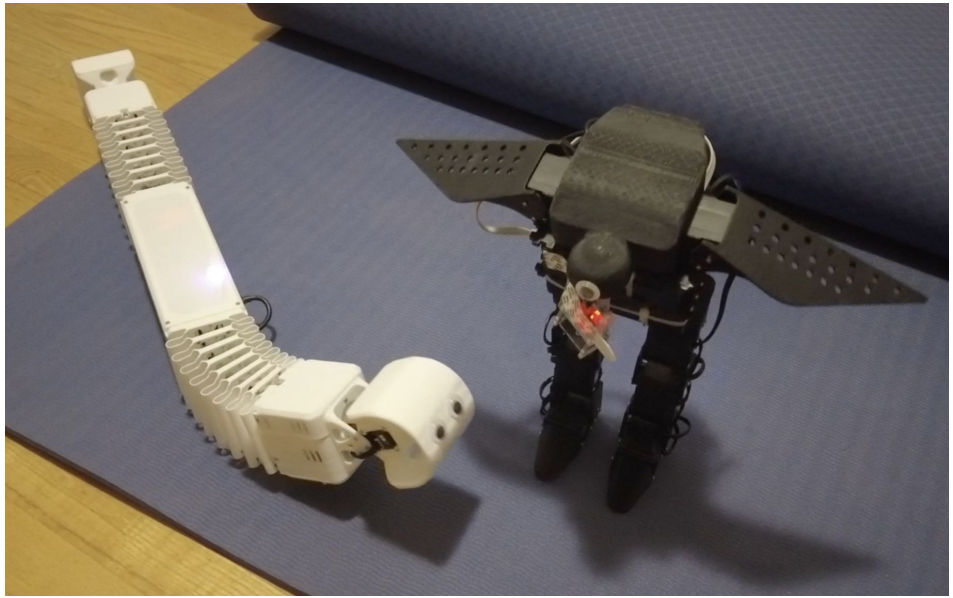
Instructor: Prof. Hod Lipson

Submitted at: 12/19/2021 8pm

Grace Hours before submission: 216

Grace Hours Used: 136

Grace Hours After Submission: 80

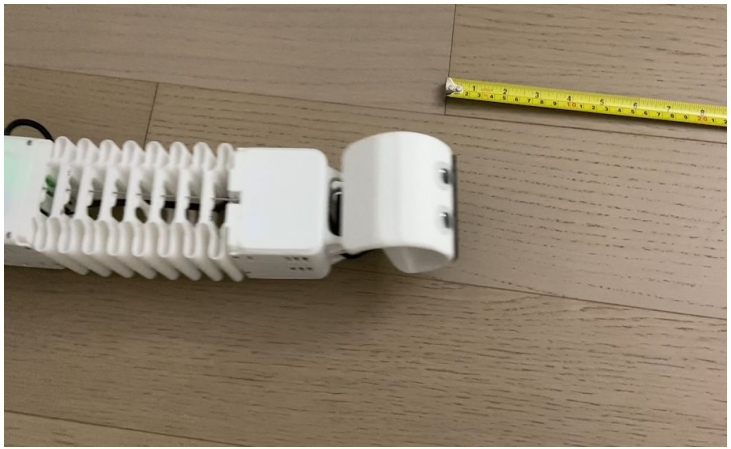


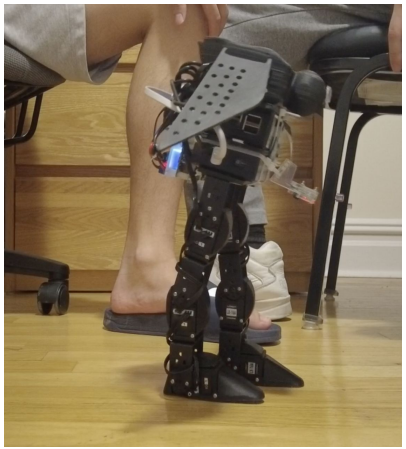
LarvaBot and Birdman

Autonomously Moving

https://youtu.be/EwVcmw2eSTw

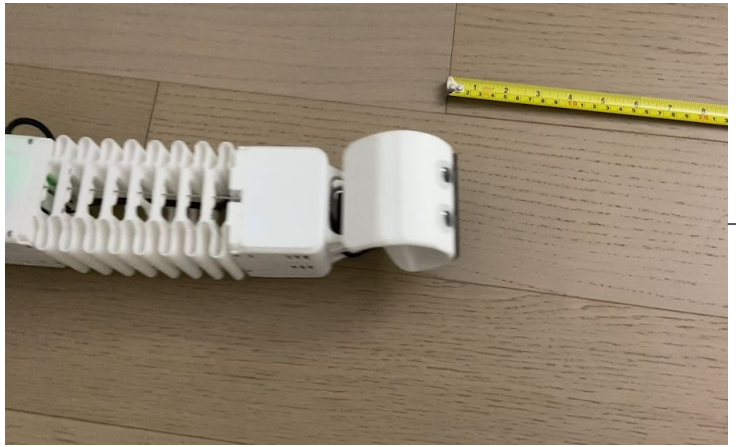
https://youtu.be/DmhAuwmqTxI





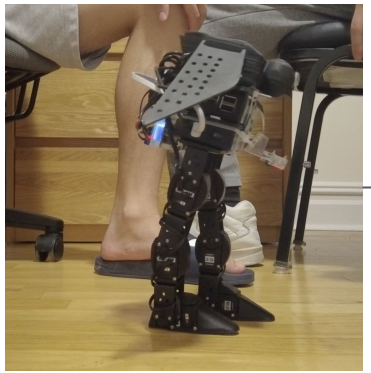
Speed!

LarvaBot: 7cm/s!!!!!!!



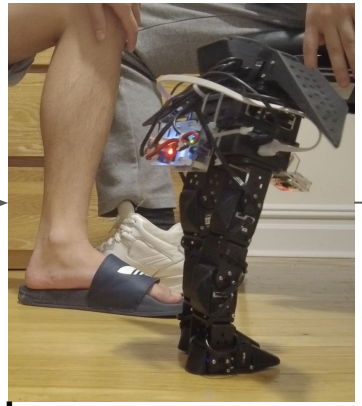
10s

70cm

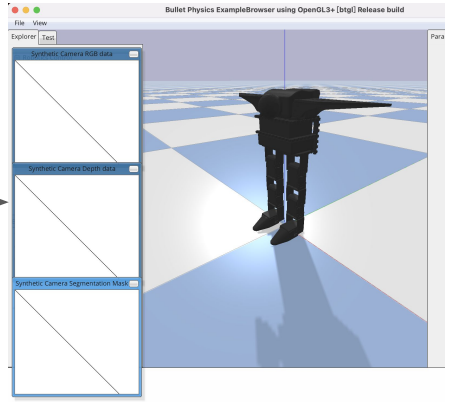


20s

14cm

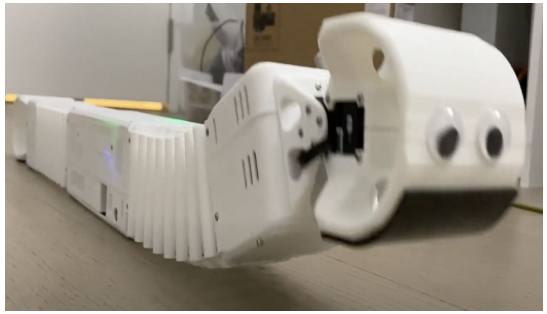


doing simulation

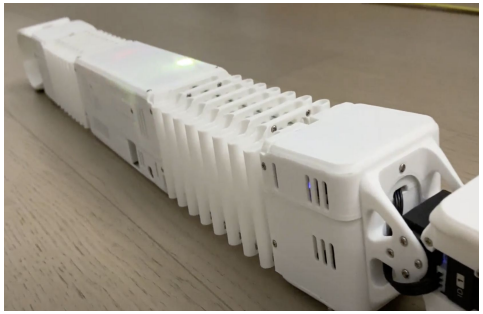


Birdman: 0.7cm/s!

Dance Move!(7 moves in total)

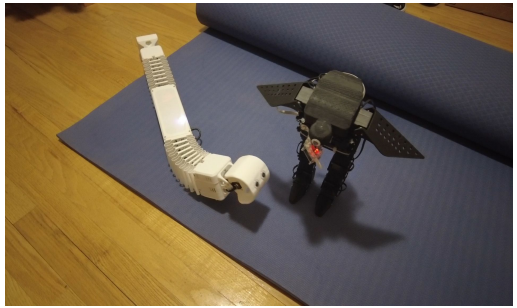


raise head

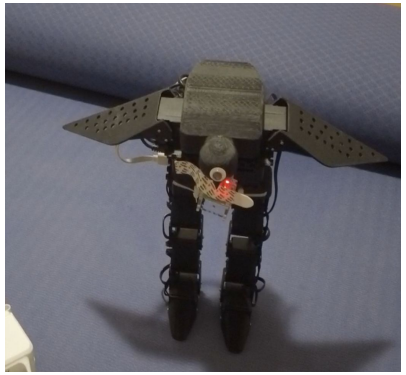


expansion and contraction

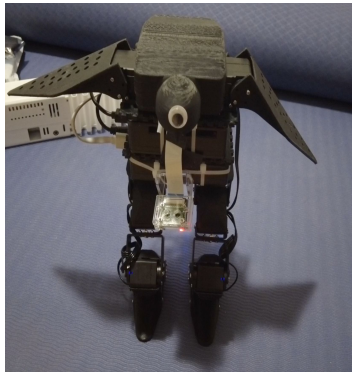
stretching



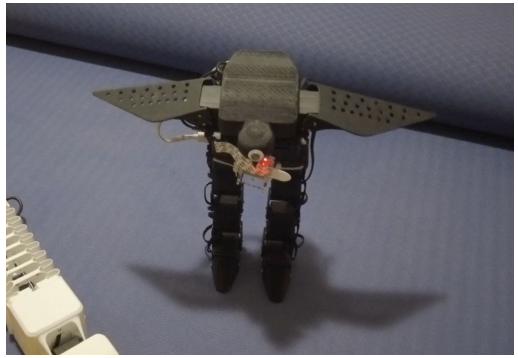
shake head
(say Hi)



flap the wings



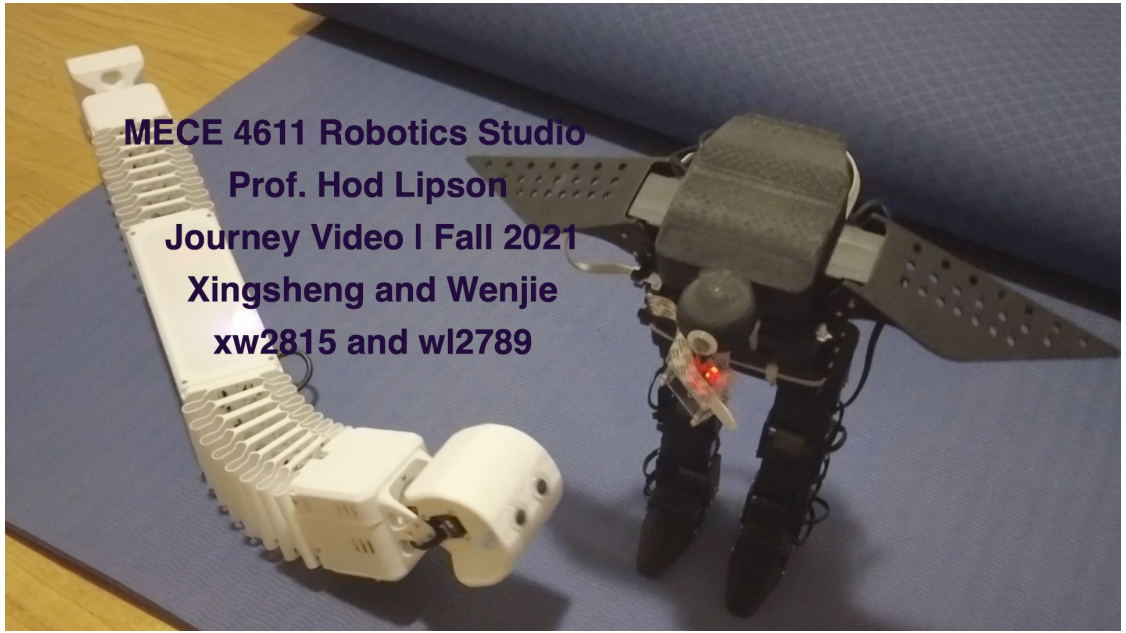
squat



shake the body back and forth

Journey Video

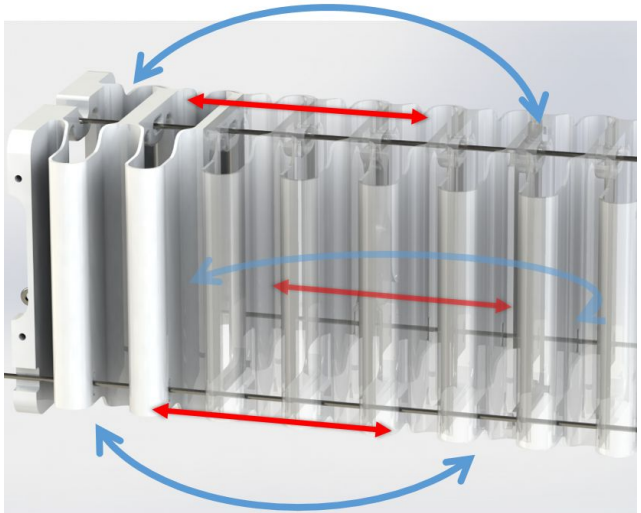
https://youtu.be/3n6W_W2n-a4

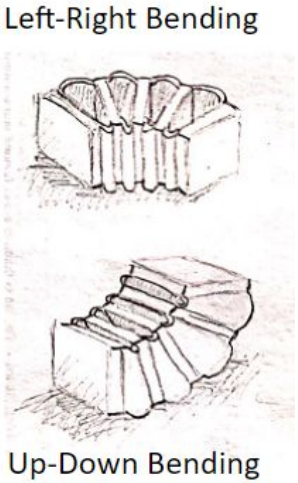


Highlight

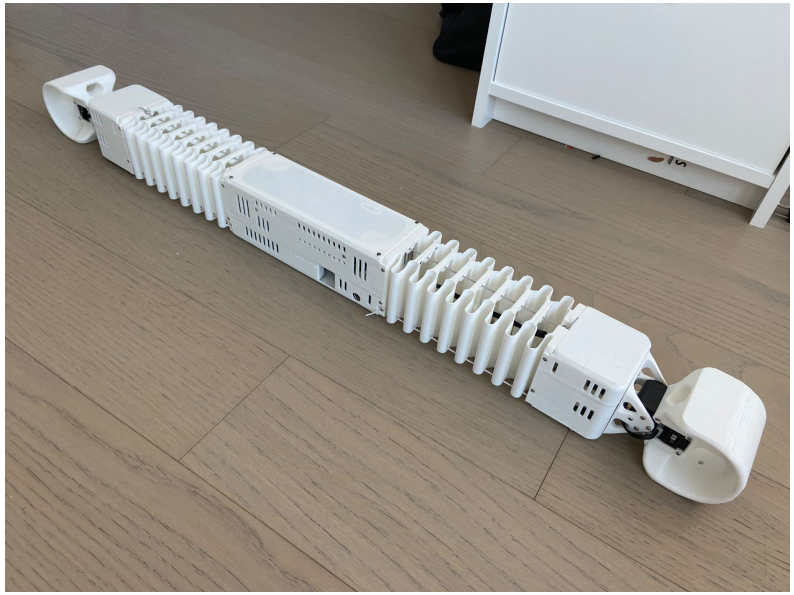
Mechanism of LarvaBot's Compliant Body:

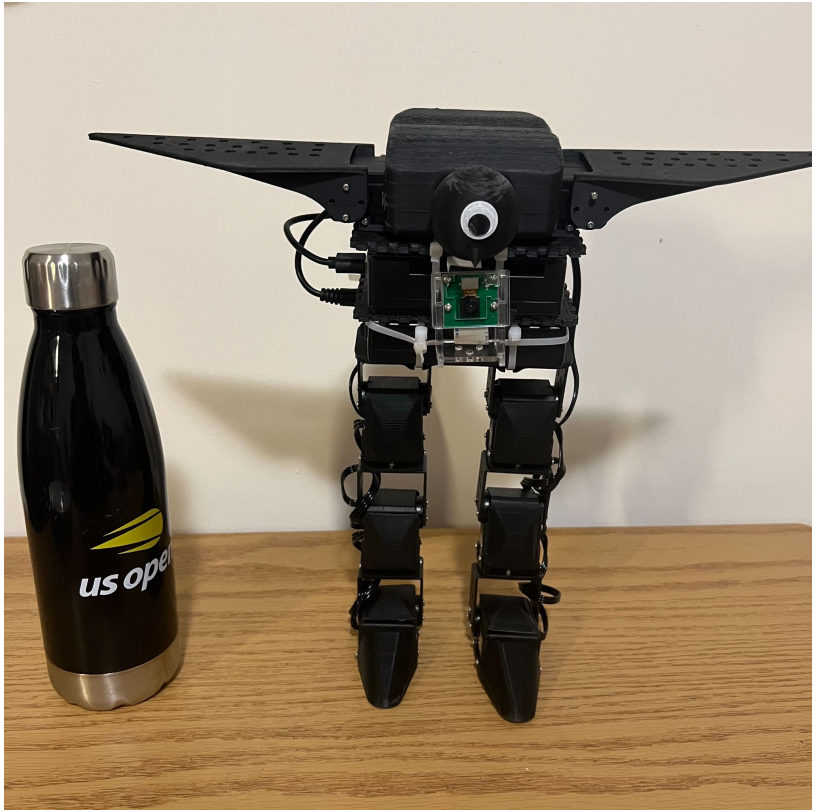
- As tendons pulled by servos (red arrows), the compliant body bends (blue arrows). There are 3 DOF for each compliant body.





Aesthetics and quality





Robotics Studio MECE 4611 Journey Video

Xingsheng Wei Wenjie Lin
UNI: xw2815 UNI: wl2789

Robot: Birdman, LarvaBot

Semester: Fall 2021

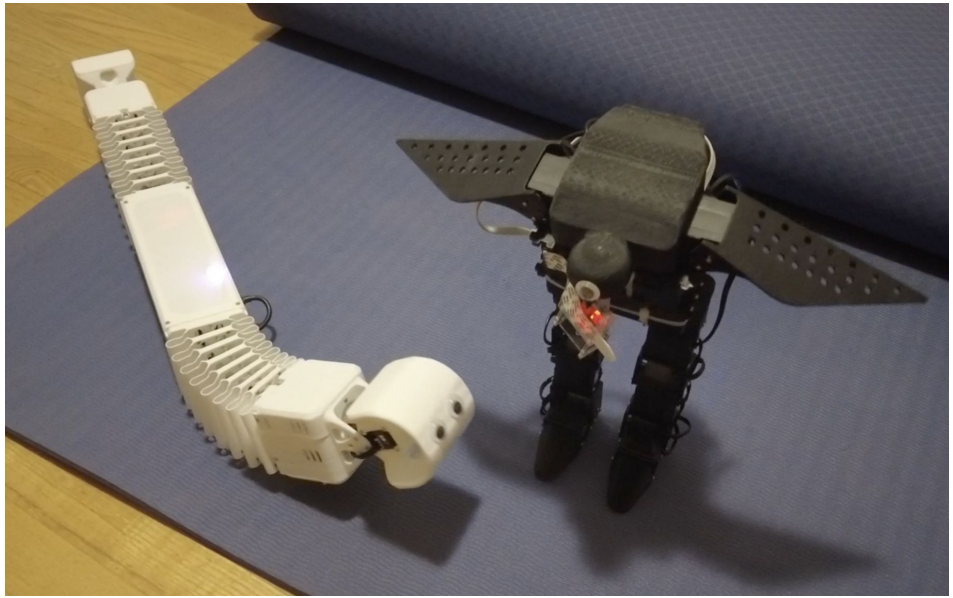
Instructor: Prof. Hod Lipson

Submitted at: 11/25/2021 3pm

Grace Hours before submission: 176

Grace Hours Gained: 40

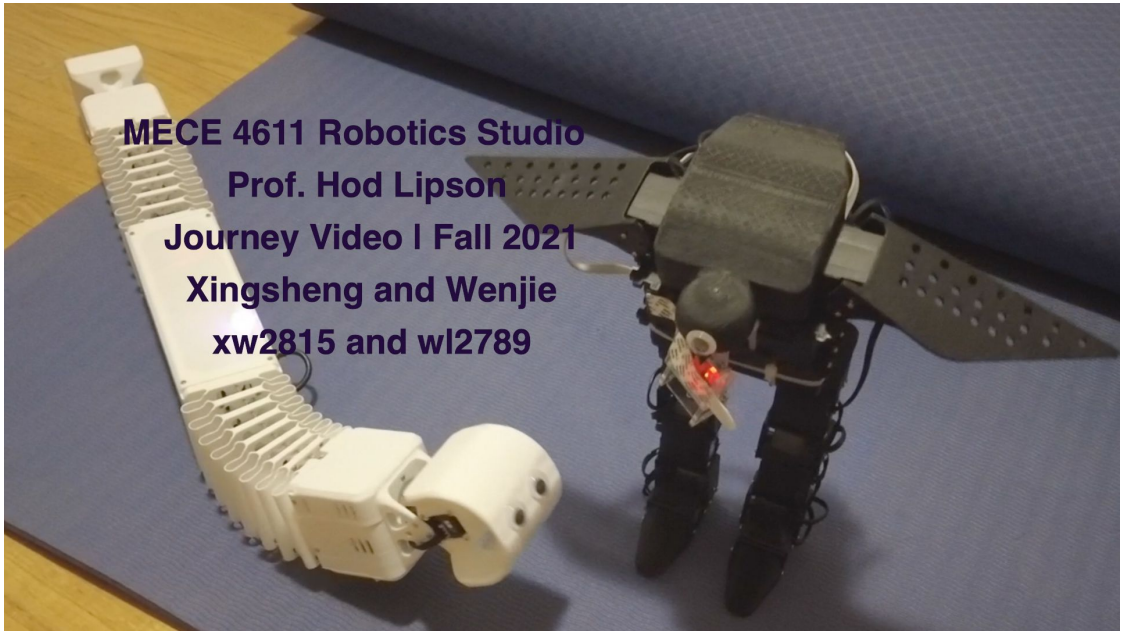
Grace Hours After Submission: 216



LarvaBot and Birdman

Journey Video_Preliminary

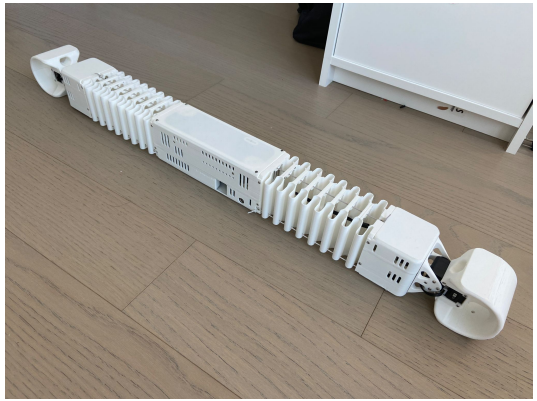
https://youtu.be/8sCL2Rur4Ao



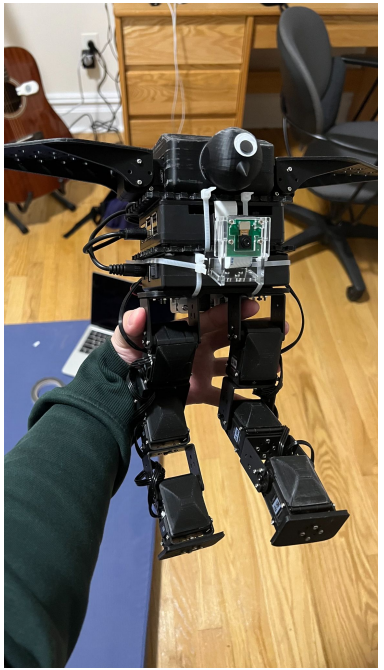
Robotics Studio MECE 4611 Assignment 6

Xingsheng Wei UNI: xw2815
Wenjie Lin UNI: wl2789

Robot: Birdman, LarvaBot
Semester: Fall 2021
Submitted at: 11/25/2021 3pm
Grace Hours before submission: 254
Grace Hours Used: 78
Grace Hours After Submission: 176



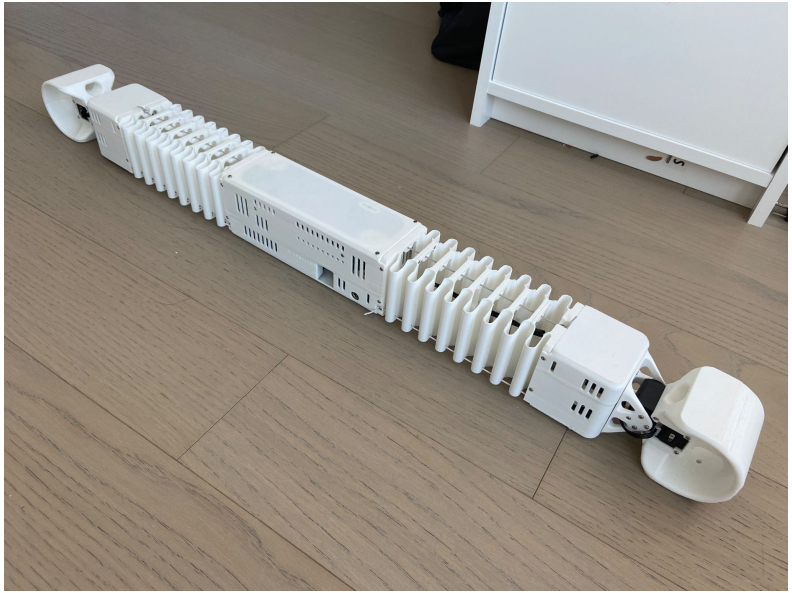
LarvaBot



Birdman

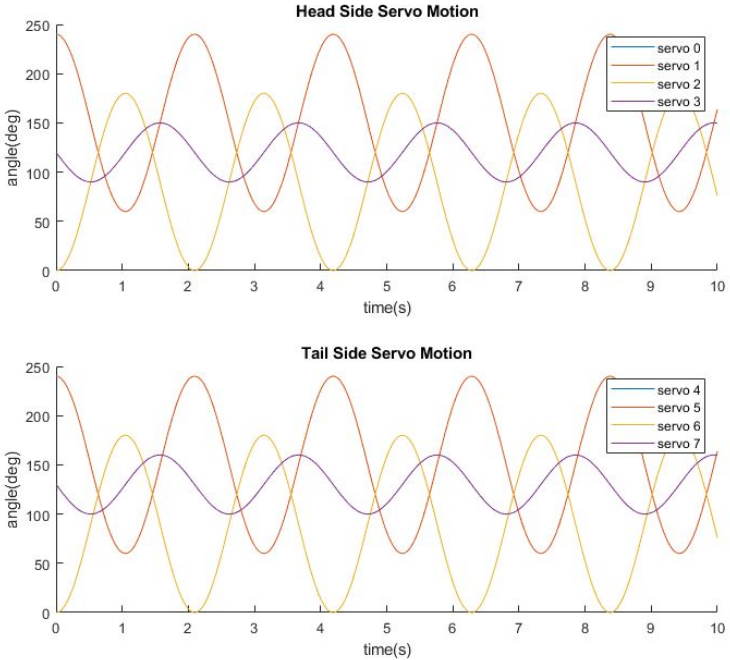
Photo of Walking Robot

Birdman



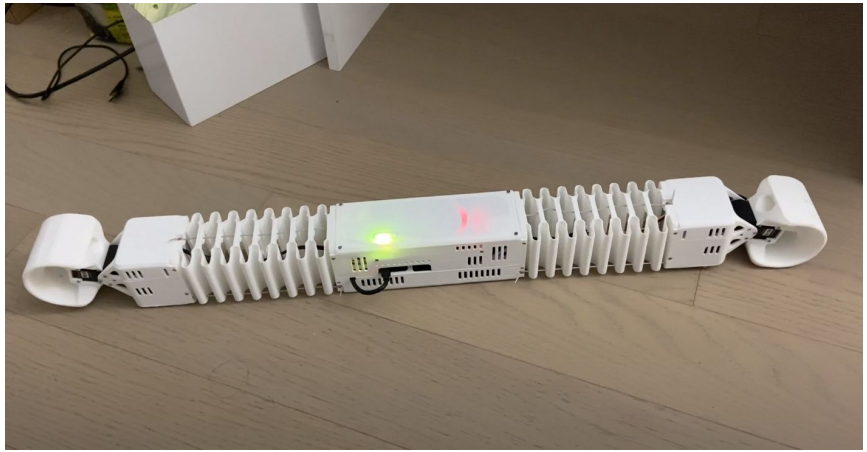
LarvaBot

Plotted motor angles



Servo Angle of LarvaBot

Robot Moving(Frame+video link)



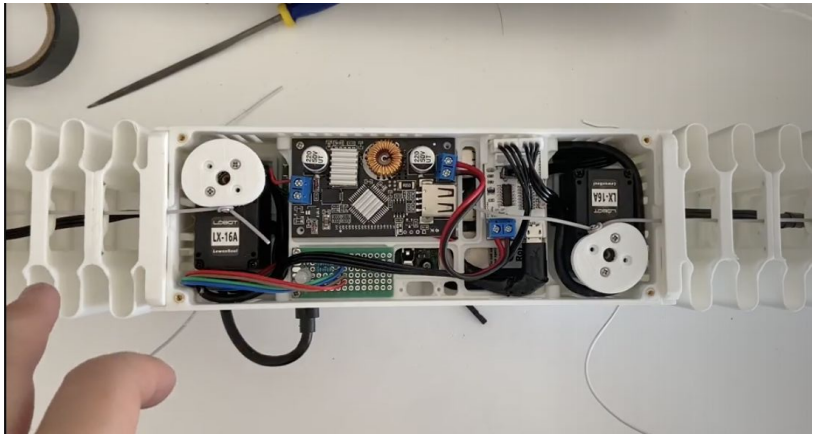
LarvaBot Video Link:
https://www.youtube.com/watch?v=Tyes84bsq1s

Robot Speed Measured

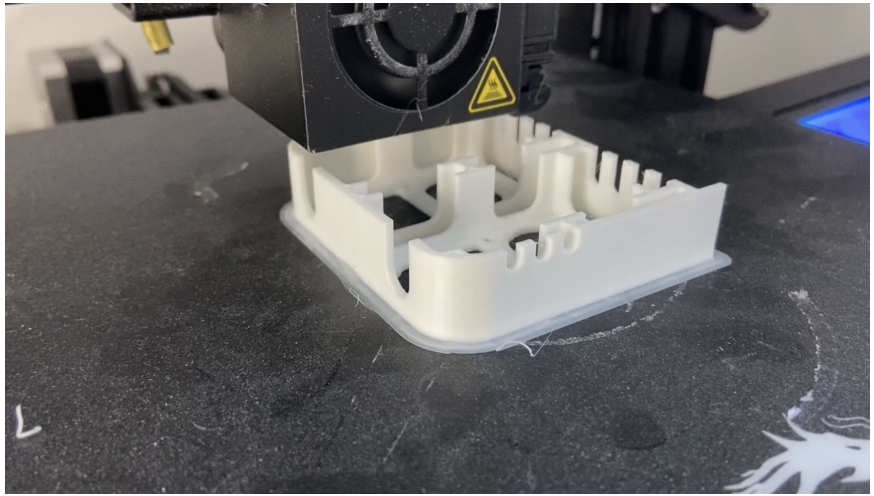
LarvaBot: 4.2cm/s → 7cm/s

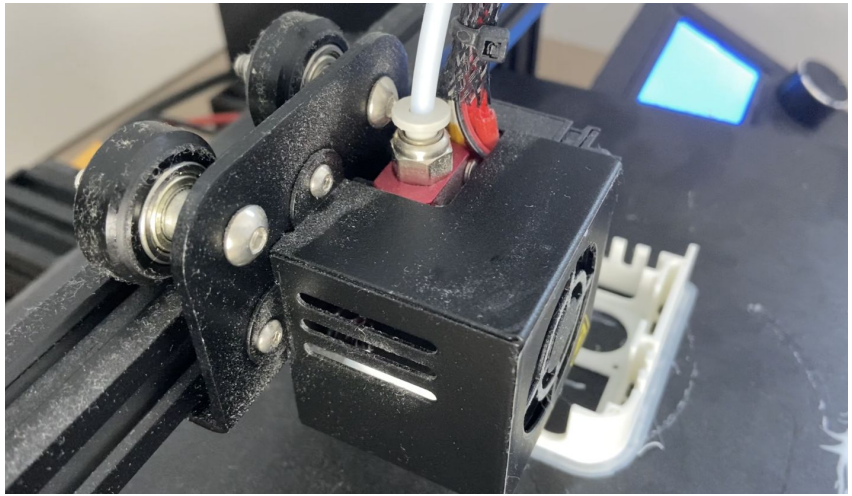
Stability Verified in Various Configurations

all components properly bolted and connected

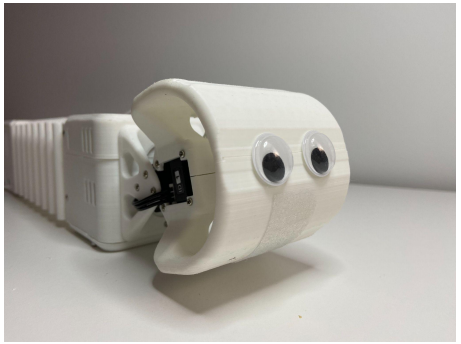


3D-print quality, support structure removed

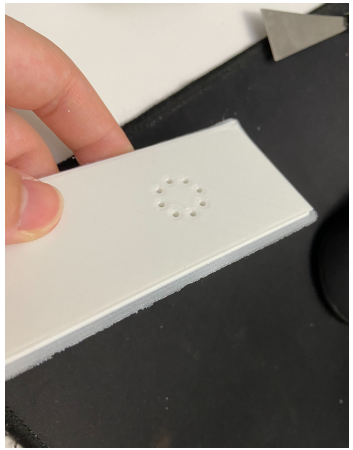




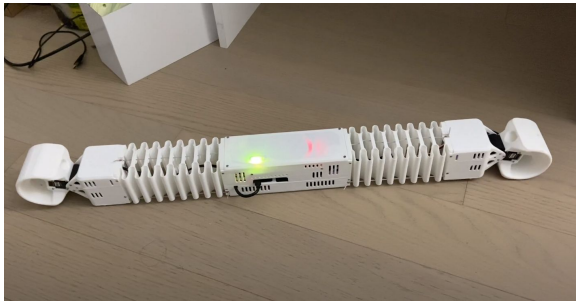
parts sanded and painted



smoother



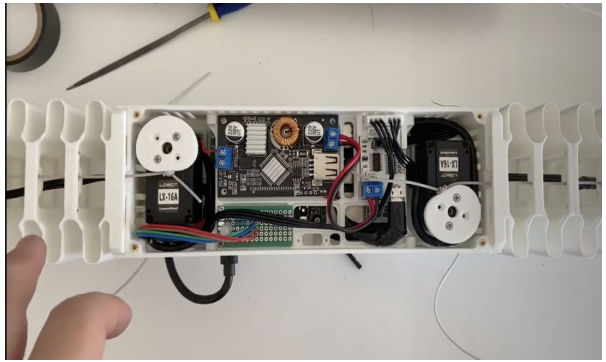
Multiple Walking Patterns tested

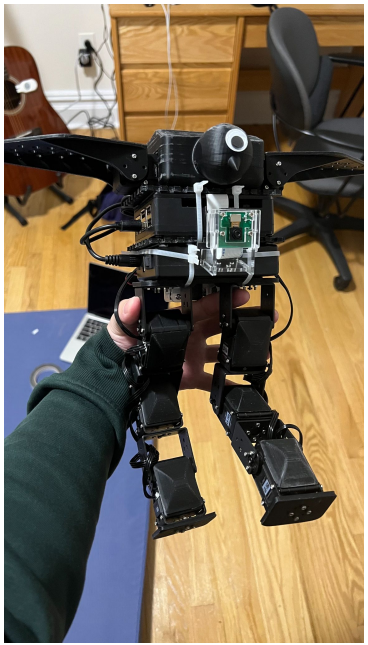


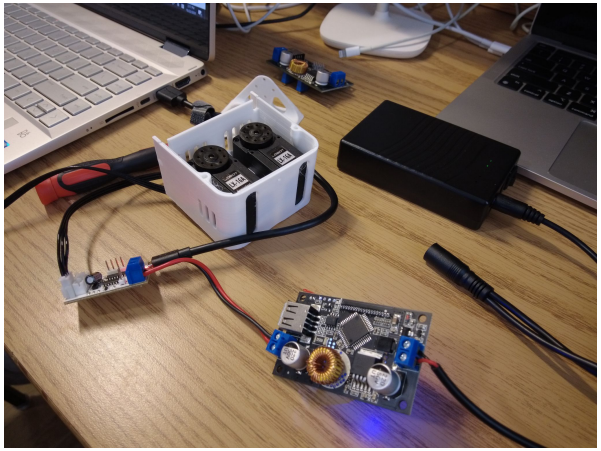
LarvaBot Go Straight:

LarvaBot Turn Right:

Cables routed properly and securely





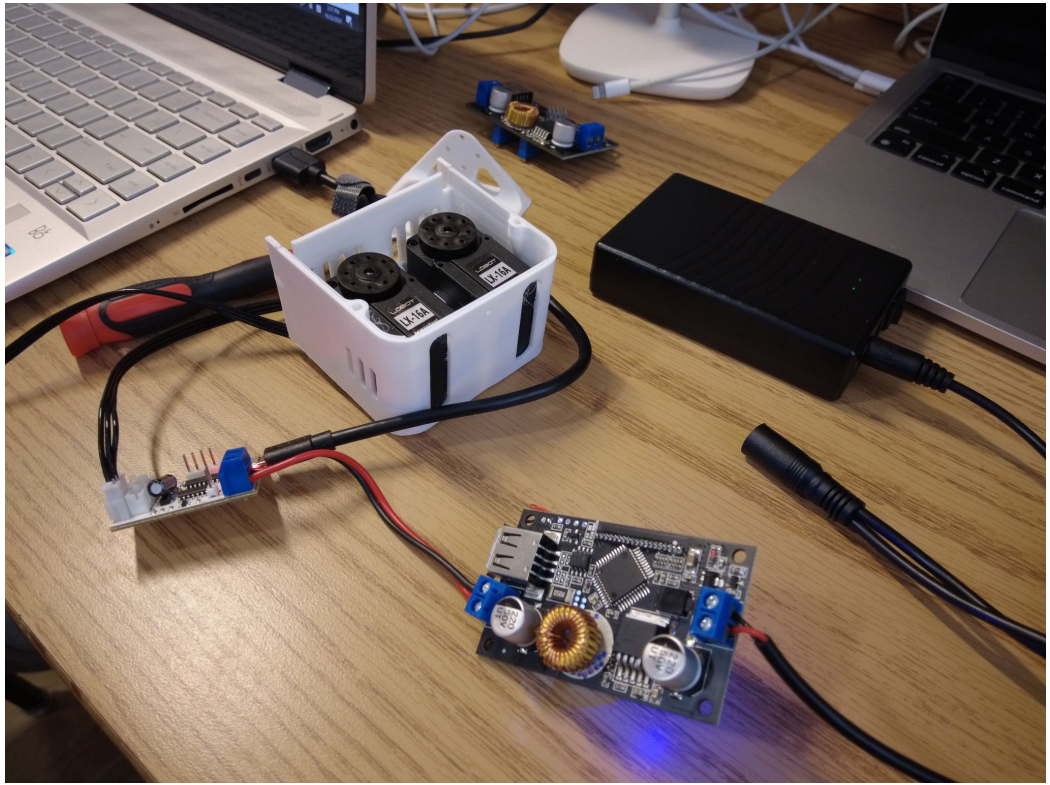


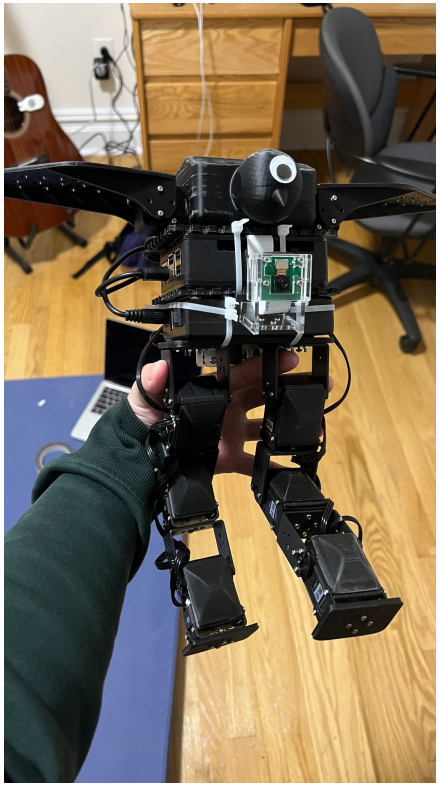
Motors Controlled Directly from Raspberry Pi

```
def goForward(duration):
        t = 0
        while t<duration:
                servo[0].moveTimeWrite(shrink-shrink*cos(omega*t))#0 is loose
                servo[1].moveTimeWrite(240-(shrink-shrink*cos(omega*t)))#240 is loose
                servo[2].moveTimeWrite(shrink-shrink*cos(omega*t))#0 is loose
                servo[3].moveTimeWrite(120-nod*sin(omega*t))#120 is rest
                servo[4].moveTimeWrite(shrink-shrink*cos(omega*t))#0 is loose
                servo[5].moveTimeWrite(240-(shrink-shrink*cos(omega*t)))#240 is loose
                servo[6].moveTimeWrite(shrink-shrink*cos(omega*t))#0 is loose
                servo[7].moveTimeWrite(130-nod*sin(omega*t))#130 is rest
                time.sleep(stepLen)  #0.01
                t += stepLen #0.01
```

function to go forward

Motors Powered Using Battery



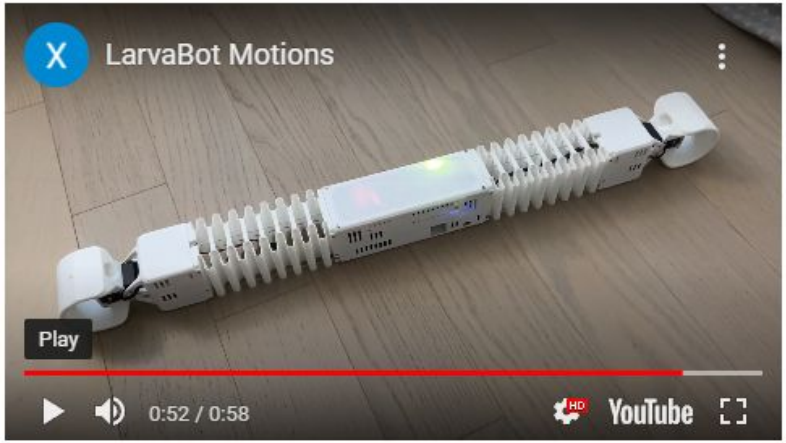


Ed Post

LarvaBot Motions - Xingsheng and Wenjie #128

Xingsheng Wei
now in General

STAR WATCHING 1 VIEW



Comment Edit Delete ...

Post on Online Portfolio

Portfolio of Xingsheng Wei:
https://xw2815.wixsite.com/xingshengwei

LarvaBot

Ongoing Health Test Routine Implemented

```
# initializing LED
print('Initializing LED...')
red = 18
green = 23
blue = 24
GPIO.setmode(GPIO.BCM)
GPIO.setwarnings(False)
GPIO.setup(red,GPIO.OUT)
GPIO.setup(green,GPIO.OUT)
GPIO.setup(blue,GPIO.OUT)
#set LED off at beginning
GPIO.output(red,GPIO.LOW)
GPIO.output(green,GPIO.LOW)
GPIO.output(blue,GPIO.LOW)
# LED show red
GPIO.output(red,GPIO.HIGH)
print('LED ready')

print('Initializing servo driver...')
# On Raspbian, try each port in /dev/
#LX16A.initialize("/dev/ttyUSB0")
LX16A.initialize("/dev/ttyUSB0")
print('Servo driver ready')
```

```
# Initializing Servo
print('Initializing servos...')
servo = [LX16A(10),LX16A(11),LX16A(12),LX16A(13),LX16A(20),LX16A(21),LX16A(22),LX16A(23)]
print('Servos ready')

#initializing parameters
print('Initializing parameters...')
nMotor = 8
homePos = [1, 240, 0, 120, 0, 240, 0, 130]
homeThresh = 1
print('Parameters ready')

# LED show yellow for 1 sec
GPIO.output(red,GPIO.HIGH)
GPIO.output(green,GPIO.HIGH)
print('Initializing Done')
#initializing done
```

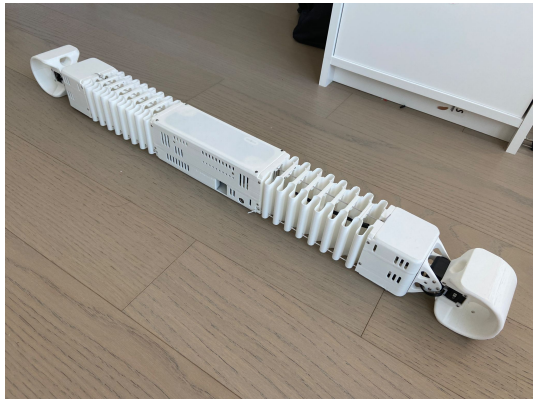
Initialization Checking All Parts

Shutdown Routine Implemented

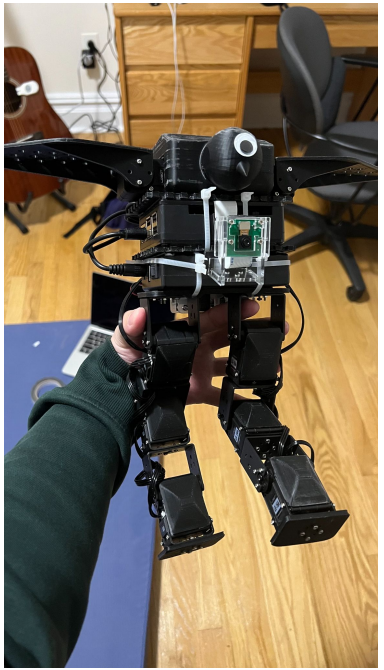
```
186   def rest():
187           autoHome()
188           print('Exited')
189           exit()
```

Robotics Studio MECE 4611
Assignment 5

Xingsheng Wei Wenjie Lin
UNI: xw2815 UNI: wl2789
Robot: Birdman, LarvaBot
Semester: Fall 2021
Submitted at: 11/10/2021 10pm
Grace Hours before submission: 298
Grace Hours Used: 44
Grace Hours After Submission: 254



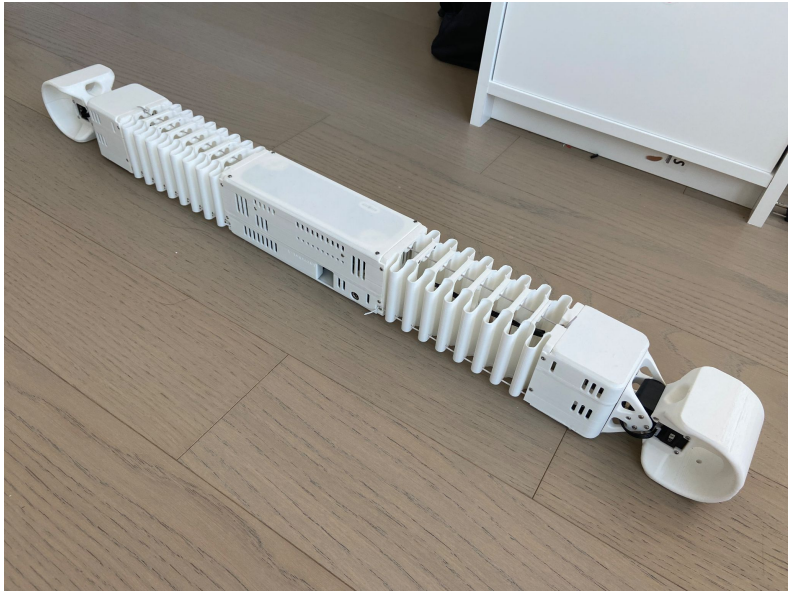
LarvaBot



Birdman

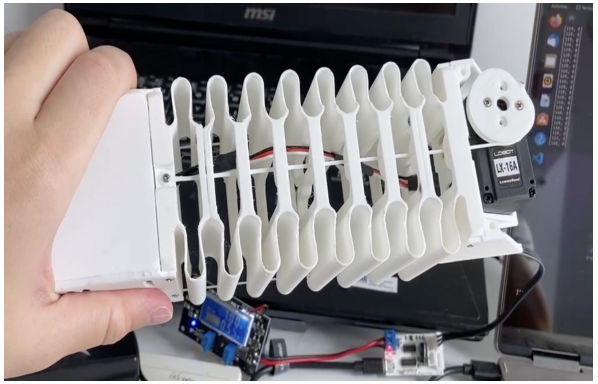
Photo of Printed Robot

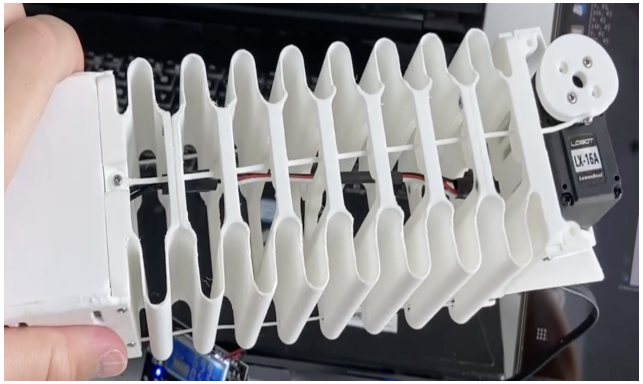
Birdman



LarvaBot

Leg Moving Video





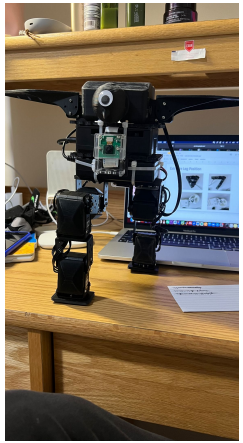
https://youtu.be/JVU5FKoS4lk

https://youtu.be/ls0SaTMchHw

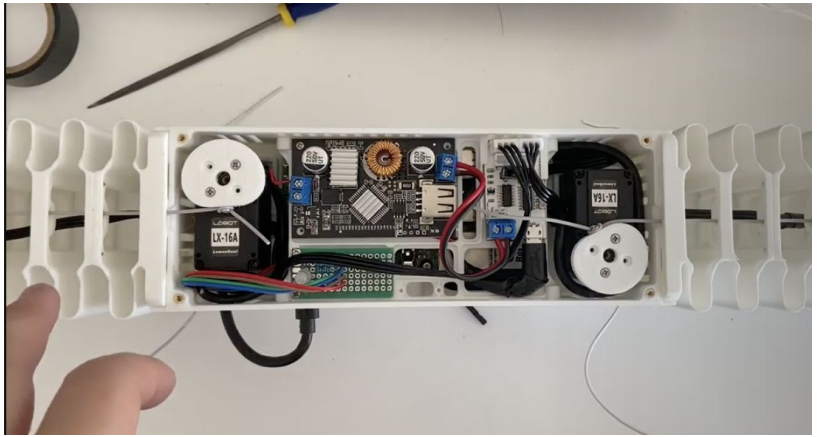
Extreme Leg Position

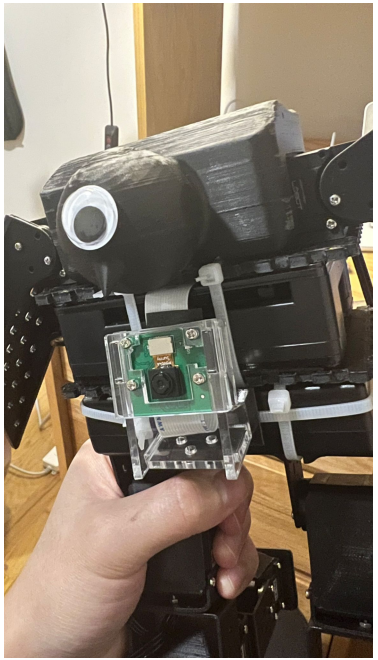
Stability Verified in Various Configurations



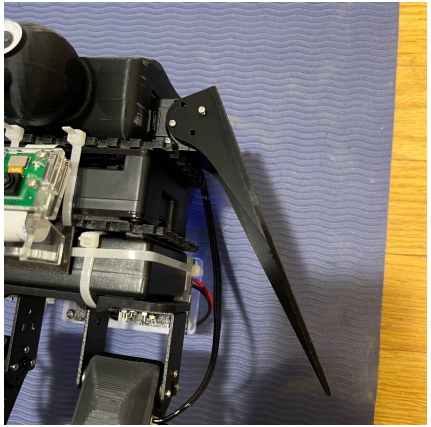


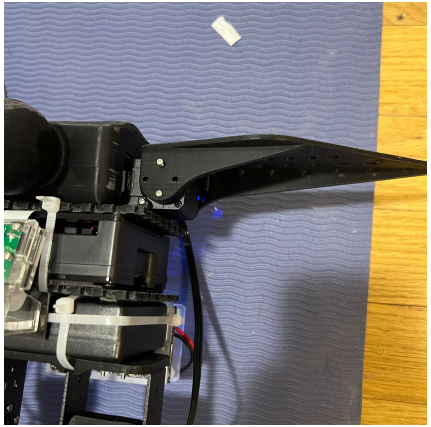

all components properly bolted and connected (with inserts)



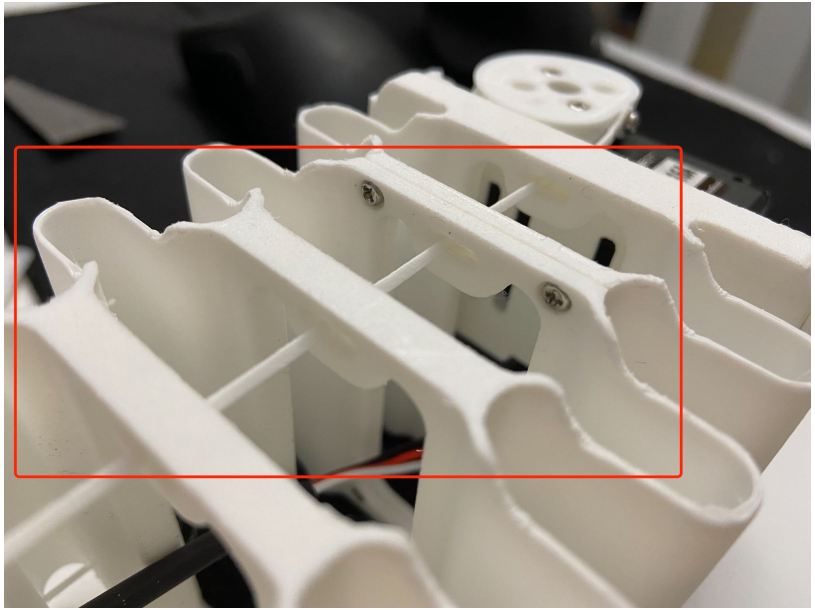


Form/Fit issue



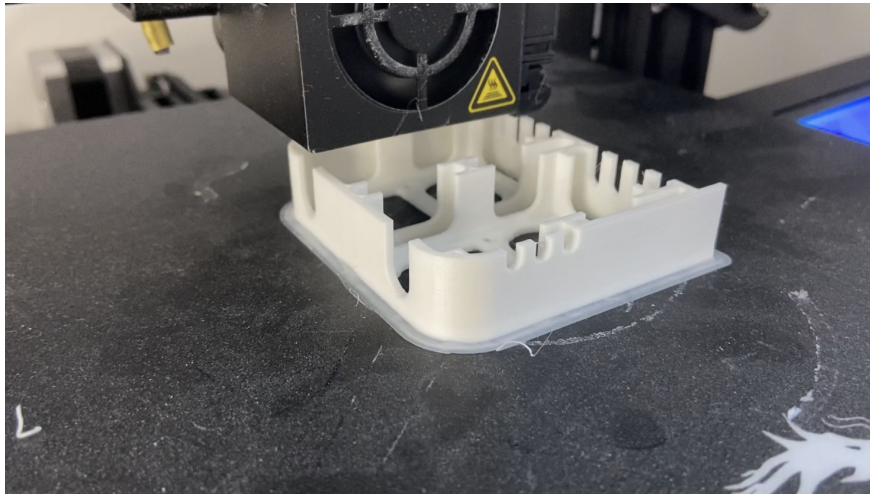


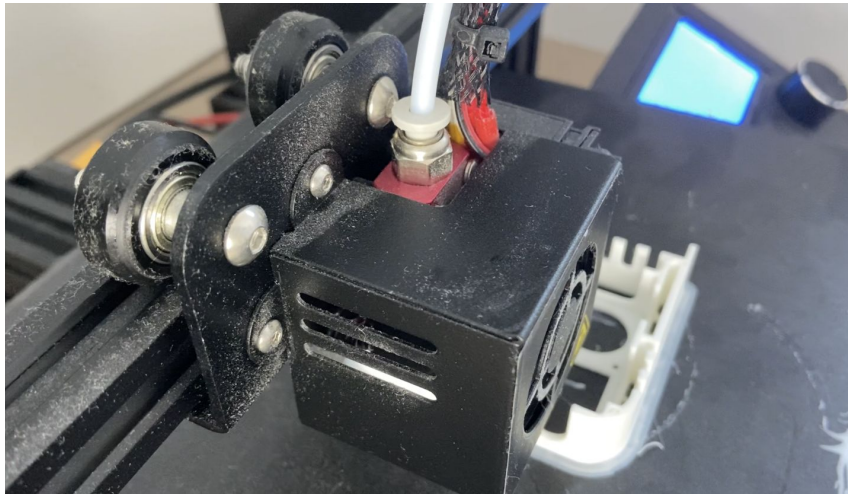
Due to the structure problem of printed wing, the rotation is only limited within 0-90°. Afterwards, we'll modify the CAD model and reprint its wings.



The cable we designed at the beginning is too thick to be assembled. Then we made it thinner, which handles the problem.

3D-print quality, support structure removed



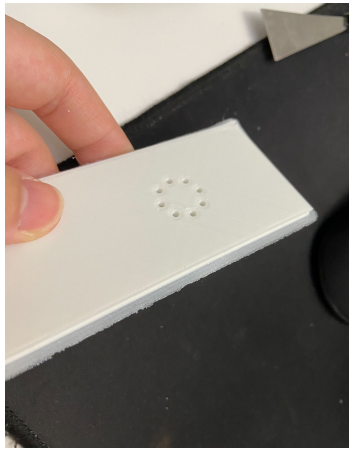


parts sanded and painted

https://youtu.be/pYST1INiHf0

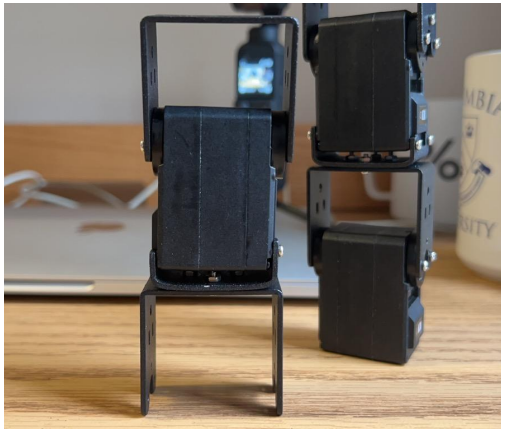
smoother

https://youtu.be/W2lf380AVsY

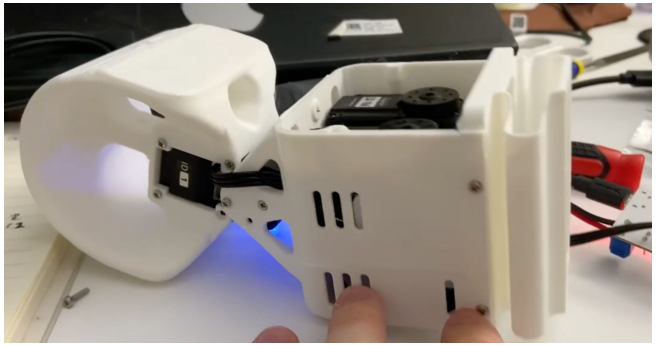


Robot Modularity demonstrated

Birdman

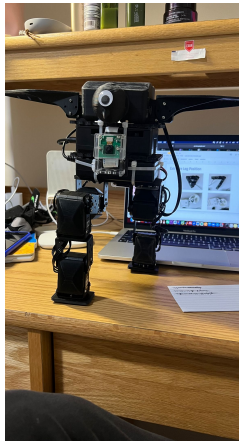


LarvaBot

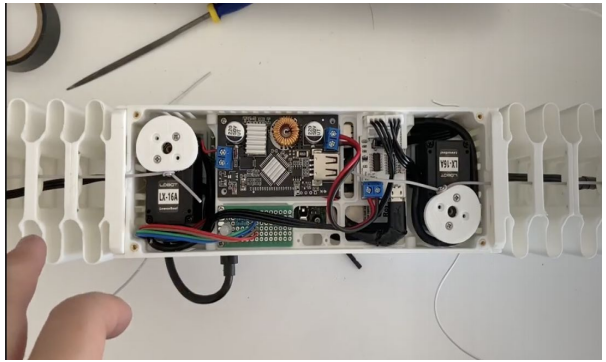


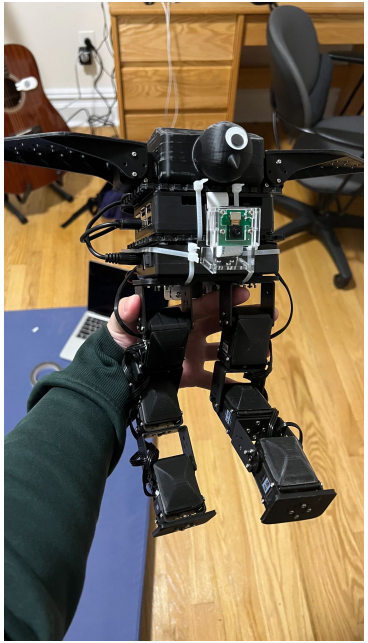
Multiple configurations tested

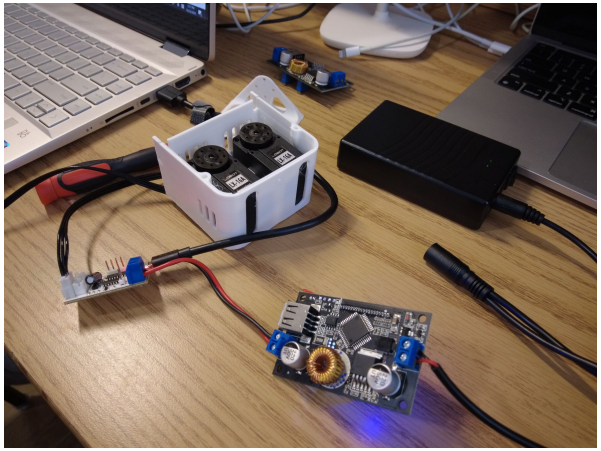





Cables routed properly and securely

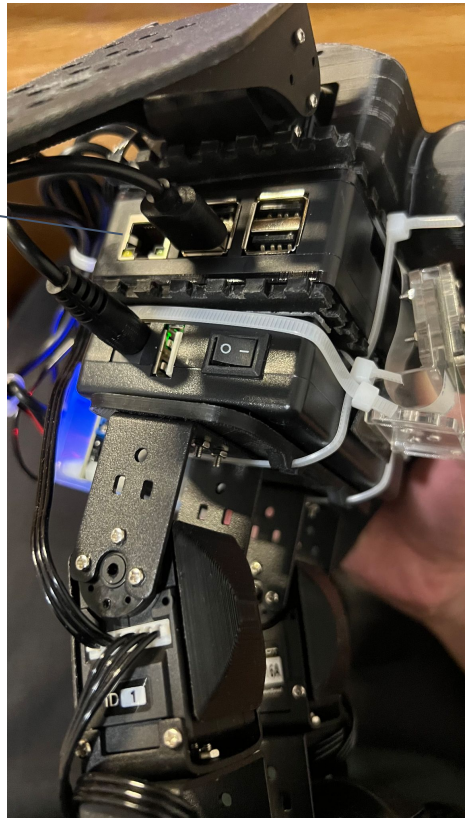


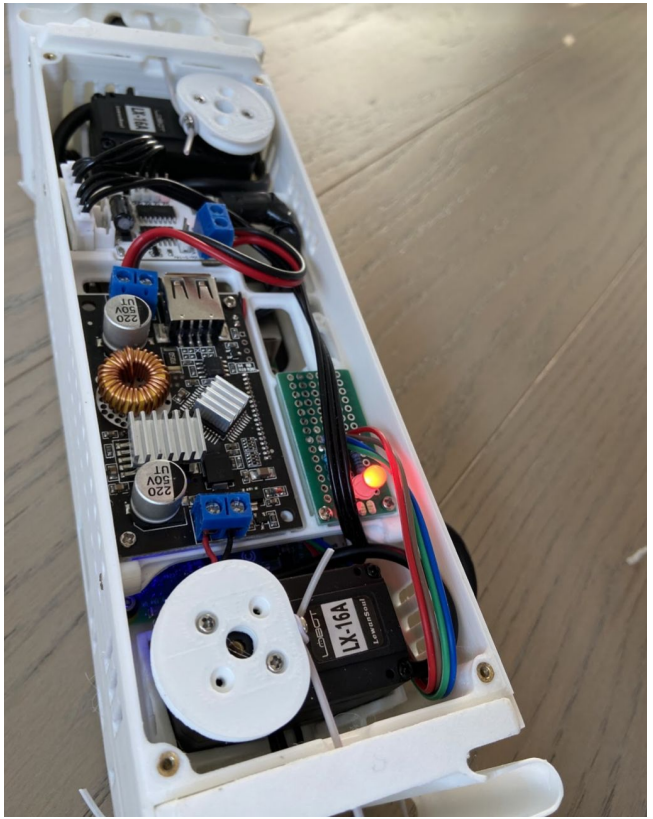




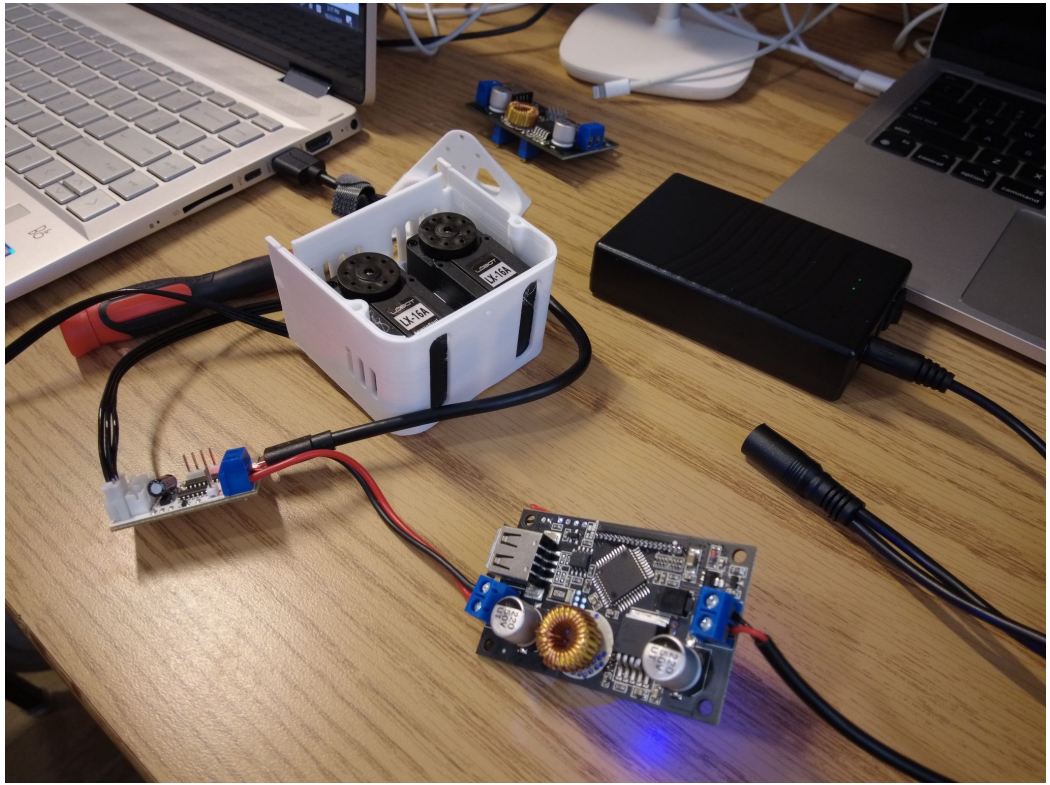
Motors Controlled Directly from Raspberry Pi

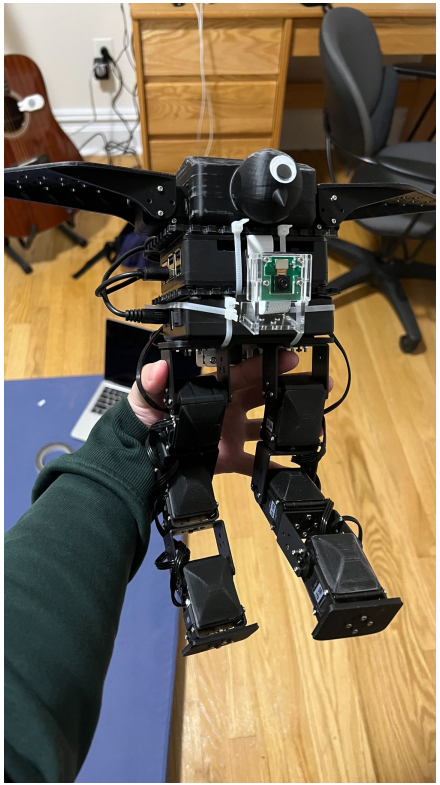
Raspberry Pi





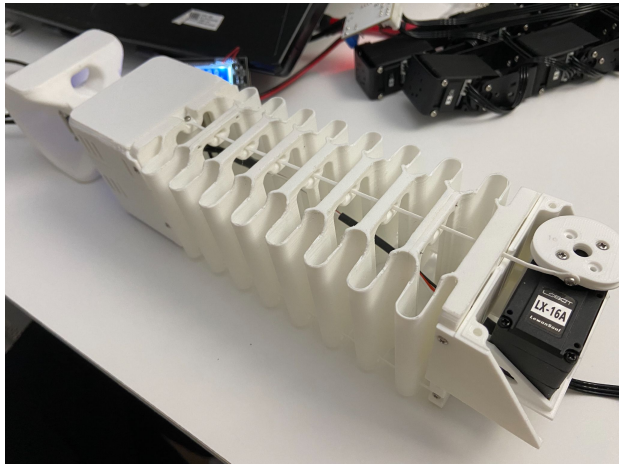
Motors Powered Using Battery





Robotics Studio MECE 4611 Assignment 4

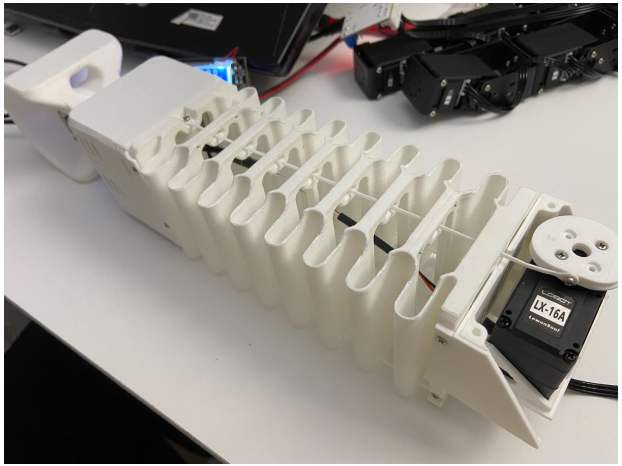
Xingsheng Wei Wenjie Lin
UNI: xw2815 UNI: wl2789
Robot: Birdman, LarvaBot
Semester: Fall 2021
Submitted at: 10/26/2021 10pm
Grace Hours before submission: 198
Grace Hours Gained: 4
Grace Hours After Submission: 202

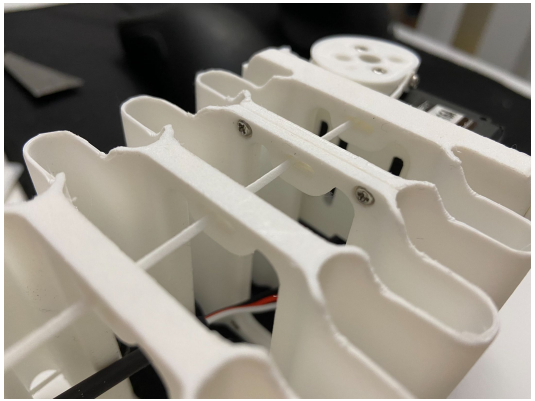


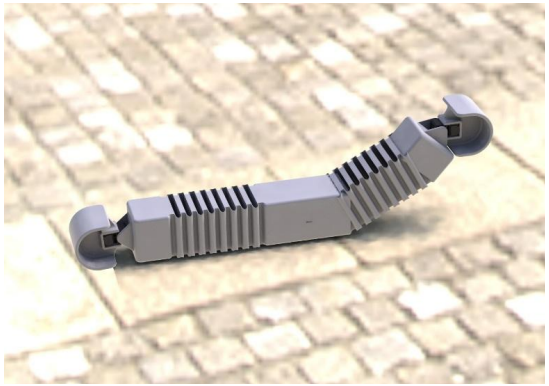
LarvaBot


Birdman

3D Renderings

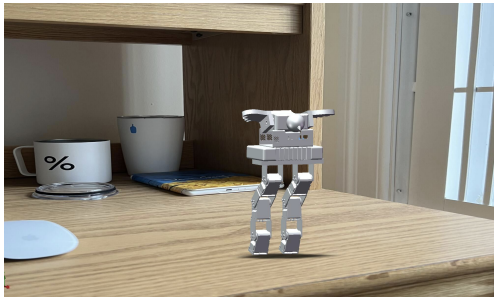




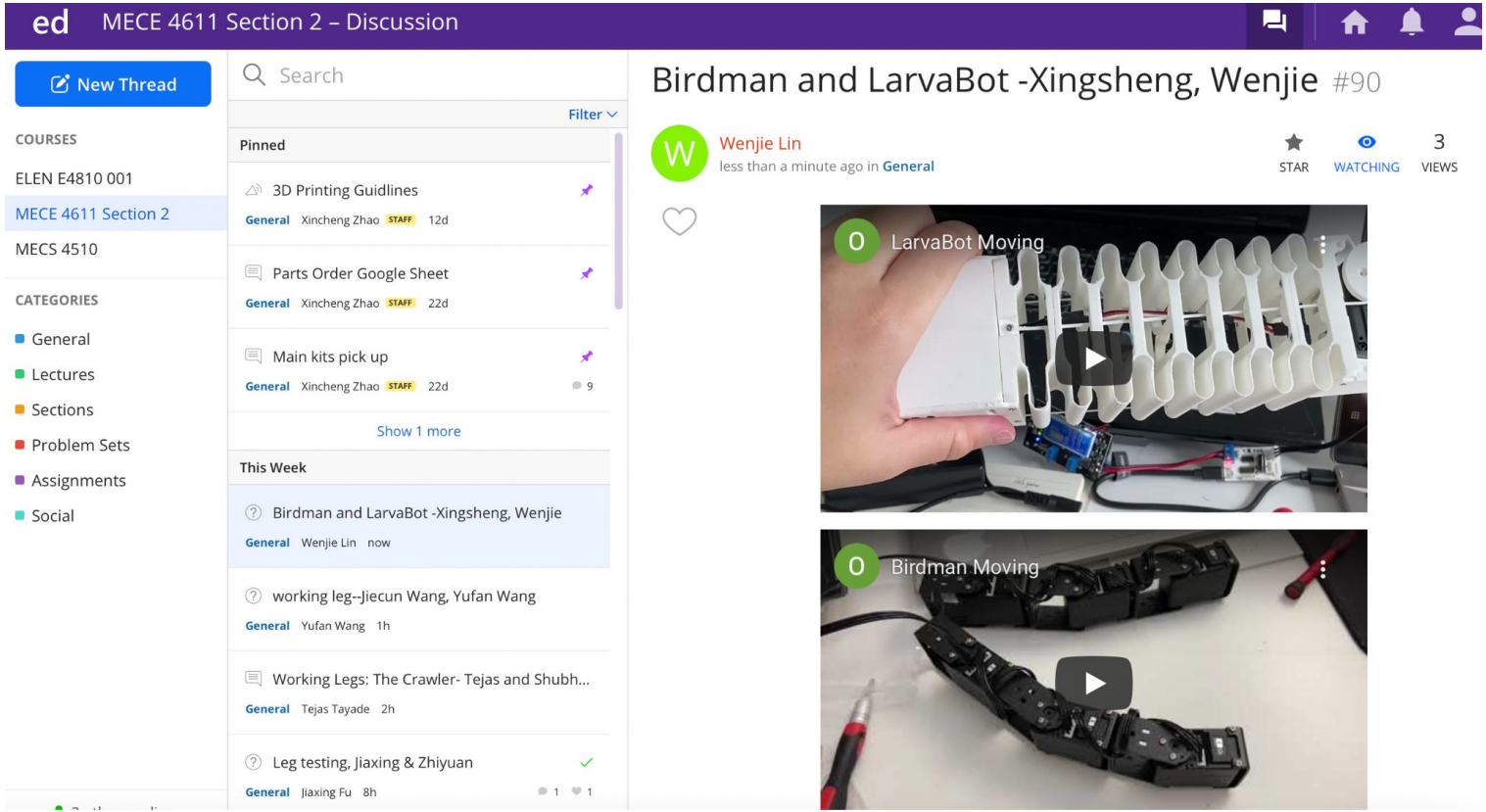


LarvaBot

Birdman



Ed Posts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MECE 4611 Section 2 – Discussion
New Thread
Search
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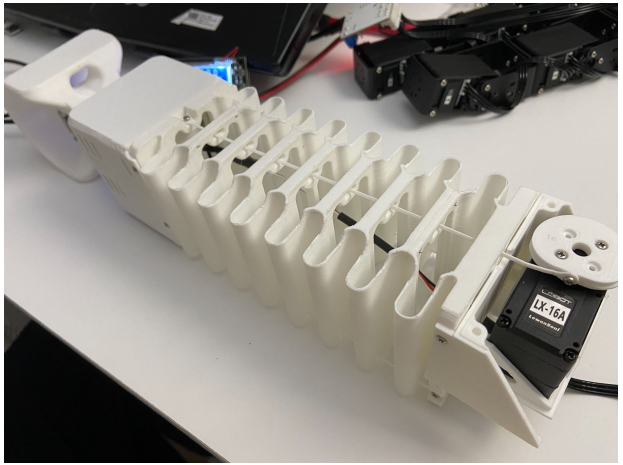
ELEN E4810 001
MECE 4611 Section 2
MECS 4510
CATEGORIES
General
Lectures
Sections
Problem Sets
Assignments
Social
Pinned
3D Printing Guidlines
General Xincheng Zhao STAFF 12d
Parts Order Google Sheet
General Xincheng Zhao STAFF 22d
Main kits pick up
General Xincheng Zhao STAFF 22d 9
Show 1 more
This Week
Birdman and LarvaBot -Xingsheng, Wenjie
General Wenjie Lin now
working leg--Jiecun Wang, Yufan Wang
General Yufan Wang 1h
Working Legs: The Crawler- Tejas and Shubh...
General Tejas Tayade 2h
Leg testing, Jiaxing & Zhiyuan
General Jiaxing Fu 8h 1 1
Birdman and LarvaBot -Xingsheng, Wenjie #90
Wenjie Lin
less than a minute ago in General
STAR
WATCHING
3
VIEWS
LarvaBot Moving
Birdman Moving

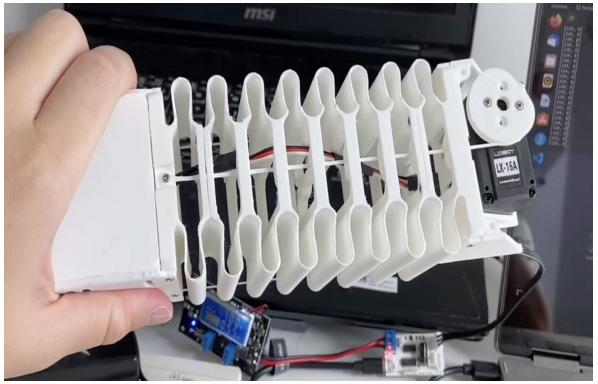
Photo of legs

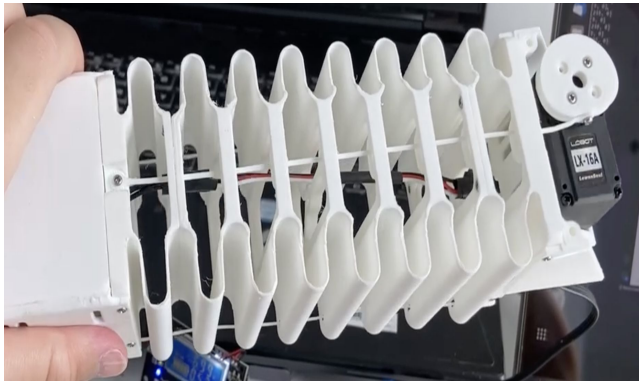
Birdman



LarvaBot

Leg Moving Video



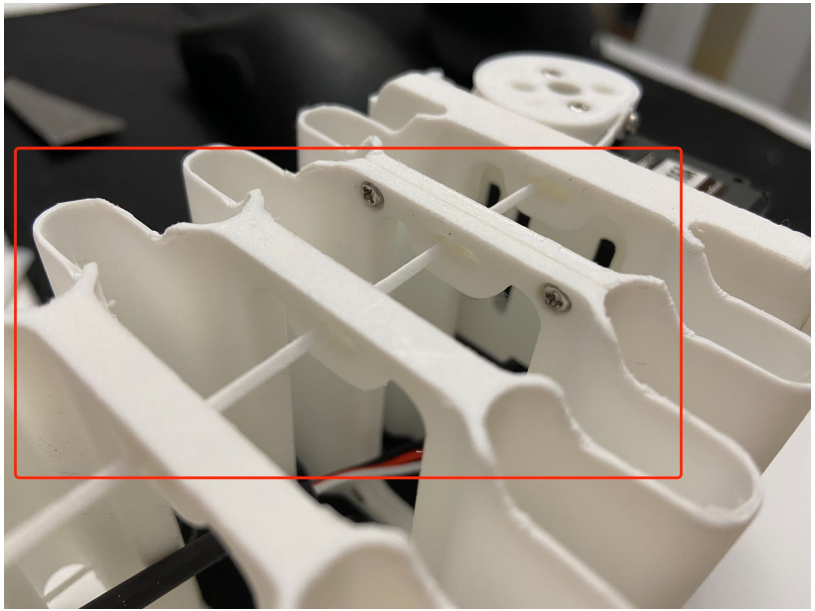


https://youtu.be/JVU5FKoS4lk

https://youtu.be/ls0SaTMchHw

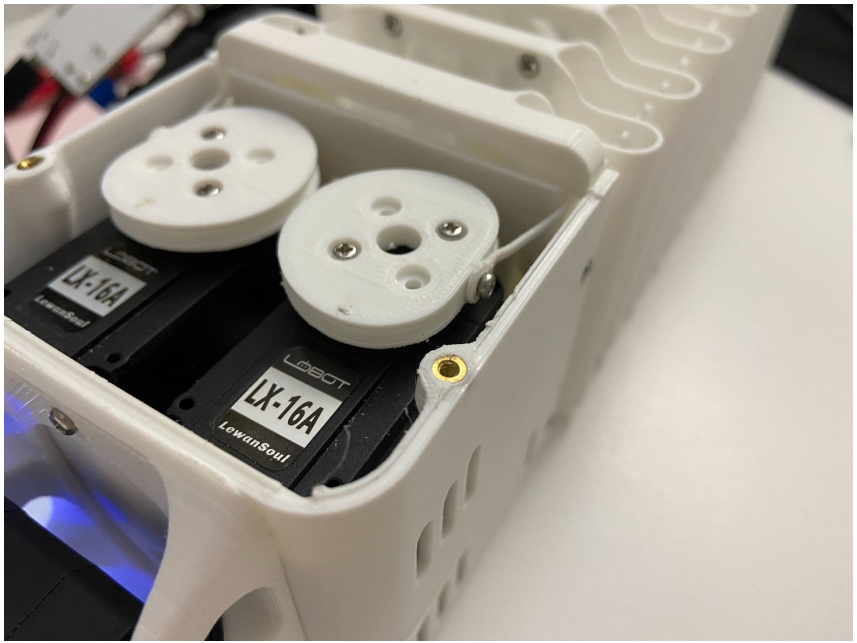
Form/Fit issue

It was not quite stable after The servo and its brackets was assembled with screws vertically. Through some adjustments(using support parts), it's better.



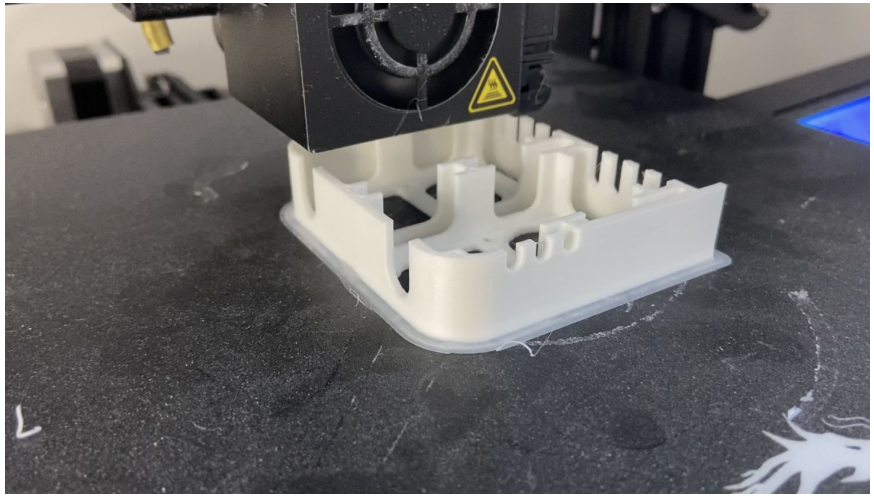
The cable we designed at the beginning is too thick to be assembled. Then we made it thinner, which handles the problem.

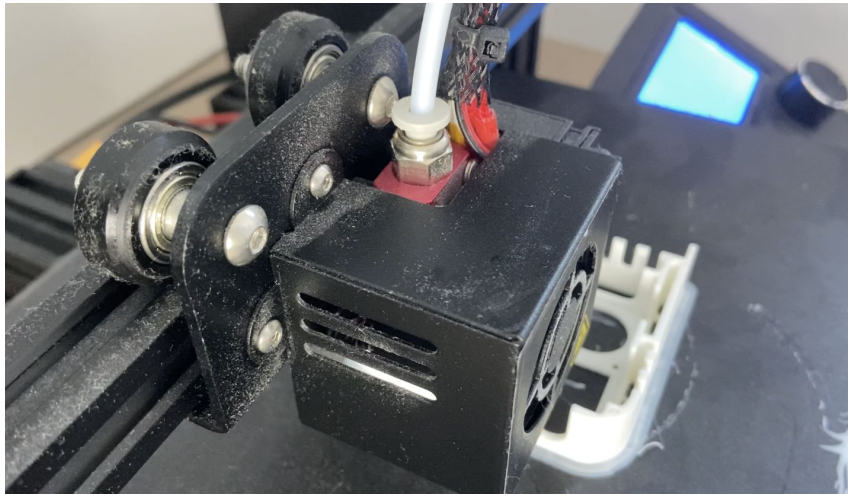
all components properly bolted and connected (with inserts)



Extreme Leg Position

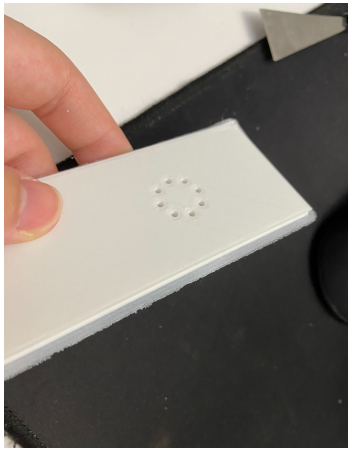
3D-print quality, support structure removed





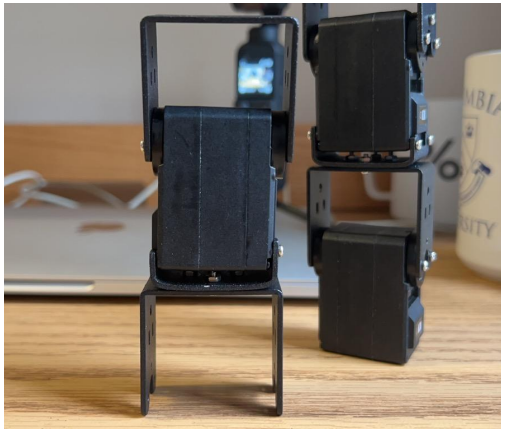
parts sanded and painted

smoother

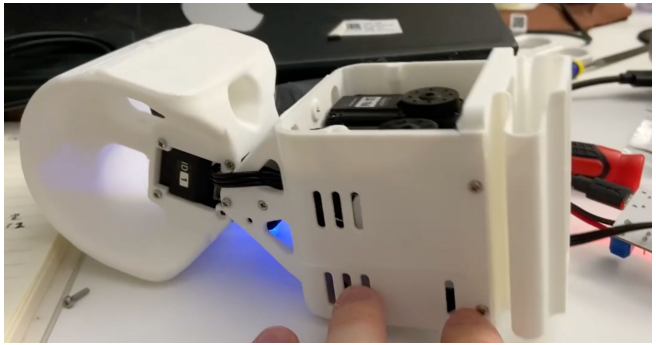


Leg Modularity demonstrated

Birdman

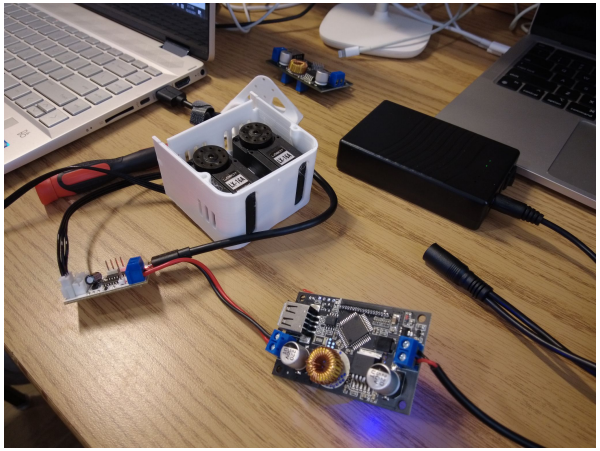


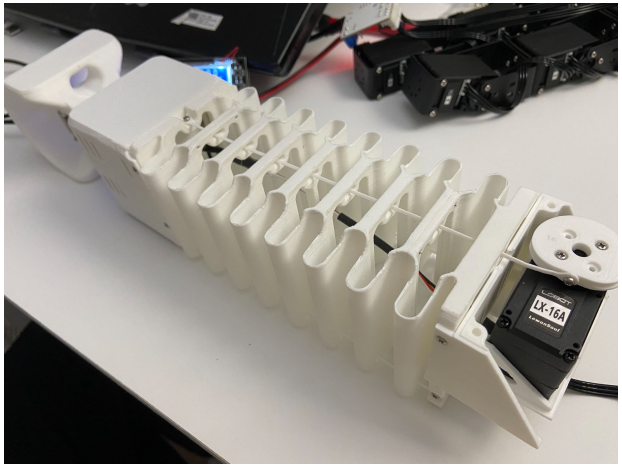
LarvaBot

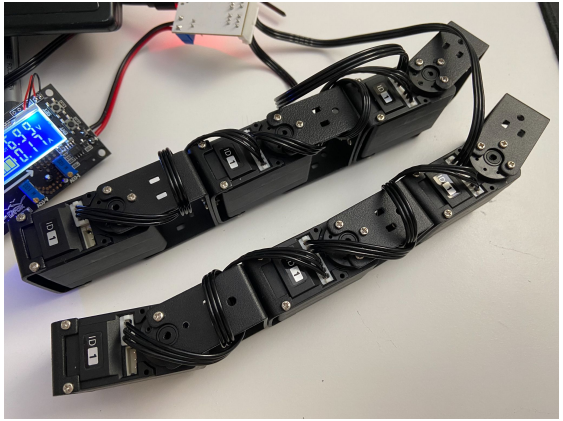


Two or more legs tested in tandem

Cables routed properly and securely

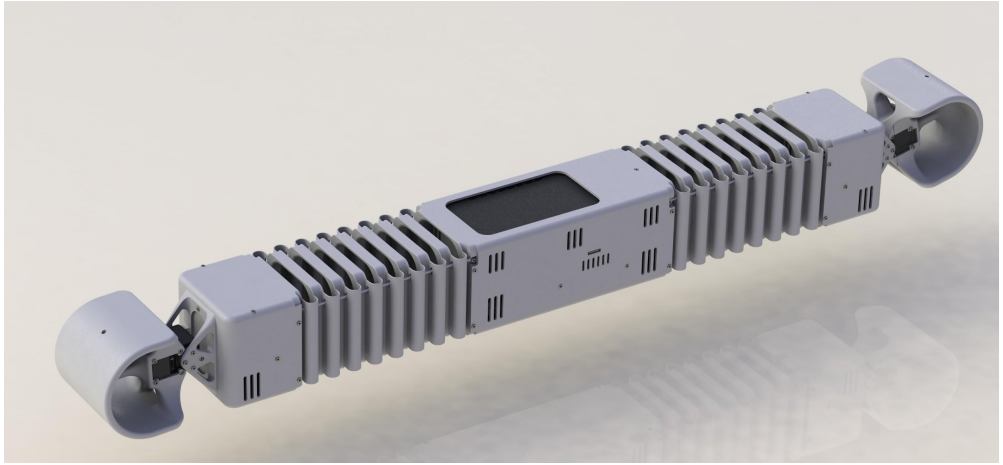






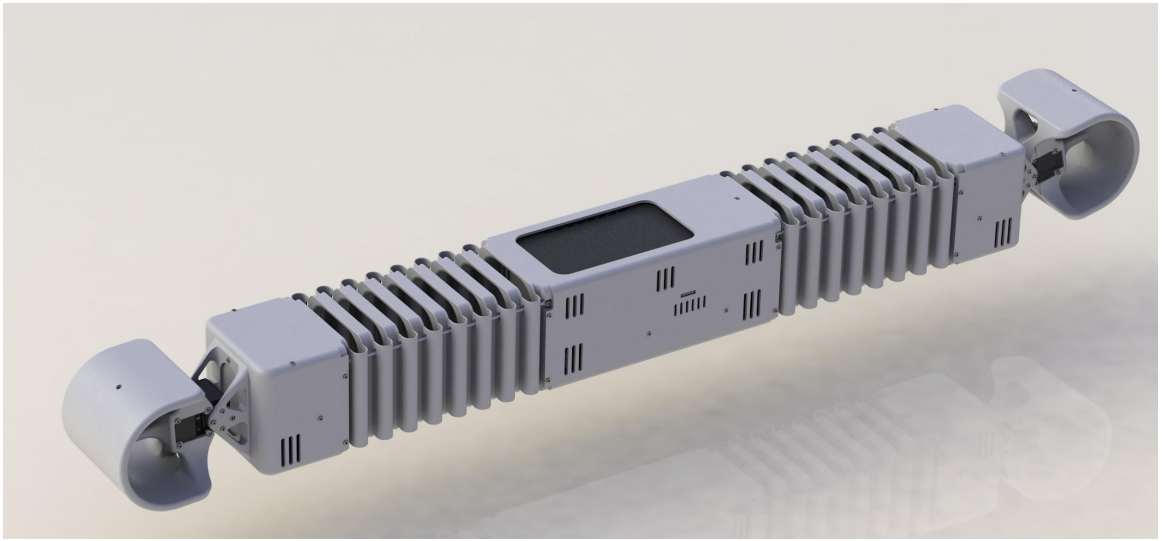
Robotics Studio MECE 4611 Assignment 3

Xingsheng Wei
UNI: xw2815
Robot: LarvaBot
Semester: Fall 2021
Submitted at: 10/12/2021 11:31pm
Grace Hours Gained: 0
Grace Hours After Submission: 109

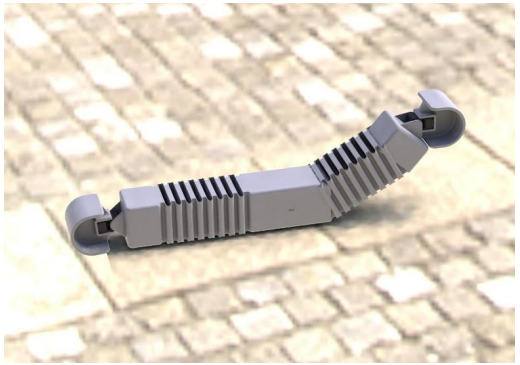


LarvaBot

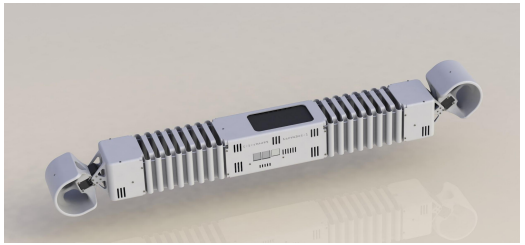
Renders



Relax

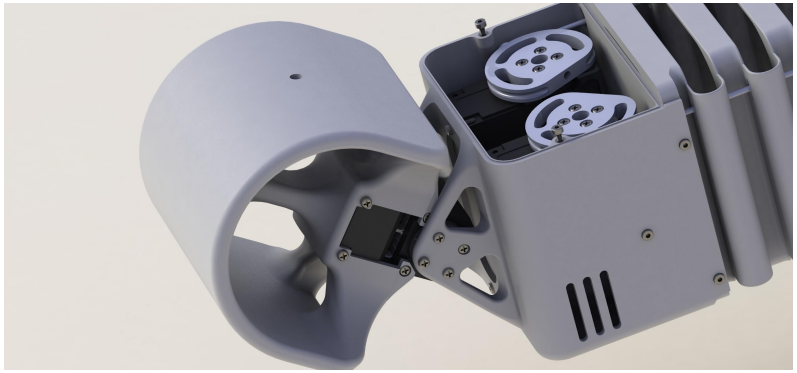


Raise Head

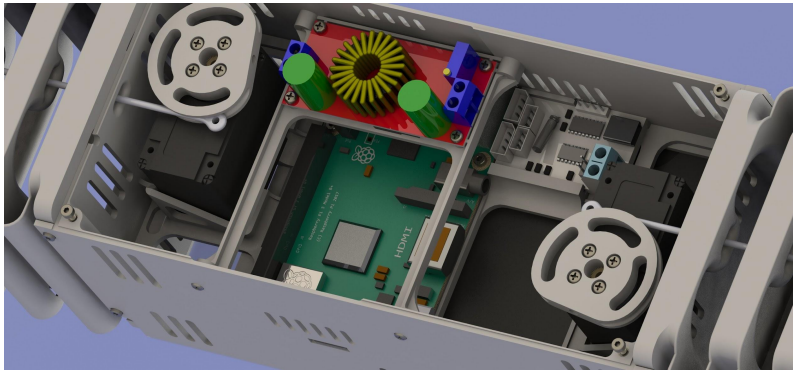


Movable Head and Tail

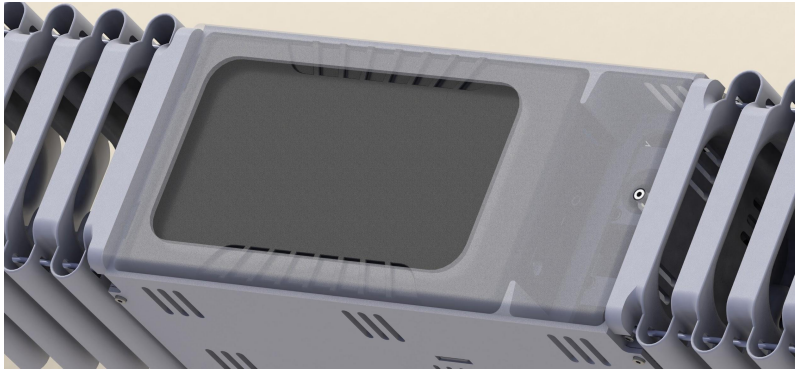
Details



Head/Tail and Neck



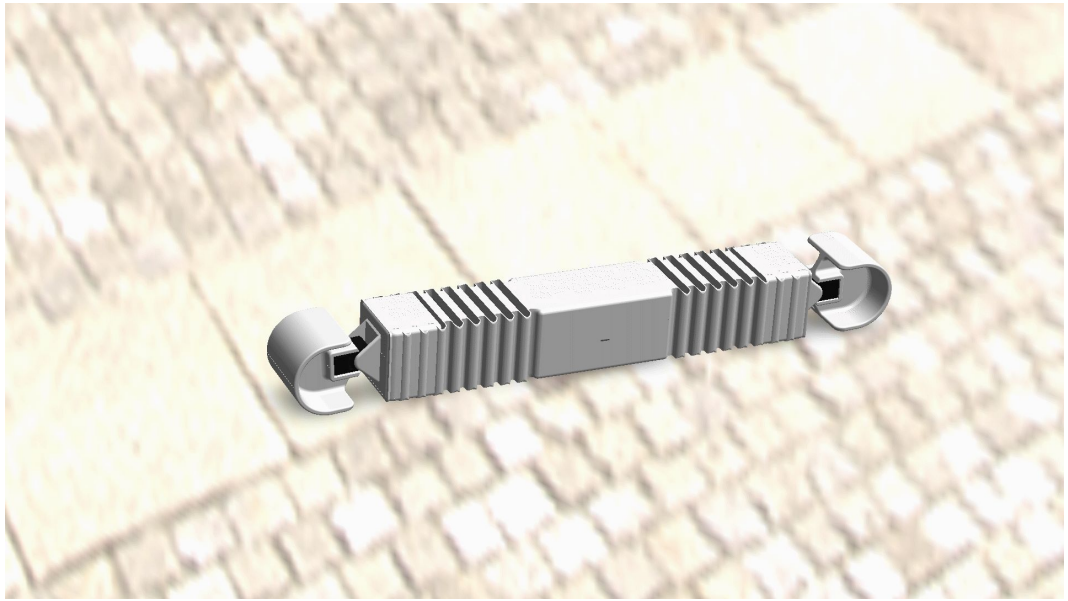
Electronics Inside



Battery Pack

Section View of Compliant Structure

Animation

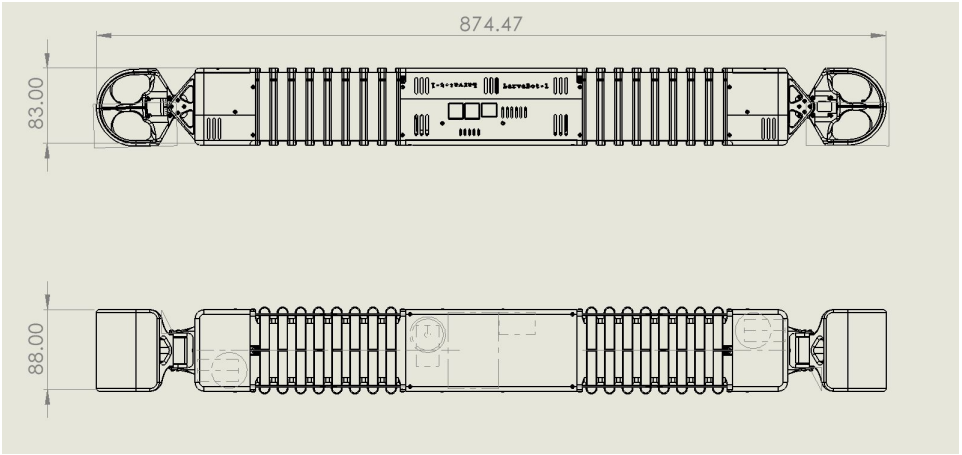


Animation of LarvaBot

https://drive.google.com/file/d/1ukUop9hFZ9QuNe5vlzJ8y0a83OQrYM3e/view?usp=sharing

Dimensions and Specs

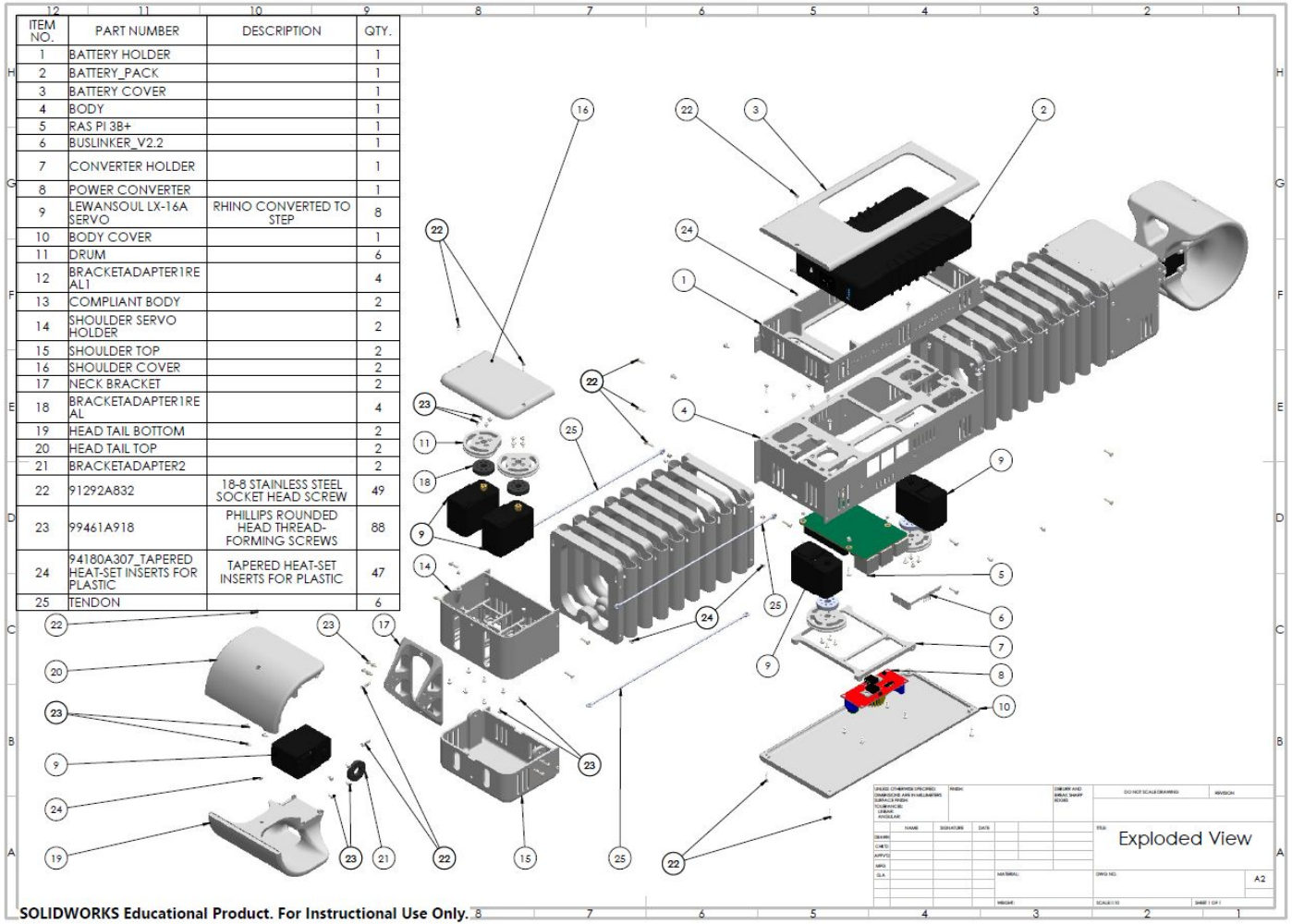
- Dimension: 847.5 x 83.0 x 88.0 (mm)
- Estimated Mass: 0.8kg
- Speed: 8cm/s

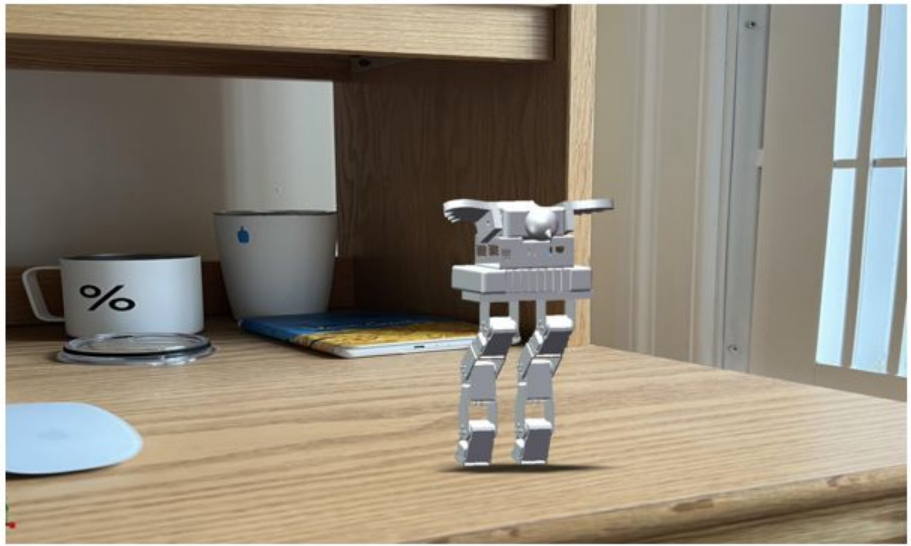


Dimension of LarvaBot

Exploded View and Bill of Material

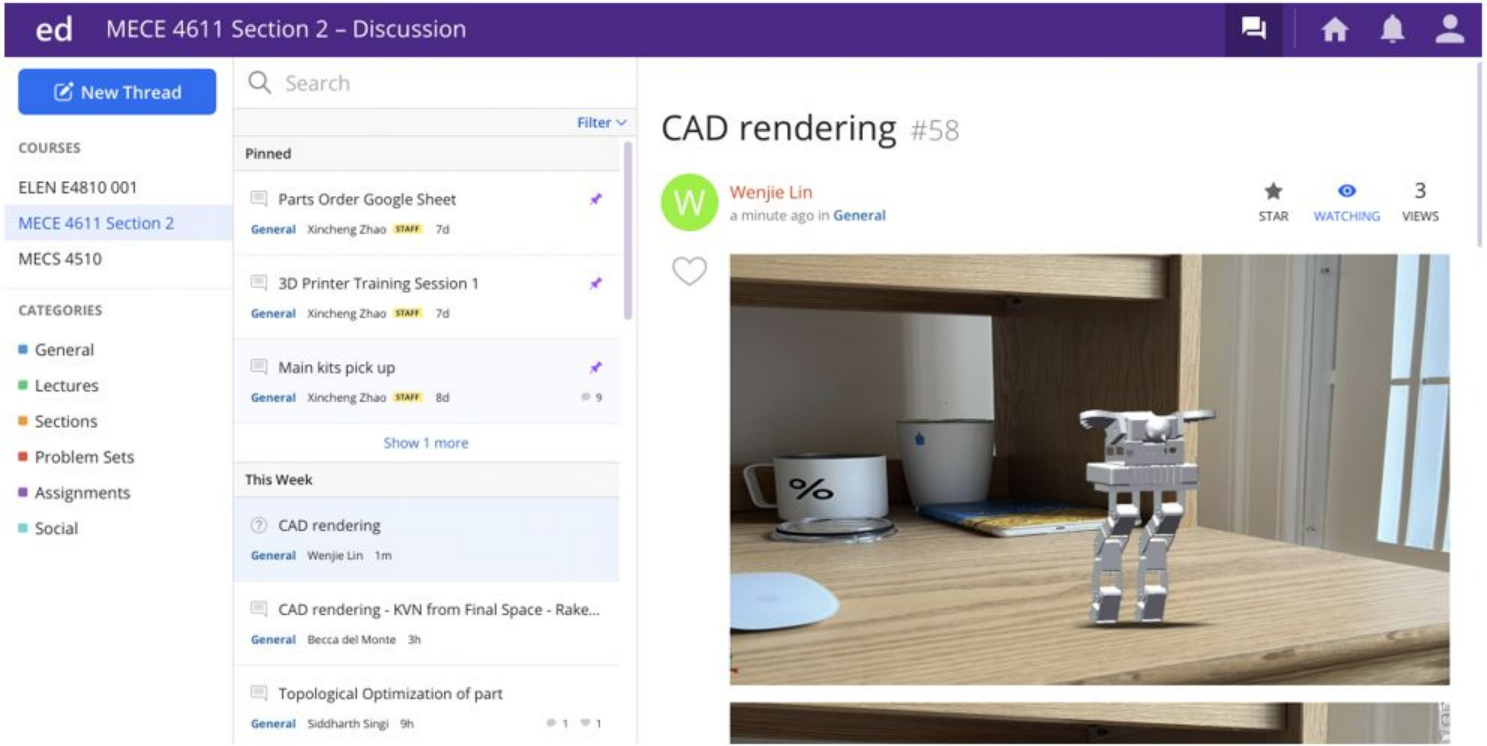
ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	BATTERY HOLDER		1
2	BATTERY_PACK		1
3	BATTERY COVER		1
4	BODY		1
5	RAS PI 3B+		1
6	BUSLINKER_V2.2		1
7	CONVERTER HOLDER		1
8	POWER CONVERTER		1
9	LEWANSOUL LX-16A SERVO	RHINO CONVERTED TO STEP	8
10	BODY COVER		1
11	DRUM		6
12	BRACKETADAPTER1REAL1		4
13	COMPLIANT BODY		2
14	SHOULDER SERVO HOLDER		2
15	SHOULDER TOP		2
16	SHOULDER COVER		2
17	NECK BRACKET		2
18	BRACKETADAPTER1REAL		4
19	HEAD TAIL BOTTOM		2
20	HEAD TAIL TOP		2
21	BRACKETADAPTER2		2
22	91292A832	18-8 STAINLESS STEEL SOCKET HEAD SCREW	49
23	99461A918	PHILLIPS ROUNDED HEAD THREAD-FORMING SCREWS	88
24	94180A307_TAPERED HEAT-SET INSERTS FOR PLASTIC	TAPERED HEAT-SET INSERTS FOR PLASTIC	47
25	TENDON		6





Robotics Studio MECE 4611
21 Fall
Assignment 3
Wenjie Lin
wl2789
Date Submitted: 15:15 10/12/2021
Grace Hour(before submission: 80, used/gained: 9, after submission: 89)
Title of Robot: Birdman

Ed Post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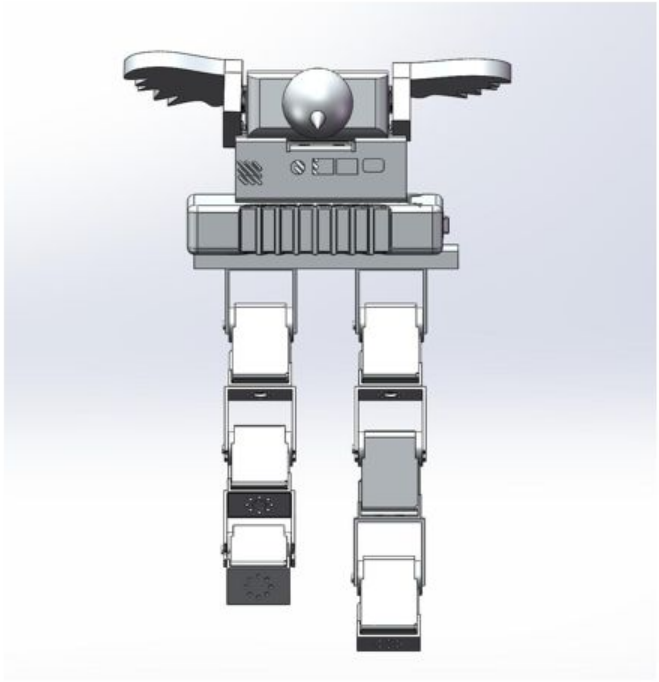
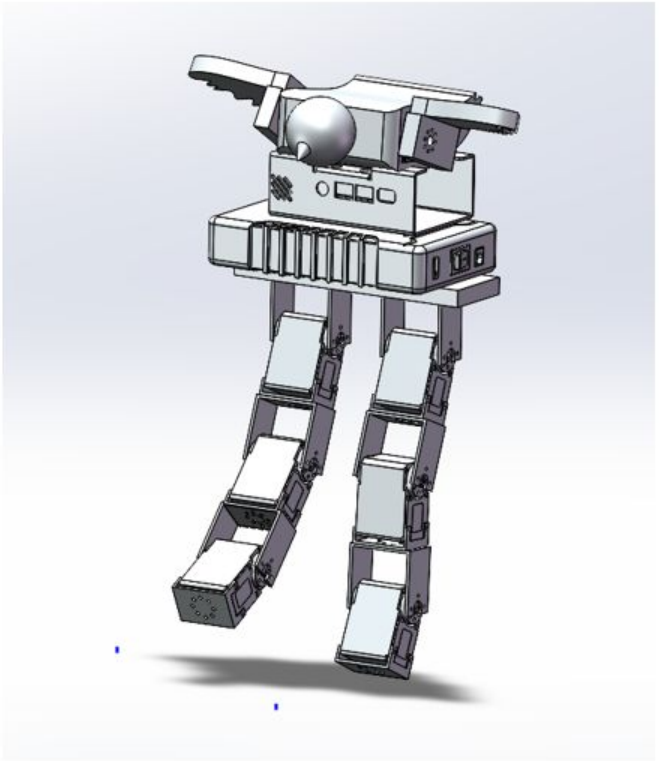
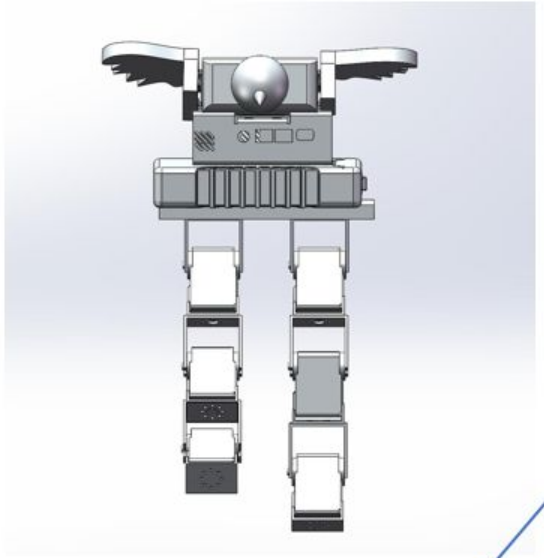
MECE 4611 Section 2 – Discussion
New Thread
COURSES
ELEN E4810 001
MECE 4611 Section 2
MECS 4510
CATEGORIES
General
Lectures
Sections
Problem Sets
Assignments
Social
Search
Filter
Pinned
Parts Order Google Sheet
General Xincheng Zhao STAFF 7d
3D Printer Training Session 1
General Xincheng Zhao STAFF 7d
Main kits pick up
General Xincheng Zhao STAFF 8d 9
Show 1 more
This Week
CAD rendering
General Wenjie Lin 1m
CAD rendering - KVN from Final Space - Rake...
General Becca del Monte 3h
Topological Optimization of part
General Siddharth Singi 9h 1 1
CAD rendering #58
W
Wenjie Lin
a minute ago in General
STAR
WATCHING
3
VIEWS

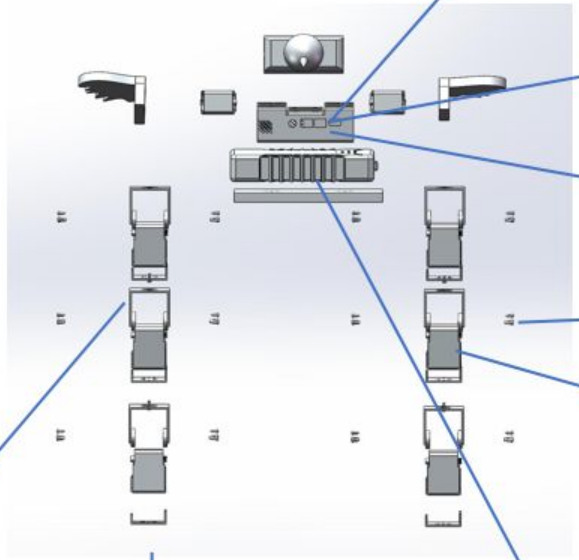
3D Renderings in perspective





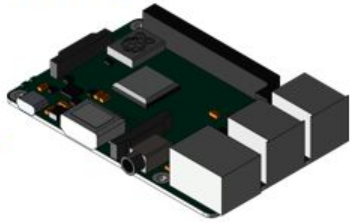
Key Components included





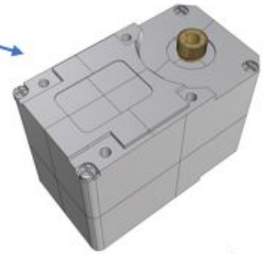
cable

Raspberry Pi



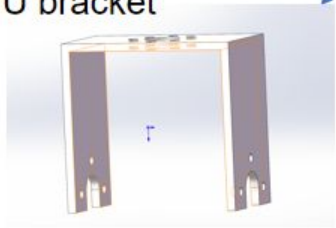
screw

Controller

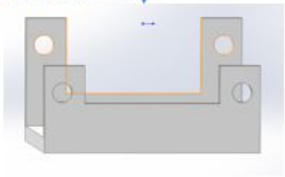


motor

U bracket

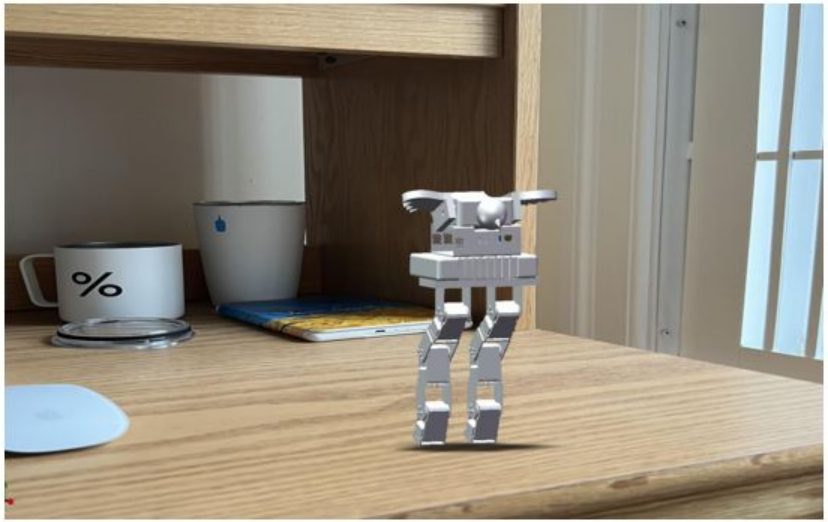


Bottom bracket



Battery

Organic Shape

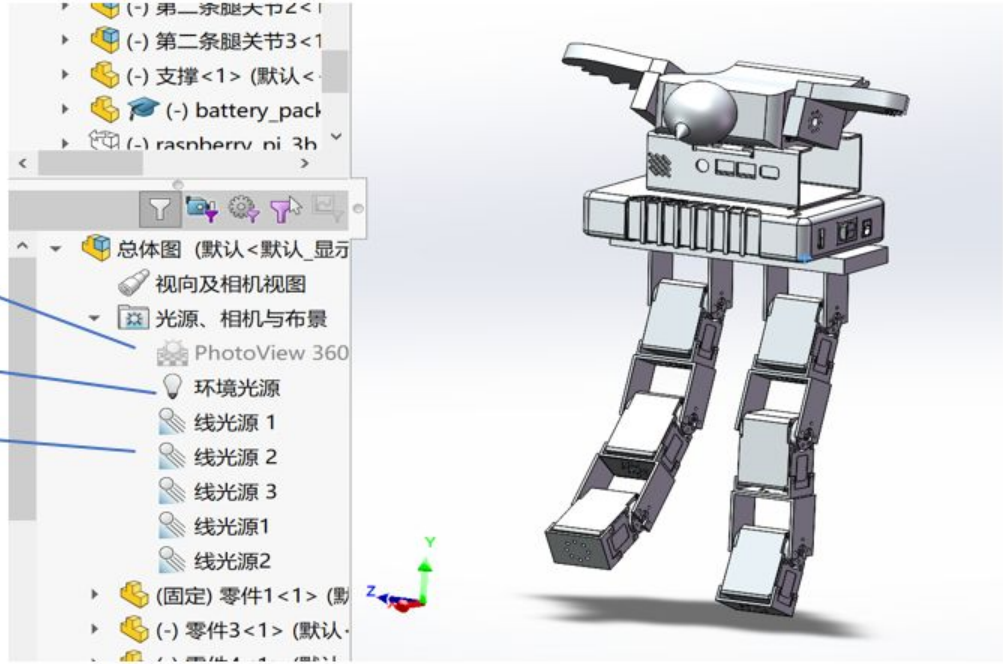


Photorealistic rendering

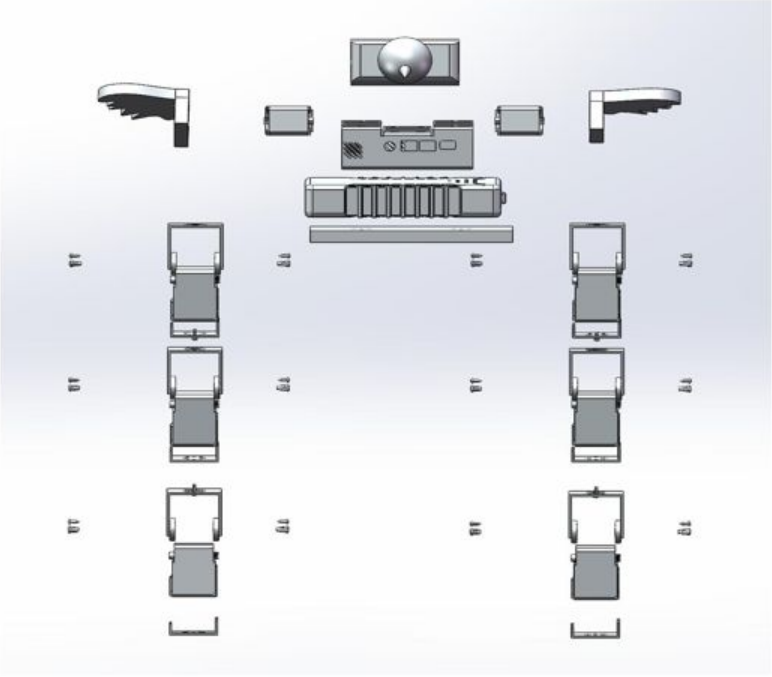
PhotoView 360 main light source

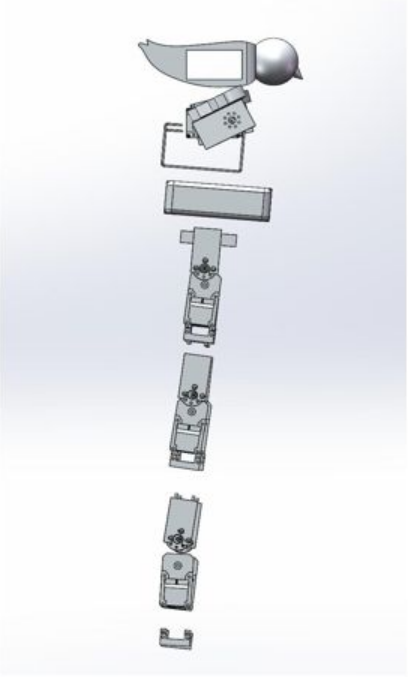
Environment light source

Line light source



Exploded view



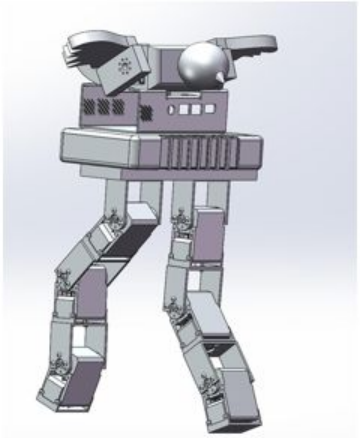


Key specs

1. Height: 161.71mm Length: 143mm Width: 23mm
2. Walking speed: 5cm/s
3. Running speed: 10cm/s
4. Jump Height: 1cm
5. Eight motors (6w each)
4. Battery Pack (3000 mAh)
5. Material: PLA

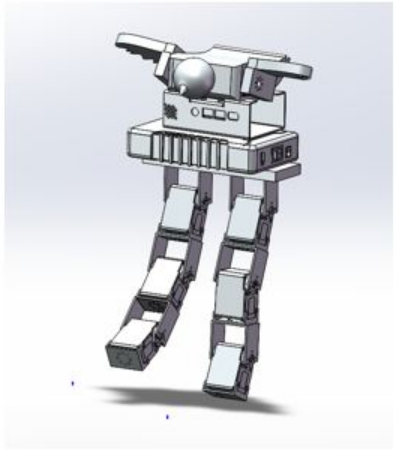
Multiple poses

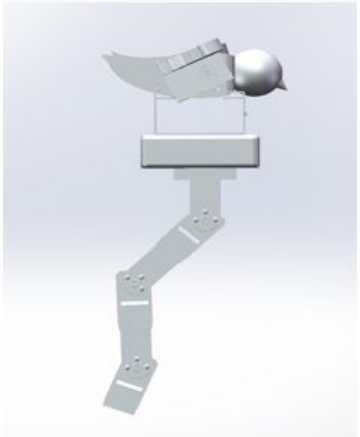
Stand



Run

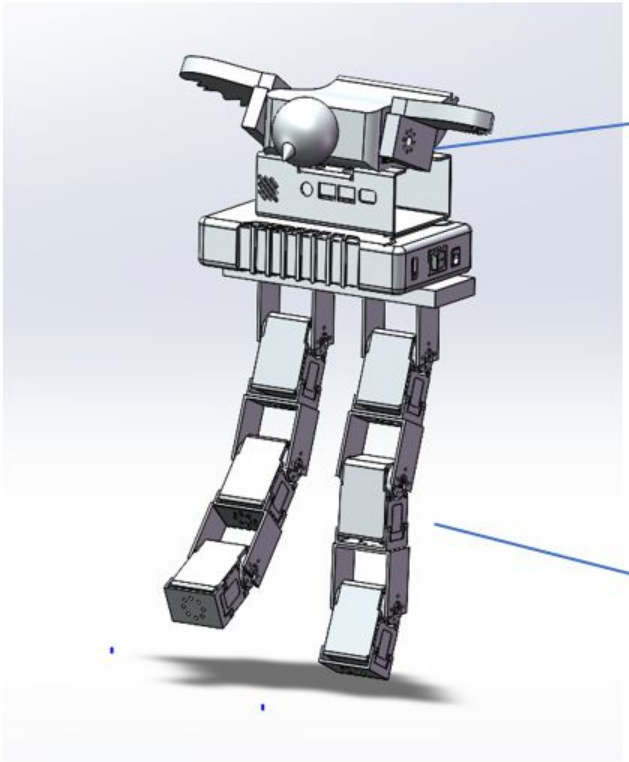
Walk

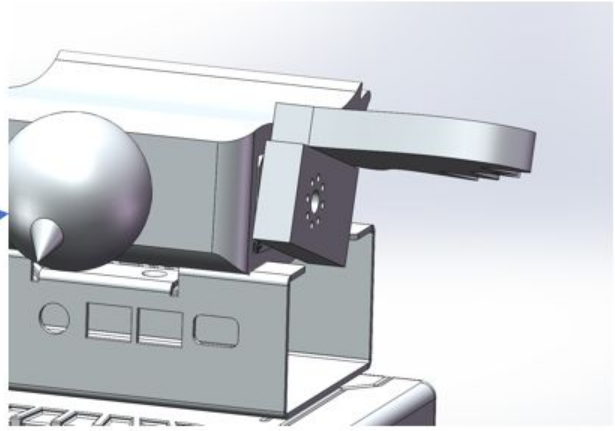


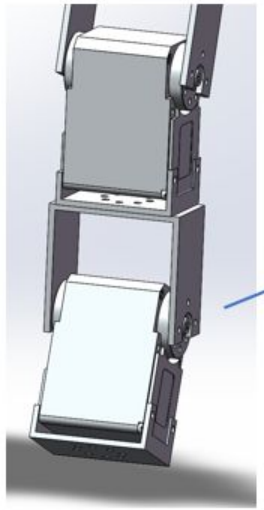


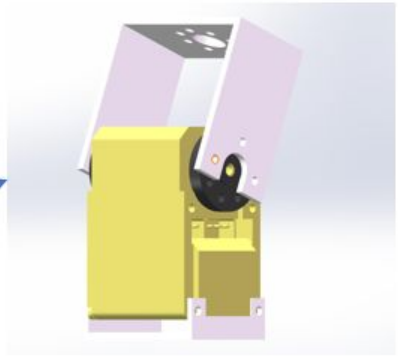
Fly(Jump)

Detail close-up

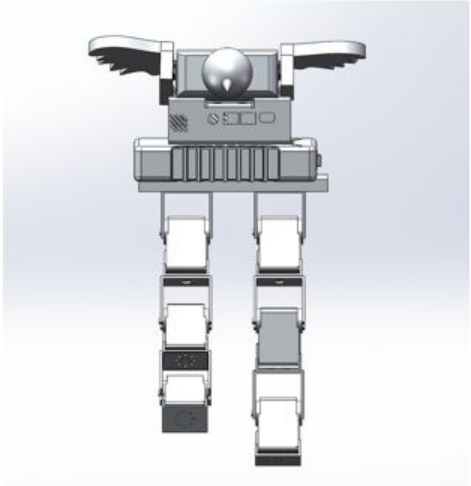


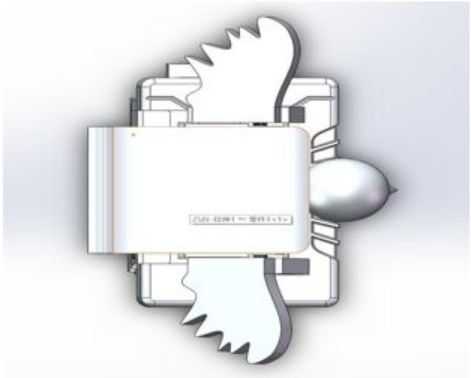






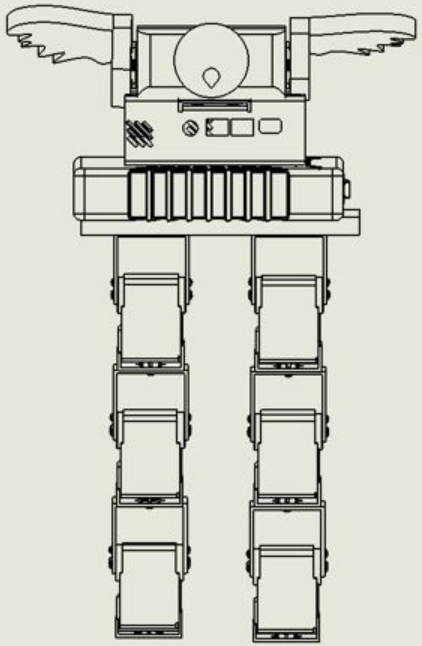
Side views with main dimensions





Bill of Materials

ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	U-SHAPED CONNECTOR	IRON	6
2	STEERING WHEEL	PLASTIC	12
3	STEERING GEAR CENTER SCREW M2	IRON	12
4	THE STEERING GEAR BASE	IRON	6
5	3D PRINTED PIECES	PLA	1
6	BATTERY	ELECTRONIC COMPONENTS	1
7	RASPBERRY	ELECTRONIC COMPONENTS	1
8	3D PRINTED PIECES FOR BIRD BODY	PLA	1
9	3D PRINTED PIECES FOR BIRD WING	PLA	2
10	RASPBERRY_BOX	PLASTIC	1
11	SCREW M2	IRON	36
12	SERVO MOTOR FRONT BRACKET	STEEL	8



Robotics Studio MECE 4611 Assignment 2

Xingsheng Wei

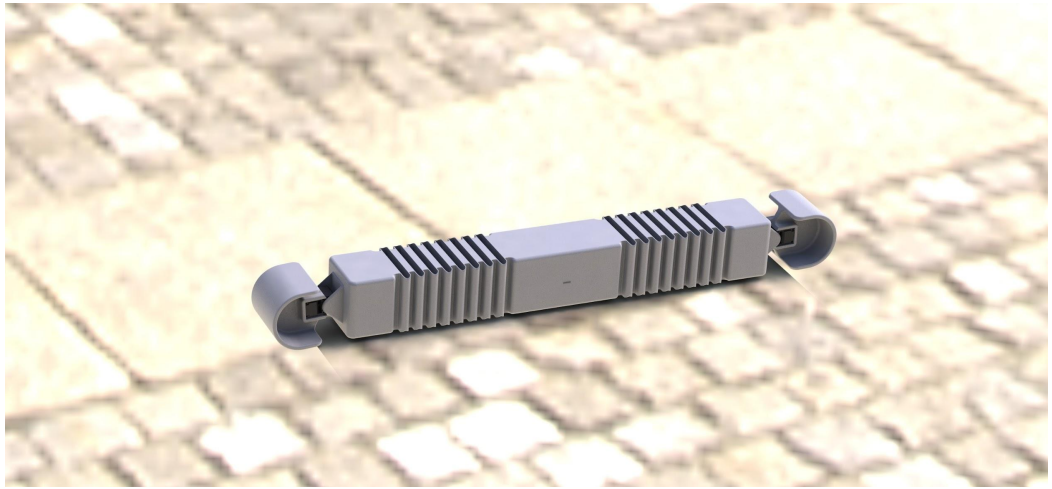
UNI: xw2815

Robot: LarvaBot

Semester: Fall 2021

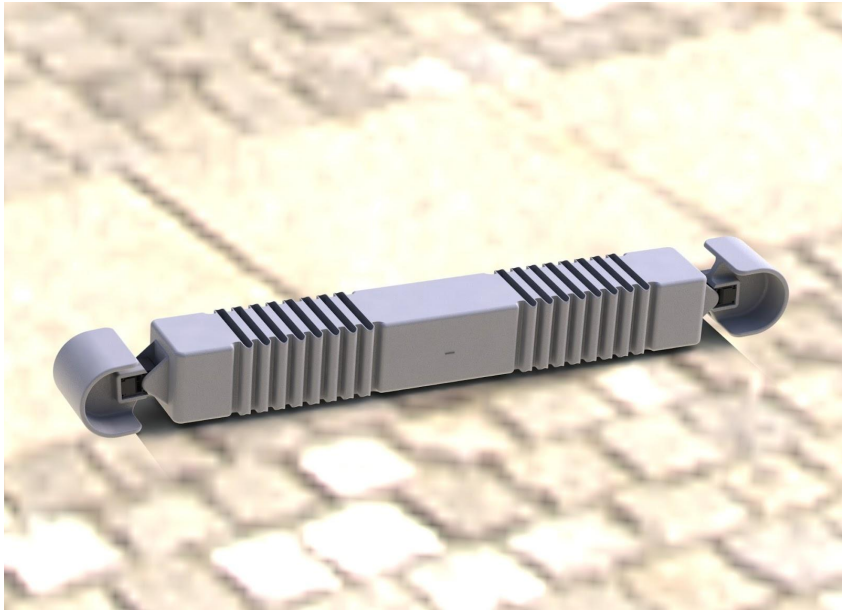
Submitted at: 9/28/2021 10:10pm

Grace hours: 1

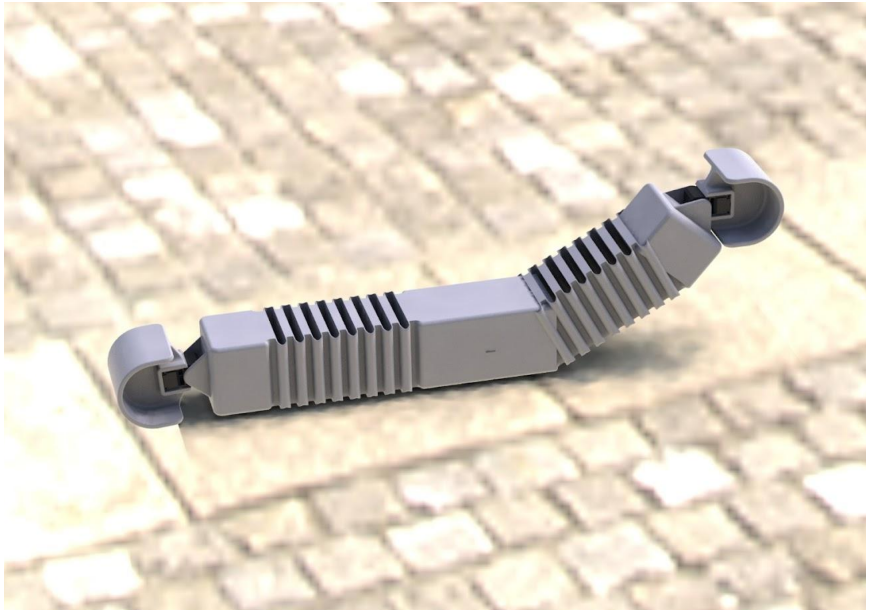


LarvaBot

Poses Renders

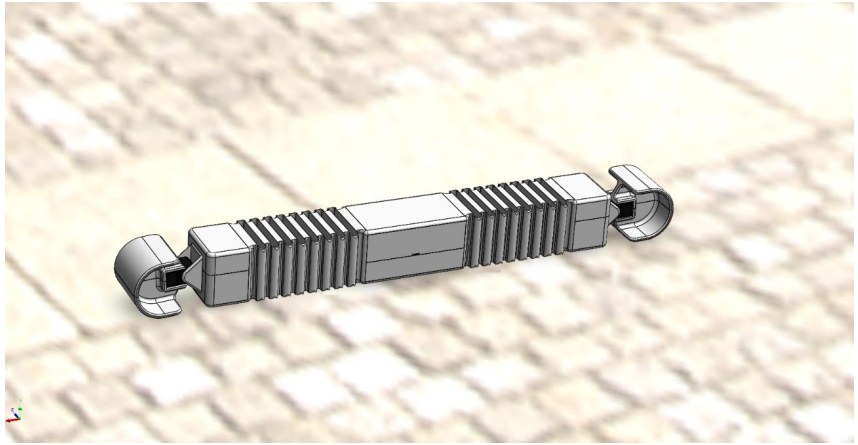


Relax

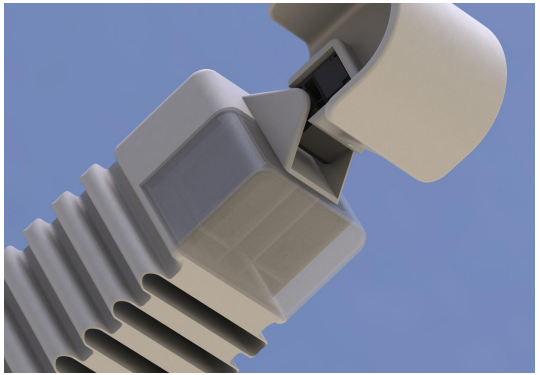


Raise Head

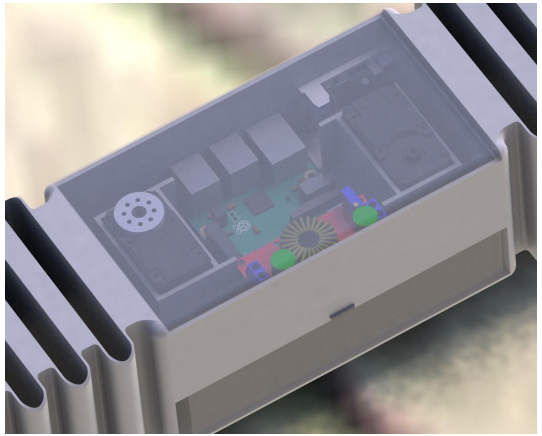
Components



Render with Edges

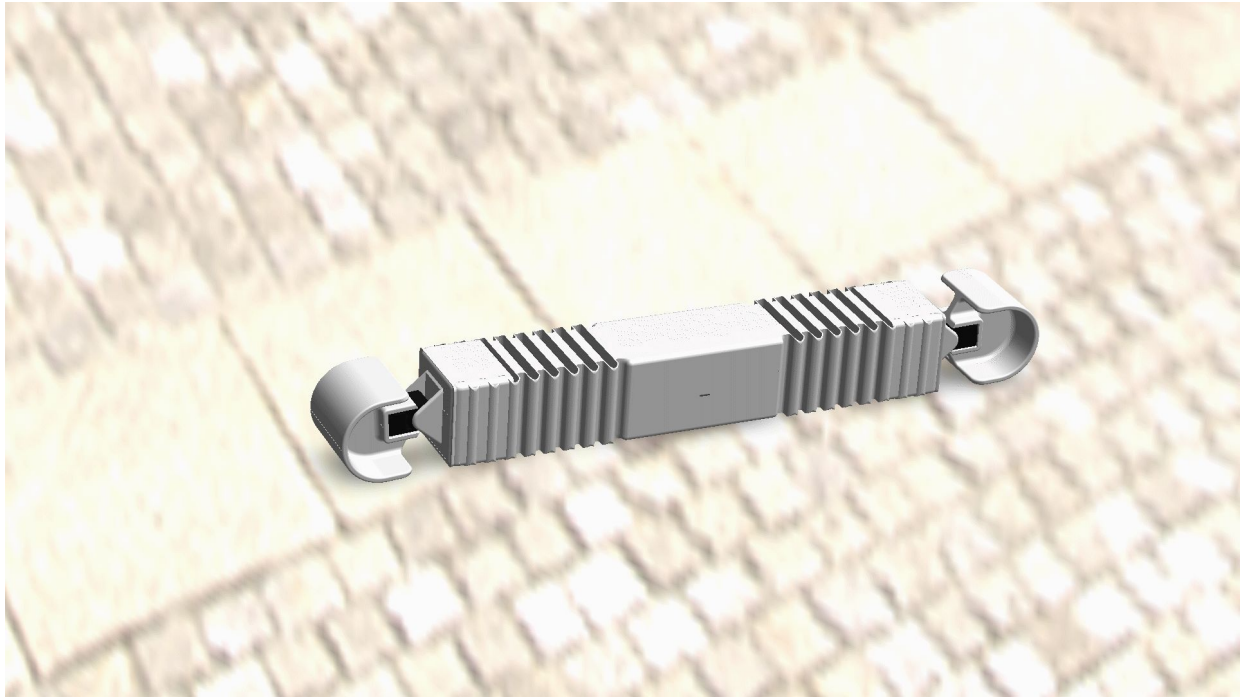


Motors in Head and Tail



Electronics in the Body

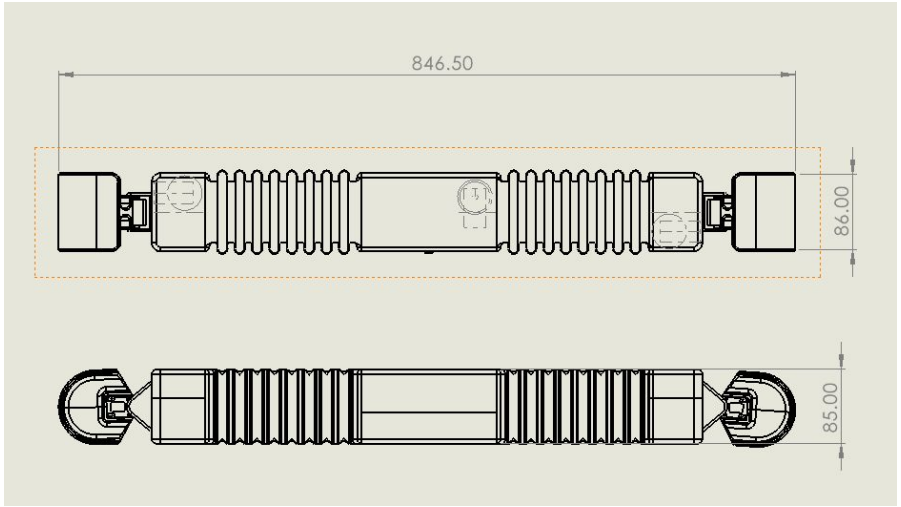
Animation



Animation of LarvaBot

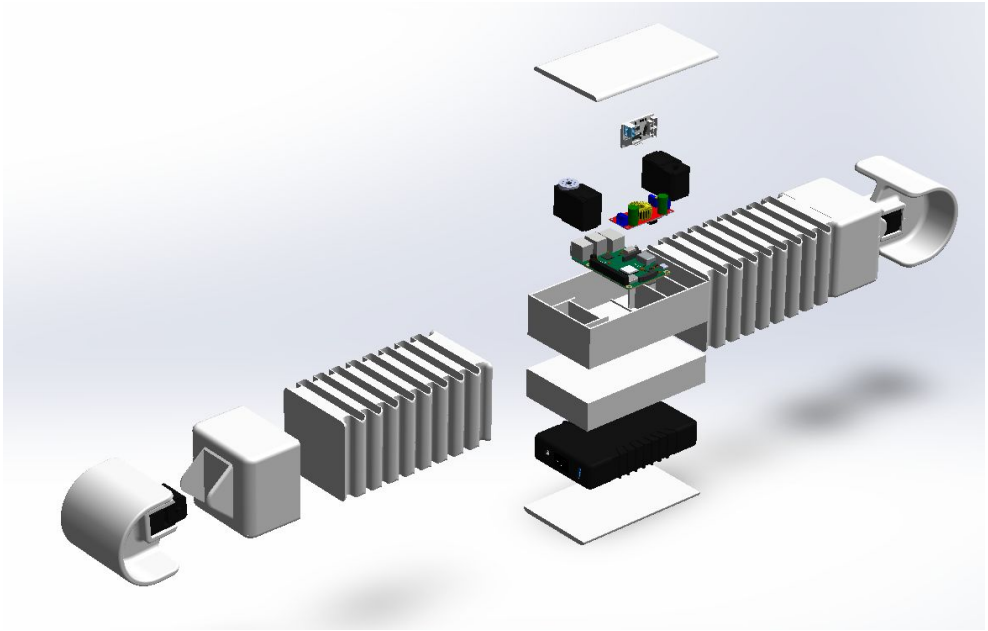
Dimensions and Specs

- Dimension: 846.5 x 86.0 x 85.0 (mm)
- Estimated Mass: 0.8kg
- Speed: 80mm/s

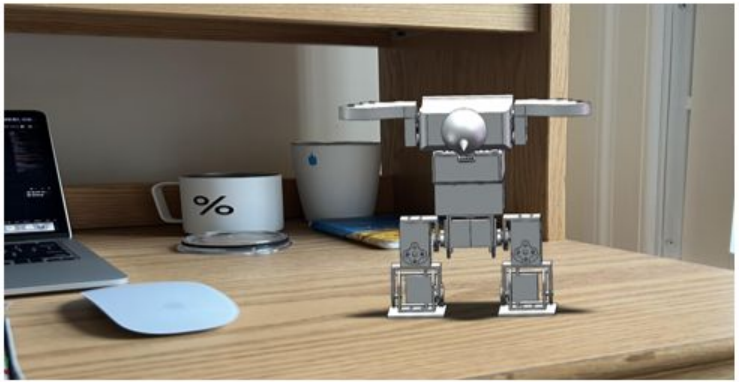


Dimension of LarvaBot

Exploded View



Exploded View of LarvaBot



Robotics Studio MECE 4611
21 Fall
Assignment 2
Wenjie Lin
wl2789
Date Submitted: 9/29 23:59
Grace Hour(before submission: 104, used/gained: 24, after submission: 80)
Title of Robot: Birdman

Ed Post

ed MECE 4611 Section 2 – Discussion

New Thread

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MECS 4510

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- Problem Sets
- Assignments
- Social

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Pinned

Welcome!
General Hod Lipson STAFF 9d 1

This Week

CAD renderings of Robot Dog by Junyi Lin
Assignments – A2 Junyi Lin 10m

KVN rendering - Becca and Rakesh
General Becca del Monte 8h 2

CAD Rendering - Eric-Deborahbot 5001 - Pra...
Assignments – A2 Pragyendra Bagediya 14h 2

CAD Rendering : Tejas and Shubhajeet- Tall-E
Assignments – A2 Tejas Tayade 16h 2

Preliminary CAD
Assignments – A2 Wenjie Lin 1d 2

Preliminary CAD #37

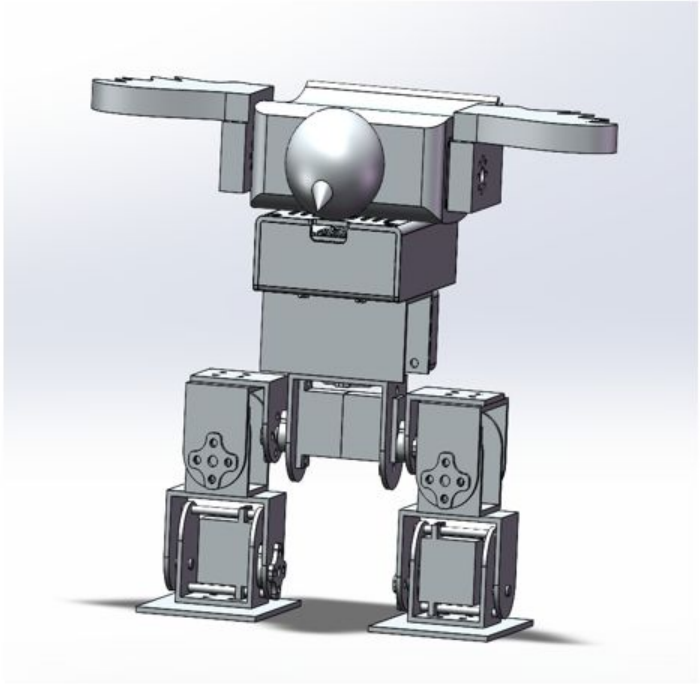
Wenjie Lin
a day ago in Assignments – A2

STAR WATCHING 46 VIEWS

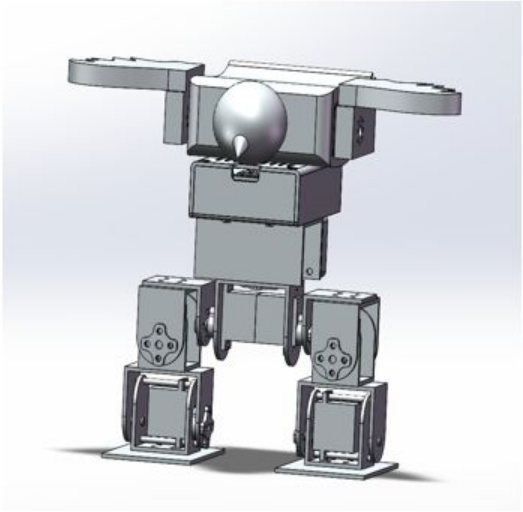
2

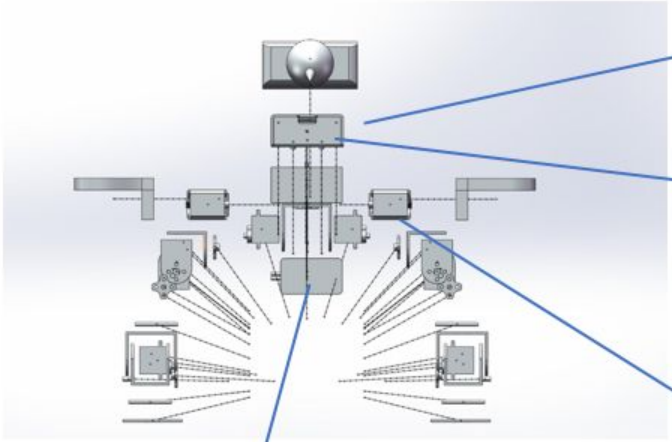
It's the preliminary CAD of my robot. And I'll update it later. Thank you!

3D Renderings in perspective

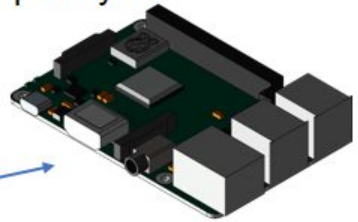


Key Components included





Raspberry Pi

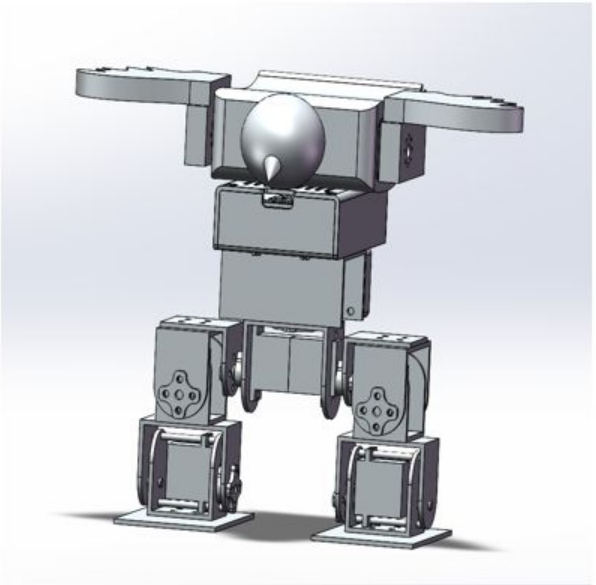


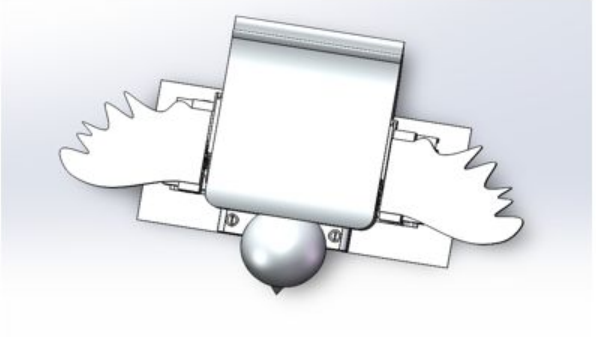
Controller

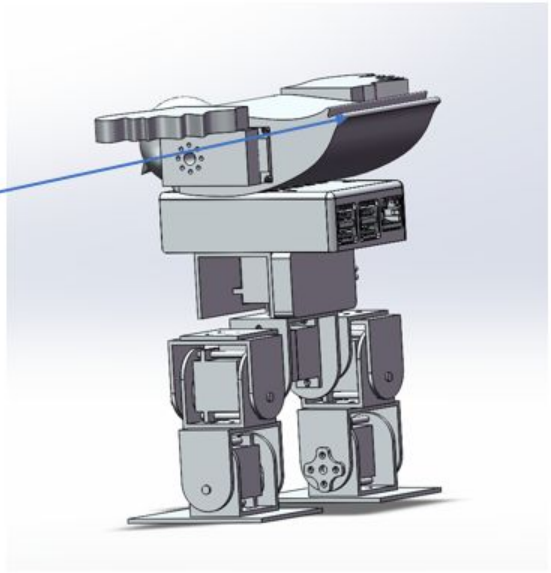
motor

Battery

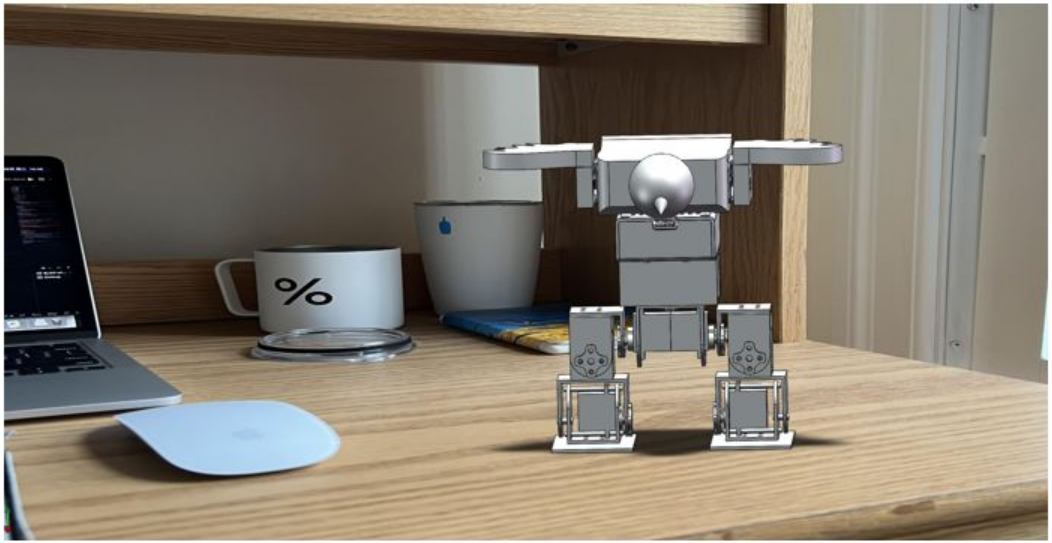
Side views with main dimensions







Organic Shape

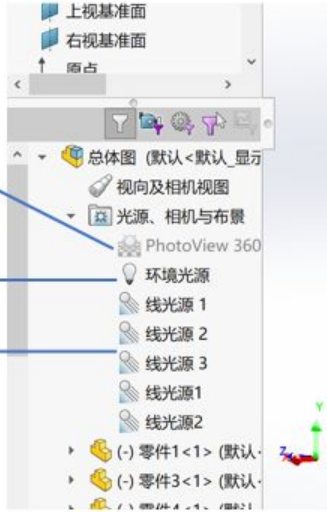


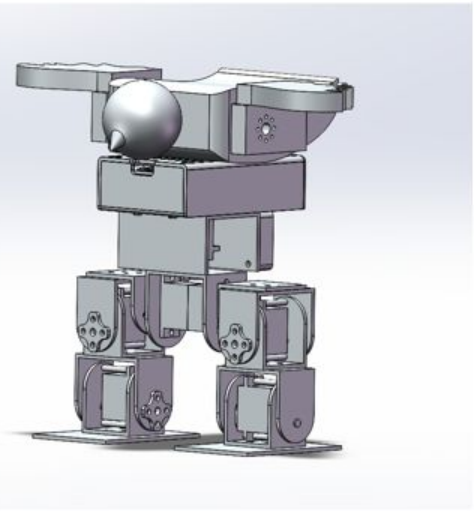
Photorealistic rendering

PhotoView 360 main light source

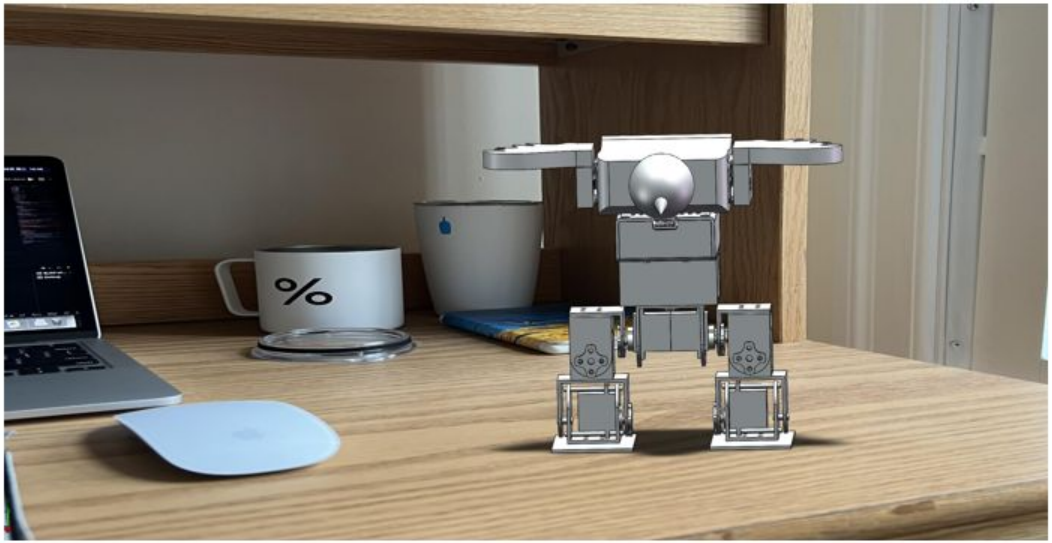
Environment light source

Line light source



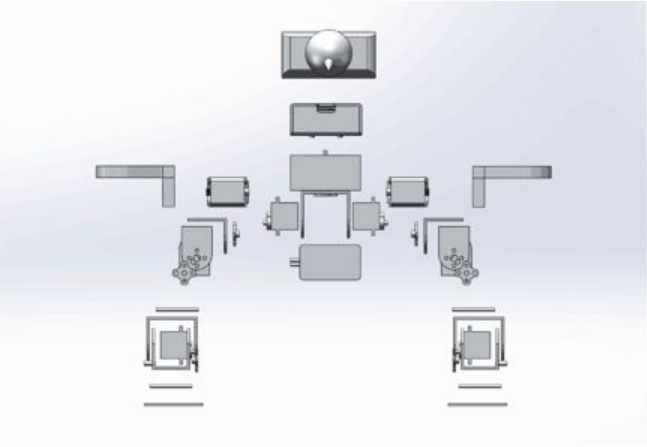


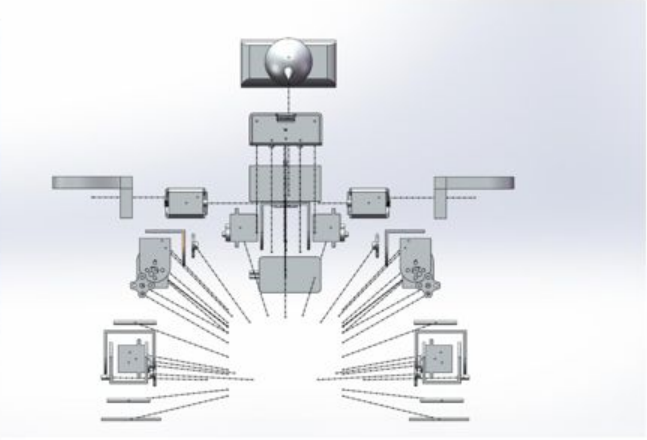
context rendering

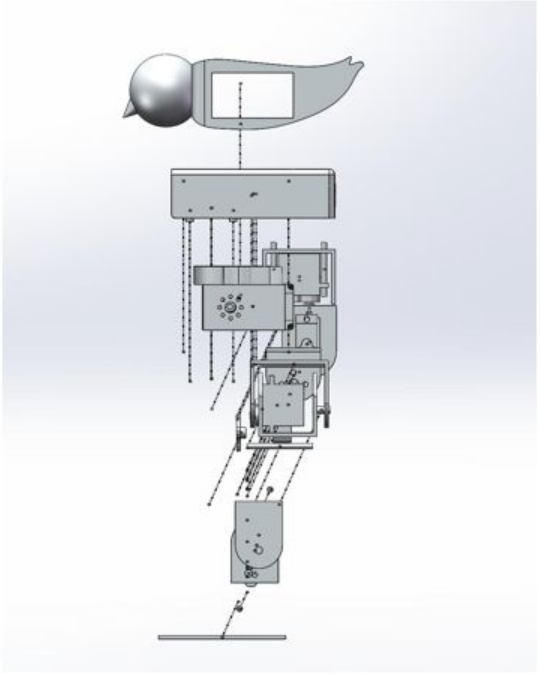


Birdman On the table(161.71mm Height)
Almost as tall as a mac pro

Exploded view





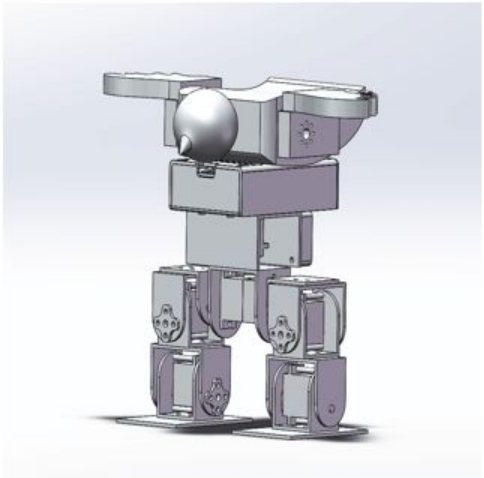


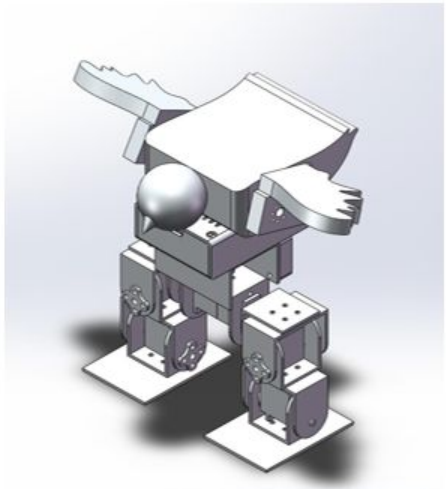
Key specs

1. Height: 161.71mm Length: 143mm Width: 23mm
2. Walking speed: 5cm/s
3. Eight motors (6w each)
4. Battery Pack (3000 mAh)
5. Material: PLA

Multiple poses

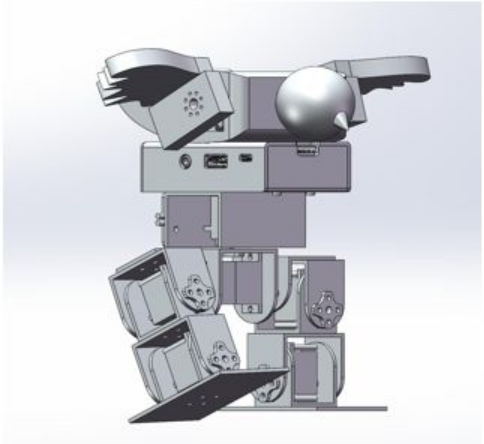
Stand

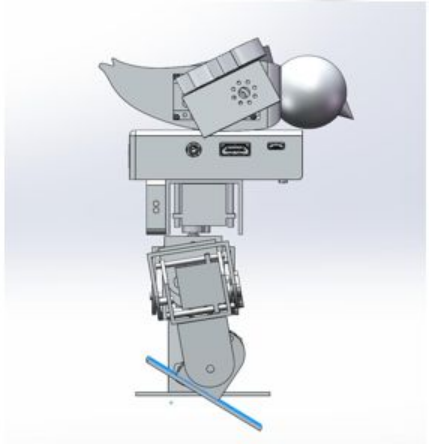




Glide

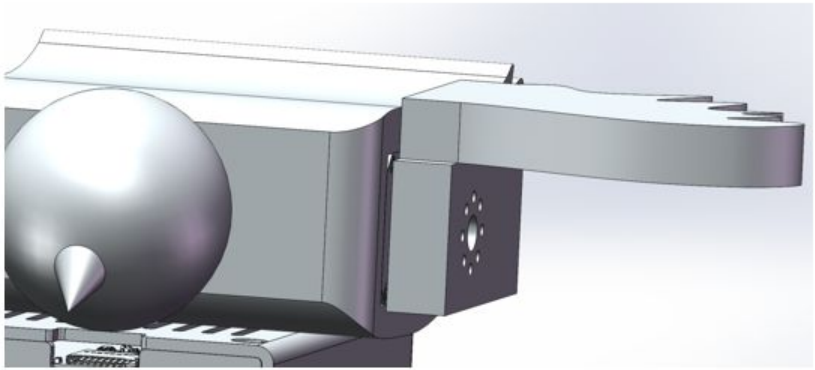
Walk

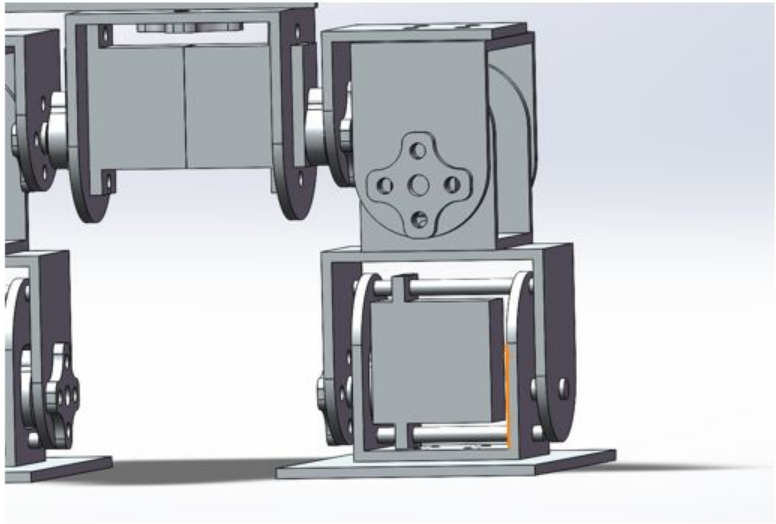




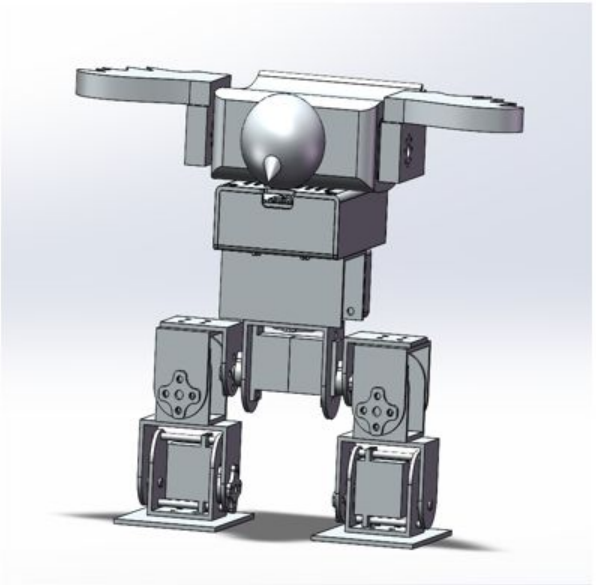
Fly(Jump)

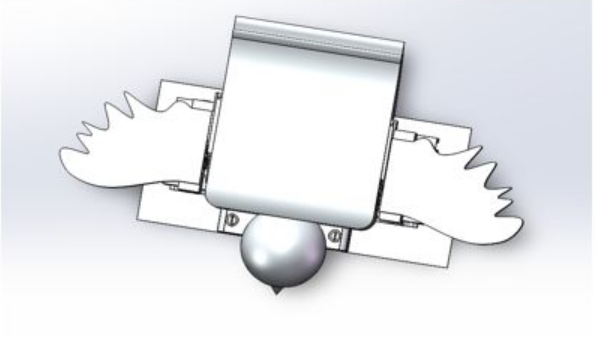
Detail close-up

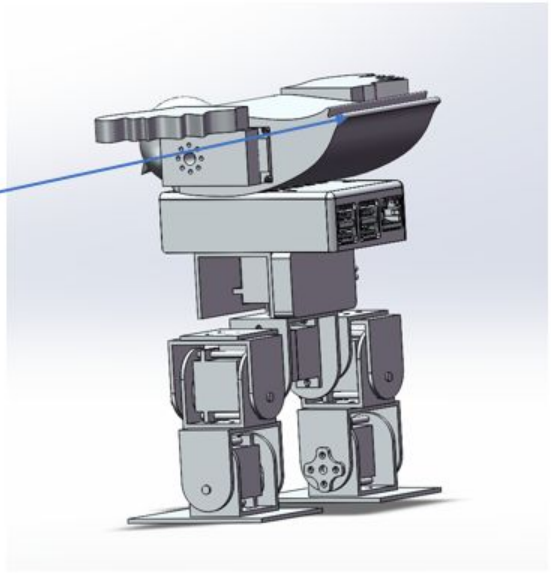




Side views with main dimensions







Sharing CAD components on GrabCAD

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Birdman Robot and its parts

Wenjie Lin
September 30th, 2021

Robot
Head and wing

Edit model

Download files

Like Share

0 Downloads 0 Likes 0 Comments

Files (4)

Birdman Robot and its parts /			
	Birdman's movement.jpg	jpg	September 30th, 2021
	Birdman's Head.SLDPRT	sldprt	September 30th, 2021
	Birdman's wing.SLDPRT	sldprt	September 30th, 2021
	Birdman Robot.SLDASM	sldasm	September 30th, 2021

Details

Uploaded: September 30th, 2021
Software: Rendering, SOLIDWORKS, SOLIDWORKS, SOLIDWORKS
Categories:
Tags:

Report this model

Comments

Robotics Studio MECE 4611 Assignment 1

Xingsheng Wei

UNI: xw2815

Semester: Fall 2021

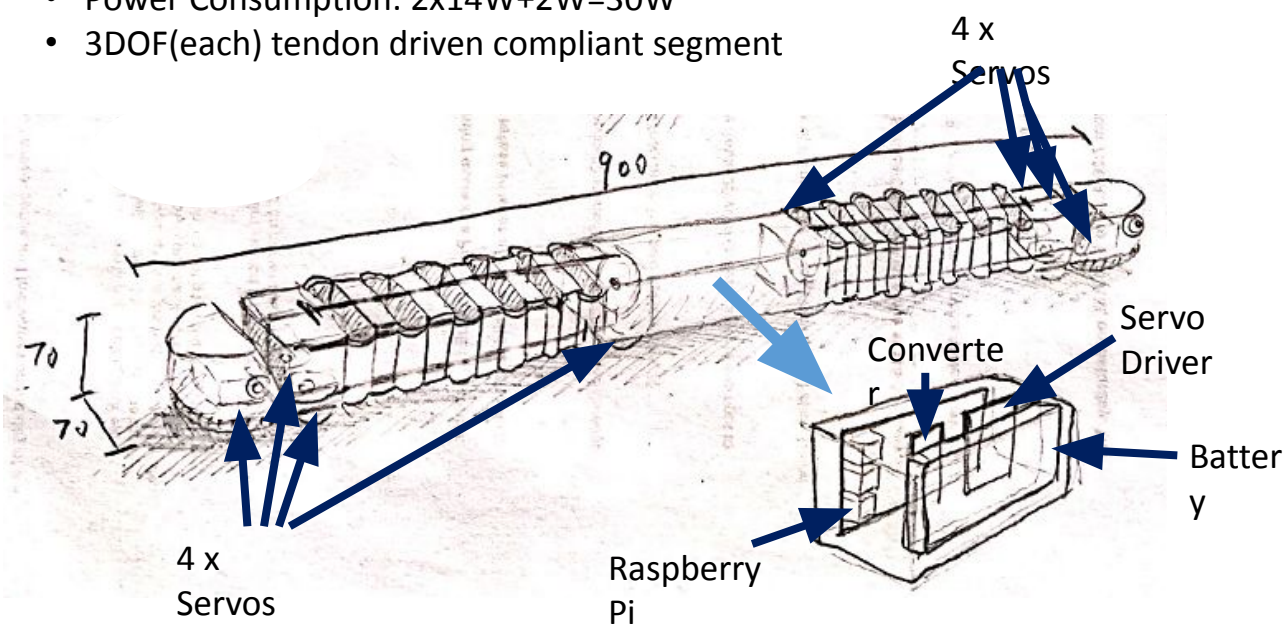
Submitted at: 9/23/2021 11:40am

Grace hours: 12

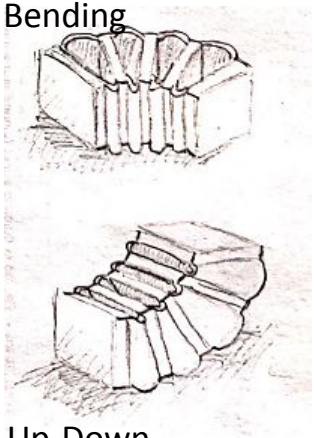
Concept 1: EarthWormBot

EarthWormBot

- Unit: mm
- Estimated Mass: 8x43g(servo)+190g(battery)+42g(raspberry Pi)+300g(rest of the body)=876g
- Power Consumption: 2x14W+2W=30W
- 3DOF(each) tendon driven compliant segment



Left-Right Bending



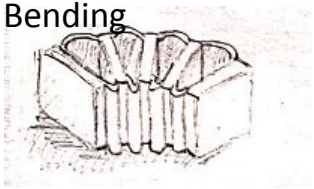
Up-Down Bending

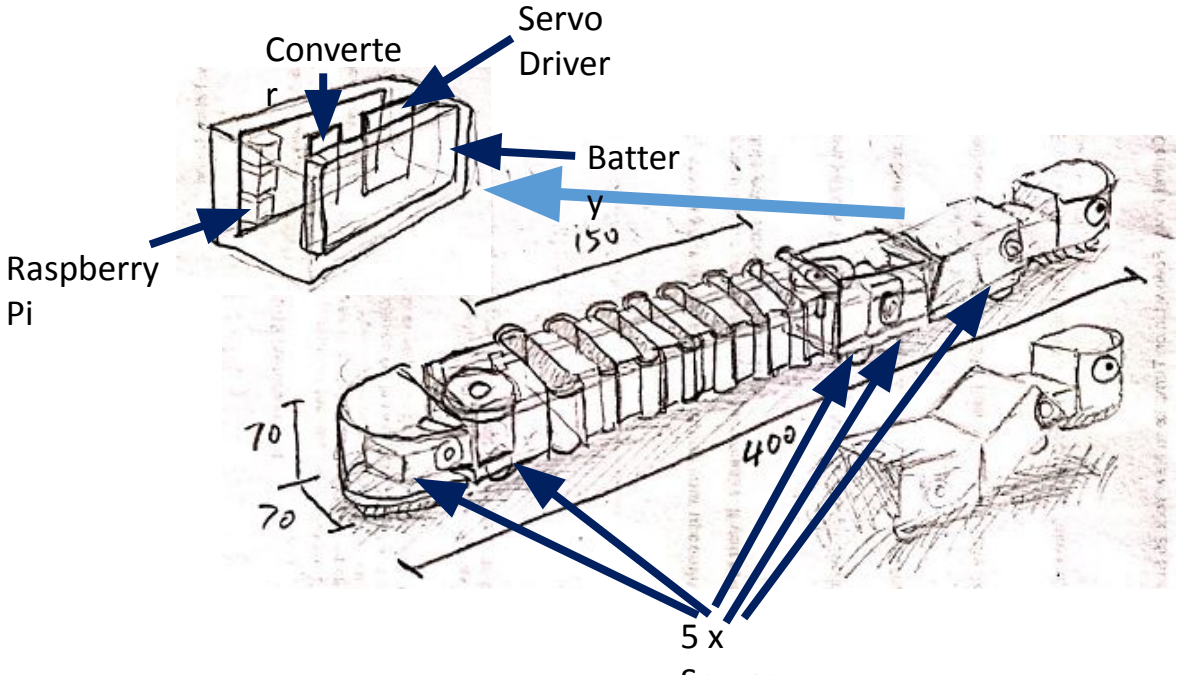
Concept 2: LarvaBot

LarvaBot

- Unit: mm
- Estimated Mass: 5x43g(servo)+190g(battery)+42g(raspberry Pi)+200g(rest of the body)=647g
- Power Consumption: 14W+8W=22W
- 2DOF tendon driven compliant segment, 2DOF head with gripping

Left-Right Bending





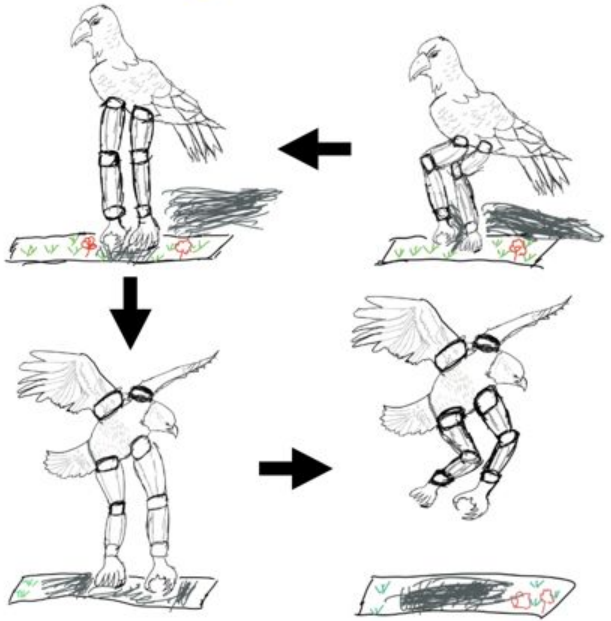
Concept 3: SilkWormBot

Robotics Studio MECE 4611
21 Fall
Assignment 1
Wenjie Lin
UNI: wl2789
Date/Time Submitted: 9/23, 4pm
Grace hours (before submission: 96, used/gained: 8, after submission: 104),

Columbia Goalkeeper

Onetoothree

Eagle Force One

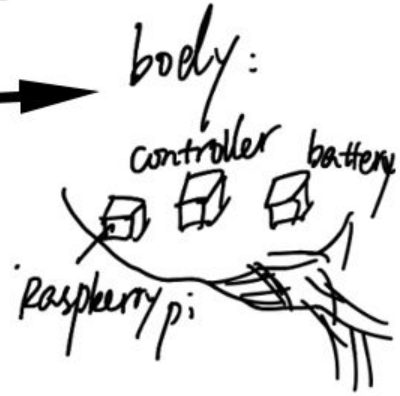


Eagle Force One

Eagle Force One

Estimation:

Weight = 0.5kg(upper body) + 1 kg(legs and feet) + 0.5kg(8 motors) = 2 kg
Height: 150 mm Length: 100 mm Width : 60 mm
Power: 4.33 w * 8 = 34.64 w
Maximum Torque = F * L ≈ 25 N.cm

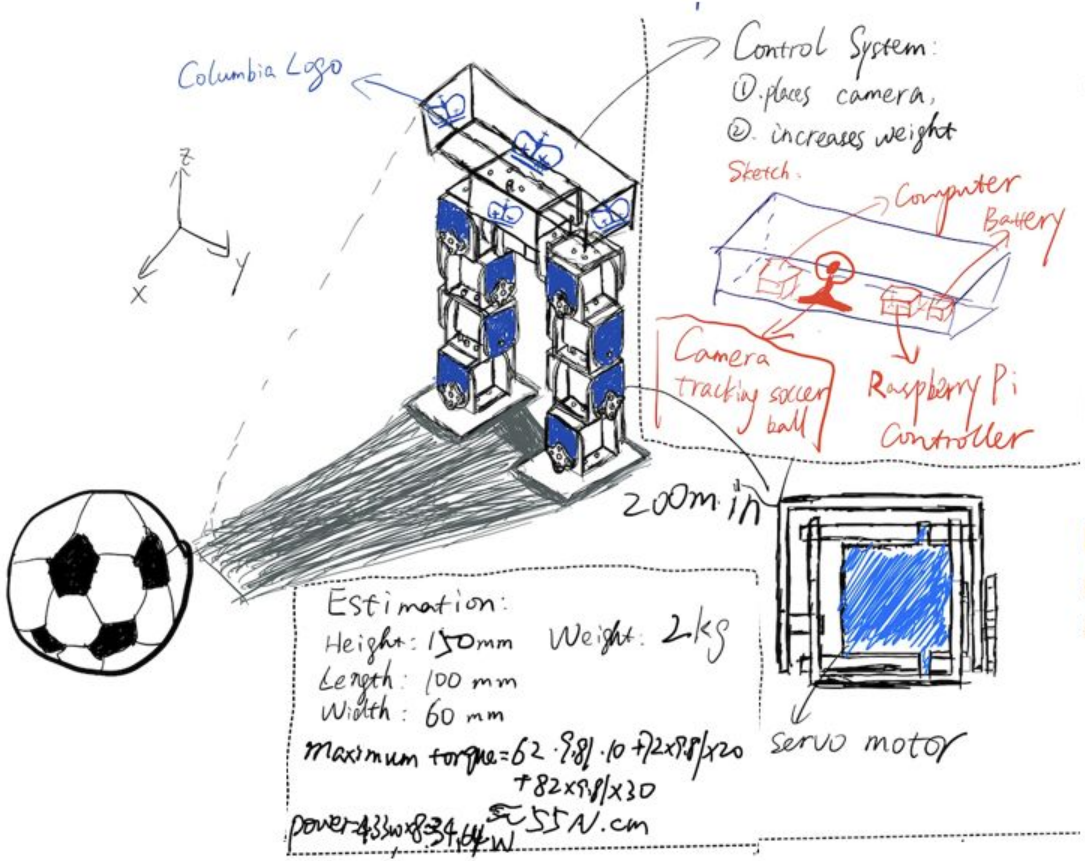


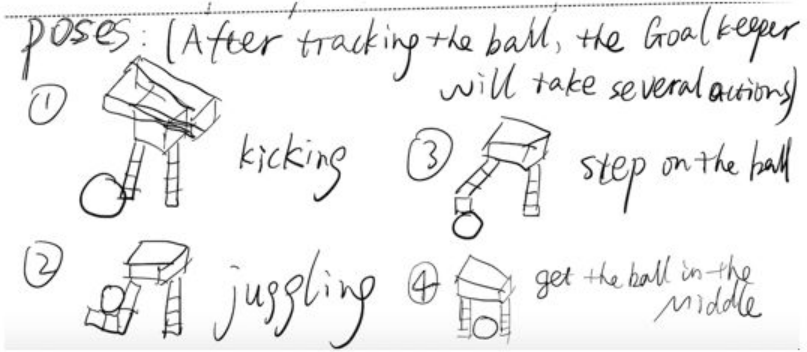
Two wings are respectively connected with eagle's body by two motors.

Three motors per leg

Columbia Goalkeeper

Columbia Goalkeeper

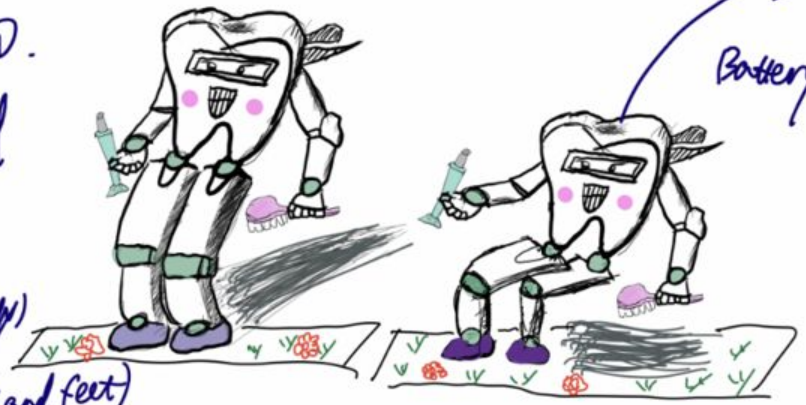




Idea: First, the Goalkeeper uses the camera to capture the soccer ball, then walks towards it and has some motions.

Onetoothree

Onetoothree



pose ①.
Stand

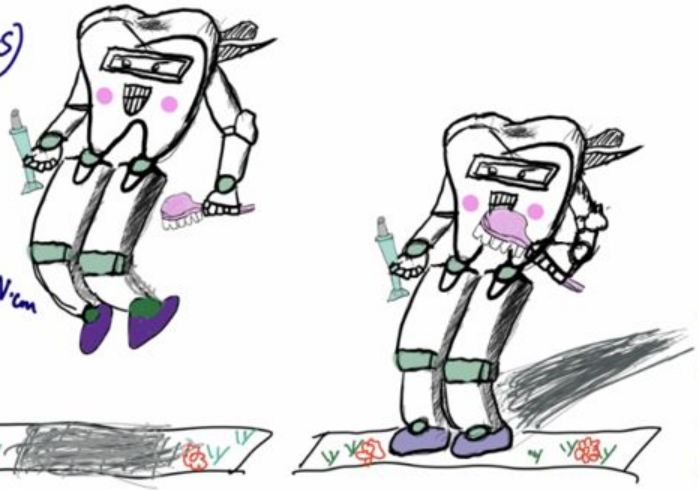
Tooth Brain
Battery → Raspberry Pi computer

pose ②
Squart

Estimation:

Weight = 0.5 kg (upper body)
+ 0.5 kg (legs and feet)
+ 0.5 kg (8 motors)
≒ 1.5 kg

Height : 163 mm Length : 60 mm
Width : 40 mm
Power : 4.33×8 = 34.64 W
Maximum Torque = F×L ≒ 2 N·cm



pose ③
Jump

pose ④
Toothbrushing

It's onetoothree robot looking like a tooth having two legs and it can dance and have some motions.