Robot Pupper Showcase

May 25th | 3:05-4:15 pm | Zoom

Faculty Advisor

Professor David Copp

- UCI MAE Prof
- Ph.D, UCSB 2016

Engineering Director

Lorjean Sagabaen

- 4th year
- MAE major

Interns

Robert Ebojo

- 4th year
- SWE

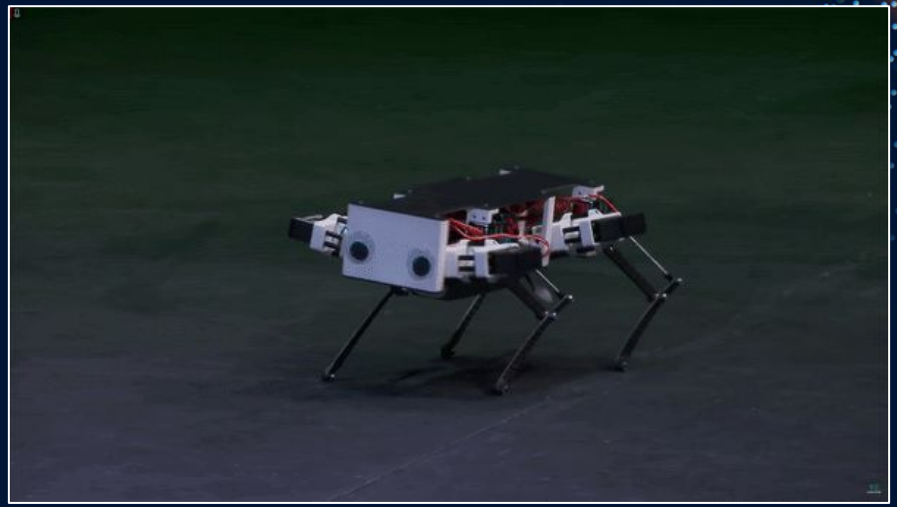
Alexandra Zhang Jiang

- 1st year
- CSE major

Project Overview

- 26 members, 4 teams
- Make dog
- Thx Colin

Stanford Pupper



Design Restriction

- $1500 budget for each team
- Must be reminiscent of a dog (four legs, head, eyes, or tail)
- Must be able to receive input from voice recognition sensors and/or a controller for basic commands

Scoring System

Features

1. Can move (40)
2. Sit (10)
3. Stand (10)
4. Walk (30)
5. Run (10)
6. Crawl (10)
7. Incline / decline (10)
8. Jumping (30)
9. Object Detection (30)
10. Speak (30)
11. Dance (30)
12. Attack (30)
13. Voice Recognition (40)
14. Wireless (20)
15. Other
16. Best feature set (depends on vote)

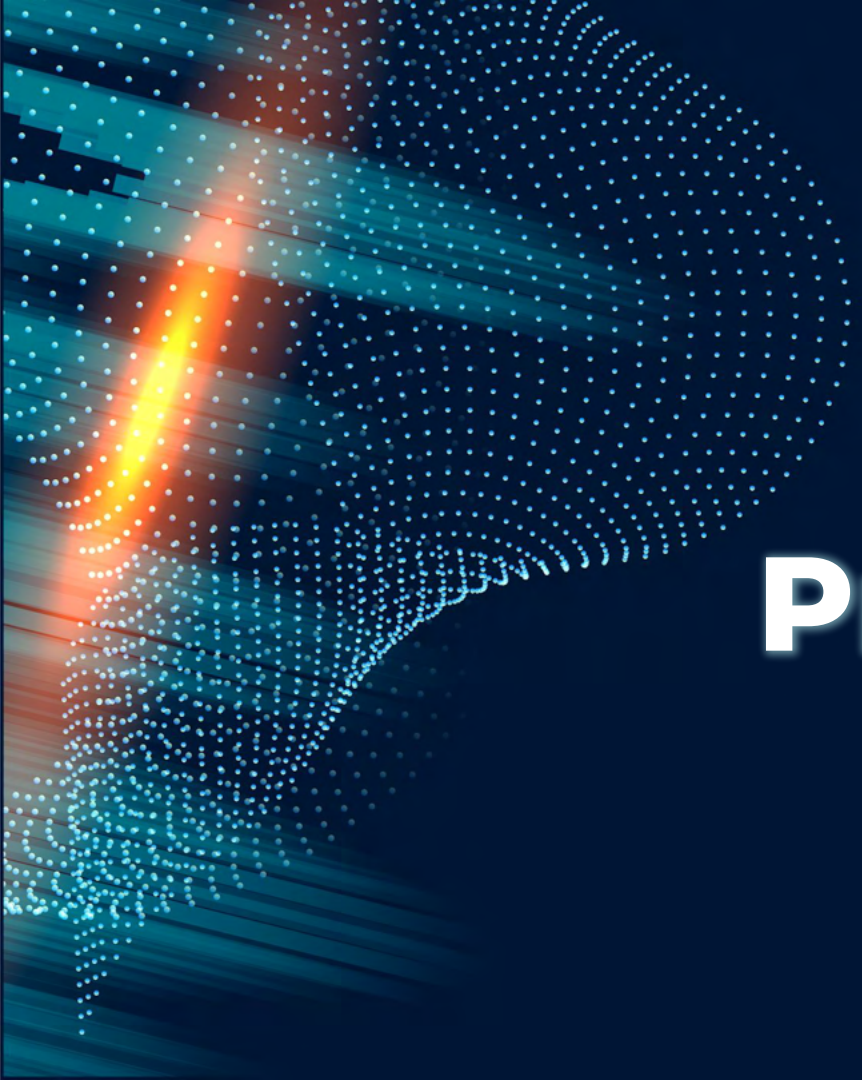
Presentation

1. Presentation (depends on vote)
2. Robot Design (depends on vote)

Carry Weight

Rank will be determined by how much weight the dog can carry relative to its own weight. (5-20)

https://forms.gle/juiHPWZPmUUsEoM19



Presentations

Hachiko

Team Lead:
Allana Ilagan

- Colin Nisbet
- Gabe Villena
- Johnny Tran
- Arianne Agno
- Angelina Licos

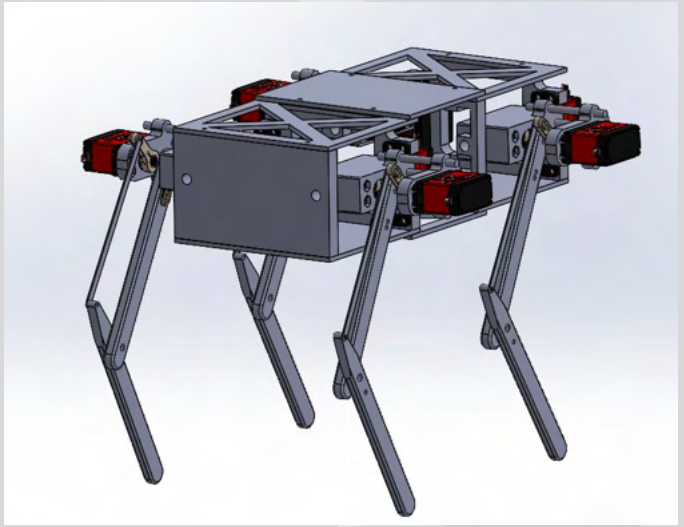
Team Hachiko

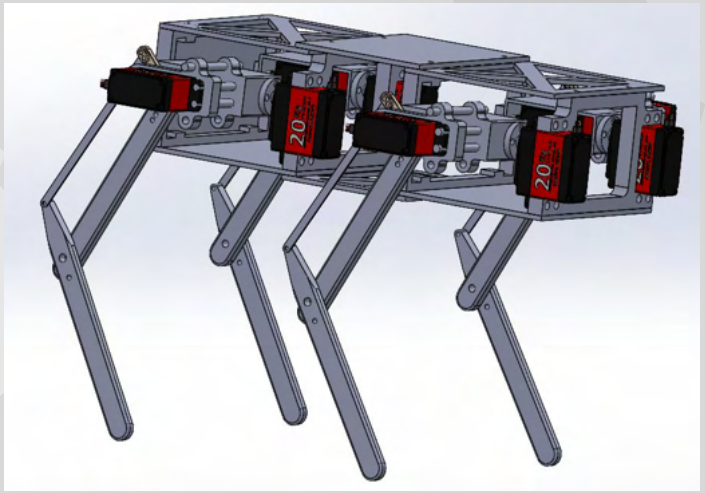
Outline

- Design Goals
- Our Design (CAD)
- Connecting and Electrical Components
- Manufacturing and Assembly
- Voice and Servo Control
- Doggo!
- Video

Mechanical Design

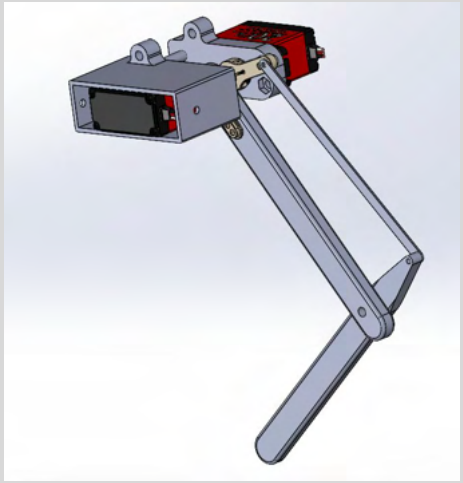
- Initial Design was focused on 3 main areas:
  - Doggo leg Design
  - Doggo frame Design
  - Connections





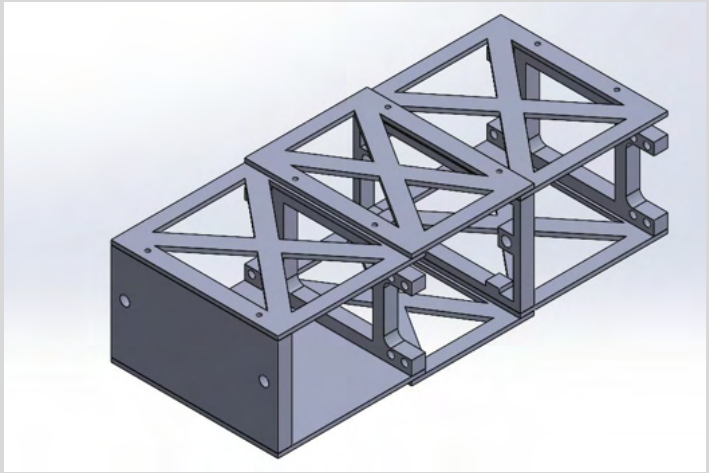
Doggo Leg

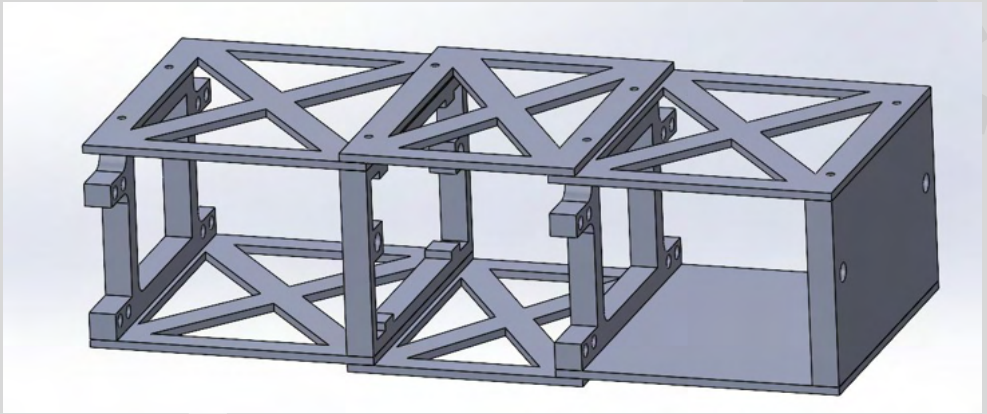
- Each leg has 3 rotational degrees of freedom, leading to a total of 12 degrees of freedom for entire doggo
- Leg design required that all 3 servo motors necessary for 3 rotational DoF must be on the leg itself, separate from the frame.



Doggo frame

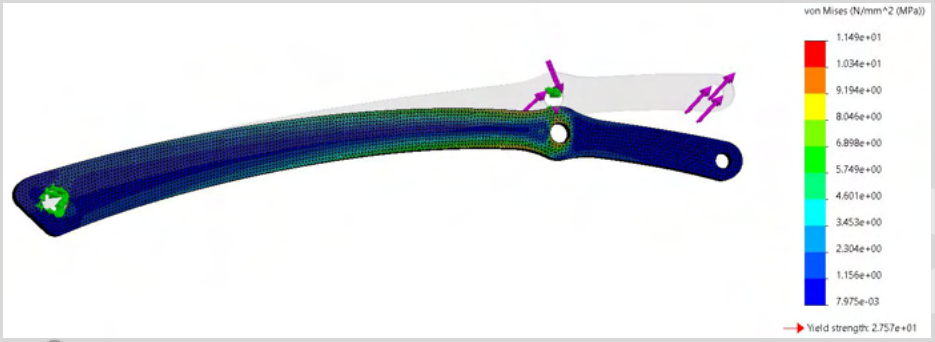
- Some time was put into frame to ensure that:
  - Electrical components had enough space on the robot
  - Legs of the robot were supported effectively

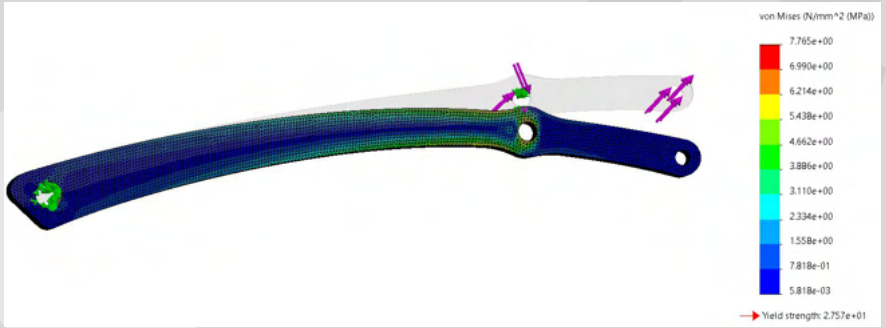




Finite Element Analysis

- Through SolidWorks FEA Analysis, we found that our legs were not thick enough to support the torques applied from the servos
- To solve this, we decided to increase the thickness of our 3D Printed Legs





Connecting Components

- Lots of types of different bearings and supports
  - Ball Bearings
  - Linear Bearings
  - Servo Horns

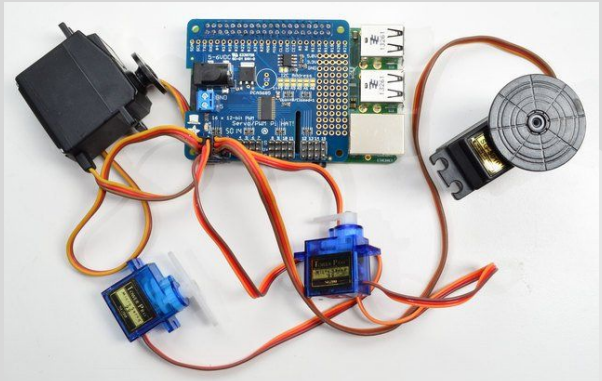
Electrical Components

Servos!

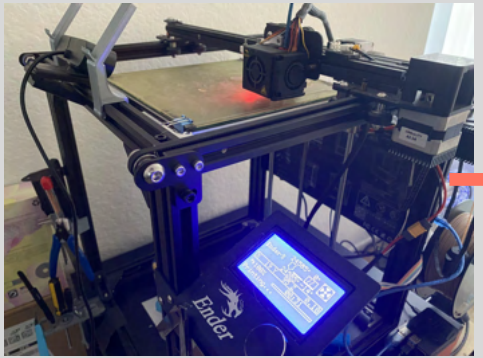
Raspberry Pi!

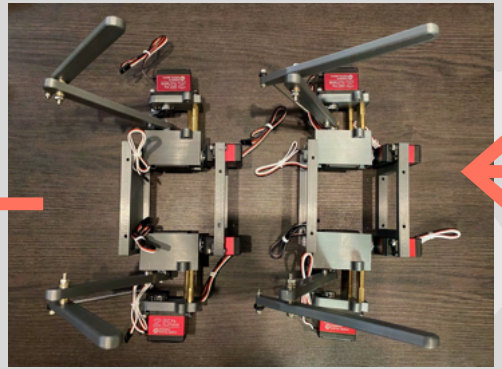
Adafruit Servo Hat!

Battery Hat!



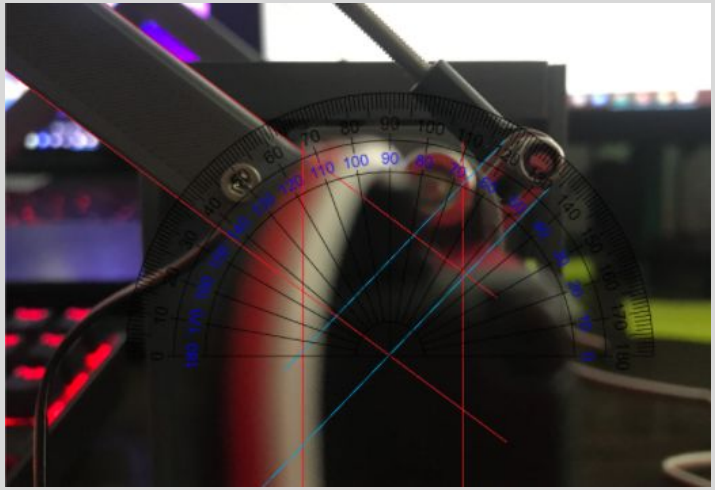
Manufacturing and Assembly





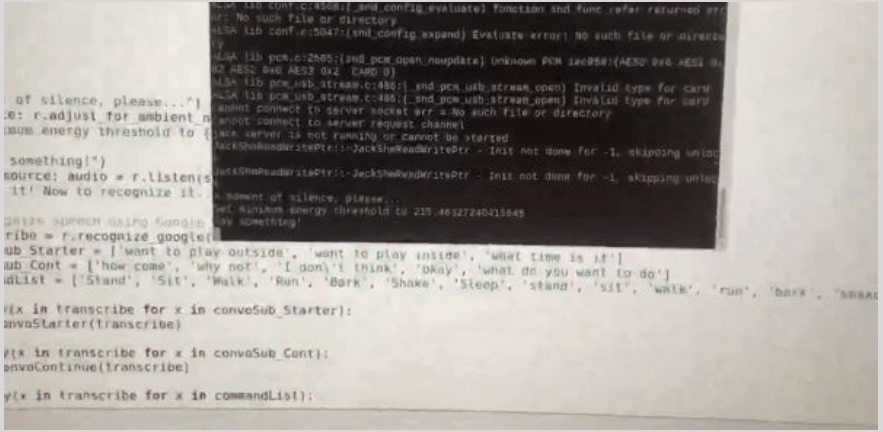
Servo Control

- Control utilizes provided Adafruit servo HAT tutorial for our specific board, incorporating the library “Adafruit CircuitPython ServoKit”
- Angles for leg positioning were hardcoded for simple movements
- Accessed only from voice command when standard dog command is given



Voice Control

- To utilize voice control, we included a voice recognition library by “Voice_Assistant”, Google’s voice recognition, and an usb microphone
- This library allows the microphone and a voice recognizer to be an object within the code, act as a source input for voice, and have that voice be translated into commands
- The commands that we recognize are stand, sit, walk, run, bark, and shake. If one of these commands are detected in the translation, the code will go into a function where either servo angles will be changed or audio files triggered

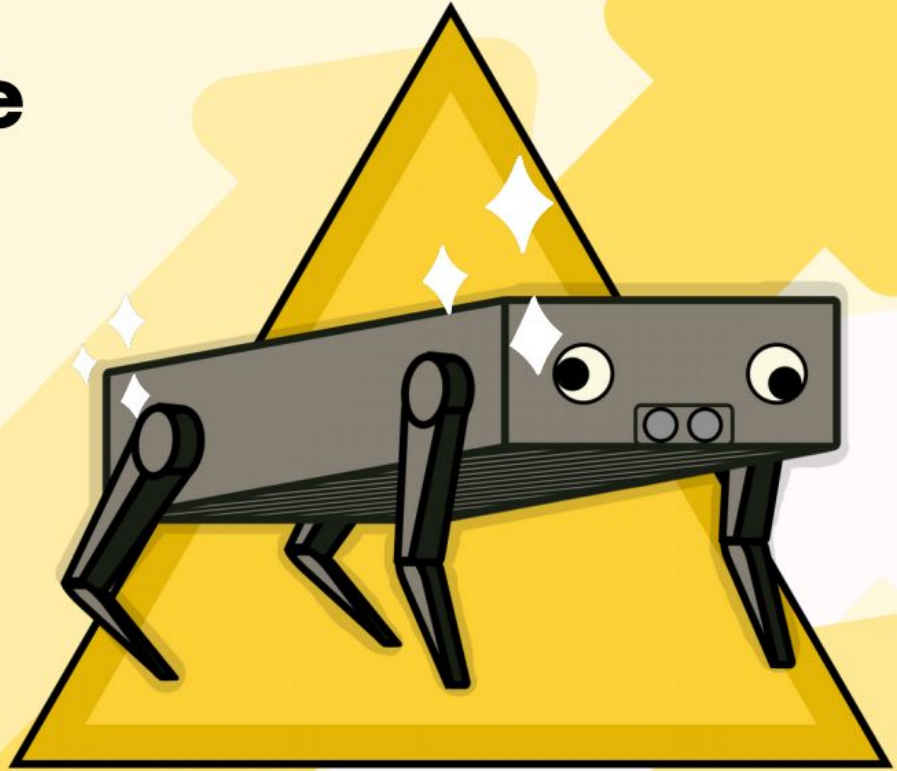


F1D0

Team Lead:
Kelby Custodio

- Chris Le
- Robert Ebojo
- Devang Taneja
- Matthew McHenry
- Sam Miao

Your new favorite quadrupedal googly eyed companion. Meet F1D0.



FUSION F1D0

FUSION F1D0

F1D0 IS BUILT DIFFERENT

Look at those legs

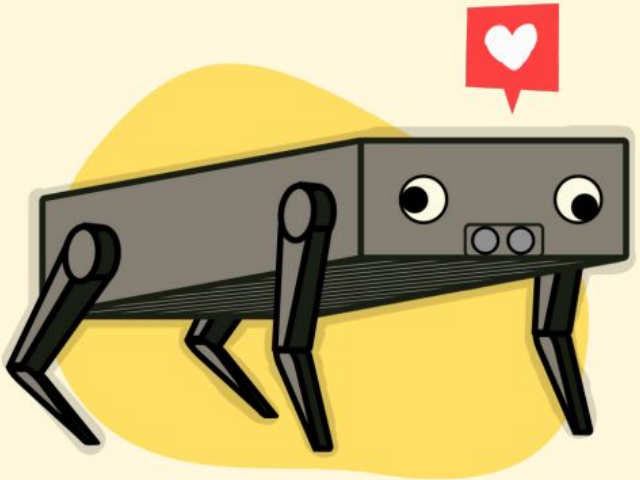
Look at this sturdy efficient body

Wow central weight distribution

Hand picked components

FUSION F1D0

F1D0 IS A GOOD BOY



F1D0 follows directions well

F1D0 is friendly; check out his tweets!

He can tell you the current weather!

We trained him ourselves!

F1D0 received a lot of care from the trainers!

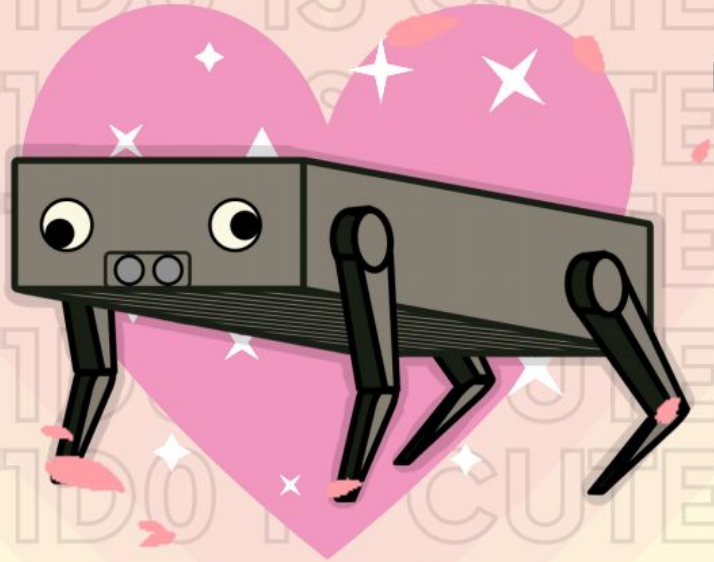
FUSION F1D0

F1D0 IS CUTE

Look at those charming eyes

F1D0 will stay by your side

F1D0 a clumsy cutie



F1D0 is loyal

A great personality

Look at those legs

F1D0 will listen to your worries

F1D0 would welcome you home

FUSION F1D0

Golden Receiver

Team Lead:
Maggie Shane

- Khuong Nguyen
- Neoh Cuizon
- J.D. Libramonte
- Aljon Viray
- Chaz Fazio
- Alexandra Zhang Jiang

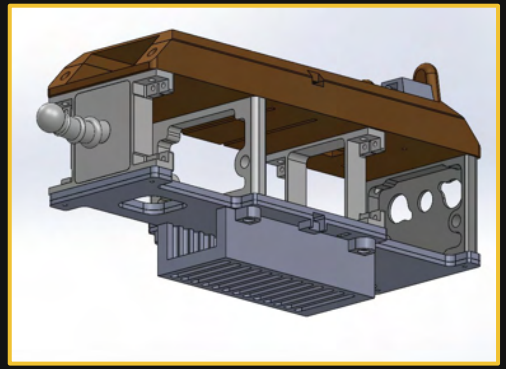
Golden Receiver

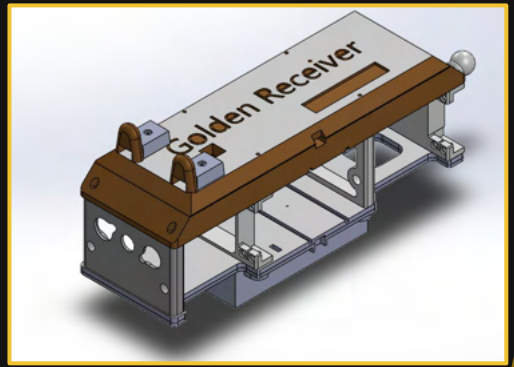
FUSION Robot Dog Project

Gertrude, the Golden Receiver

Mechanical: Chassis

- **Chassis dimensions:** 356.56mm x 104mm x 168.59mm
- **Chassis weight:** 0.4812 kg (printed at 30% infill)
- **Power bank slot dimensions:** 66mm x 25mm x 120mm
- **Battery holder dimensions:** 47.5mm x 25mm x 139mm
- Plates held to support walls by bolts paired with threaded inserts
- Battery holder venting for heat mitigation



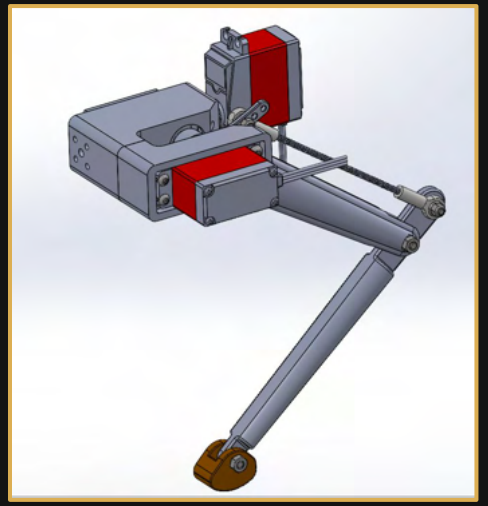


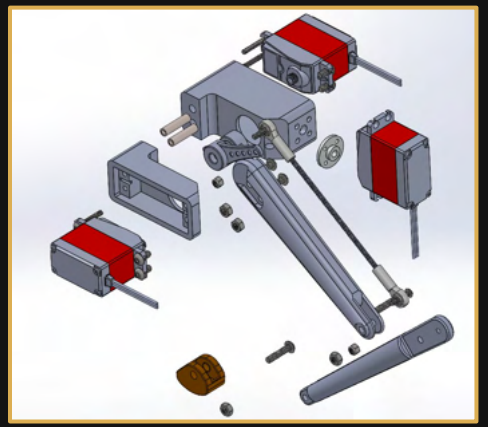
Mechanical: Legs

- Upper leg dimension: 120mm x 24mm x 15.4mm
- Lower leg dimension: 161mm x 16mm x 14mm
- Upper leg weight: 23 grams each (50% infill)
- Lower leg weight: 20 grams each (50% infill)
- Hip dimension: 67.6mm x 67mm x 28.2mm
- The dog can stand as high as 208mm from the ground

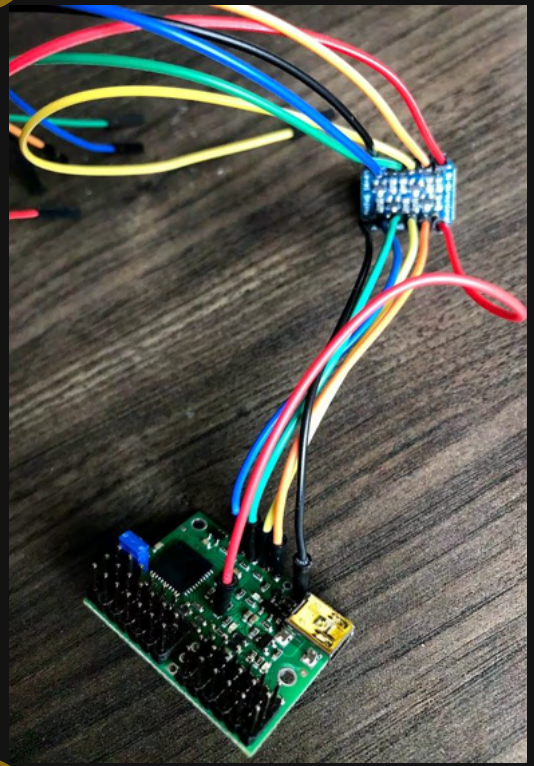
Mechanical: Legs

- Each leg uses 3 servo motors in 3D-printed hip brackets
  - Lower leg is controlled by threaded rod
  - Upper leg is connected directly to horn
  - Vertical motor utilizes disc
- Lower leg max angle from resting position: ~70°
- Upper leg max angle from resting position: ~60°
- Each leg assembly can withstand 8.5 lbf in default standing position (upper angle = 29°)





ELECTRONICS

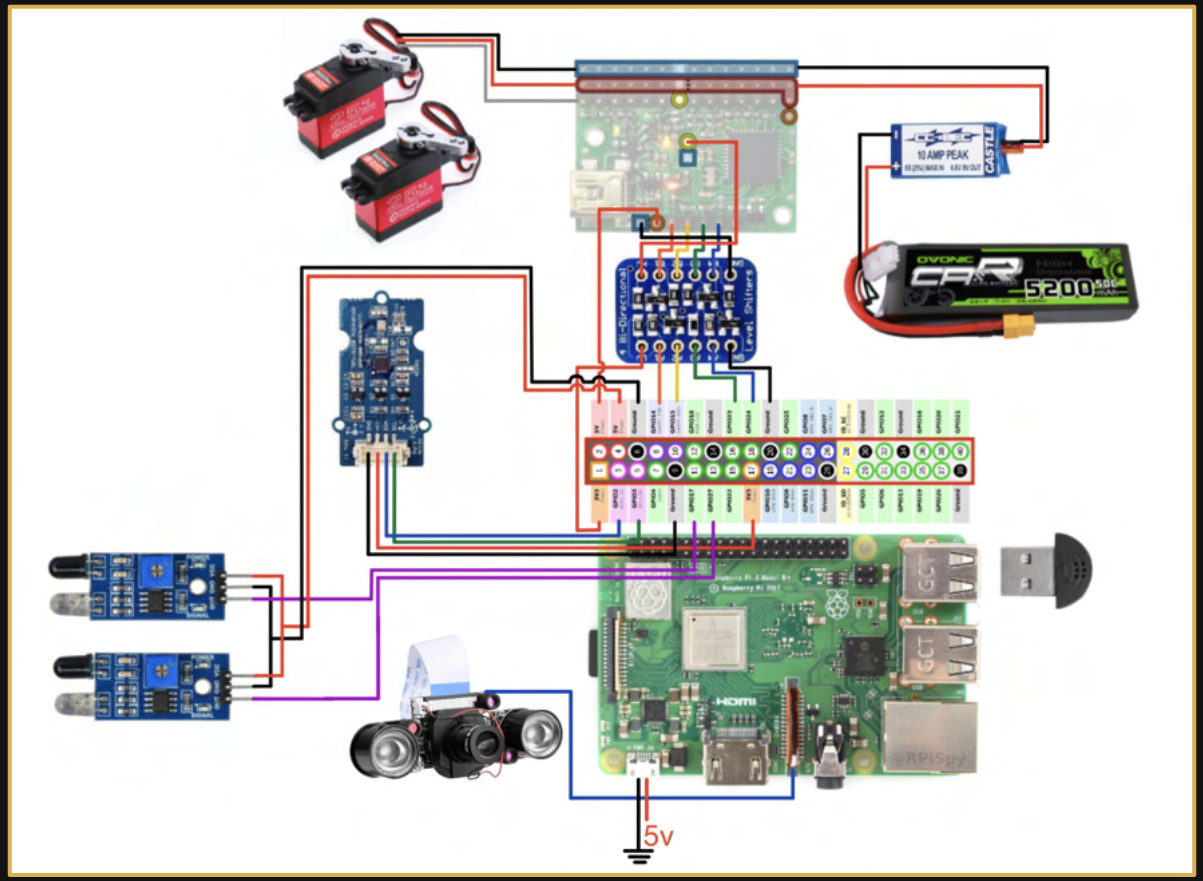


- Two microcontrollers
  - Pololu Maestro Mini 12 channel
    - Servo control - 12 digital servos
    - Powered by a 7.4 V 5200mAh lithium ion battery
      - BEC acts as a fuse that caps current at 10 A
  - Raspberry Pi 4 Model B
    - Sensors
    - Powered by a 5 V, 3 A portable battery
  - TTL Serial Communication
    - 5 V to 3.3 V level shifter

ELECTRONICS: SENSORS

- 9 axis Groove IMU
  - Angles and direction
- IR Sensors
  - For obstacle avoidance
- USB Microphone
  - Gets sound input to be parsed for speech recognition
- 1080P Camera
  - Planned for object detection
  - Planned to show in real time video
    - The camera was not implemented

ELECTRICAL: LAYOUT

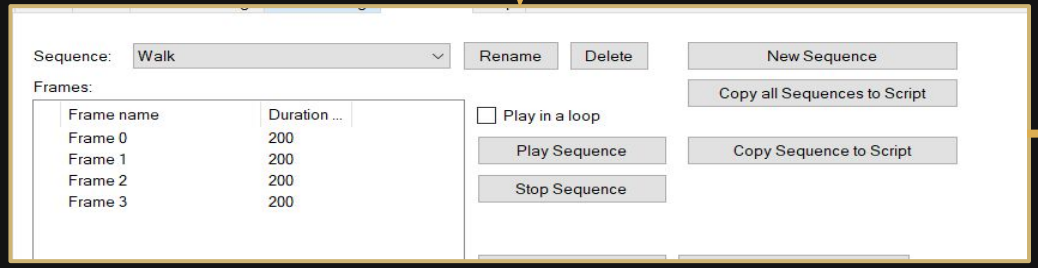


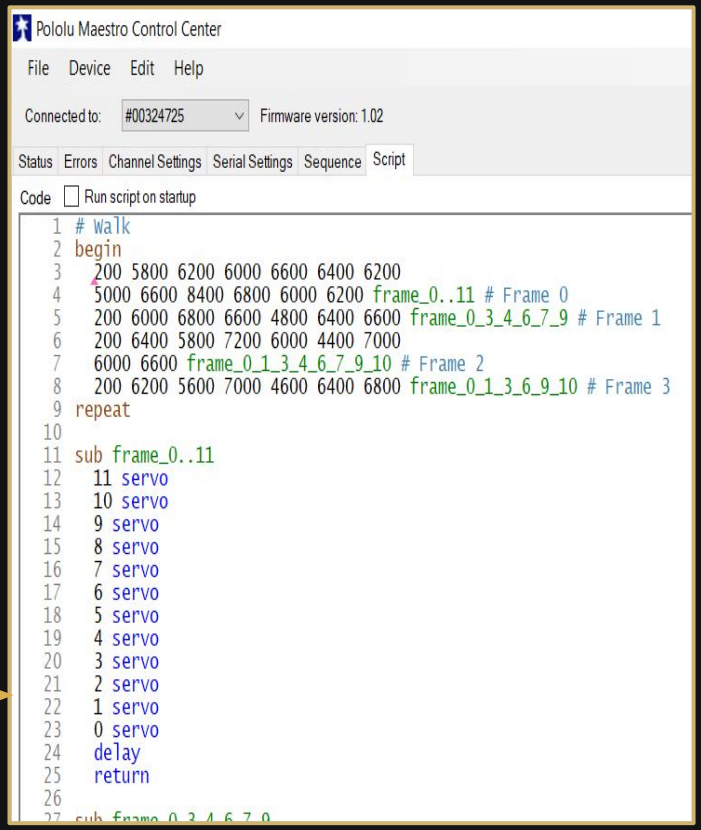
PROGRAMMING

- The primary way our dog moves is with the Maestro Control Center software.
  - First, I manually controlled the motors into the right positions.
  - Then, I saved a “frame of animation” of those positions within a sequence.
    - Repeated for each part of the movement I wanted.
  - Lastly, I saved the sequence as a script saved within the Maestro Microcontroller.

- We planned to “call” these sequence scripts through the Raspberry Pi 4, but the middle-man script was not working.
  - “maestro.py” from https://github.com/FRC4564/Maestro
  - The primary script (“robotDog.py” by Aljon) allows for both text-based and voice controlled commands.
  - These commands “work” but cannot interact with the Maestro/motors at the moment.

PROGRAMMING





PROGRAMMING

```python
# Maestro control initialization
m = maestro.Controller()

# Mode text = 0 vs Mode voice = 1
mode = 0

while True:
    if (mode == 0):
        command = input("> ").strip()

        # Change mode
        if (command == "mode 1"):
            print("Now in Mode 1 [voice recognition]")
            mode = 1

        # Walk Forward
        elif (command == "walk"):
            m.runScriptSub(1) # run standing sequence
            while (m.getMovingState):
                time.sleep(0.25)

            print("Walking... press Ctrl+C to stop walking.")
            try:
                m.runScriptSub(1) # run walking sequence
                while (m.getMovingState):
                    print("Walking... press Ctrl+C to stop walking.")
                    time.sleep(0.25)

            except KeyboardInterrupt:
                print('Done walking!')
```

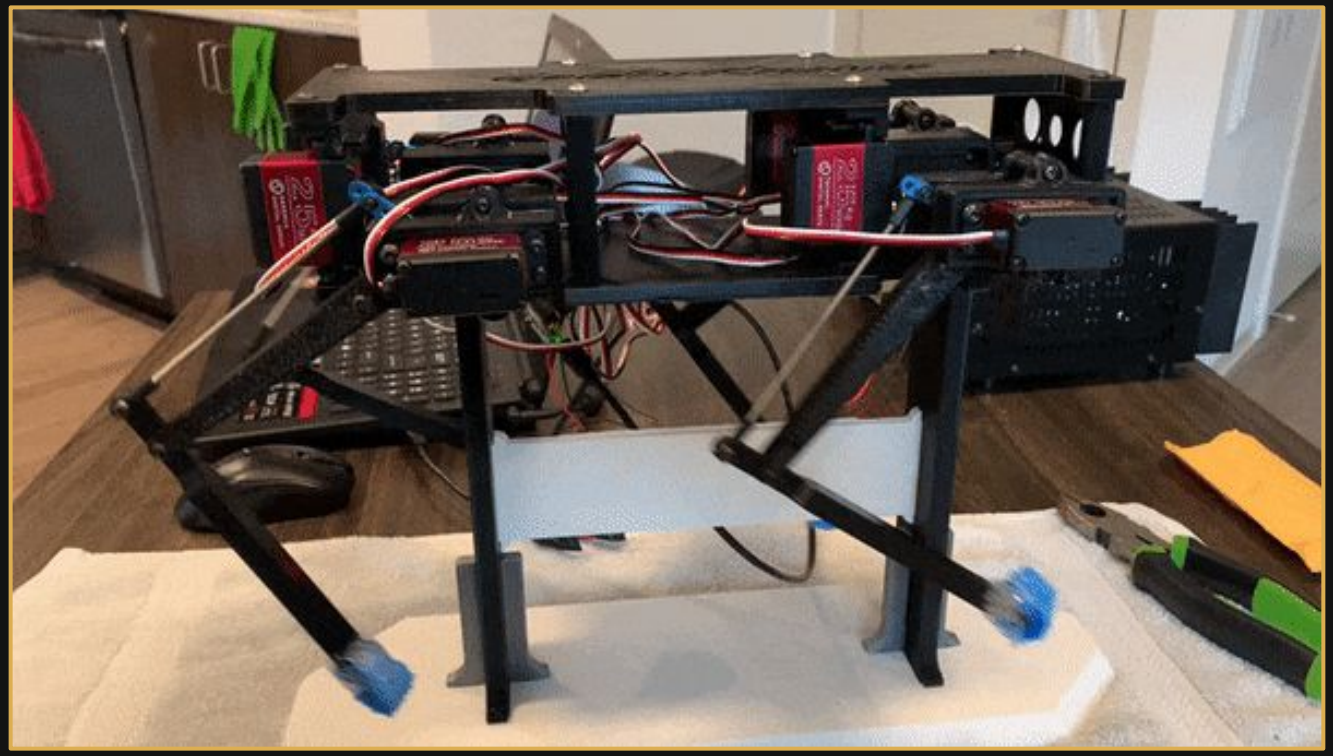
Text-based commands

```python
# Stream from microphone to DeepSpeech using VAD
spinner = None
if not ARGS.nospinner:
    spinner = Halo(spinner='line')
stream_context = model.createStream()
wav_data = bytearray()
for frame in frames:
    if frame is not None:
        if spinner: spinner.start()
        logging.debug("streaming frame")
        stream_context.feedAudioContent(np.frombuffer(frame, np
        if ARGS.savewav: wav_data.extend(frame)
    else:
        if spinner: spinner.stop()
        logging.debug("end utterence")
        if ARGS.savewav:
            vad_audio.write_wav(os.path.join(ARGS.savewav, date
            wav_data = bytearray()

        # Record words that were said
        command = stream_context.finishStream()
        print("Recognized: %s" % command)
```

Voice Recognition

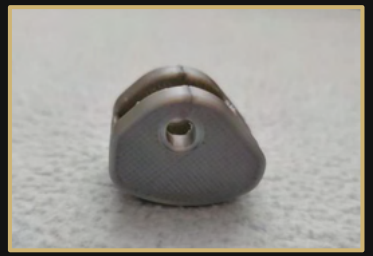
Programming



Walking motion test

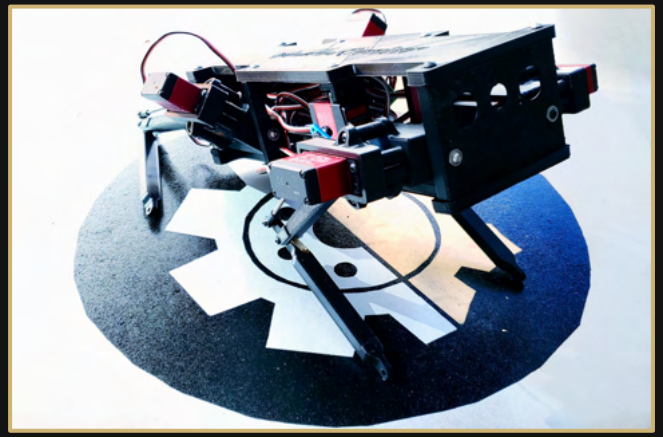
Fun facts:
What makes our dog unique

- Has short spine syndrome for better stability
- 90% of the body is 3D printed parts
- Utilizes IR sensors as ears
- Resembles an AT-AT from Star Wars
- Fashions custom sneakers called **Shapups™**



Fun facts:
What makes our dog unique

- Developed rheumatoid arthritis and can't move like she used to
- Loves food and has a large belly
  - Dimensions: (385mm x 250mm x 245mm) (L x W x H while standing)
  - Prototype Weight: 3.59 lbs or 1.63 kg
- Still learning to regulate its metabolism (tends to crash pretty early)



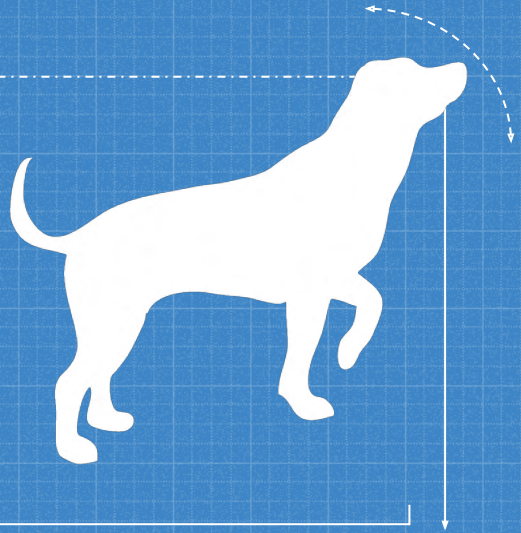
Bolt

Team Lead:
Cameron Sherry

- Ian Gonzales
- Sean Manilay
- Allison Eiler
- Olivia Ih
- Raniel Kent Baki
- Samantha Golding

Team Bolt

Robot Canine Project



$165.76

Cost of Tools

$321.56

Cost of Parts

$487.32

Overall Cost

1

Budget and Planning

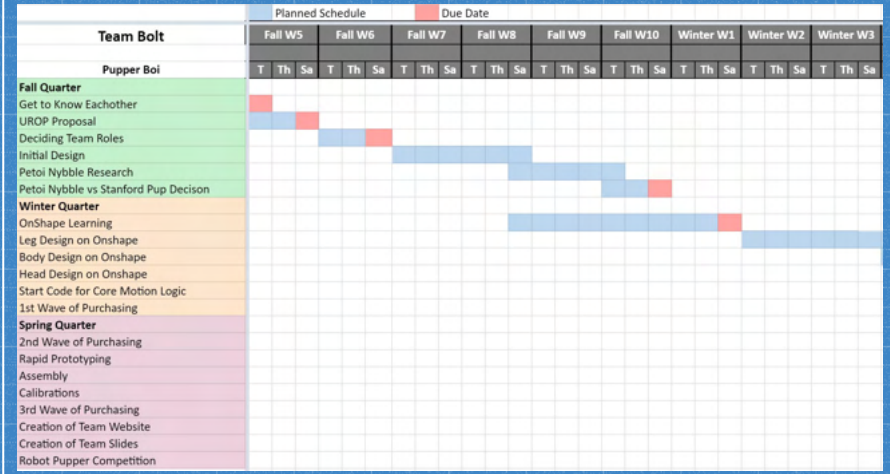
Bill of Materials

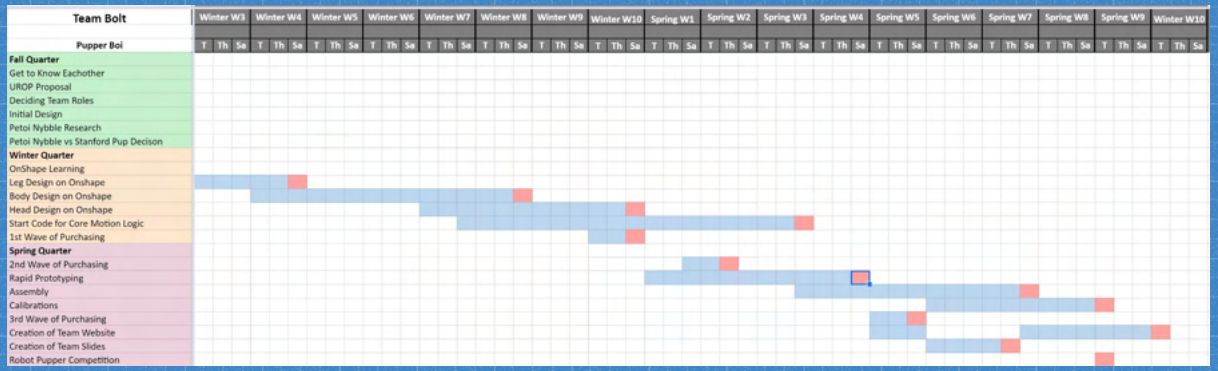
Category Tag	Item	Retailer	Unit Price	Quantity	Total Price
Power	8 Pack AA Battery Holder Bundle	Amazon	$6.99	1	$6.99
	EBL 8-Pack 14500 Battery 3.7V 800mAh Li-ion	Walmart	$15.99	1	$15.99
	EBL Universal Lithium Battery Charger	Amazon	$7.99	1	$7.99
Motion	MG90D Micro Servo	Adafruit	$9.95	7	$69.65
	MG92B Micro Servo	Adafruit	$11.95	4	$47.80
Control	Raspberry Pi 3 Model B+	Raspberry Pi	$29.99	1	$29.99
	NyBoard V1	IndieGogo	$50	1	$50.00
	Ultrasonic Sensor (1-pack + Resistor)	Adafruit	$3.95	2	$7.90
	32GB Micro SD Card	Microcenter	$3.29	1	$3.29
	SchmartBoard Female Jumpers and 40 Headers	Microcenter	$7.99	1	$7.99
(optional)	Xbox Controller	Amazon	$54.99	1	$54.99

Bill of Materials

Category Tag	Item	Retailer	Unit Price	Quantity	Total Price
Aesthetic	Digital RBG LED Strip (1m)	Adafruit	$16.99	1	$16.99
	Premium Felt Cloth 12x18	Michaels	$1.99	1	$1.99
Tools	FTDI Serial to USB Adapter	Adafruit	$14.75	1	$14.75
	Solder Wick 1.5mm wide and 1.5m / 5 feet long	Adafruit	$3.00	1	$3.00
	Solder Wick 0.8mm wide and 1.5m / 5 feet long	Adafruit	$2.95	1	$2.95
	Hakko Digital Soldering Iron	Microcenter	$96.99	1	$96.99
	Pro's Kit MT1210 Multimeter	Microcenter	$15.99	1	$15.99
	Solder .6mm/50g	Amazon	$8.59	1	$8.59
(optional)	Caliper 0-6in	Amazon	$23.49	1	$23.49
Total Price:					$487.32

GANTT CHART

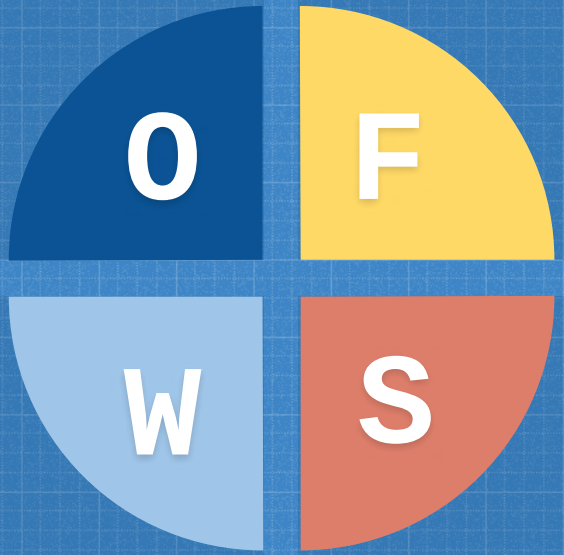

Planned Schedule
Due Date
Team Bolt
Pupper Boi
Fall W5
Fall W6
Fall W7
Fall W8
Fall W9
Fall W10
Winter W1
Winter W2
Winter W3
T Th Sa
Fall Quarter
Get to Know Eachother
UROP Proposal
Deciding Team Roles
Initial Design
Petoi Nybble Research
Petoi Nybble vs Stanford Pup Decison
Winter Quarter
OnShape Learning
Leg Design on Onshape
Body Design on Onshape
Head Design on Onshape
Start Code for Core Motion Logic
1st Wave of Purchasing
Spring Quarter
2nd Wave of Purchasing
Rapid Prototyping
Assembly
Calibrations
3rd Wave of Purchasing
Creation of Team Website
Creation of Team Slides
Robot Pupper Competition


Team Bolt
Pupper Boi
Winter W3
Winter W4
Winter W5
Winter W6
Winter W7
Winter W8
Winter W9
Winter W10
Spring W1
Spring W2
Spring W3
Spring W4
Spring W5
Spring W6
Spring W7
Spring W8
Spring W9
Winter W10
T Th Sa
Fall Quarter
Get to Know Eachother
UROP Proposal
Deciding Team Roles
Initial Design
Petoi Nybble Research
Petoi Nybble vs Stanford Pup Decison
Winter Quarter
OnShape Learning
Leg Design on Onshape
Body Design on Onshape
Head Design on Onshape
Start Code for Core Motion Logic
1st Wave of Purchasing
Spring Quarter
2nd Wave of Purchasing
Rapid Prototyping
Assembly
Calibrations
3rd Wave of Purchasing
Creation of Team Website
Creation of Team Slides
Robot Pupper Competition

Quarterly Goals

Overall

Create a low cost pupper that can be easily replicated with small groups



Fall

Solidified Design

Solidworks to Onshape

Team Bonding

UROP Proposal

Winter

Draft Onshape Parts

Prepare 3D printed parts for assembly

Establish code base

Spring

Rapid Prototyping

Assembly

Finalizing Code

Competition!

2

Design and Assembly

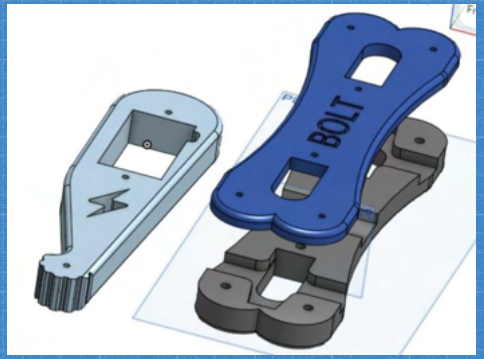
Design and Assembly

Onshape

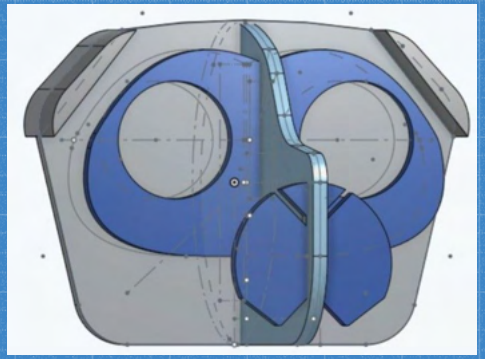
- A CAD software system online
- Chosen over SolidWorks
  - Allowed real time collaboration
- Used to design the parts using the Petoi nybble for reference

Part Sub-Sections

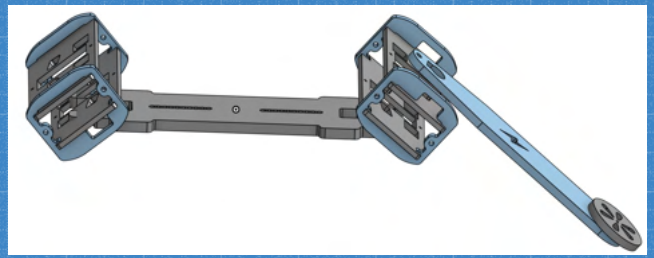
- Leg and Thigh



- Head



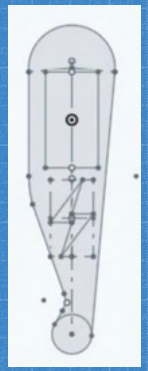
- Body

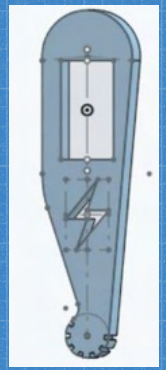


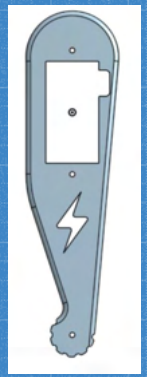
Design and Assembly [Leg and Thigh]

- Leg
  - Designed to be like Petoi but sturdier with a custom cutout

Petoi



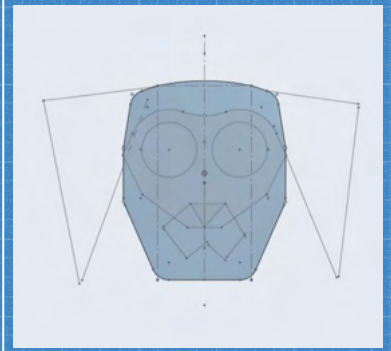


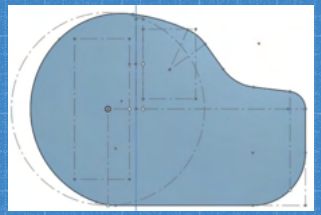


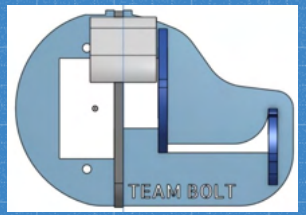
- Thigh
  - Shape changed to a bone
  - Utilizes 2 parts to support the servo arms and springs

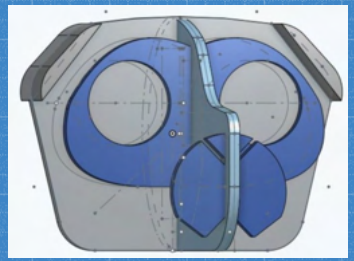
Design and Assembly [Head and Body]

- Head
  - Changed the overall shape to appear dog-like
  - Relied on interlocking pieces to stay in place

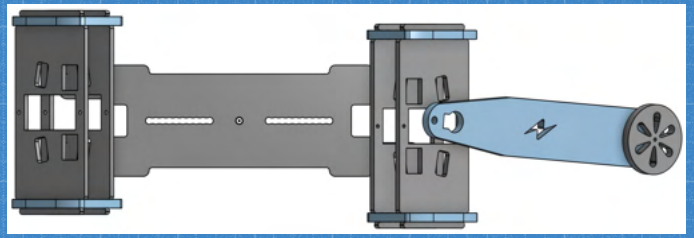


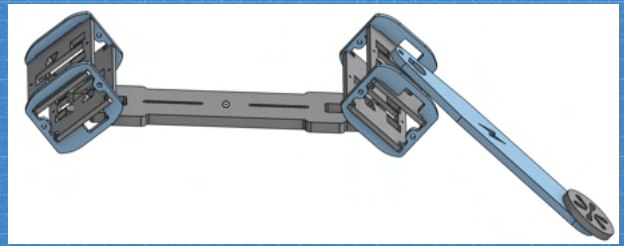






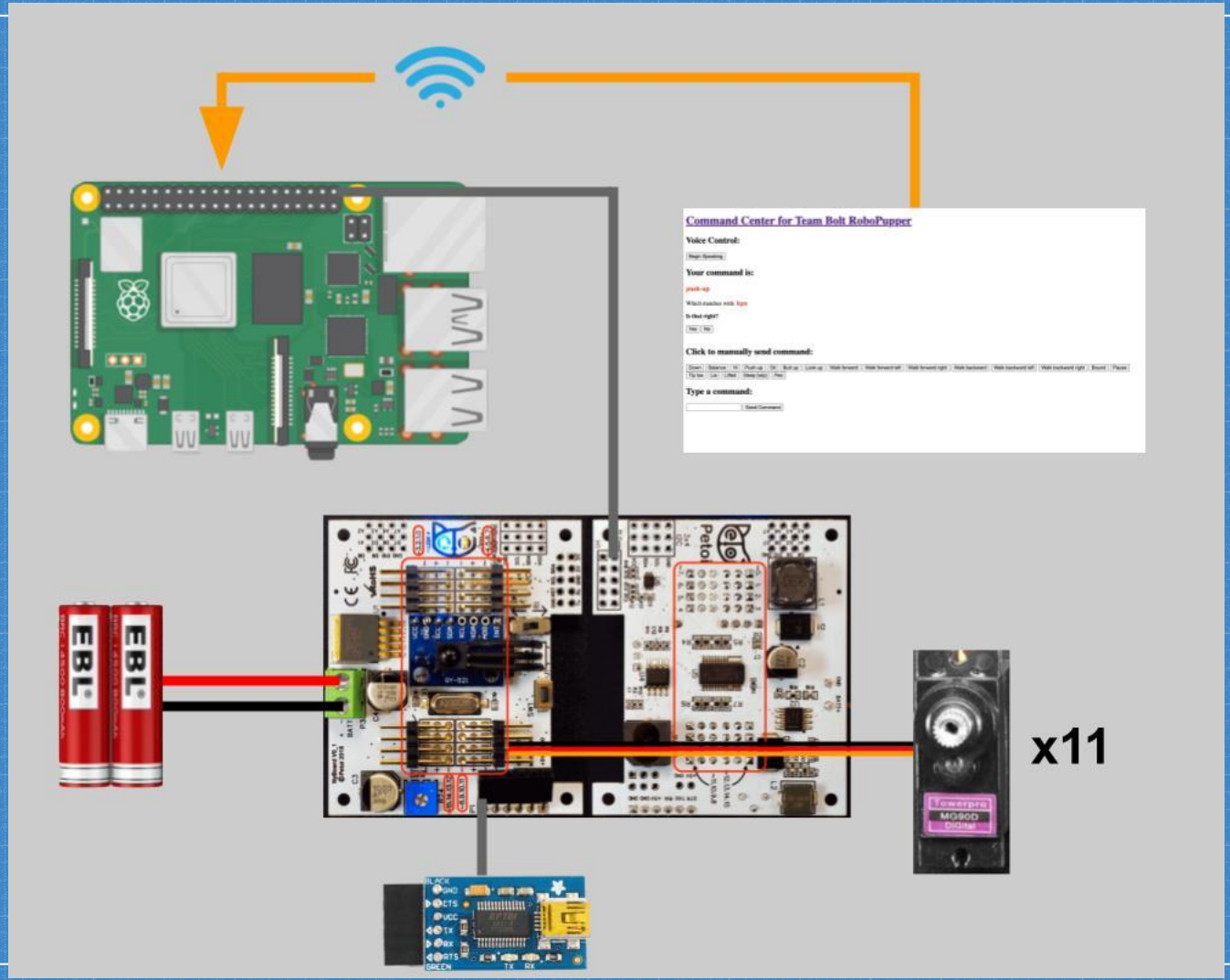
- Body
  - Used dimensional analysis and ratios to estimate the size

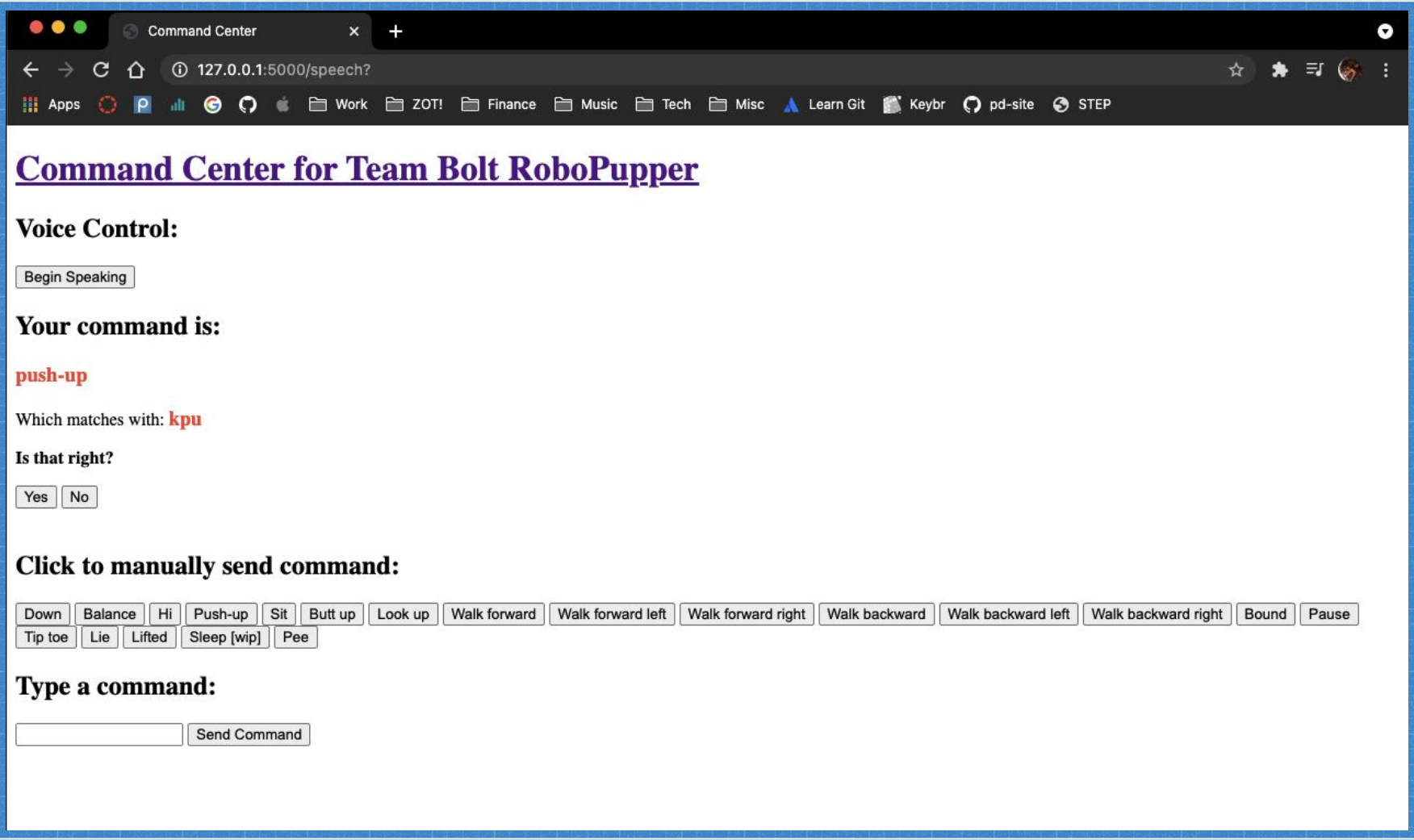




3

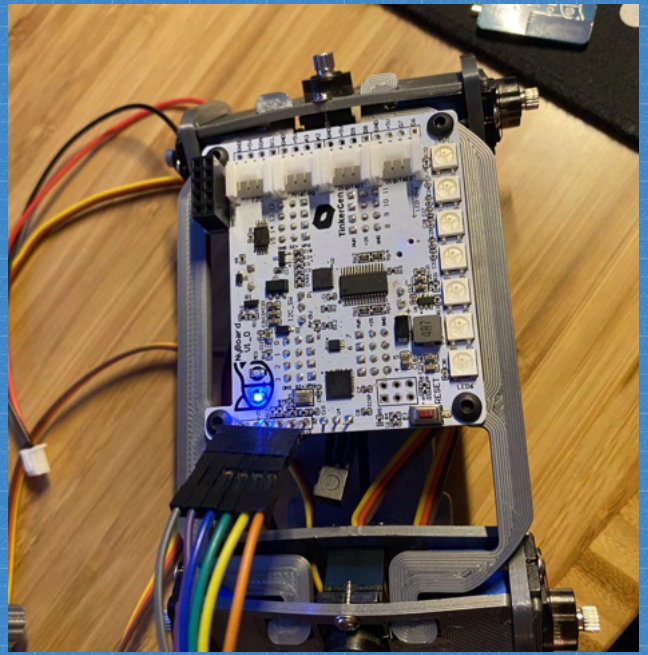
Software/Hardware

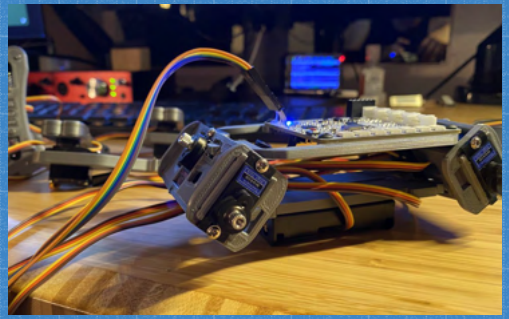

Command Center for Team Bolt RoboPupper
Voice Control:
Your command is:
Click to manually send command:
Type a command:
EBL
EBL
x11


Command Center
127.0.0.1:5000/speech?
Apps
Work
ZOT!
Finance
Music
Tech
Misc
Learn Git
Keybr
pd-site
STEP
Command Center for Team Bolt RoboPupper
Voice Control:
Begin Speaking
Your command is:
push-up
Which matches with: kpu
Is that right?
Yes
No
Click to manually send command:
Down
Balance
Hi
Push-up
Sit
Butt up
Look up
Walk forward
Walk forward left
Walk forward right
Walk backward
Walk backward left
Walk backward right
Bound
Pause
Tip toe
Lie
Lifted
Sleep [wip]
Pee
Type a command:
Send Command

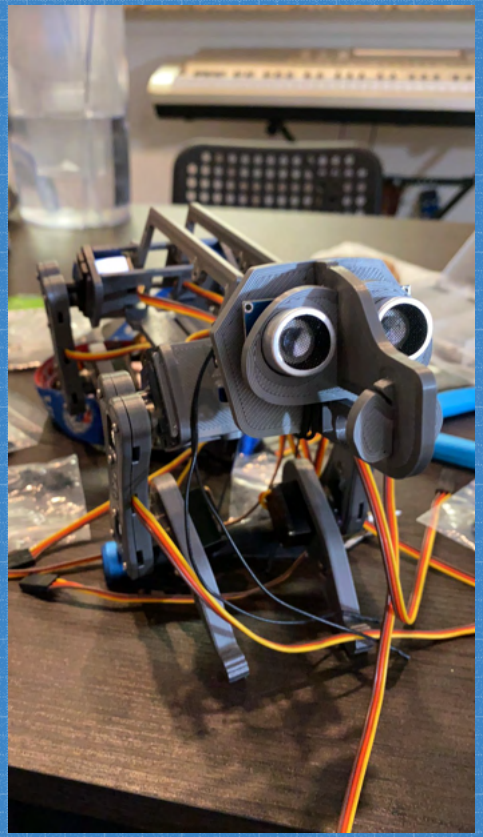
4
Prototype

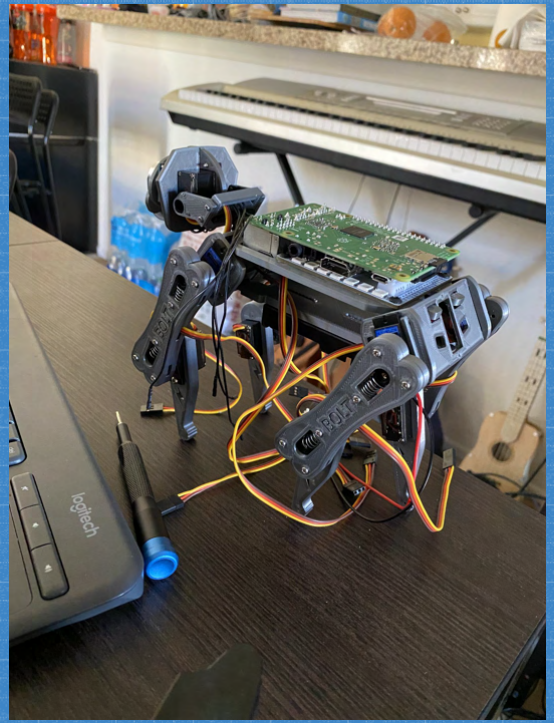
Prototype

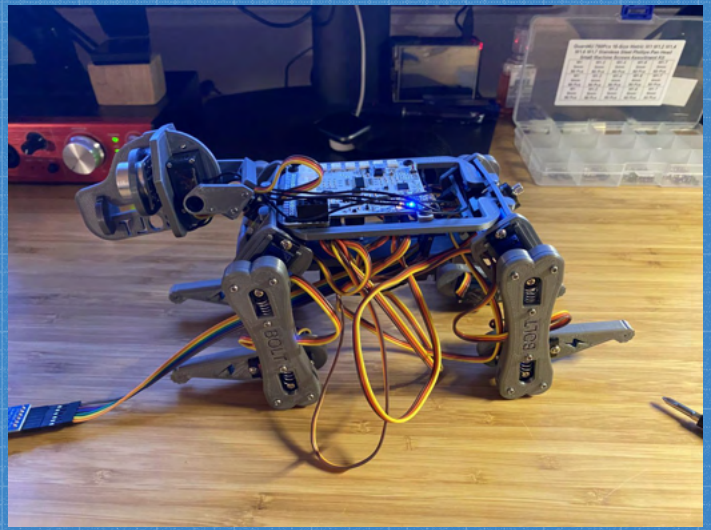




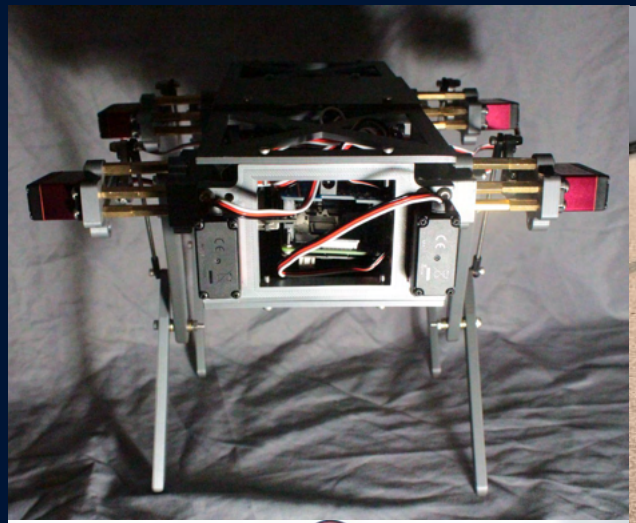
Prototype

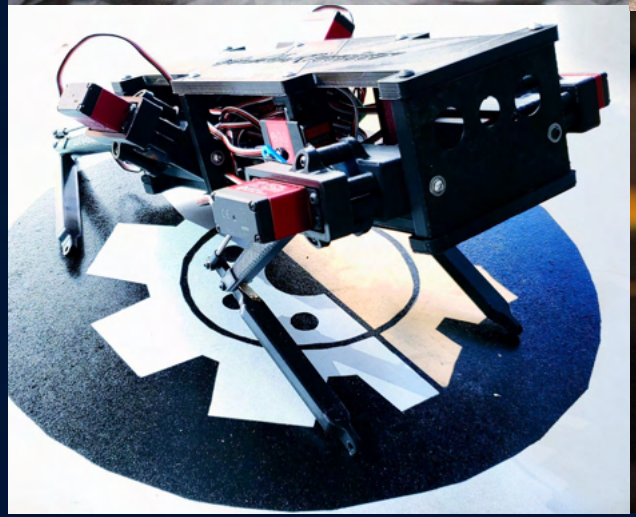


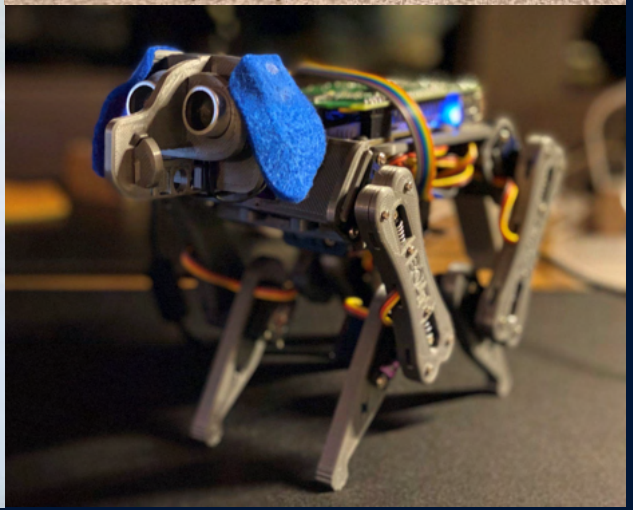




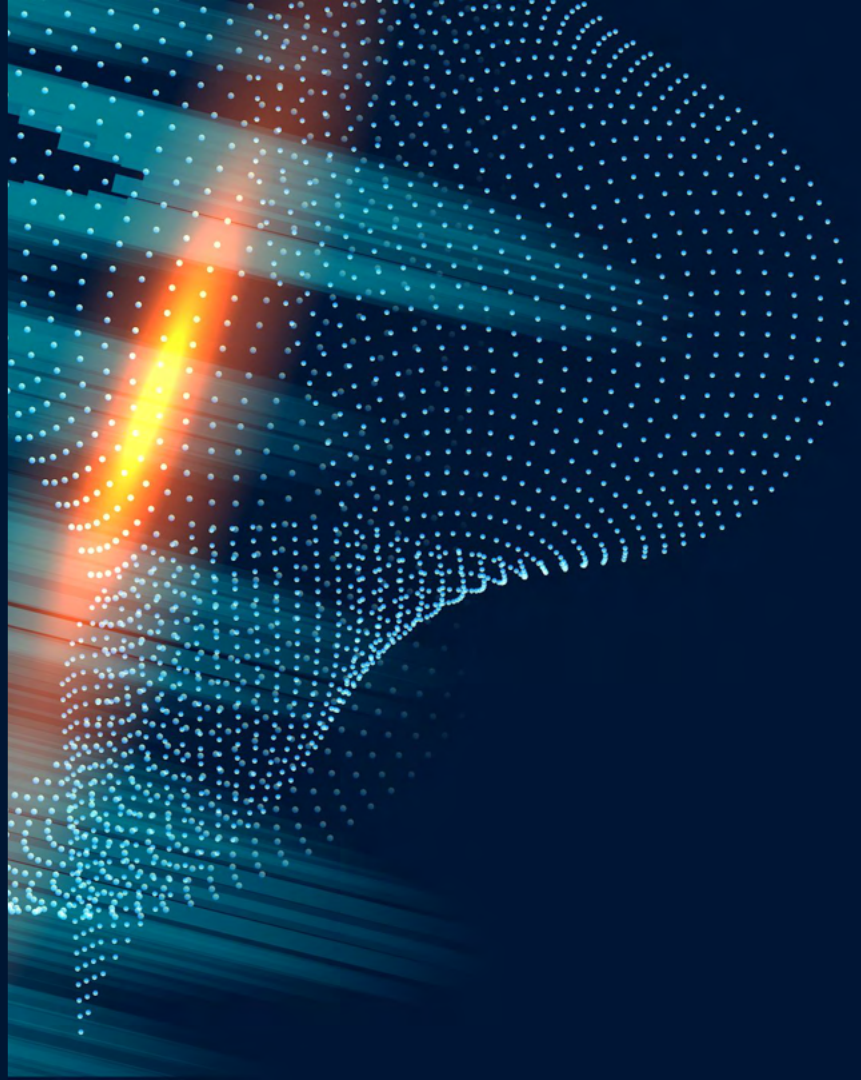
Vote!



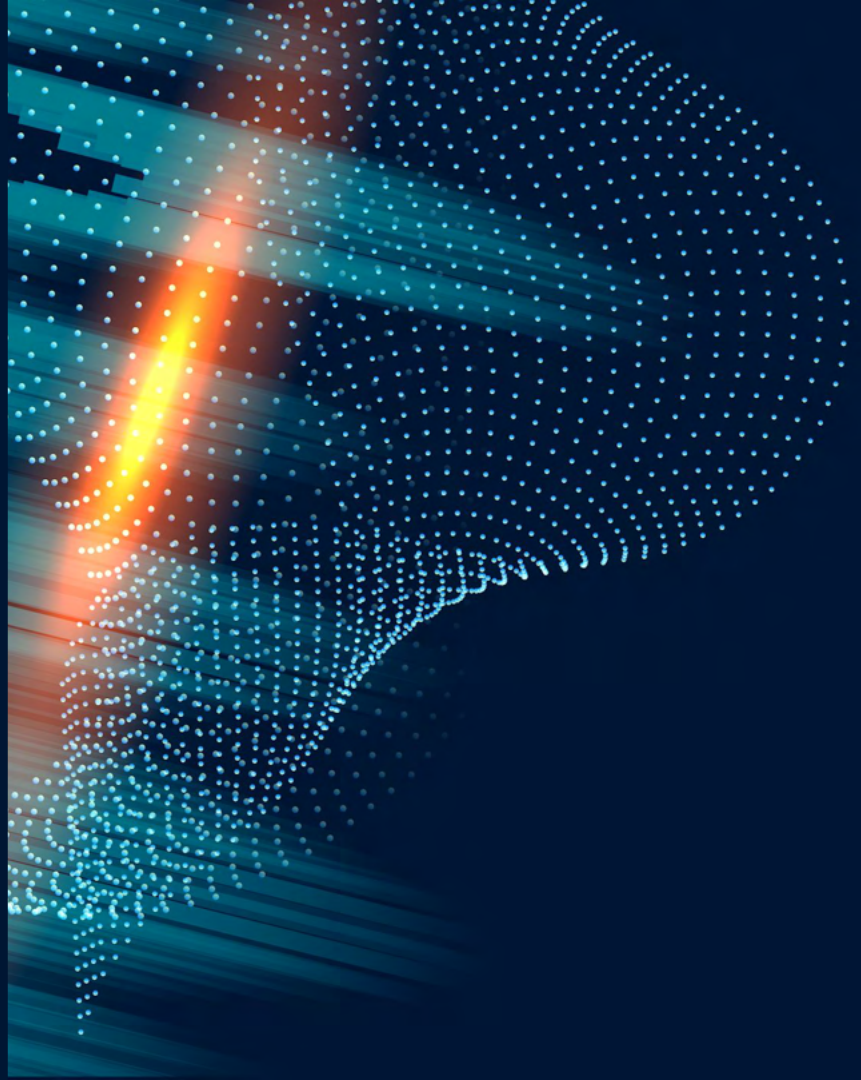




https://forms.gle/juiHPWZPmUUsEoM19



AND THE WINNER IS...



BOT

Rewards


ONE HUNDRED DOLLARS
THE UNITED STATES OF AMERICA
100
LJ34987974A
FEDERAL RESERVE NOTE
LJ3498797
J10


FUSION
ROBOT DOG
2020-2021
WINNER

Rewards For All Participants!

- Custom dog bowls with treats
- Custom logos on Stickers
- Miniature models of your robot puppers
- Keep your creations!
- More FUSION spinners??

Thank you!