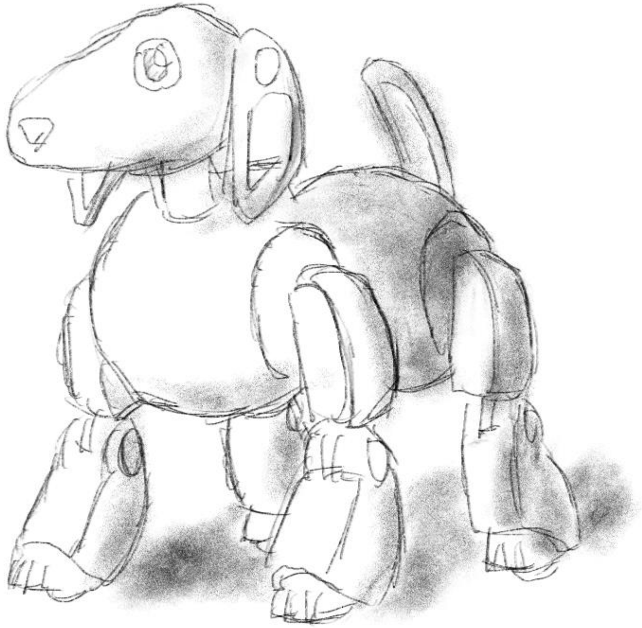
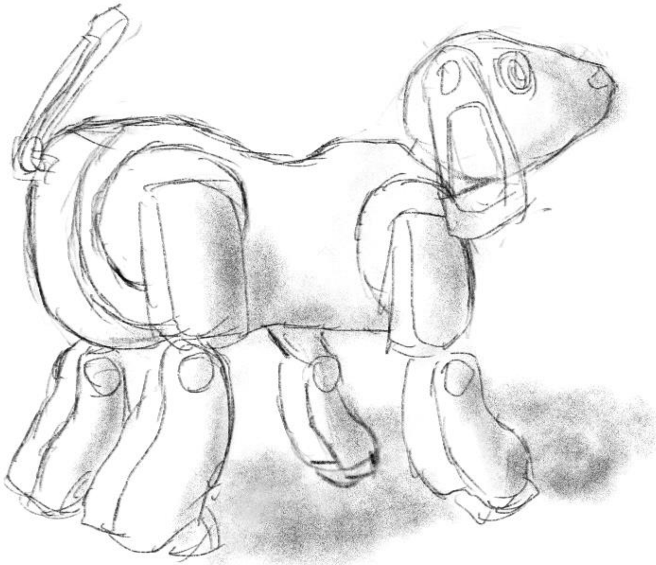
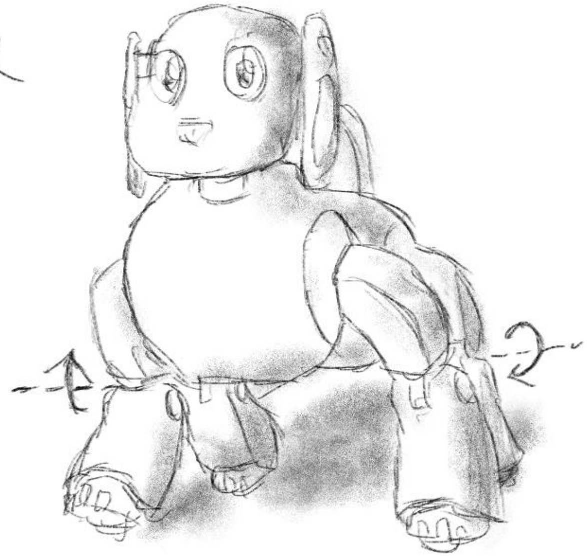
Robotics Studio

Sketching

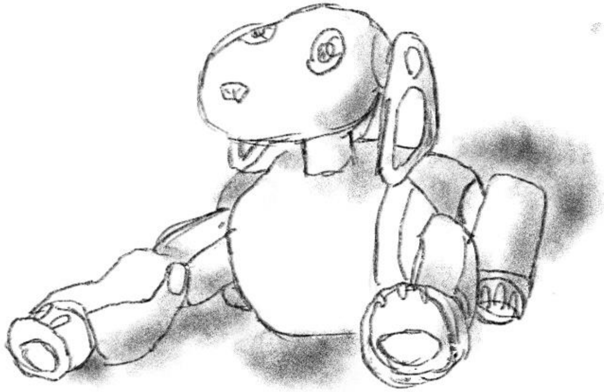




walk

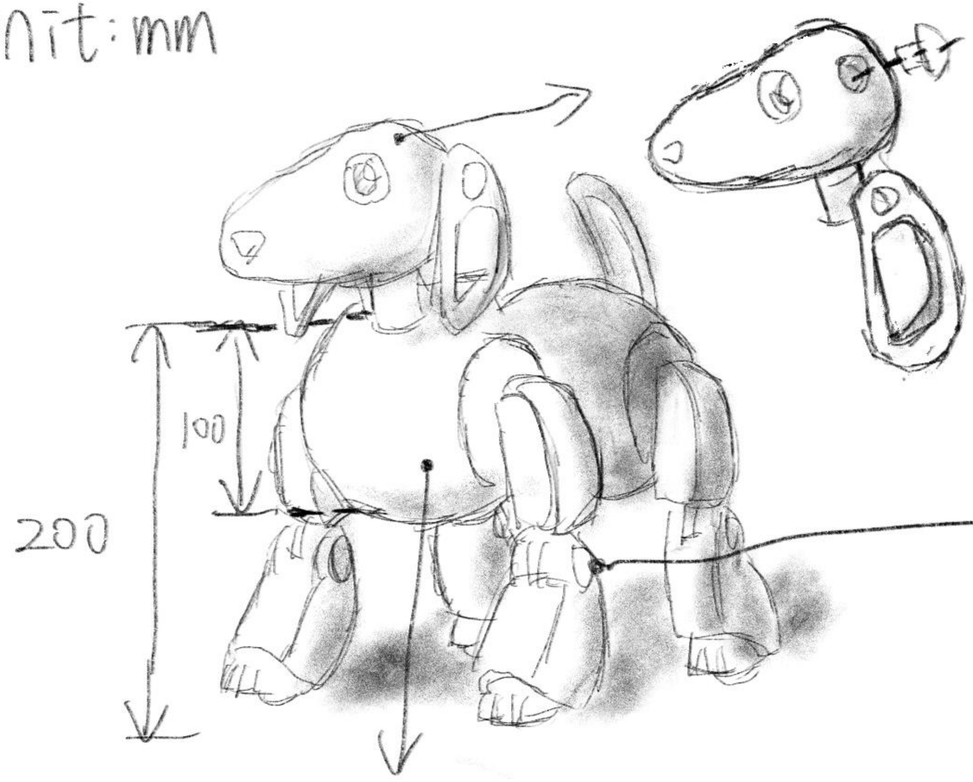


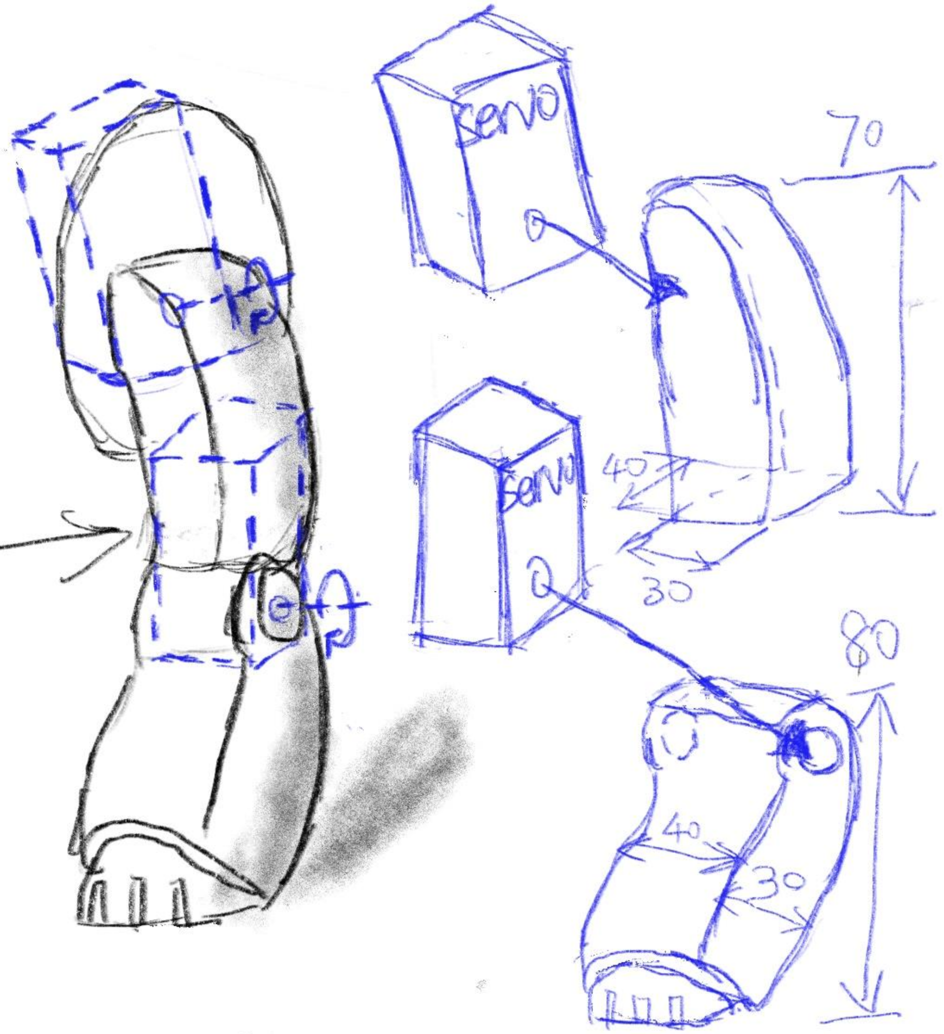
sit

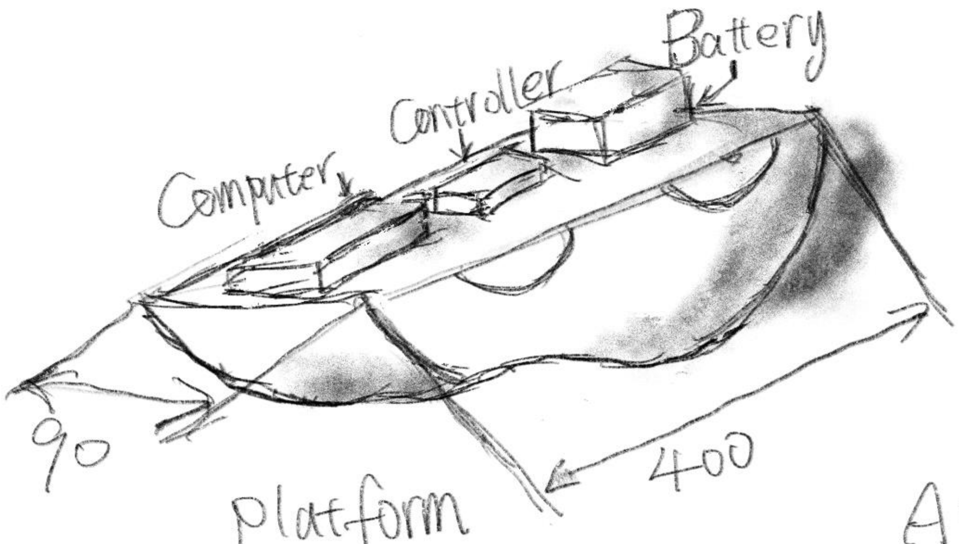


Junyi Lin

Unit: mm







Approx weight:
1.6kg (0.8kg electronic components
0.8kg materials)

Approx power: $P = 7V \times 3A = 21W$

Assignment 1 – Concept Sketches

Sketch out a few potential designs in pencil and paper. Propose at least four different designs. Calculate weight and make sure motors and structure can handle the loads. For an organic look, minimize the use of straight edges, orthogonal corners, and flat surfaces.

Create sketches of at least four different concepts. Sketches should be drawn with soft pencil on blank pages, in perspective. Shading, shadows, bounding boxes and motion axes are a plus. Include rough placement of motors, battery, Computer (Raspberry Pi) and controller board.

Present a draft of your PowerPoint in Monday meeting.

Hand in:

A PowerPoint presentation of your four concepts (Save as PDF). Scan your sketches into the PowerPoint at maximum size and resolution possible, and present them on a clean white background. Add textboxes with name of concept, brief explanation, estimated weight, maximum torque, and maximum power consumption. Add labels and text boxes to explain main components and features of your concepts. Consider adding multiple exploratory sketches of various parts of the concept. For example, show the robot in different poses.

PowerPoint Format:

1. Page 1: Title slide: Robotics Studio MECE 4611, Semester, Assignment 1, Full name(s), UNI(s), Date/Time Submitted, sketch of favorite concept. Grace hours: before submission, used/accumulated in this submission, after submission
2. Page 2: Concept 1. Title of robot.
3. Page 3-X: Sketches of concept 1 with text and details.
4. Repeat for three more concepts (or more)

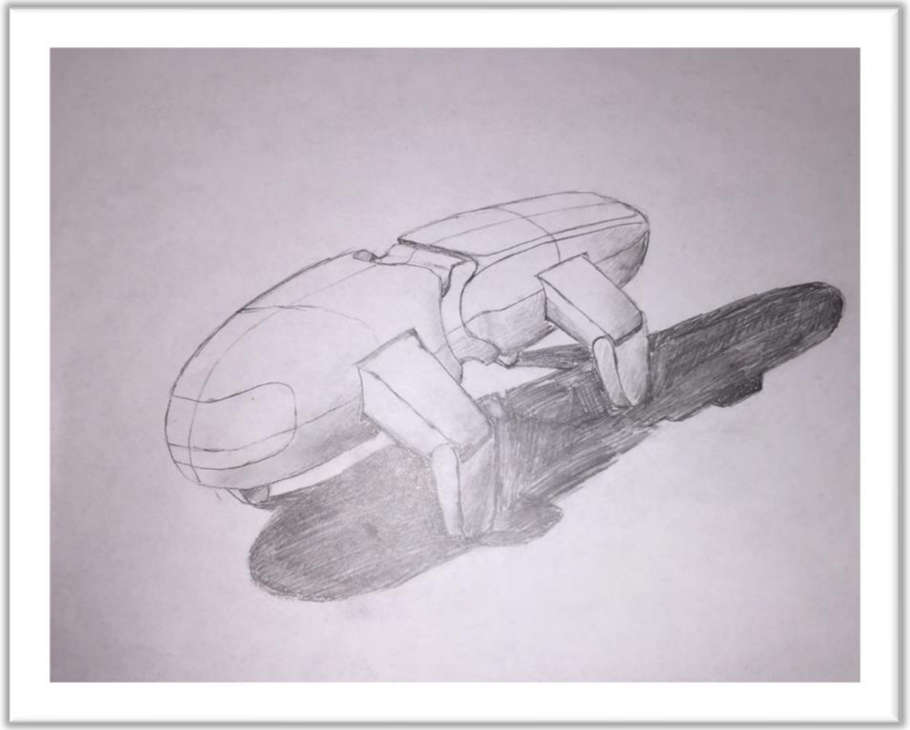
Grading

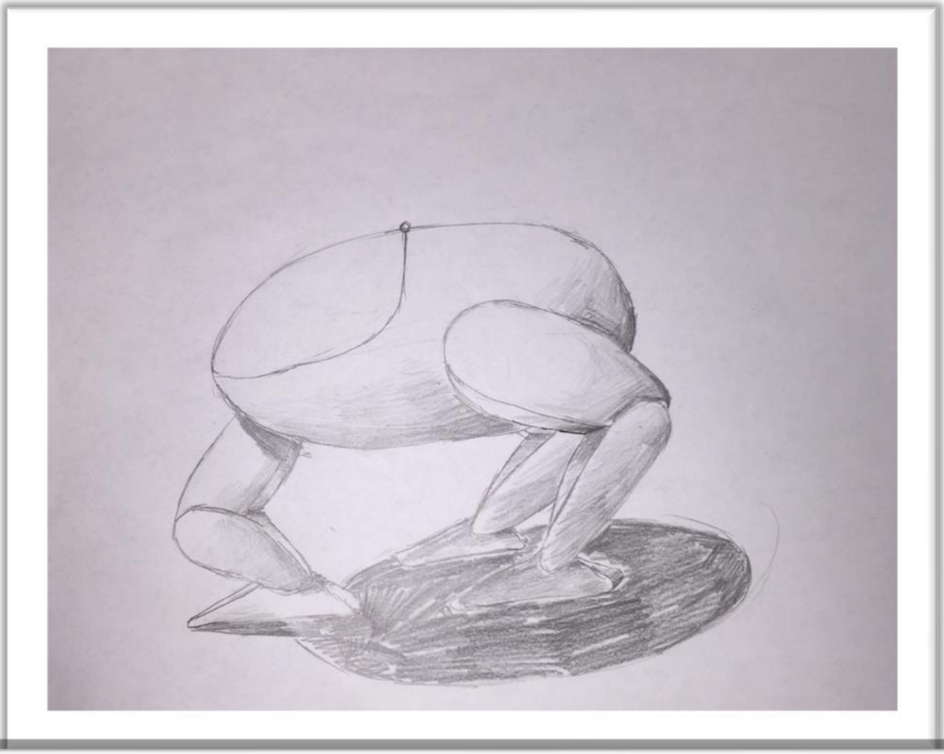
Grading of this part is incremental. You get points for various aspects and the more you do the more you get. 100 Points maximum

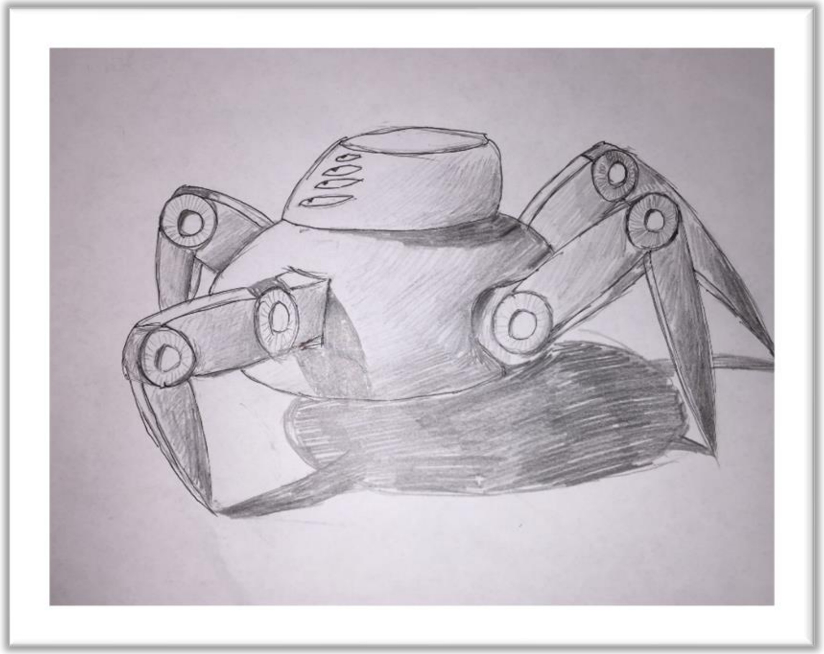
1. 4 Points for good title page with all information

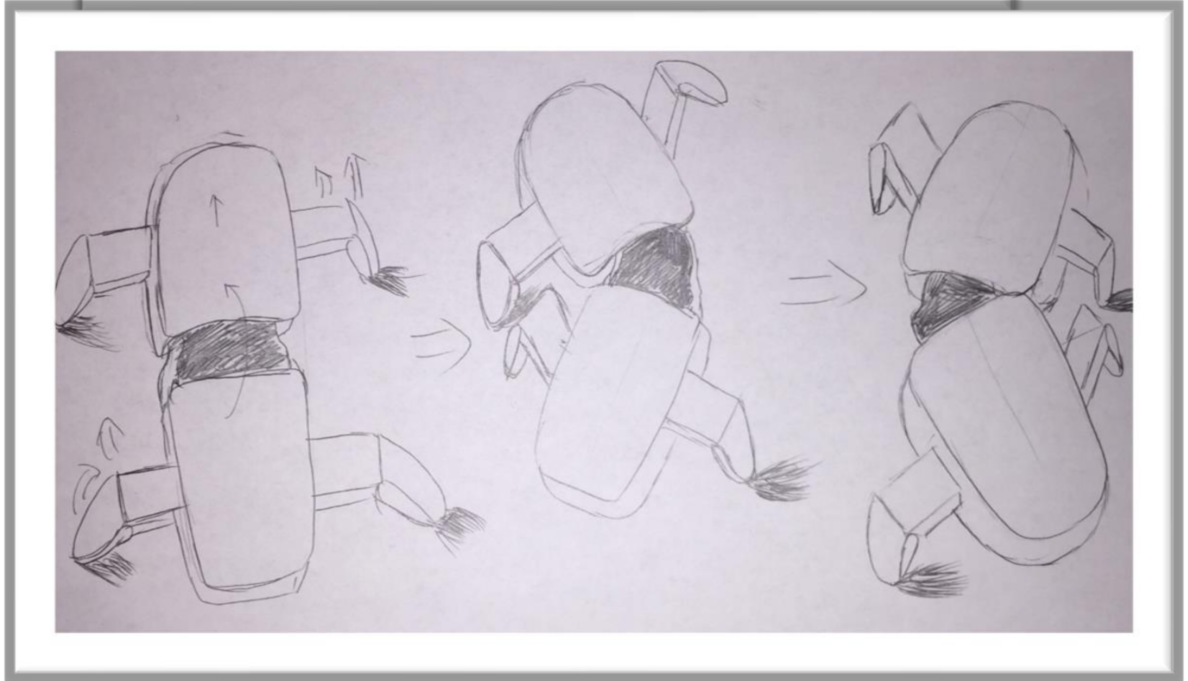
Each concept is worth 25 points. Four concepts = 100 points. Following are point rubrics you can receive for each concept:

1. 4 Points 3D sketch
2. 4 Points shading
3. 4 Points shadows
4. 4 Points Weight and dimensions
5. 4 Points power calculation
6. 4 Points including Computer, controller, battery
7. 4 Points showing in multiple poses
8. 4 Points showing “Zoom in” of some feature
9. 4 Points overall aesthetics of the presentation





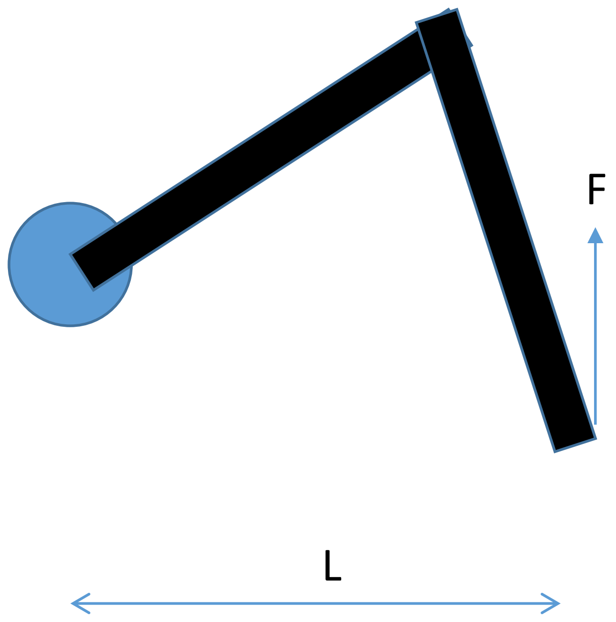




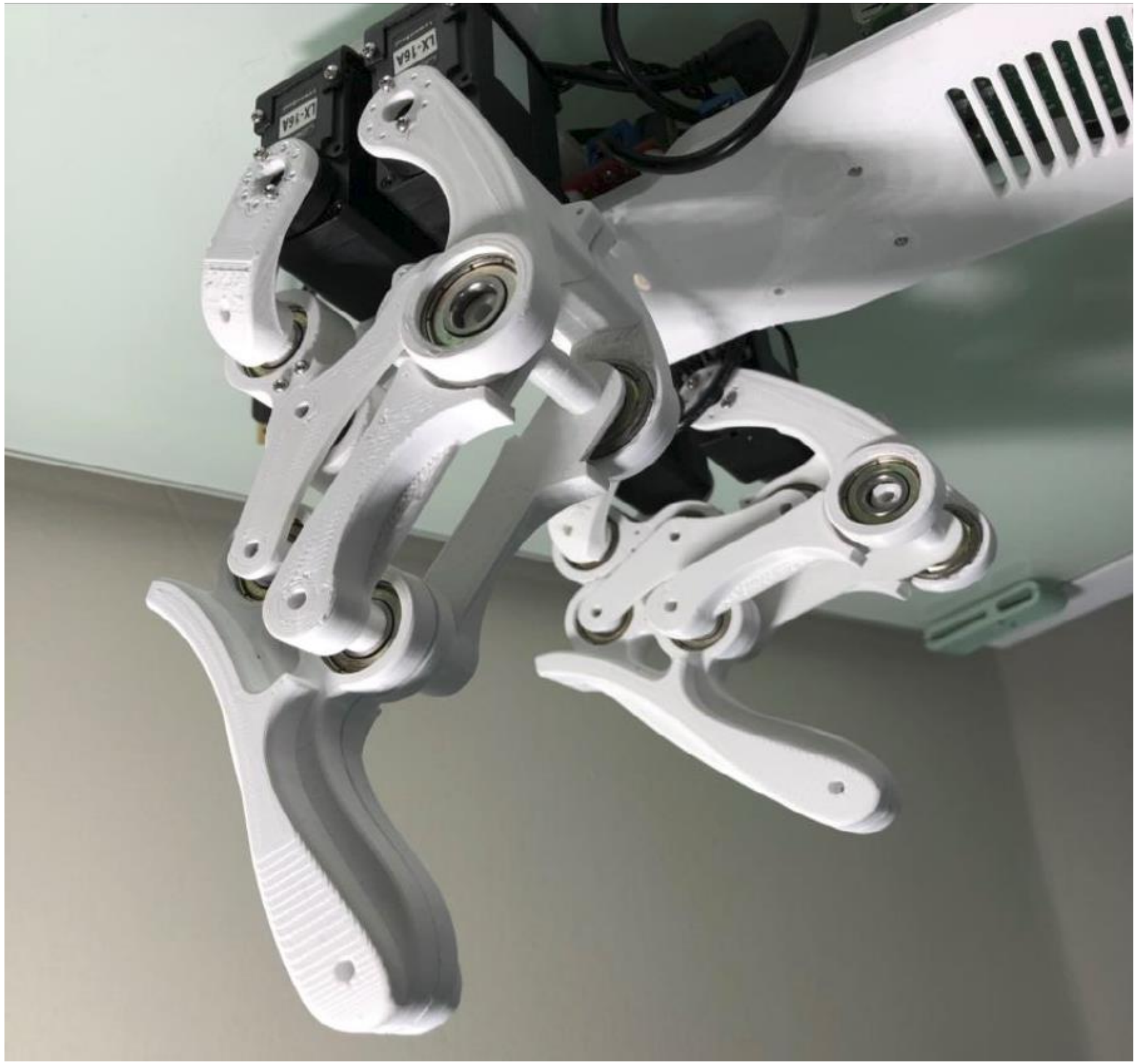
Shanbin Sun
(ss5555)
Mengyu Yang
(my2580)
Sep 28, 2018

Weight/Torque calculation – Stick figure

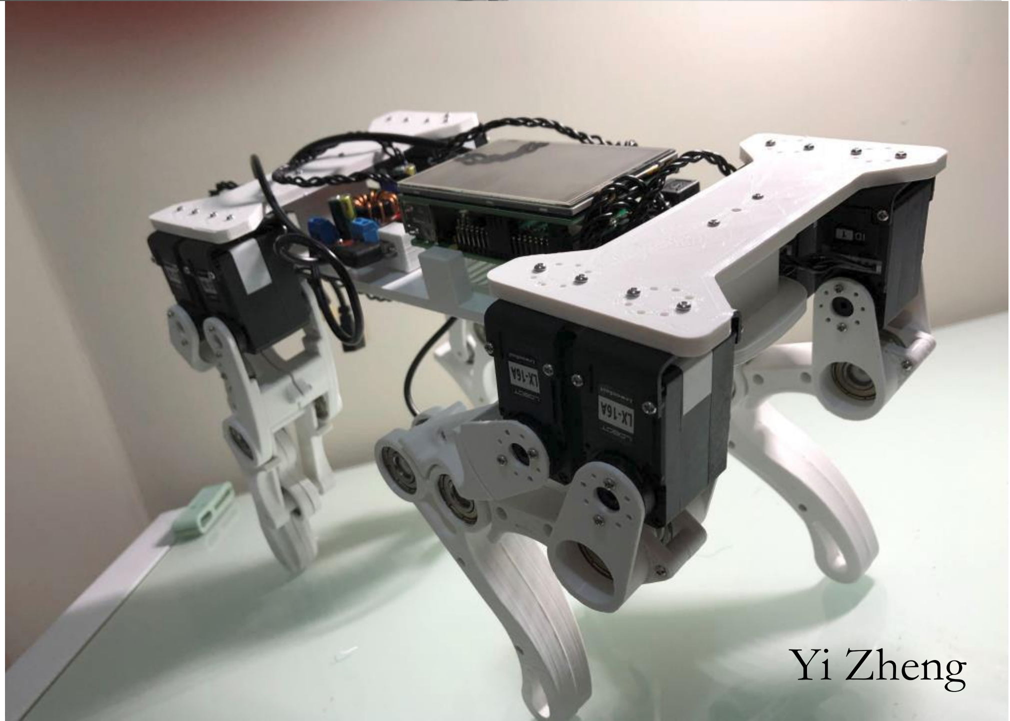
- Estimate total weight of robot
- Use free body diagram to estimate maximum static moment/torque on motors
  - T = L*F
- Estimate dynamic torque
- Verify stability
  - Center of gravity inside footprint
  - Maximum tilt



Serial

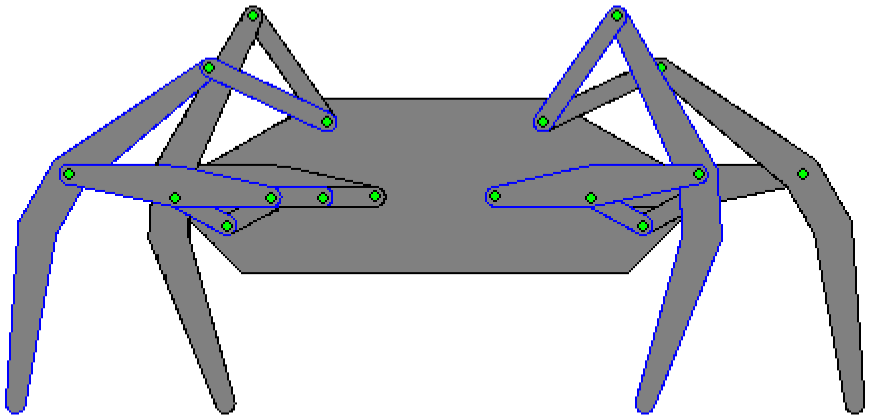


Parallel

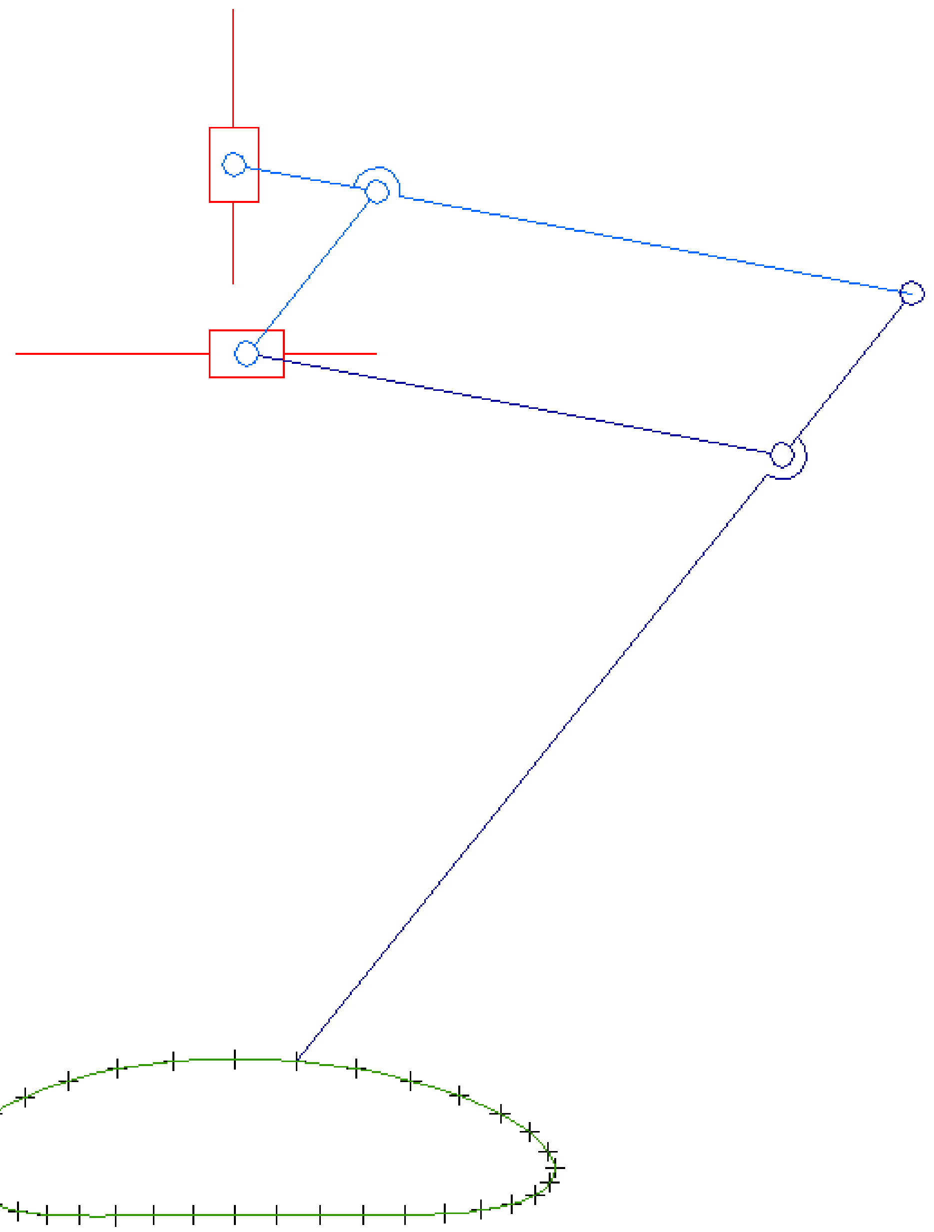


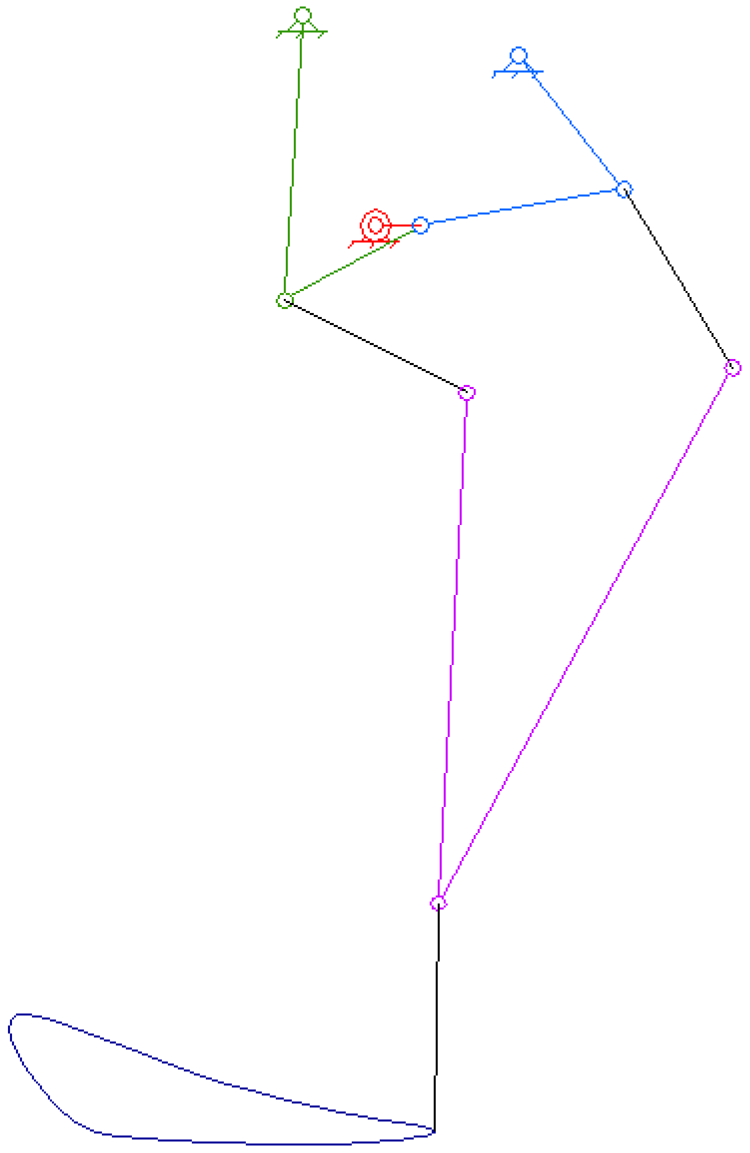
Yi Zheng

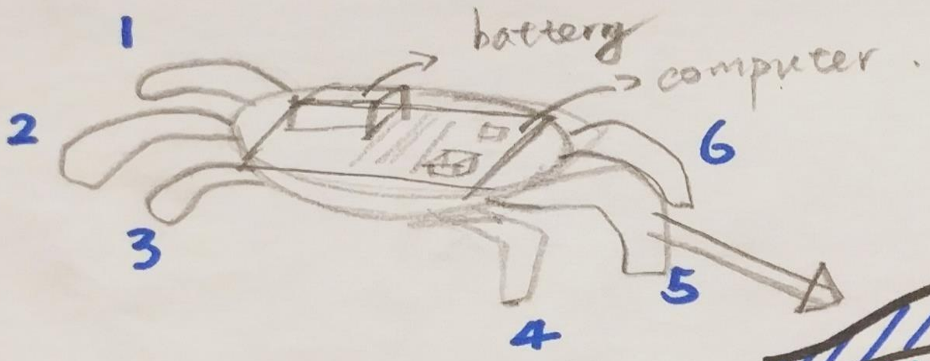
Leg Design



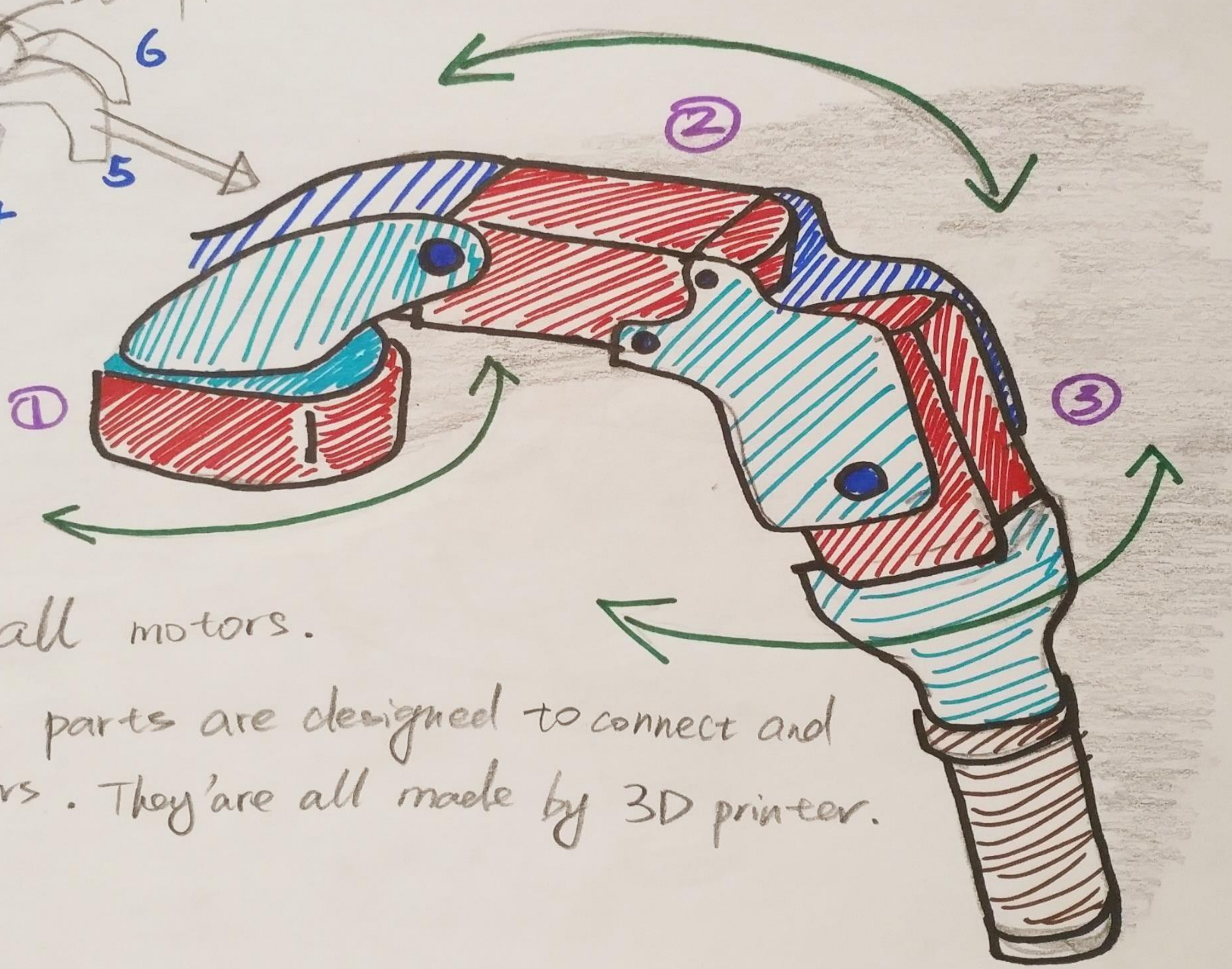
https://en.wikipedia.org/wiki/Leg_mechanism







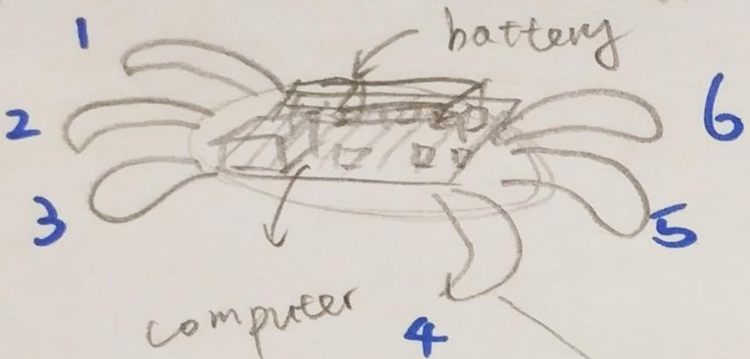
2 and 5 legs are like this.



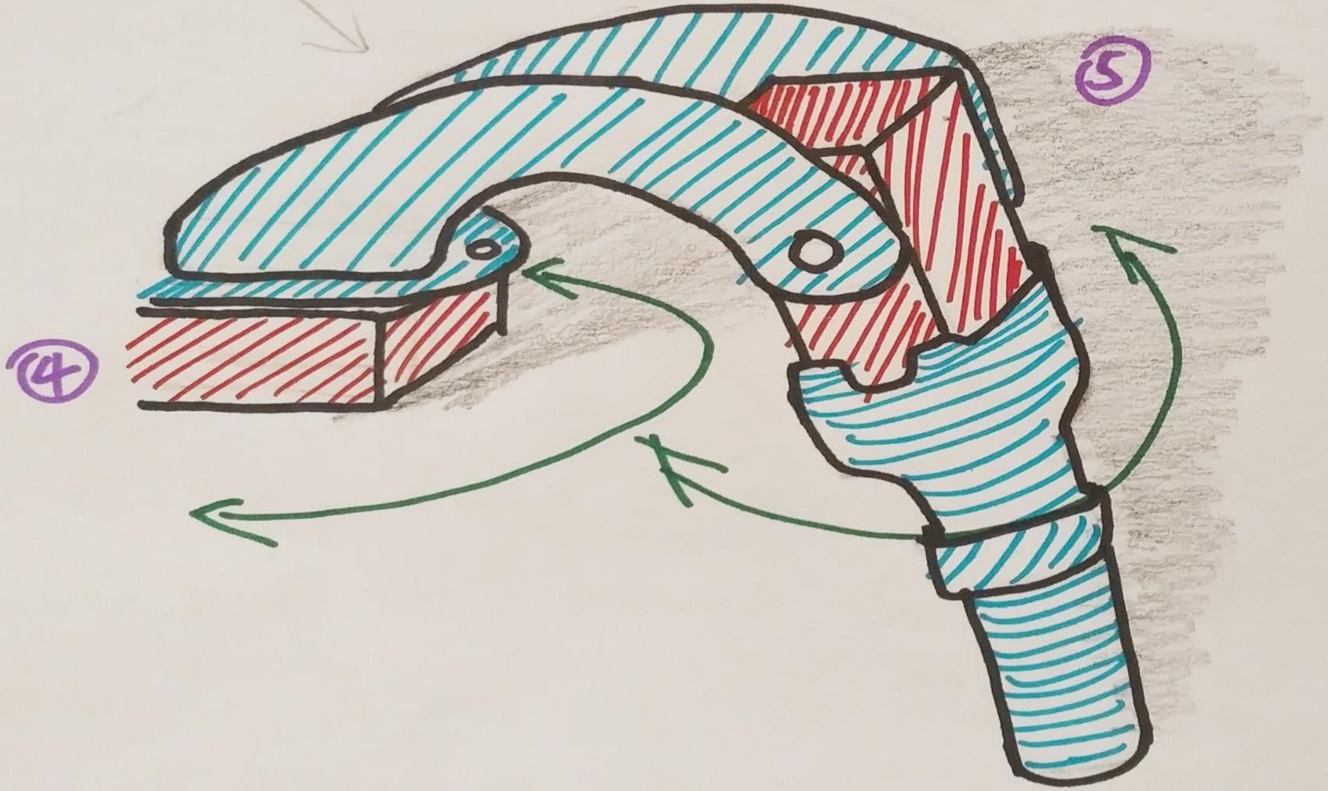
Because the motors are all in the air. So we do not need to consider the heat made by working motors.

①②③ are all motors.

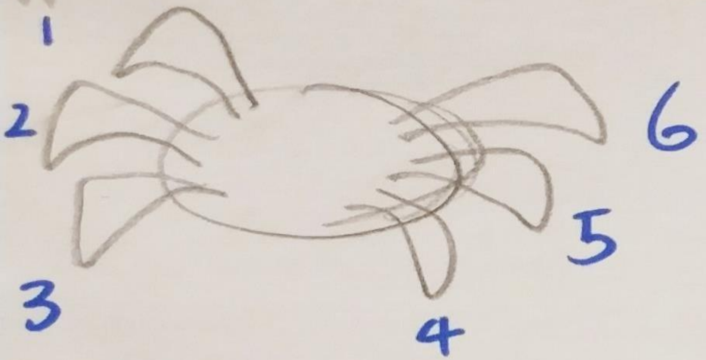
The other blue parts are designed to connect and support the motors. They're all made by 3D printer.



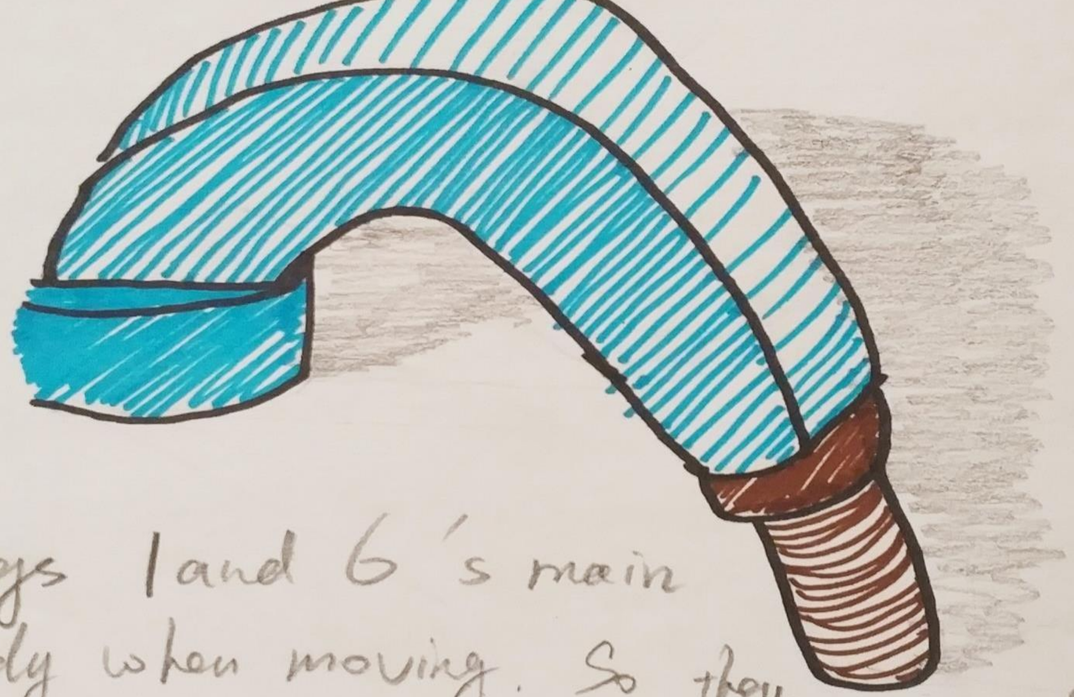
3 and 4 legs are like this



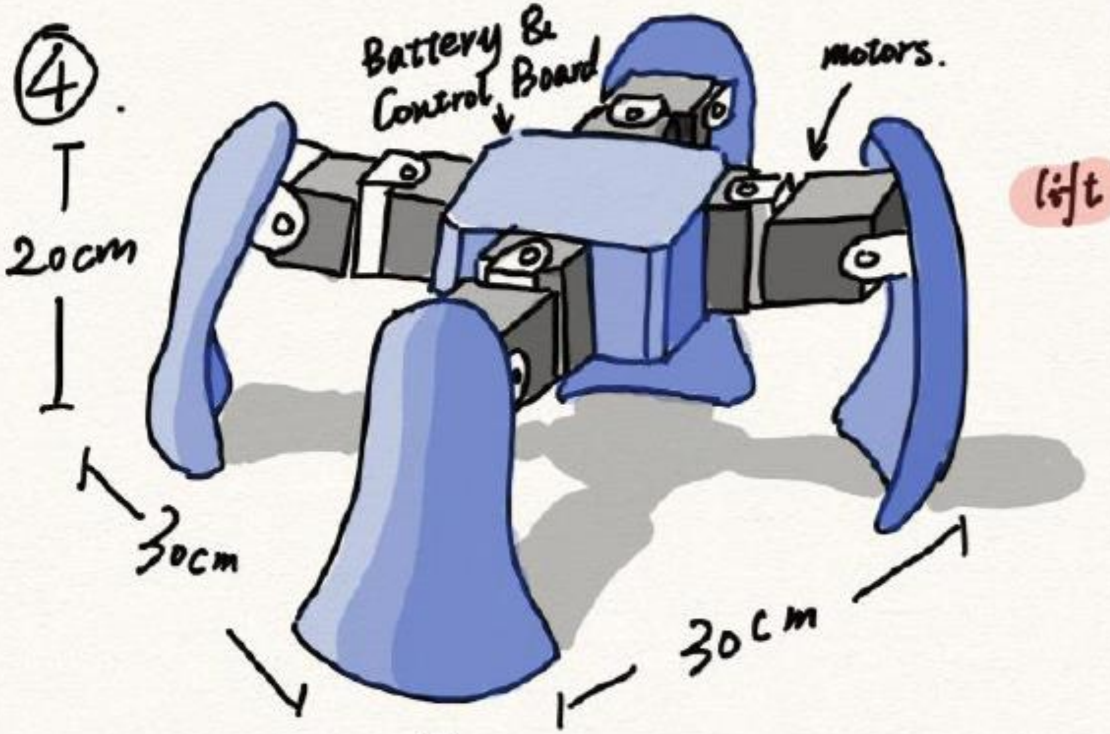
Red are motors.

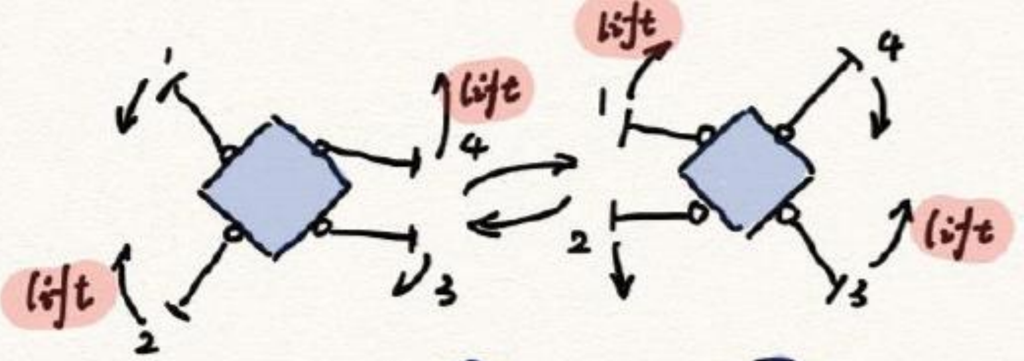


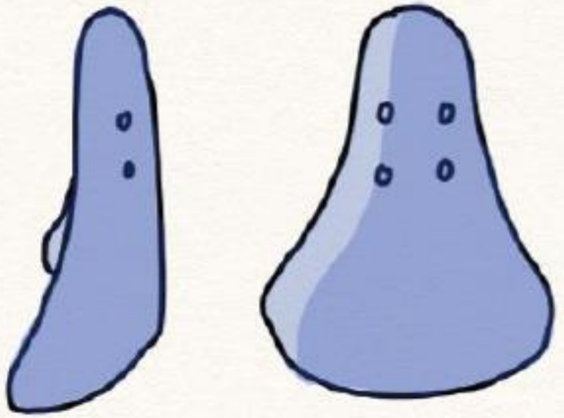
1 and 6 legs. are like this



These two legs 1 and 6's main function are supporting the whole body when moving. So they are alway connected to the ground. When the crab robot move, there are alway 4 legs support the body. So it can move stably.

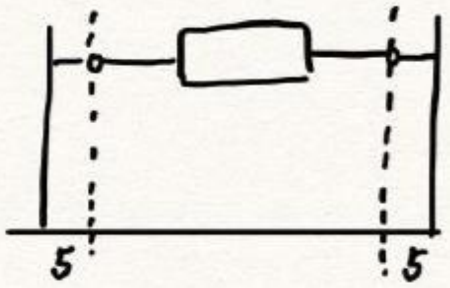






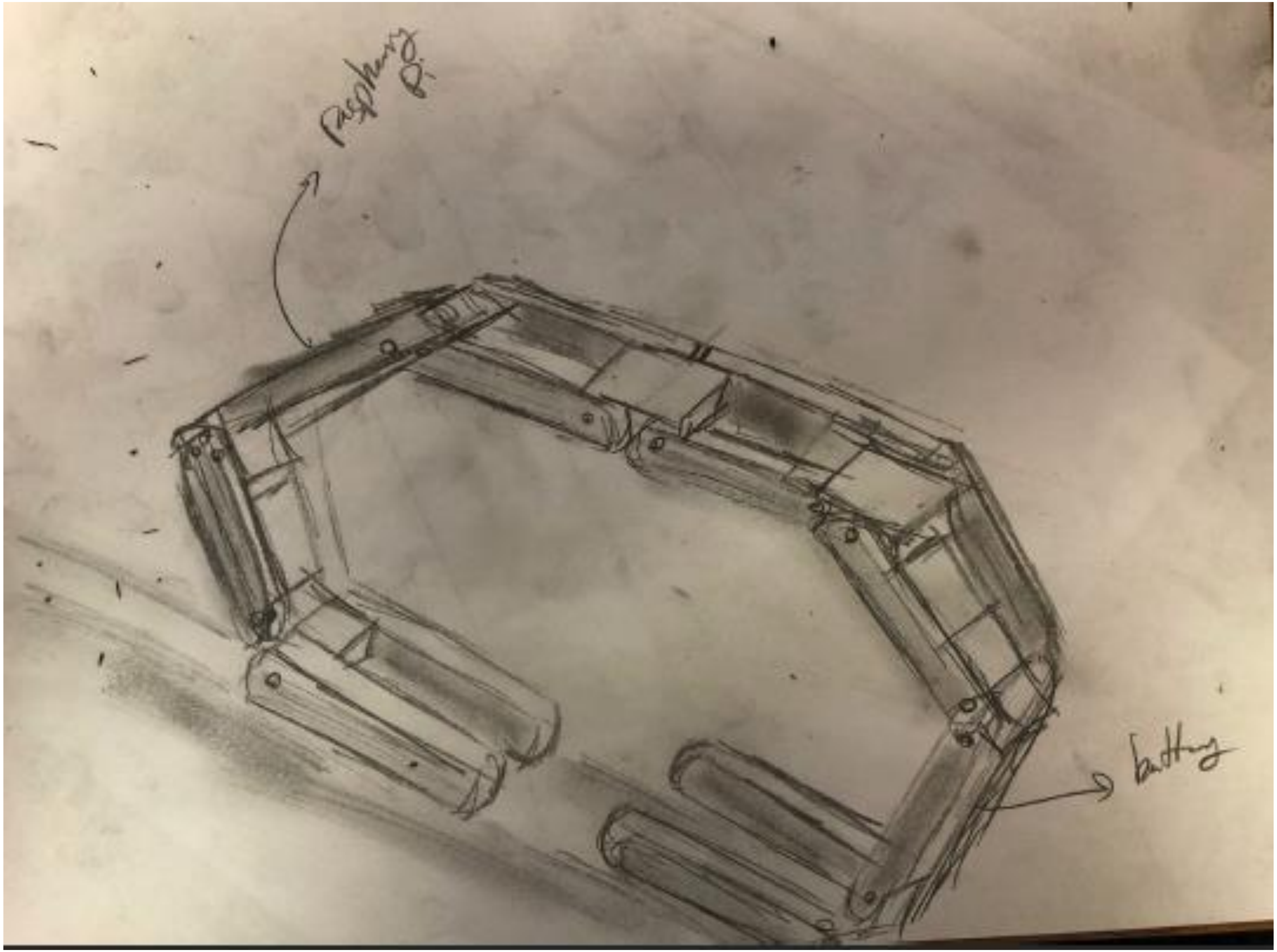
(a) 8 motors, 4 move same time.

(b) 2.3kg.

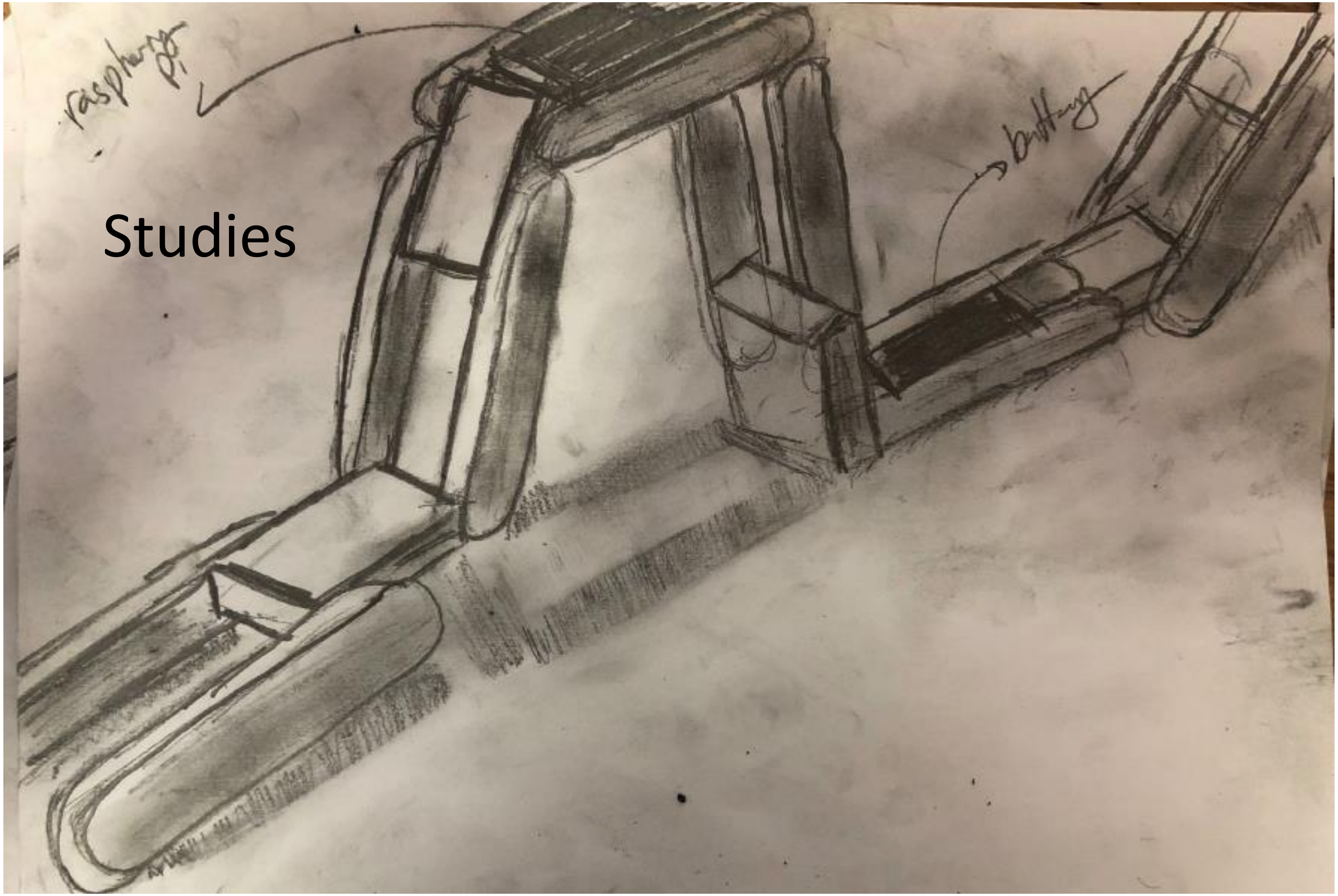


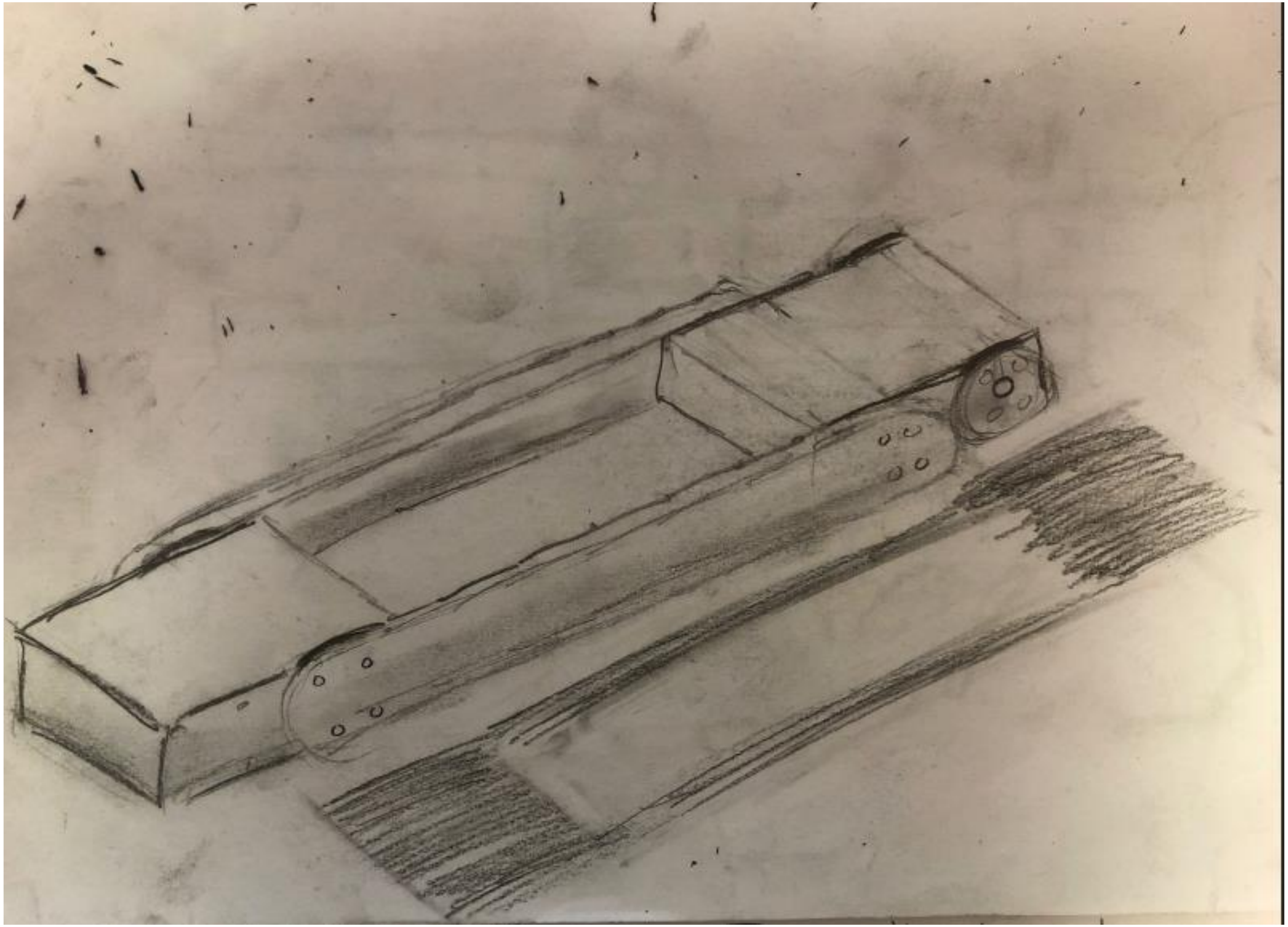
1.15kg · 5cm = 5.75 kg · cm.

Xinhuan Sang (xs2339) & TieshengHuang (th2747)


Raspberry Pi
battery

Studies

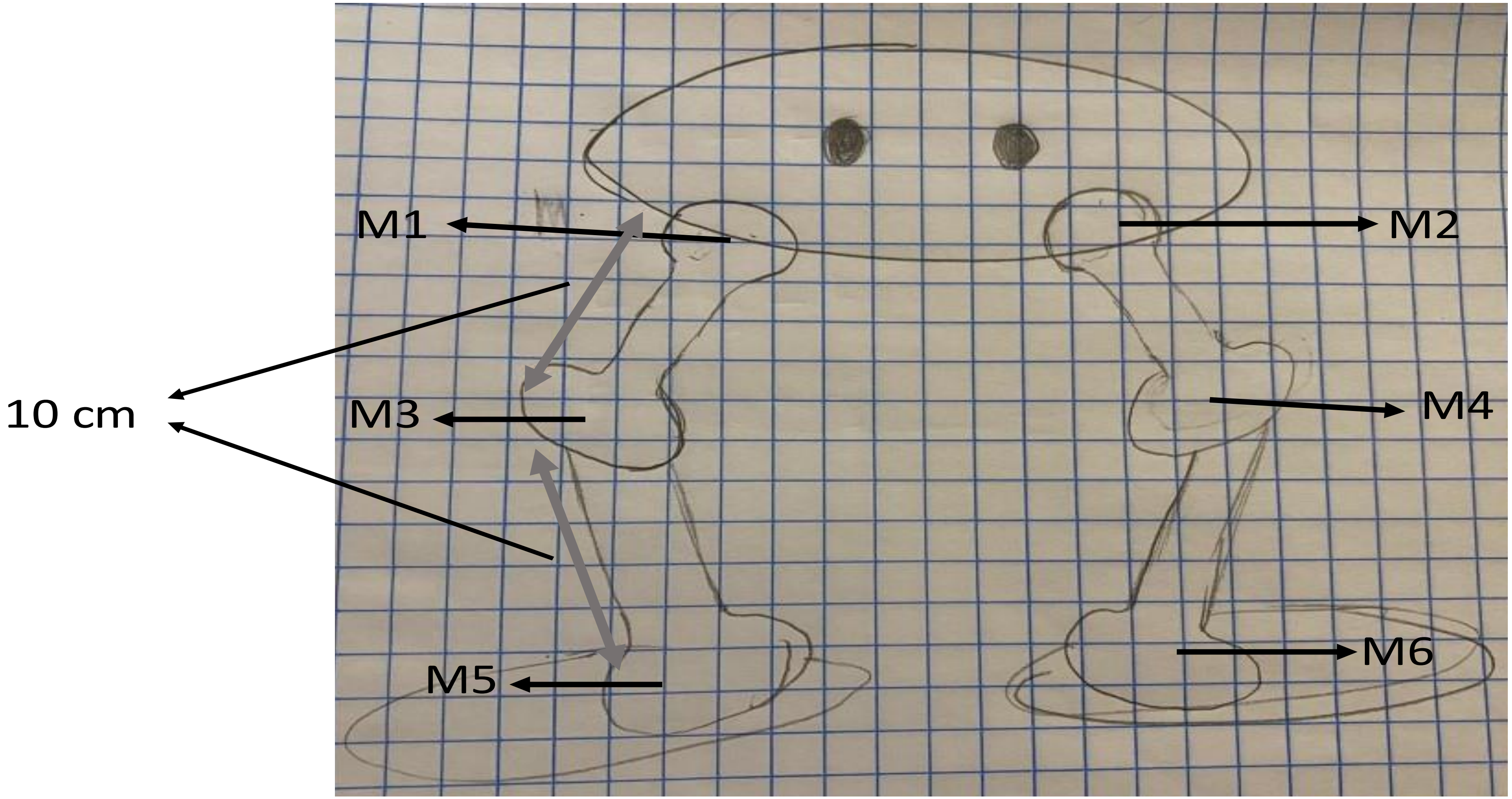




Estimate Power requirement

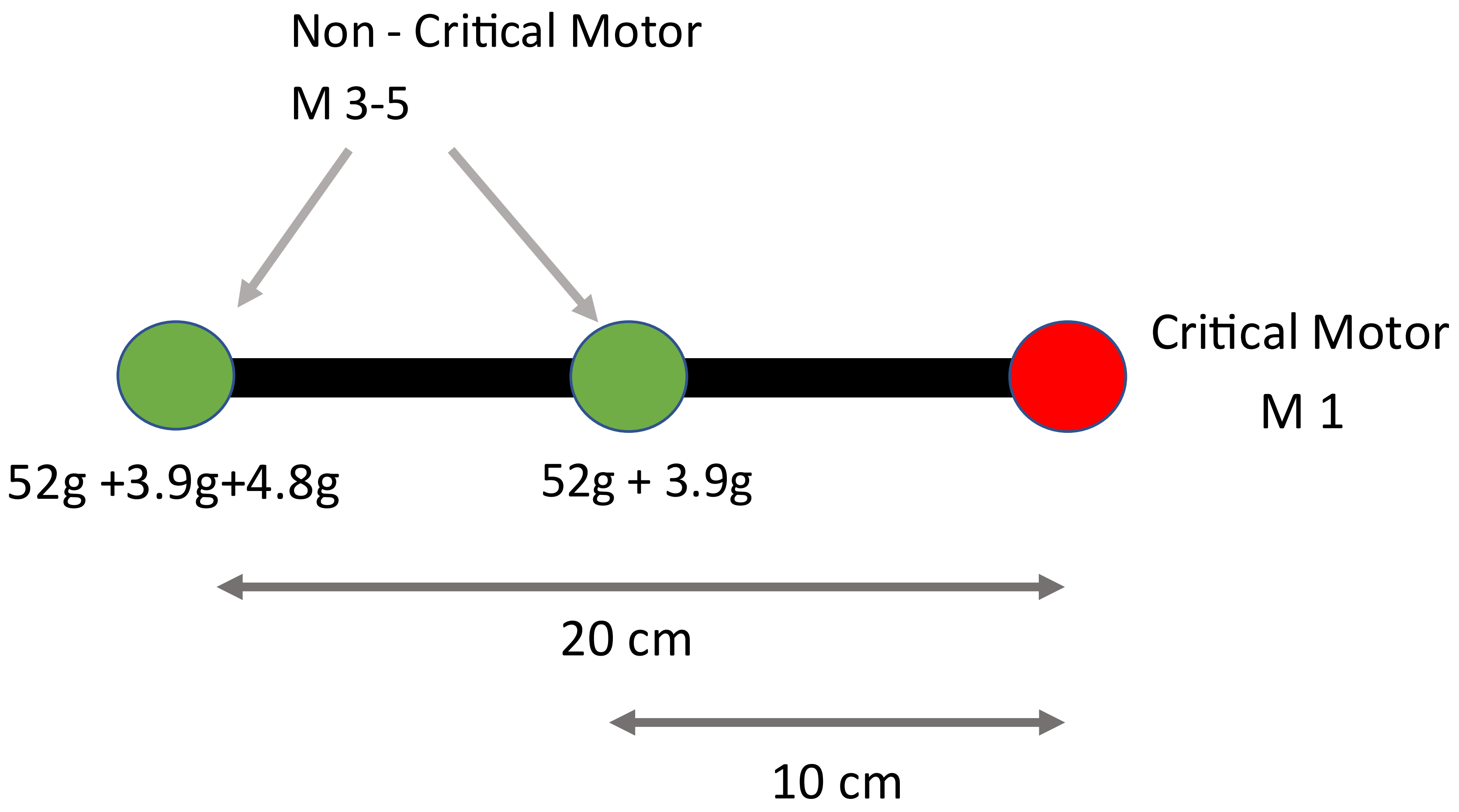
- Each motor 1A/6V max = 6W
- Battery power output: 30W

Simple Static Torque Calculation Example



There are 6 motors in this robot. Motors 3, 4, 5 and 6 are non-critical since the torques required to move knees and feet are less than hip motors. The heaviest load is attached to the hip motors 1 and 2.

Yahya Kancal



The most extreme case would be that the legs are 90 degrees strait that would cause the highest load on the motors. If we verify that our motors can handle this amount of torque, it will cover all other cases. This will even give us a safety cushion.

Yahya Kancal

Calculations

The motors are 52 g each. To calculate the static torque I assumed the links to be point masses placed on the far end of the link (giving the system another safety factor, since normally it would be a mass distribution which would generate less torque).

To find the mass I assumed the links are cylindrical with 2 cm of diameter. We create a volume of $\mathbf{31.4\ cm^3}$

PLA density assumed $\mathbf{1.24\,\frac{g}{cm^3}}$

Assuming the print density is **10%**

$$Volume\ of\ one\ link = 31.4\ cm^3$$

$$Mass = Volume\ X\ density\ X\ infill\ percentage$$

$$Mass = 31.14 * 1.24 * 1/10$$

$$Mass = \mathbf{3.9\ g}$$

This means each link is 3.9 grams. Gravitational acceleration is 9.81 $\frac{m}{s^2}$

(With a similar calculation 5 cm diameter feet with 0.5 cm height will give us **4.8 grams** weight)

Yahya Kancal

Calculations

Torque calculation:

$$Force = Weight * Gravtitational\ accelearation$$

$$Static\ torque\ for\ motor\ 1 = Force * Distance$$

$$Static\ torque\ for\ motor\ 1 = (52 + 3.9)g * 9.81\frac{m}{s^2} * 10\ cm + (52 + 3.9 + 4.8)g * 9.81\frac{m}{s^2} * 20\ cm$$

$$Static\ torque\ for\ motor\ 1 = \mathbf{17.3\ N.cm}$$

The motor specification is 17 kg.cm which is **166.7 N.cm** since:

$$\mathbf{17.3\ N.cm} \lll \mathbf{166.7\ N.cm}$$

<u>Conclusion:</u>

We are well within the motor specifications. We also have some safety cushion in place. We could also add additional safety factors which would be even more safe.

Yahya Kancal

Need help sketching?

- Warmup: https://www.youtube.com/watch?v=cE6JBbTvTp4
- Perspective: https://www.youtube.com/watch?v=JK0qlnnG1WA
- Contour lines: https://www.youtube.com/watch?v=YEYQe_81M4U
- Basic Sketching: https://www.youtube.com/watch?v=IM_zvACz2og&t=12s
- Basic Shapes: https://www.youtube.com/watch?v=IDrnj8BPp9w
- Random shapes: https://www.youtube.com/watch?v=QNNbpLO4mEI
- Organic shapes: https://www.youtube.com/watch?v=_JK73WLM3xQ
- Shadows: https://www.youtube.com/watch?v=umuPO77DEbA
- Two point perspective: https://www.youtube.com/watch?v=YInBreaClY0
- Presenting ideas: https://www.youtube.com/watch?v=iVy0qGqmKFU

Modularity

- Consider making robot in parts (modules)
  - Easy testing and reprinting subcomponents for fast iteration
  - Keep prints under 12h limit, print in parallel
  - Optimize print orientation for each part
  - Interchangeable components for better functionality
    - Interchangeable feet for tile vs. carpet
    - Snap-on skin for different visual effects