Project Orbitron

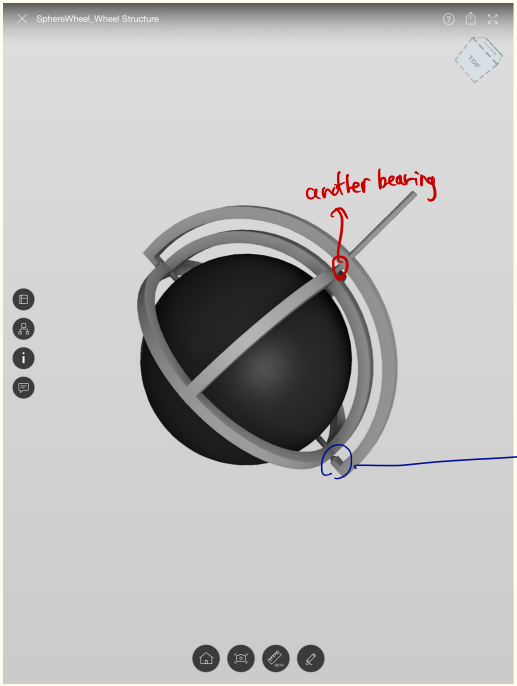
Research Notebook

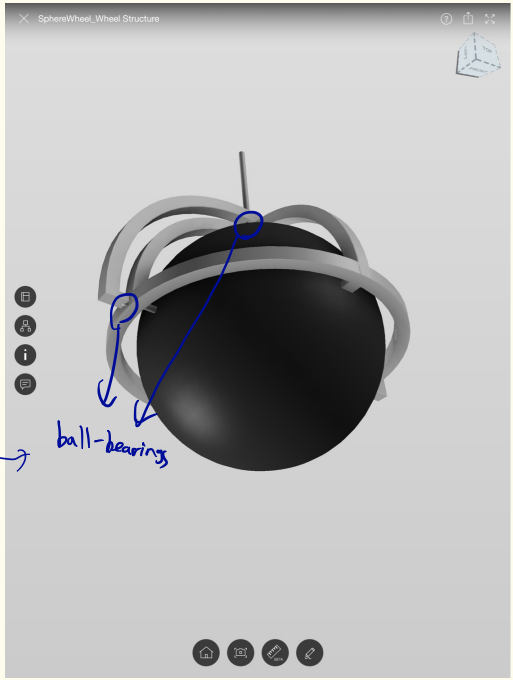
2018/01/01

Bundang Starbucks

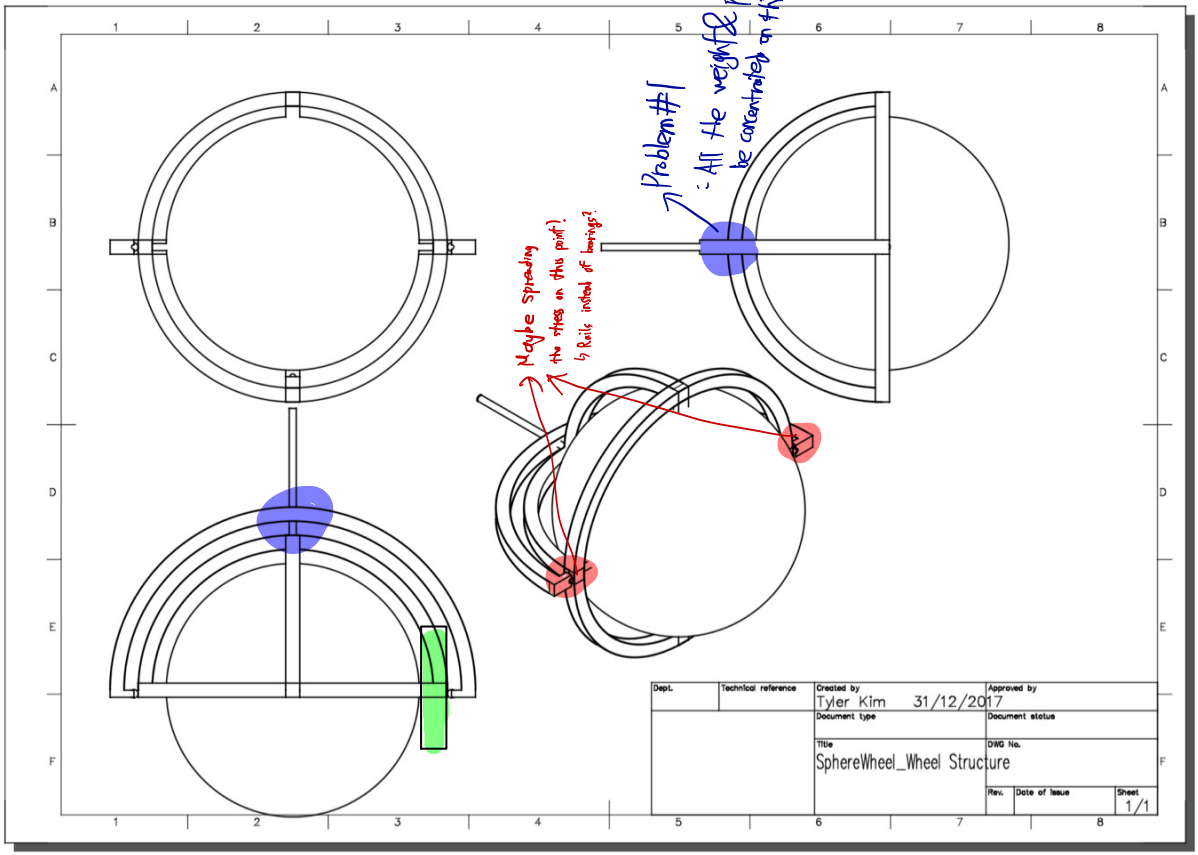
Tyler Kim

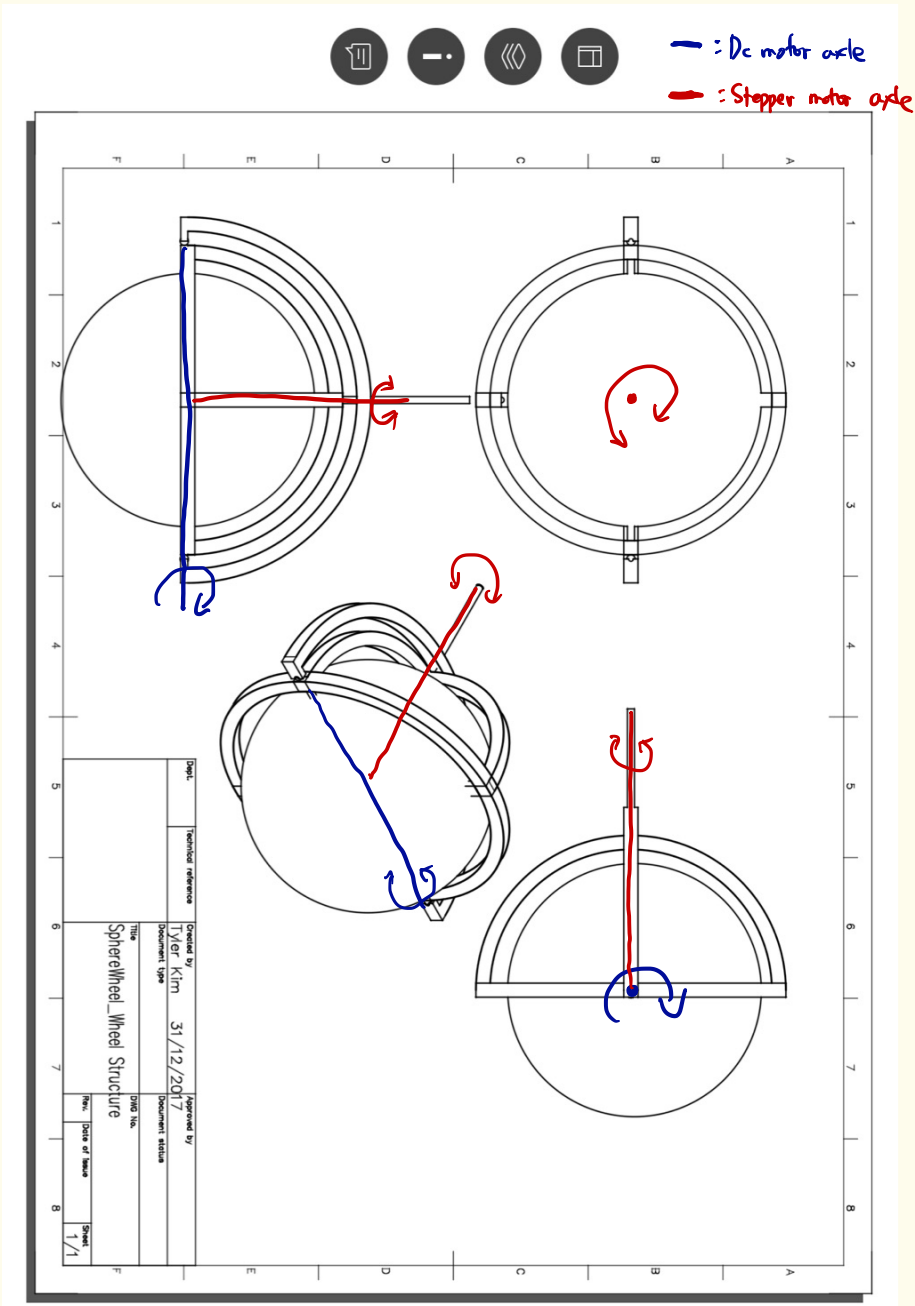
First model of tire structure : 1/1 10:50PM





* Version Description
  - Sphere tire
  - Added both axises
  - Enhanced structure for stability of the vehicle
    - Added ball-bearings


Problem #1
: All the weight of picture will be concentrated on this point
Maybe spreading the stress on this point by rails instead of bearings?
Dept.
Technical reference
Created by
Tyler Kim 31/12/2017
Approved by
Document type
Document status
Title
SphereWheel_Wheel Structure
DWG No.
Rev.
Date of Issue
Sheet
1/1


: Dc motor axle
: Stepper motor axle
Dept.
Technical reference
Created by
Tyler Kim
31/12/2017
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Document type
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Title
SphereWheel_Wheel Structure
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1/1

V02 - Rails iden

SphereWheel_Wheel Structure

circular rail needed for this part

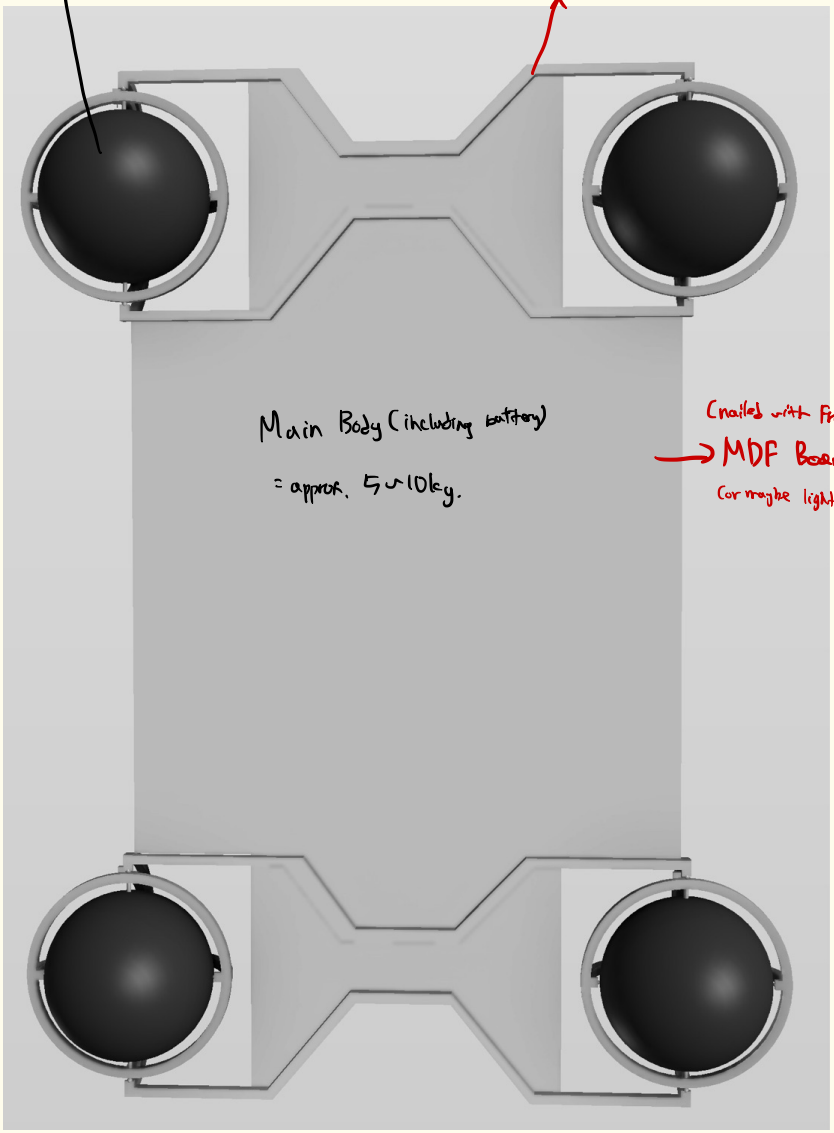
bearing

→ Adv.
- Able to spread the force exerted on the stepper motor
- More smooth rotations

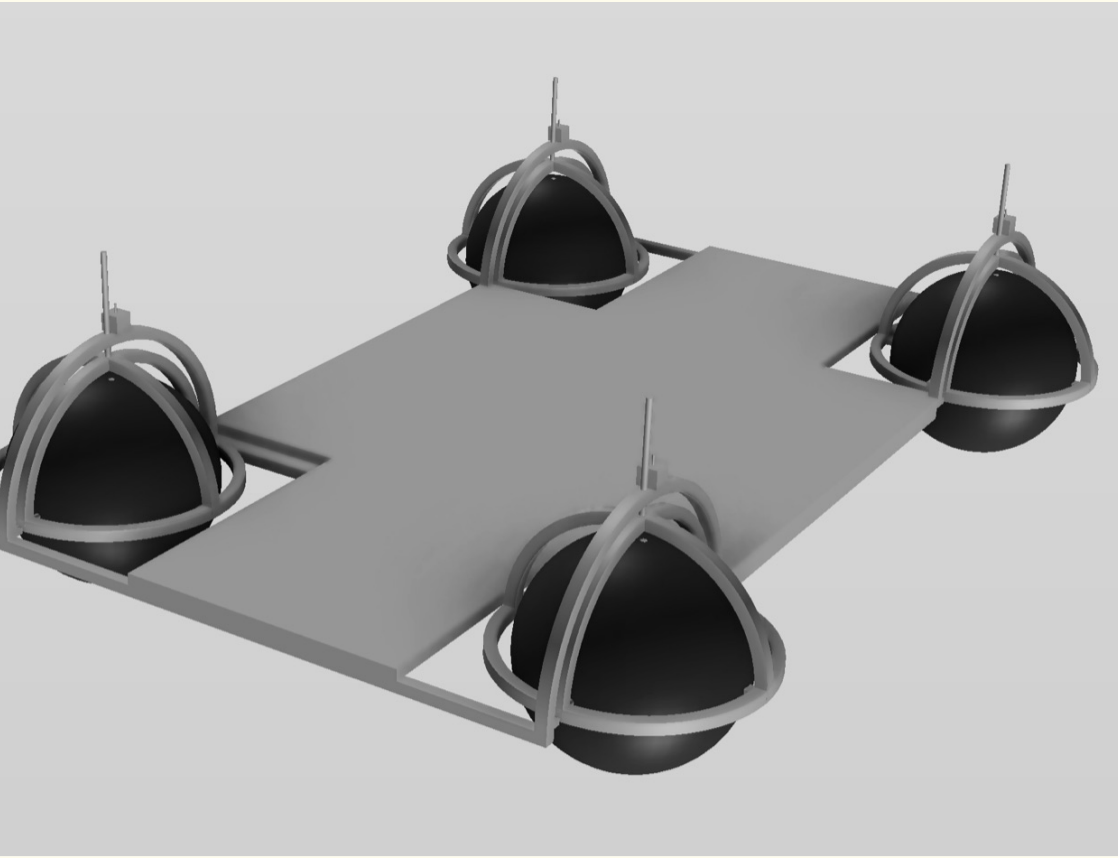
Disadv.
- Too complicated
- Where am I gonna get the rail with that exact size?

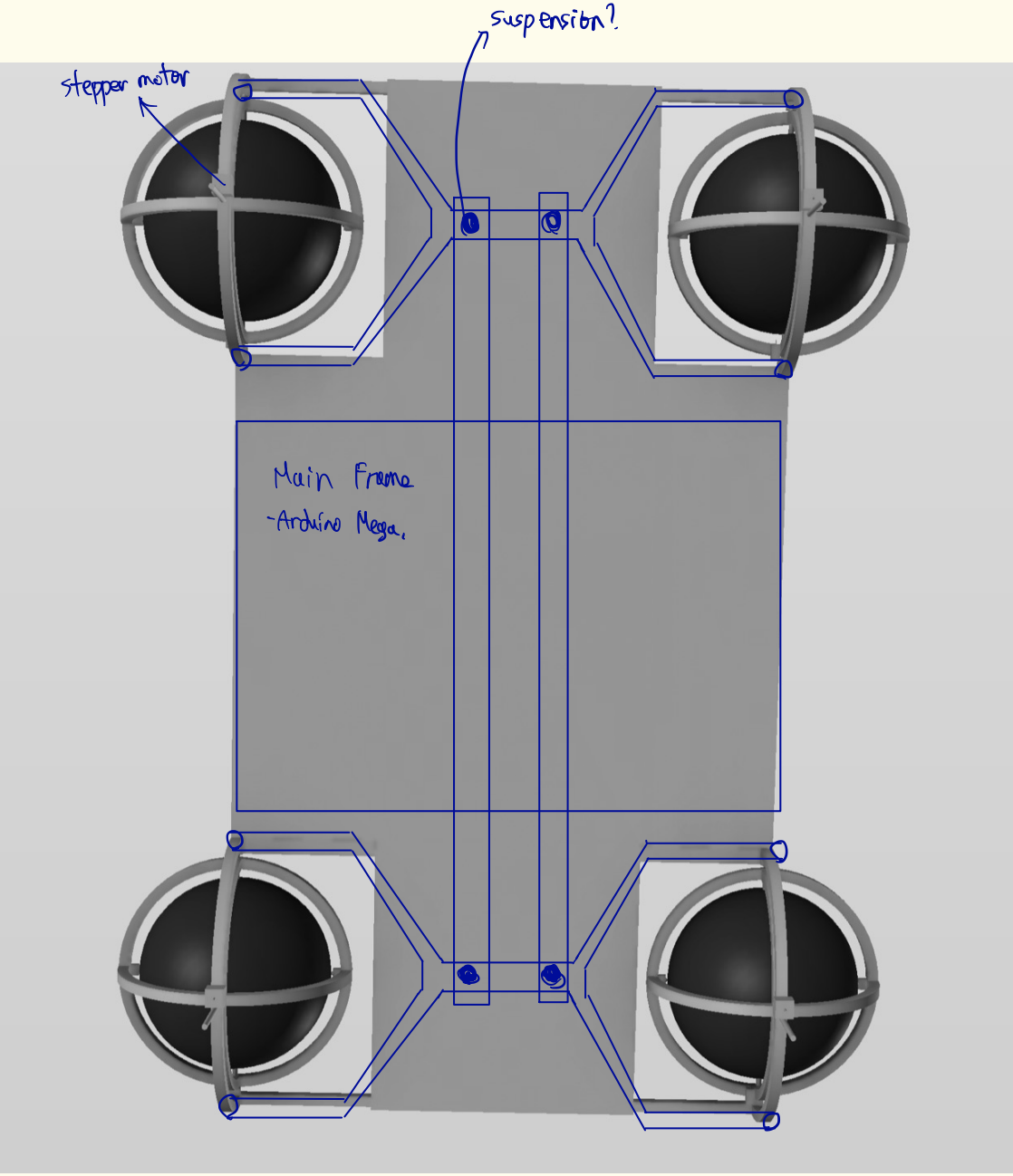
★ 장점
- 레일형 베어링으로 차체의 무게를 레일에 분산시킬 수 있음

1/3 - Initial CAD Design

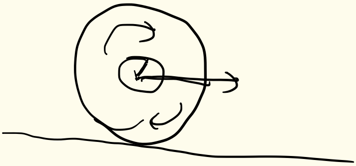


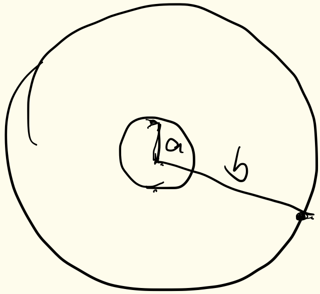
☆ Torque need for this vehicle to approach. (5mph. (1m/s?

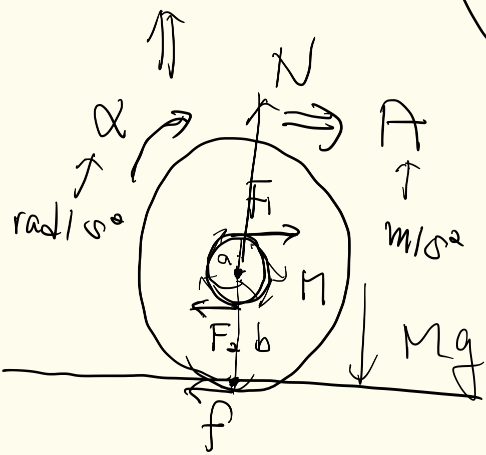



suspension?
stepper motor
Main Frame
-Arduino Mega.

1/19 - Calculating Torque - At Yale with 경주형







No skidding

$A = b \cdot \alpha$

① Translation

$F_1 - F_2 - f = MA$

$\Rightarrow 0.1F - f = MA$

② Rotation

$F_1 a + F_2 a + f \cdot b$

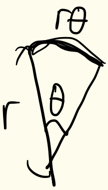
$= I \cdot \alpha$

$\uparrow$ → 회전에 대응되는 질량

$\frac{2}{5} M b^2$

$1.9Fa + fb = \frac{2}{5} M b^2 \cdot \alpha$

$= \frac{2}{5} M b A$



$X = b \Delta \theta$

$F_2 = r F_1$

$0 \leq r \leq 1$

$I = F \cdot \Delta d$

$I = (F_1 + F_2) a$

$F_2 = 0.9 F_1 = 0.9 F$

$A = f(r) F$

$0.1F - f = MA$ ← mass ... ①

$1.9Fa + fb = \frac{2}{5}MbA$ ... ②

$1.9F \cdot \frac{a}{b} + f = \frac{2}{5}MA$ ... ②′ ← 2/b × ( )

$f = \mu_s N \geq A$ ← # ← #

$= \mu_s Mg$

① + ②′

$\Rightarrow \quad 0.1F + 1.9F \cdot \frac{a}{b} = \frac{7}{5}MA$

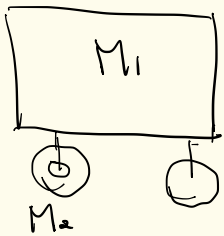
$\uparrow F = \frac{1.4}{0.1 + 1.9\frac{a}{b}} MA$ ↑ ↑

$(1+r)Fa$ ← 초기값 곱셈

3s $\quad v=0 \rightarrow 100\,km/h$

$\rightarrow \bigcirc m/s$

$A = \bigcirc\ m/s^2$



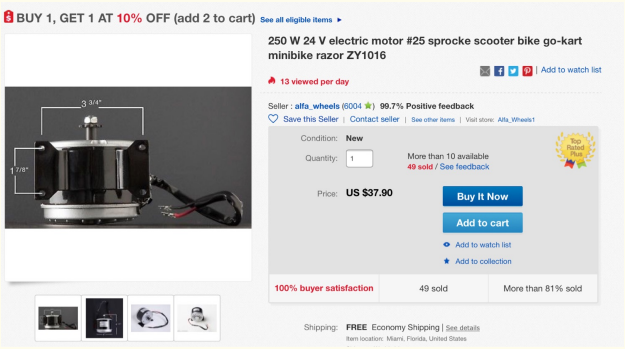
$4(0.1F - f) = (M_1 + 4M_2)A$

$1.9Fa + fb = \frac{2}{5}M_2 b^2 \alpha$

$= \frac{2}{5}M_2 bA$

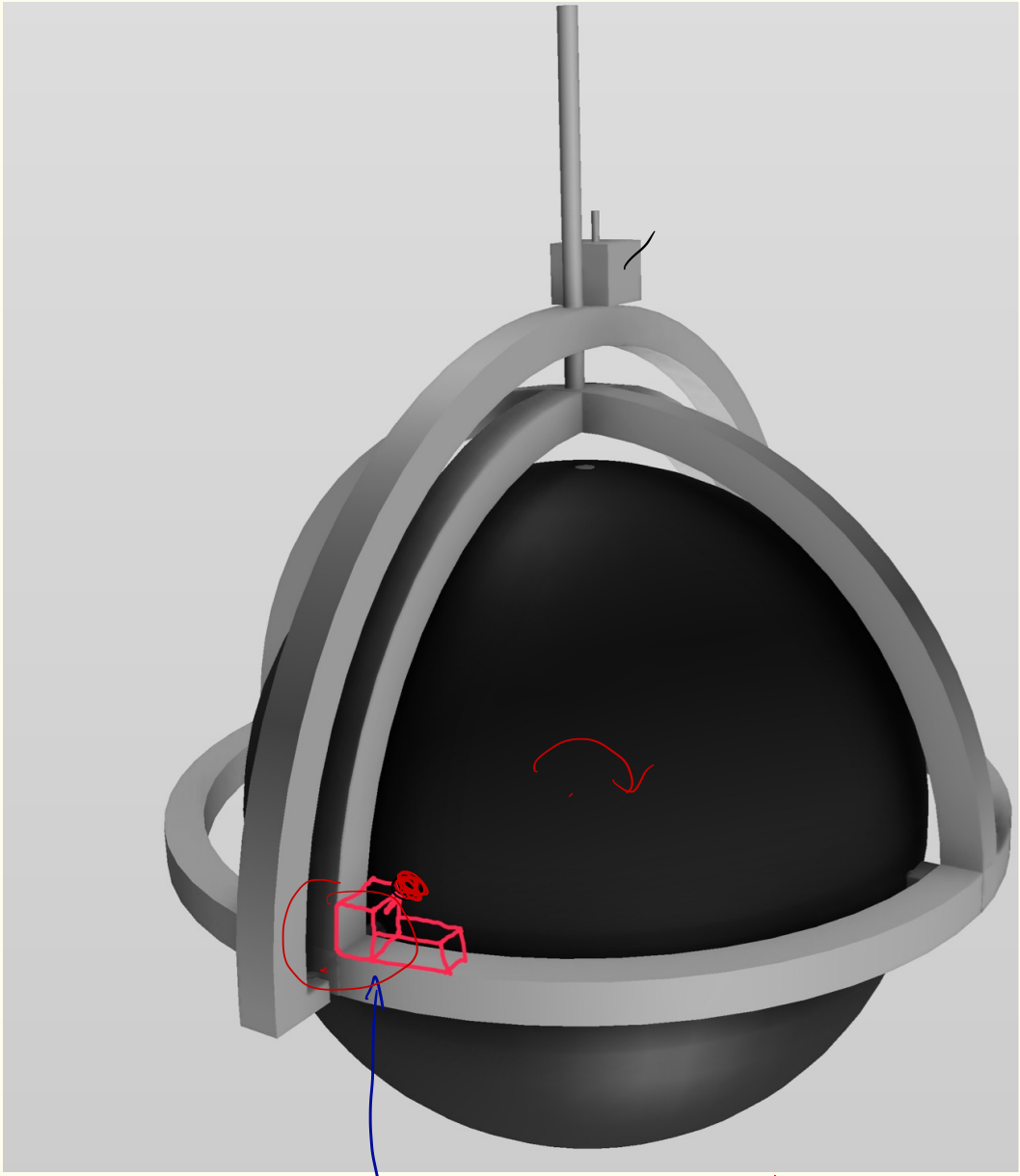
- Scooter Motor

https://www.ebay.com/itm/250-W-24-V-electric-motor-5M-Belt-f-scooter-bike-go-kart-minibike-razor-MY1016/152460235594?_trkparms=aid%3D555018%26algo%3DPL.SIM%26ao%3D2%26asc%3D47300%26meid%3D663474fd56fc45aab7c335365df720b9%26pid%3D100005%26rk%3D3%26rkt%3D6%26sd%3D352113714890&_trksid=p2047675.c100005.m1851

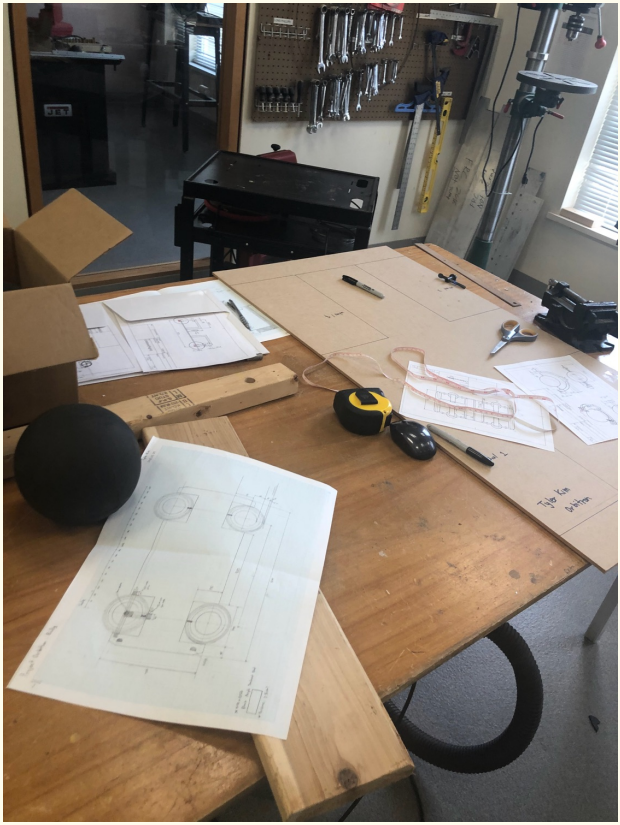


- Right angle gearbox motor

https://www.superdroidrobots.com/shop/item.aspx/ig32-right-angle-12vdc-220-rpm-gear-motor/720/


right-angle gearbox or motor directly attached?

Build Note 4/1/2018 2-4pm



- Drilled holes for all 4 wheels
- Found 1/4" x 3' x 4' MDF Board
- Cut MDF into right size (1140 x 595)
- Traced outlines on MDF according to the drawing

To-Do

- Cut MDF board border cleanly
- Cut along the sharpie line
- Weld the sheets into the
- Do we have a wifi router available for me to use
- cut wood in curve

Build Note: 4/7/2018

- Gathered all (well, for now) materials for the project
  - ↳ from servocity
  - ↳ PVC pipe
- Assembled all four servo gearboxes

Build Note 4/13/2018 → D-1 ACT! 6pm

- Moved EVERYTHING to the Pre-E center!
  - ↳ 2.3m iron bar
  - ↳ PVC pipe x2
  - ↳ MDF Board
  - ↳ Servocity
  - ↳ Arduino stuff

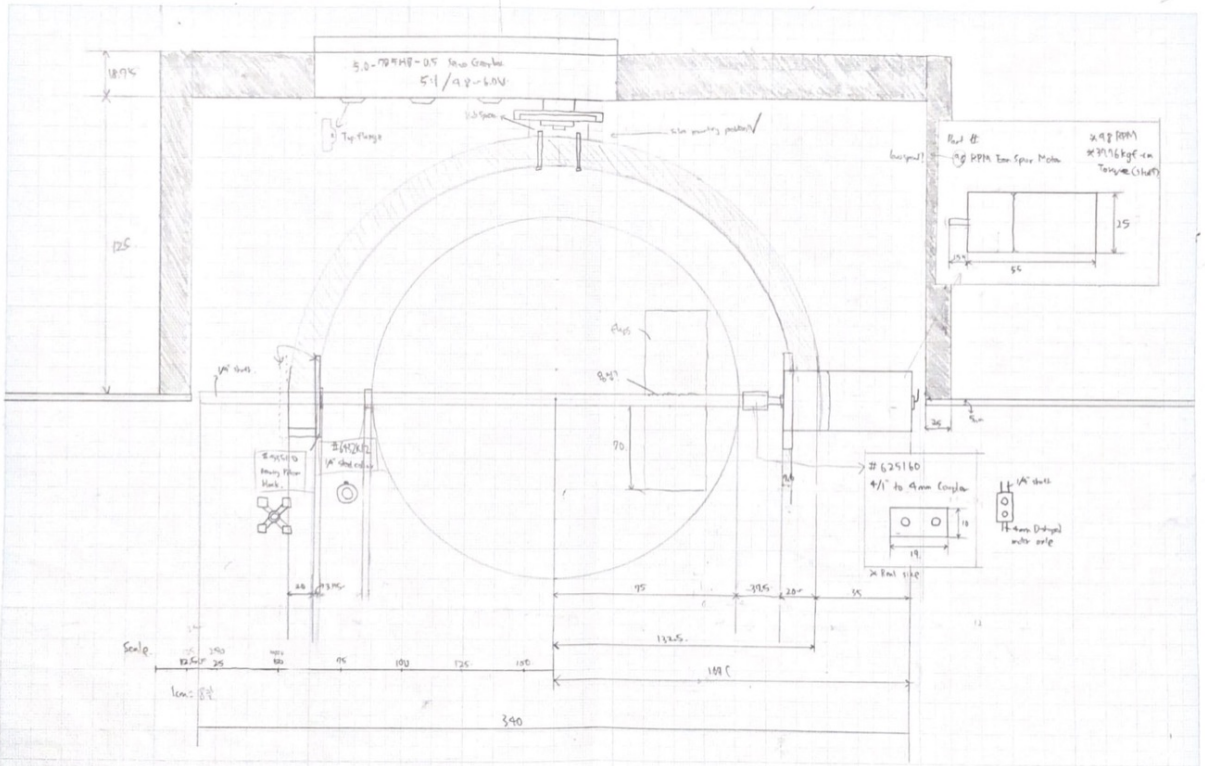
↳ (+) Mr. Hinman explained briefly about e-bike projects in inventor club.

Build Note 4/14/2018 - 2~4pm (Finally DONE with ACT)

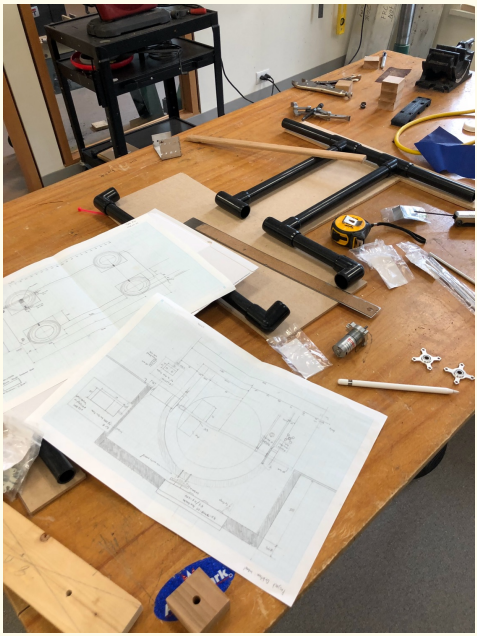
- Cut the MDF Board along the outline
- Built the PVC structure (80% done)
- Gathered various wood for structure

To-Do

Project Orbitron: Wheel

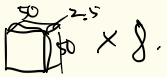


Build Note - 4/15/18 1-3PM



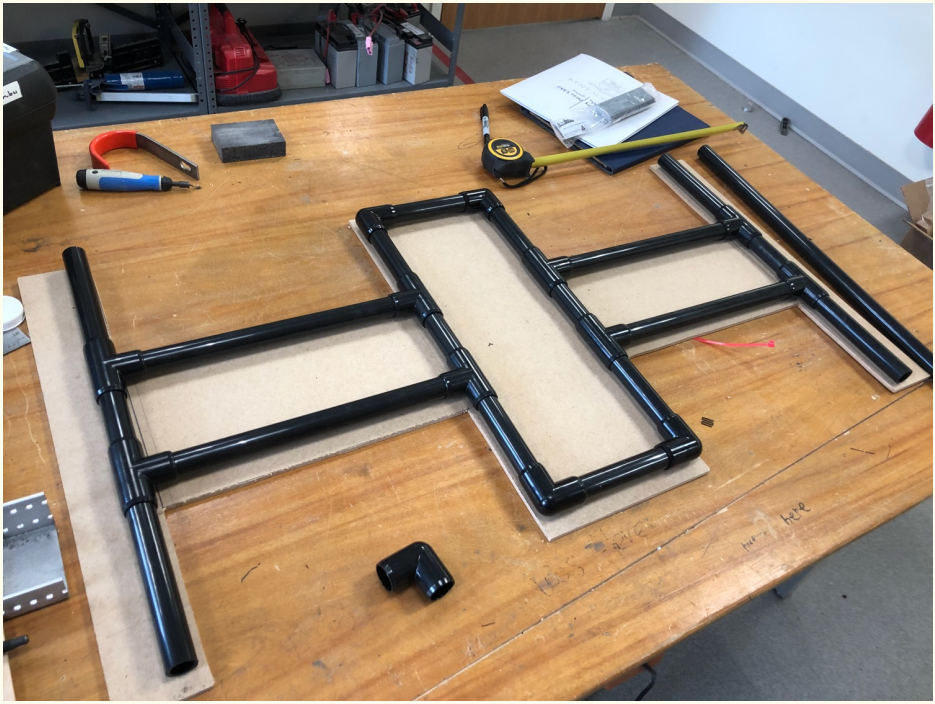
- Cut the giant iron bar into 6" long pieces
  - ↳ To-do: meet with maintenance -> weld!
  - ↳ Draw the dimensions for wheel structure

- Found woodboard and cut into size



- Attached clamps

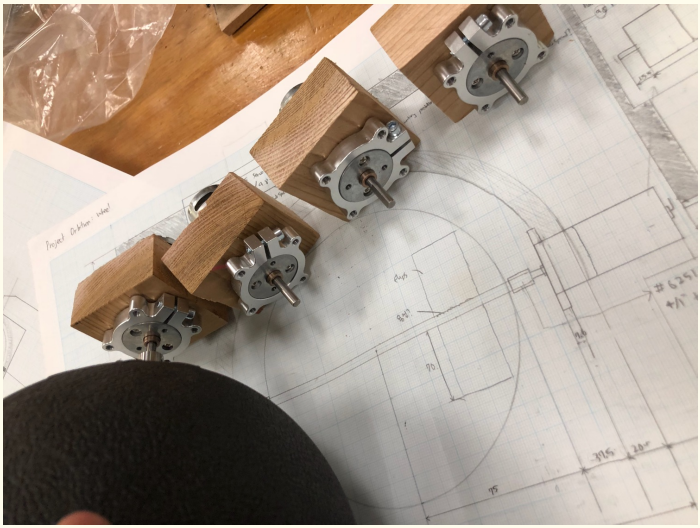
Build Note - 4/20/2018



- Finished the PVC structure
  - ↳ Glued with gluegun
- Bored 25mm holes on all wooden blocks
- ☆ Figured out how to attach the wheels to the shaft
  - ↳ Details behind

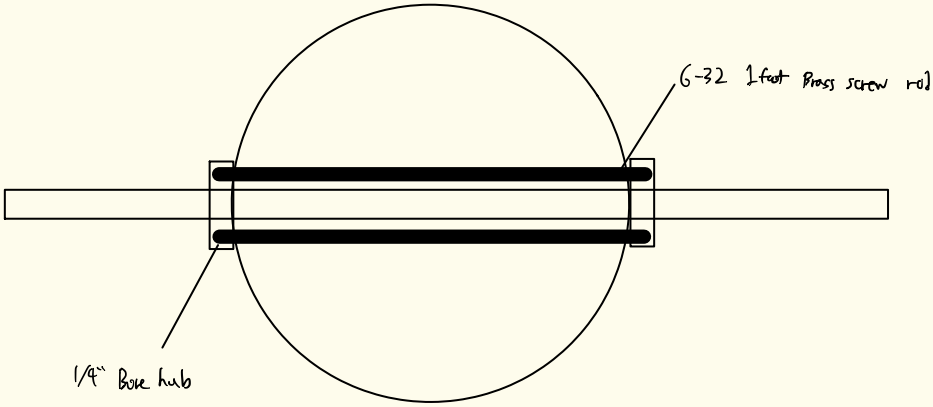
- 3D model the wheel hubs
  ↳ Or actually, search for the wheel hubs already available ✓
- Saturday
  ↳ CAD more specifically about steel structure
  - order screw & nuts ✓

← Boring 25mm today to wood blocks

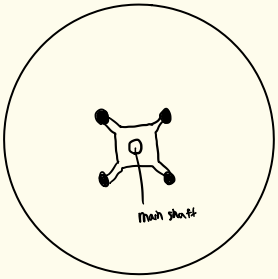


← Need to be screwed in !

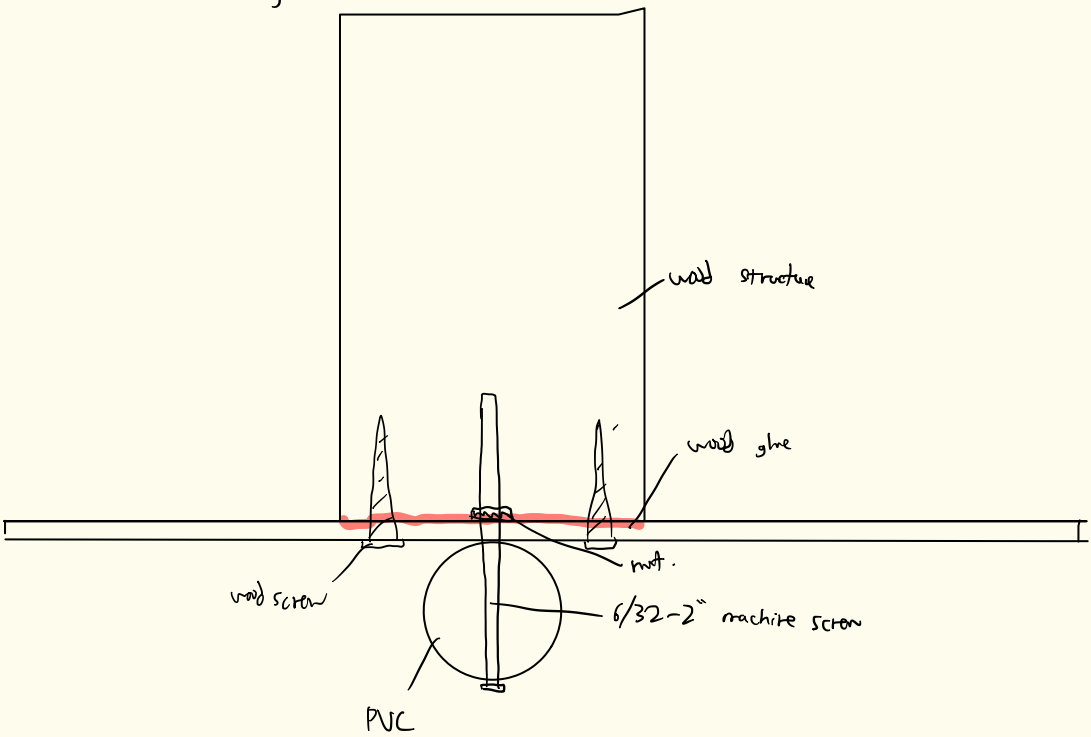
4/20 - Mr. Harris's Idea!



- 3D - model the wheel hub to be attached to the wheel
- Drill 4 holes



4/26 - Attaching PVC + structure.



① Attach PVC using machine screw + nuts

② Drill holes on the wood structure to align properly

③ Use wood glue to hold in place

④ Use wood screw to finish attaching it.

→ 4/28 planned

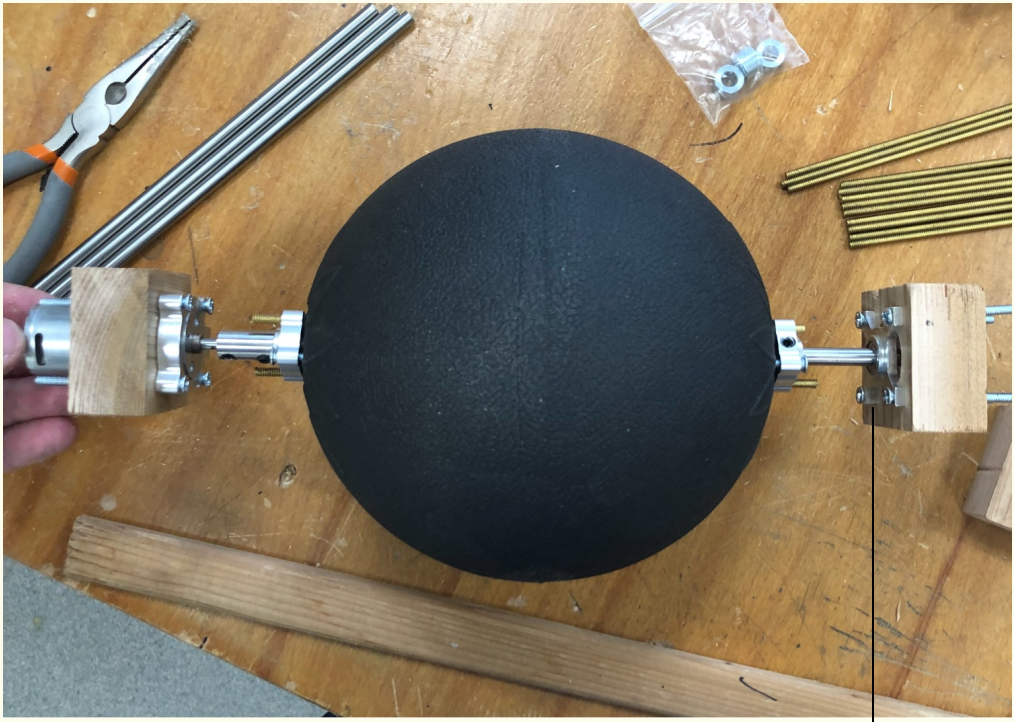
→ After finishing measurements

↓

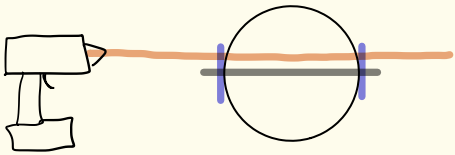
☆ Review this plan

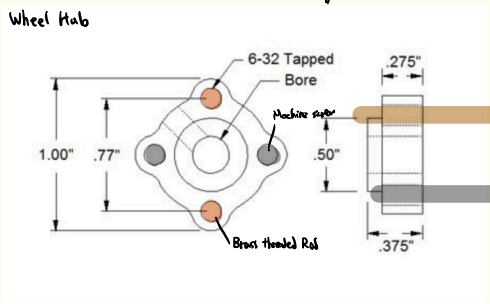
↳ These parts can be brought home for guild project.

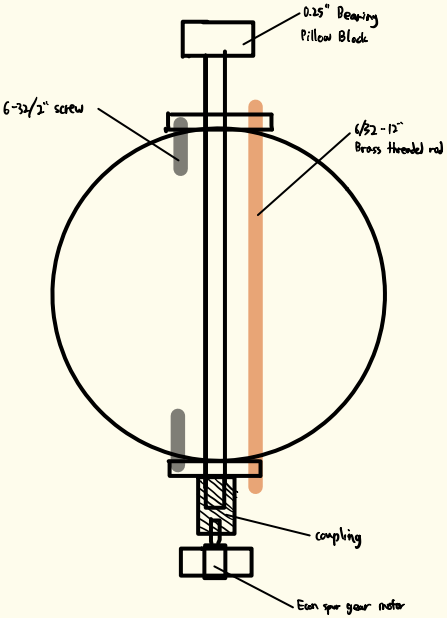
Build Note - 4/29/2018 1-3pm



- Attached Wheel hub + coupler + shaft to all four wheels
- Screwed 2 bearing and 1 motor to the wood block
- Attached 2 machine screws, 2 brass rods to 2 wheels
-
- Used handdrill to insert brass rod straightly





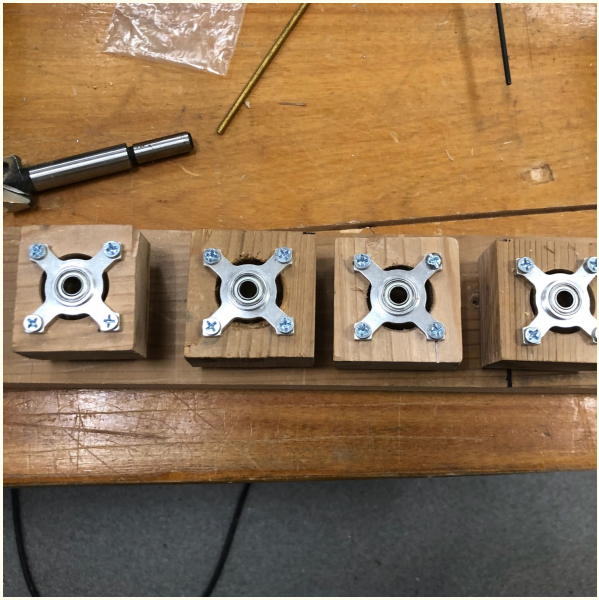


- Screwed 1 motor and 2 bearing pillows.

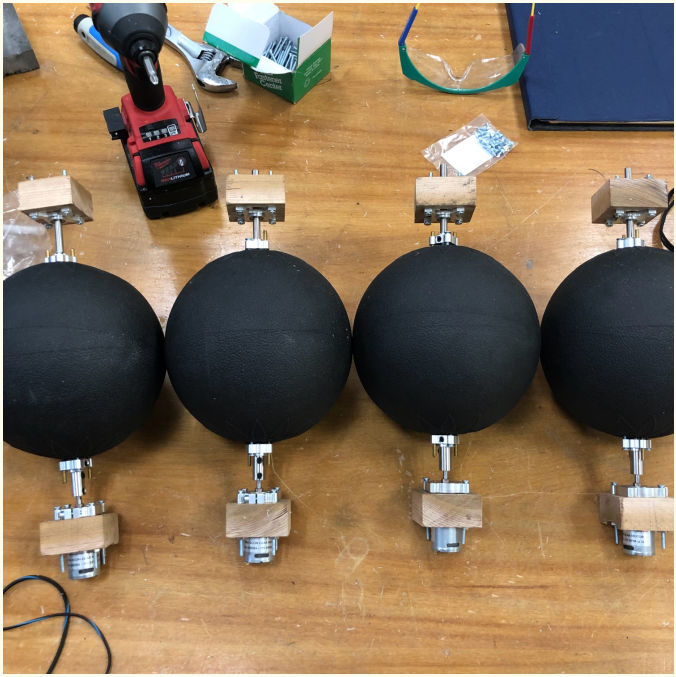
To-Do:

- Finish screwing pillow blocks (2) & motors (7) to the wood blocks

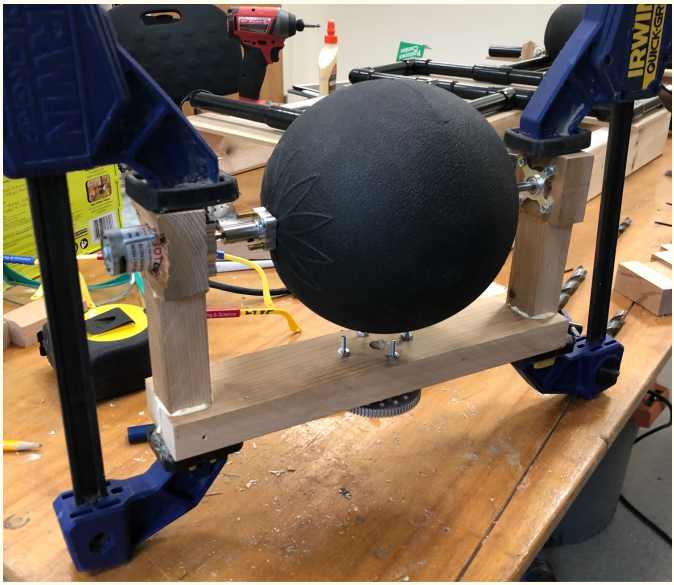
Build Note - 5/4/2018



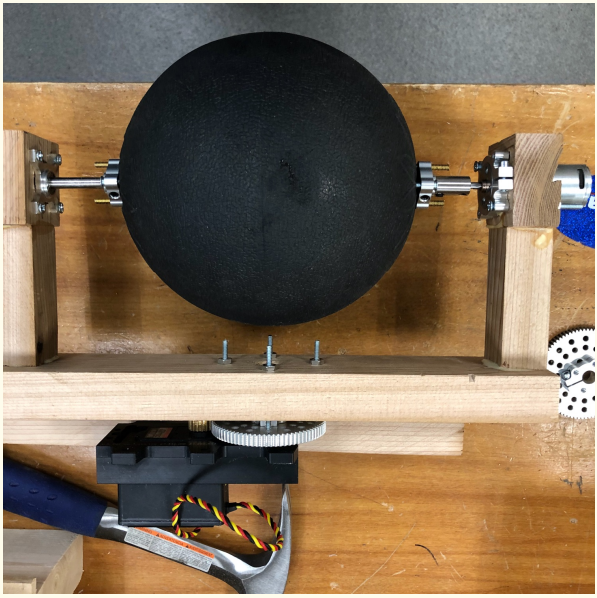
- Finished screwing all four bearings
- Finished assembling all four wheel parts

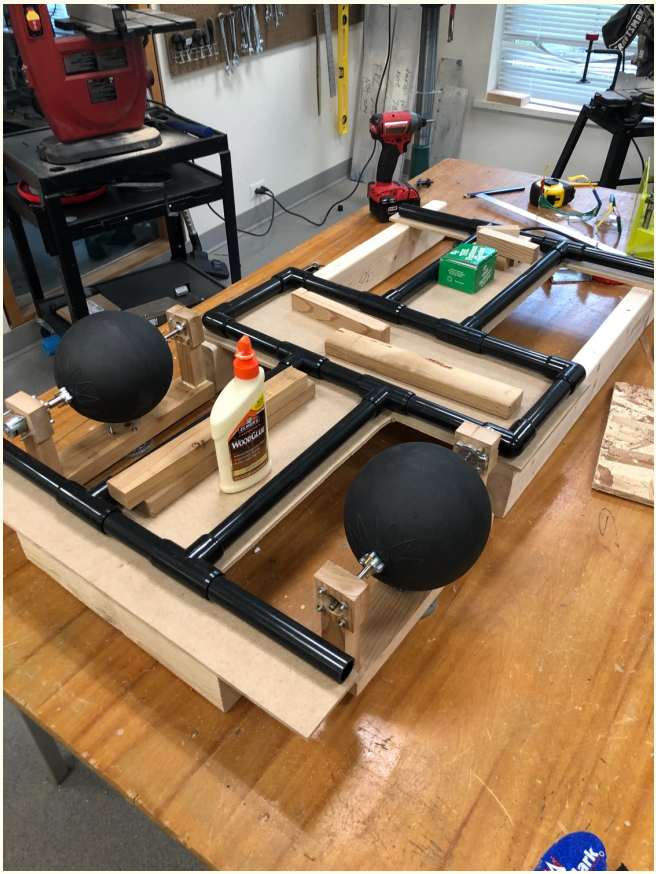


5/12 - Build Note



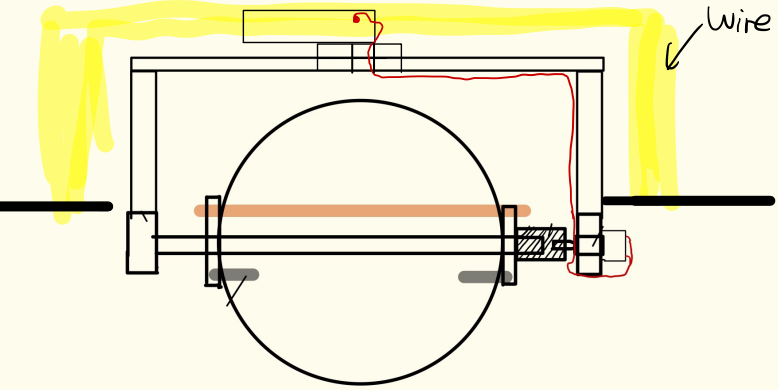
- Finished wheel structure for two
  - ↳ Glued with wood glue
  - ↳ SHOULD screw it after.



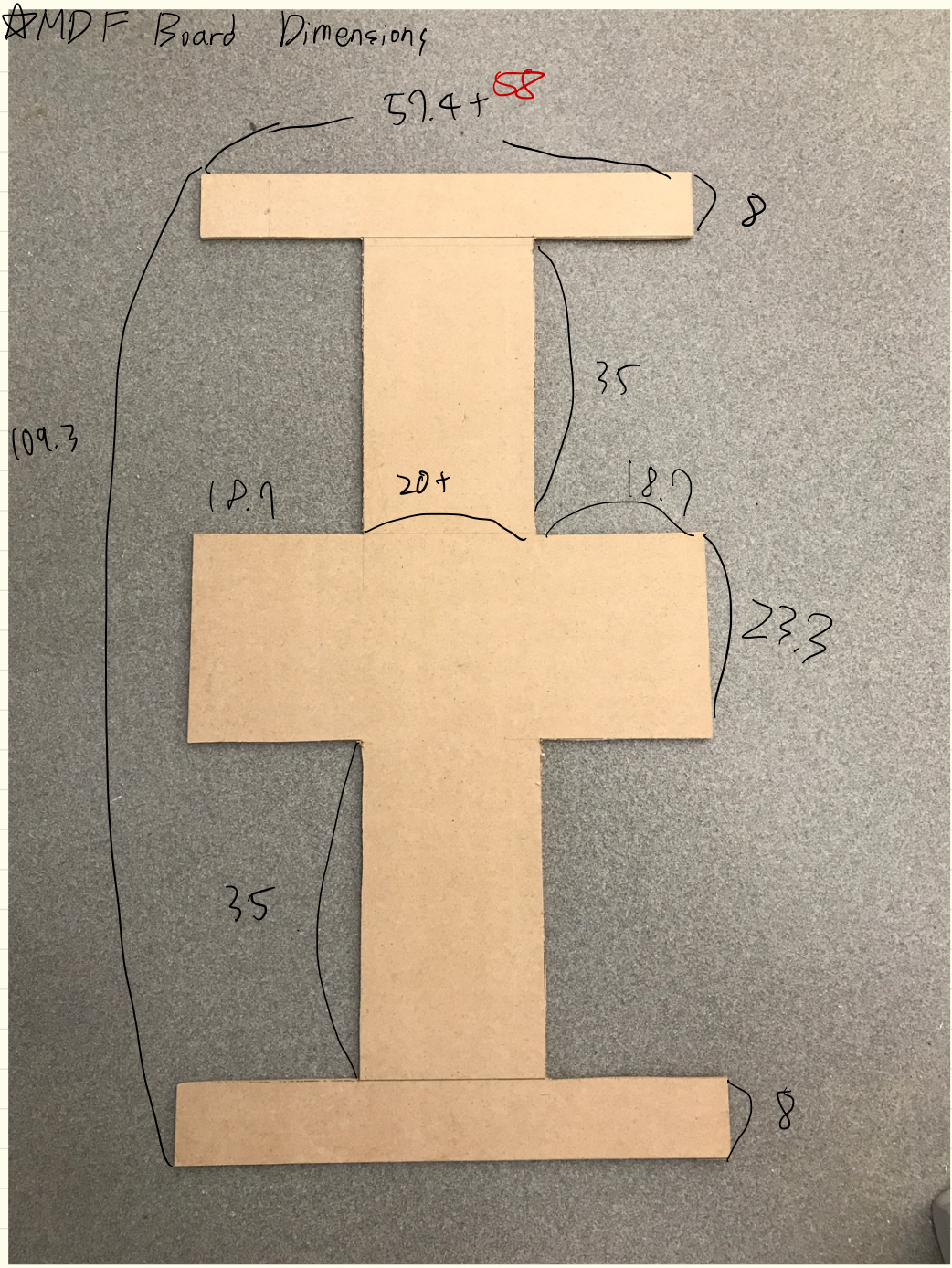


To-Do:

- Make 4- wood blocks
- Finish building wheel structures
  ↳ 2 left
- Prepare for packing



☆MDF Board Dimensions



7/9

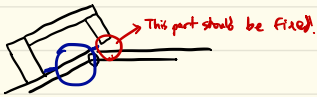
← Foamex board received

To-Do

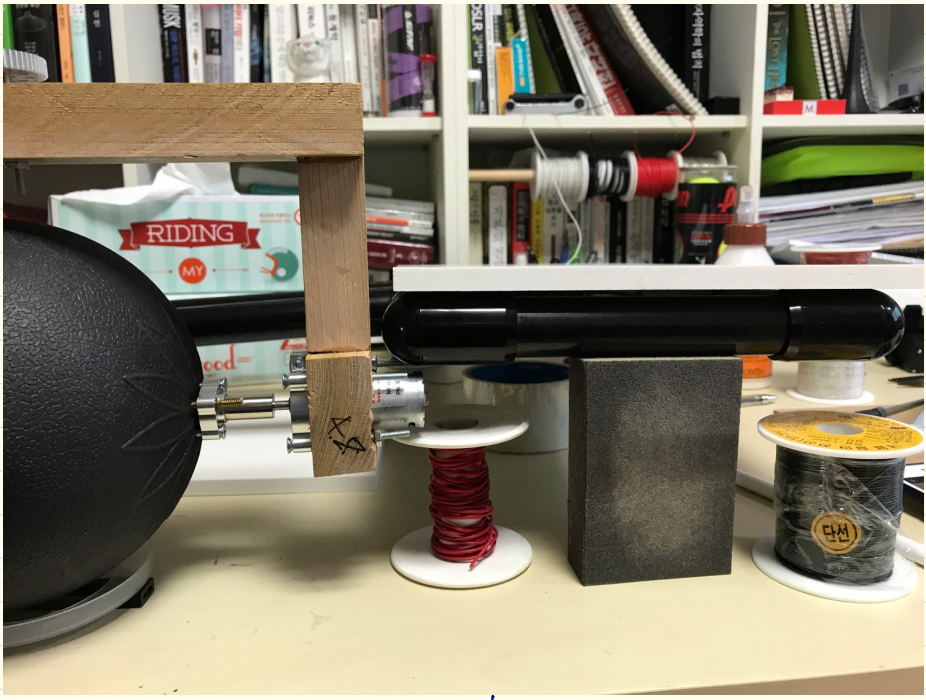
- Figure out a way to fold this thing
- Glue it with glue gun first
- Bond the PVC's with cement

7/14

← Okay, we can fold it, but we have a problem



9/15

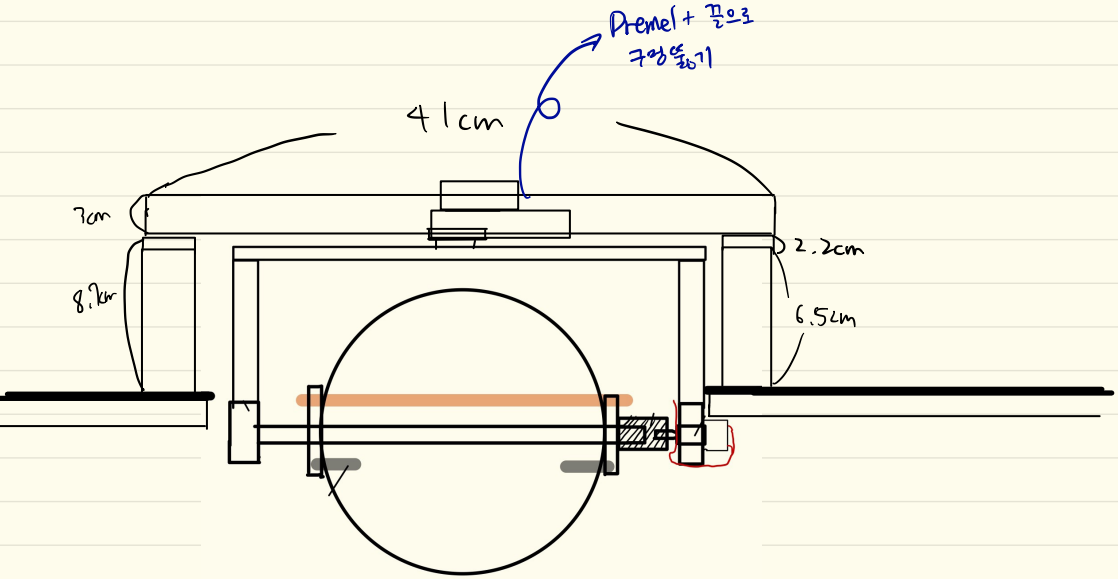


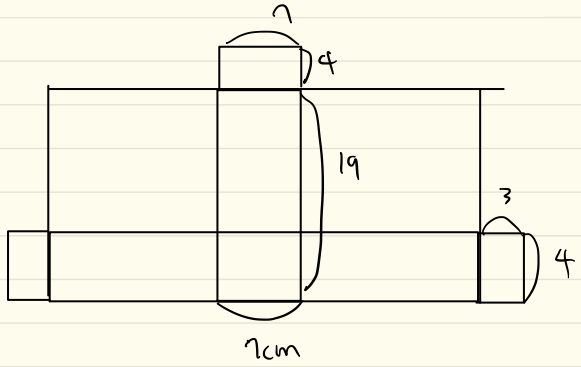
- Working on fixing the wheels to the board

To-Do:
- 풀산공예에서 wood blocks 가져오기
- Buy wood gorilla glue, clamp, etc.

Wide-View

7/17



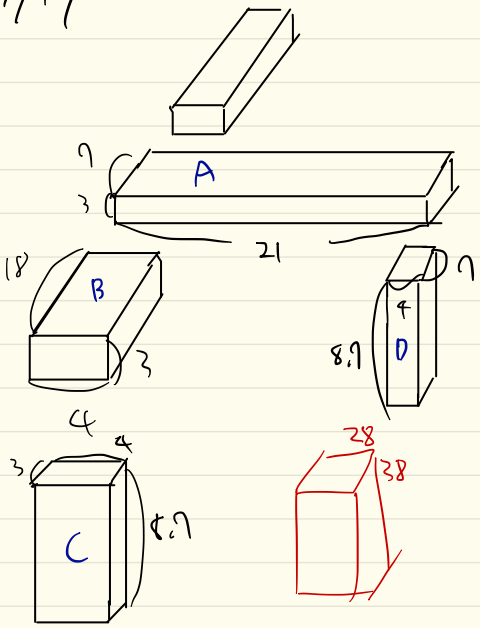


35+6

41-7

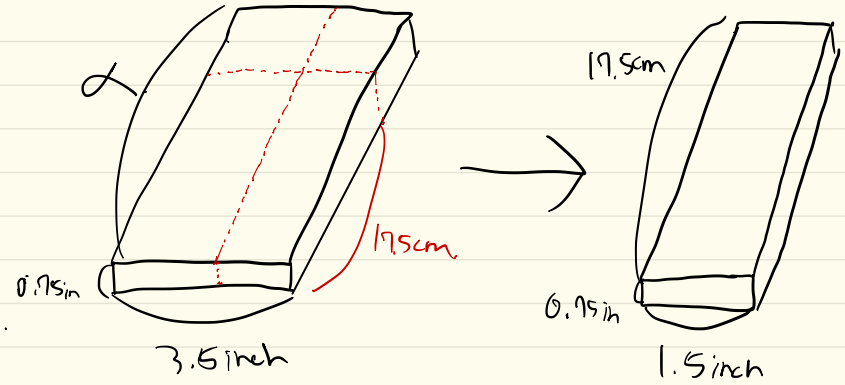
34

7/17

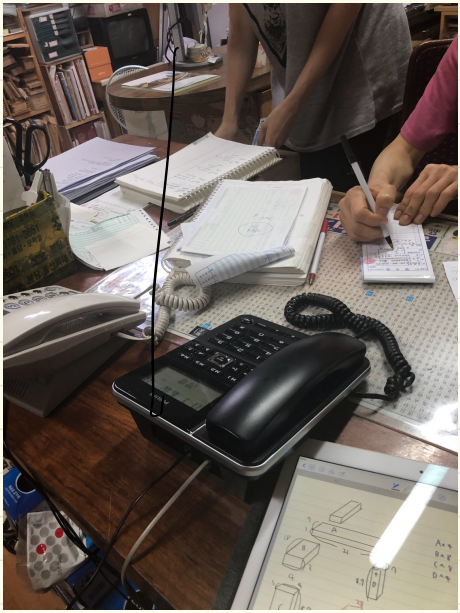


A × 4 1in × 4in × 21cm
B × 8 2in × 2in × 18cm
C × 8 2in × 2in × 8.7cm
D × 4 2in × 2in × 8.7cm

☆ 7/19 – B block 다시 자르기



7/17 - Poong San Woods



- 나무 주문완료

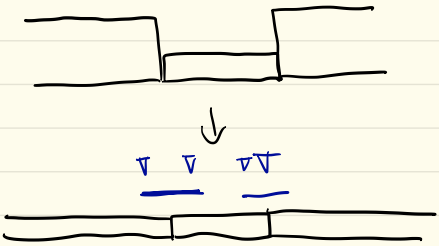
↓

7/19 = Picked up

↓

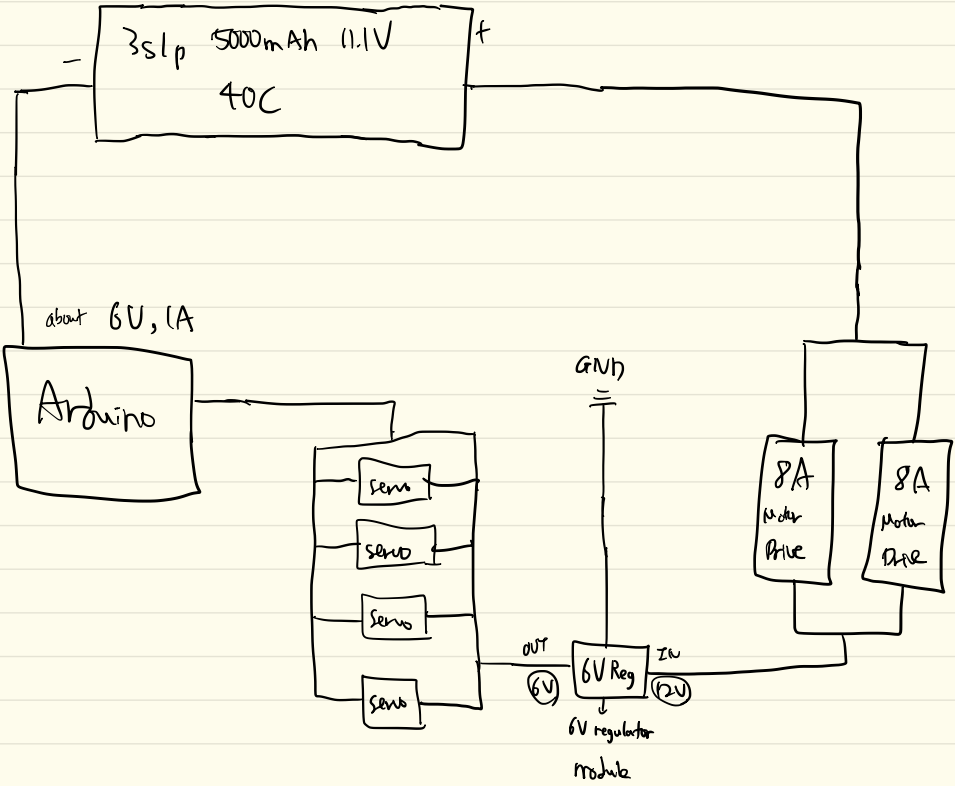
7/20 : Okay, wrong order.

We need to make another part



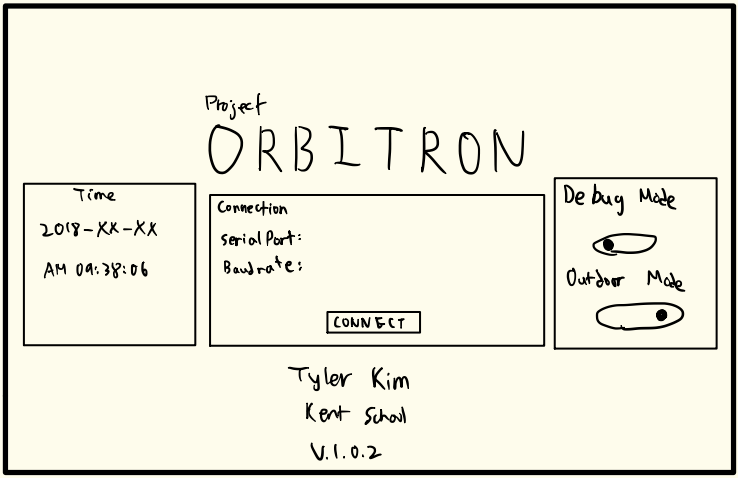
Battery V/A Calculation

Power

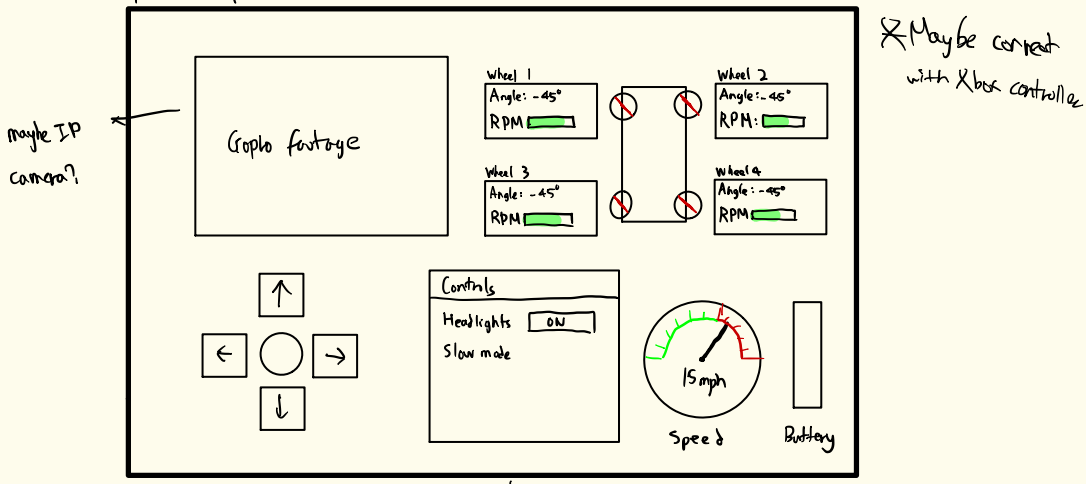


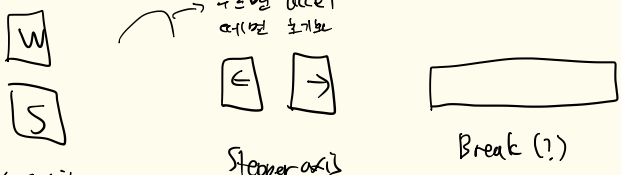
Basic Interface - 7/19

Form_Connect

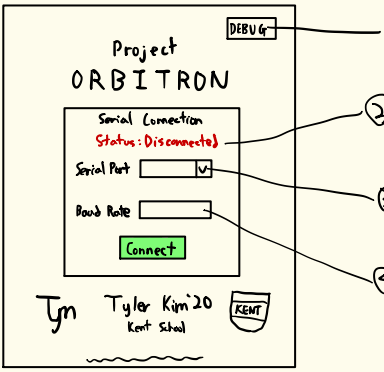


Form_Control





① Form – Connect



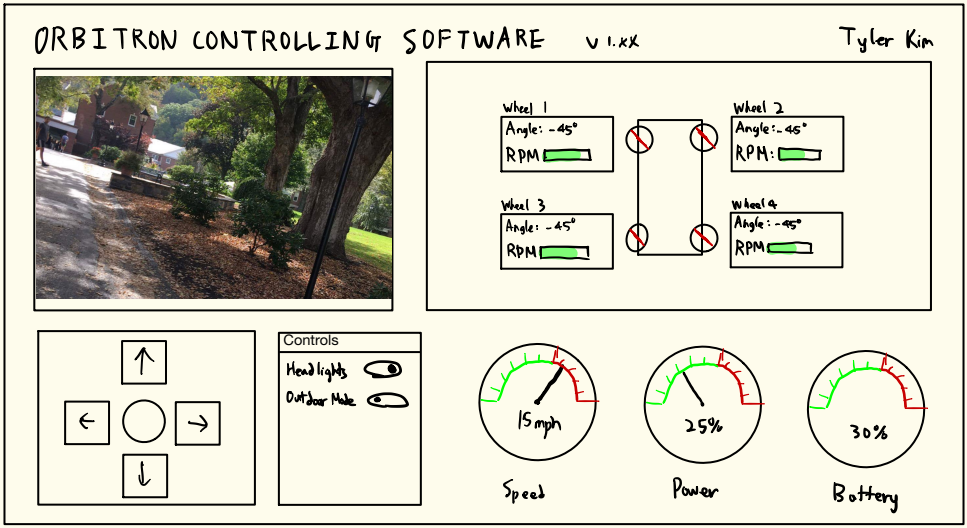
① Debug Mode
-

② Status indicator
- Shows if it's connected with the vehicle or not

③ Serial Port
- Selecting the proper port to connect

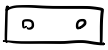
④ Baud Rate
- Selecting proper Baud Rate(How fast data is sent over a serial line)

② Form_Main



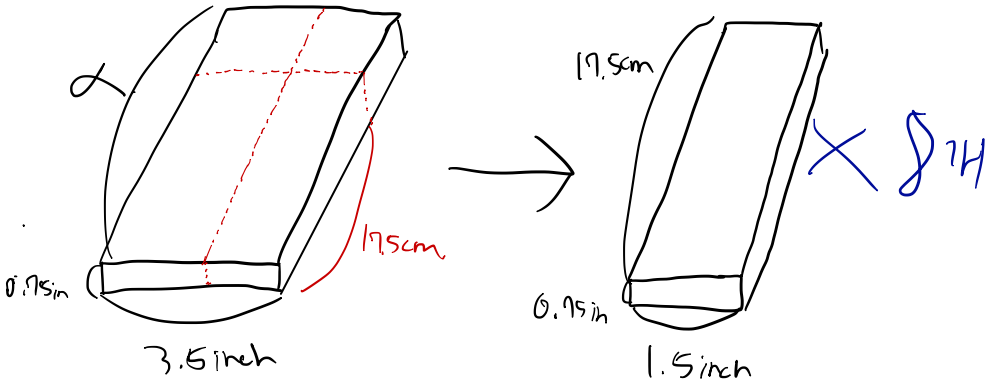
7/21 - Shopping List & To-Do

- Wood Panel bracket x 16



- β-Block 다시 제작
- Wood screw V
- 6-32 machine screw
- LiPO Battery + Circuit 구성 → 재필이상철 도움받기
- Start the wirings + coding (Arduino + C#)

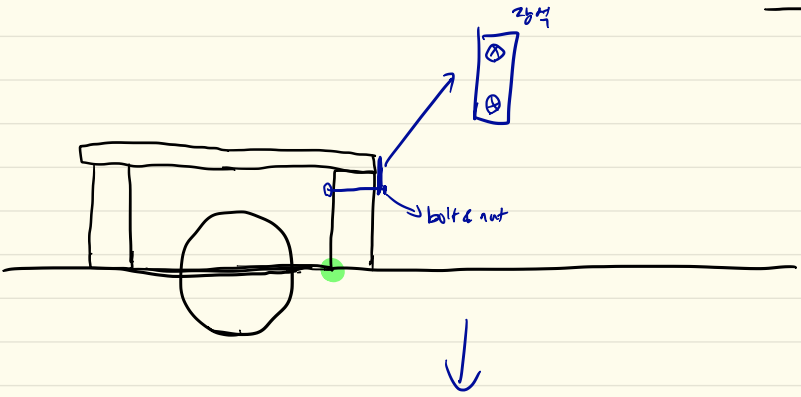
☆7/19 - β block 다시 제작

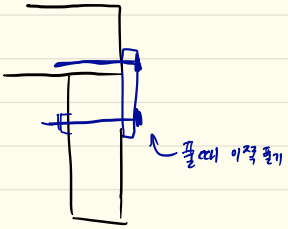


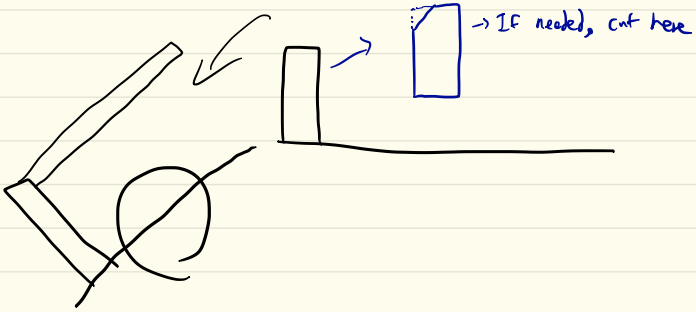
7/24

- Screws, nuts, and wood blocks acquired!

9/25

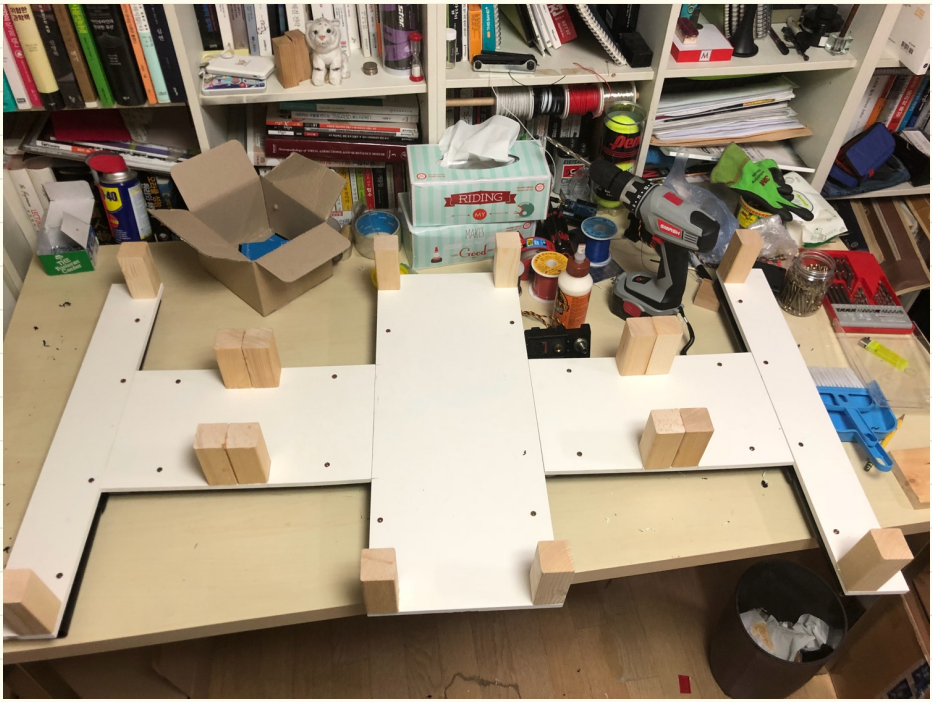




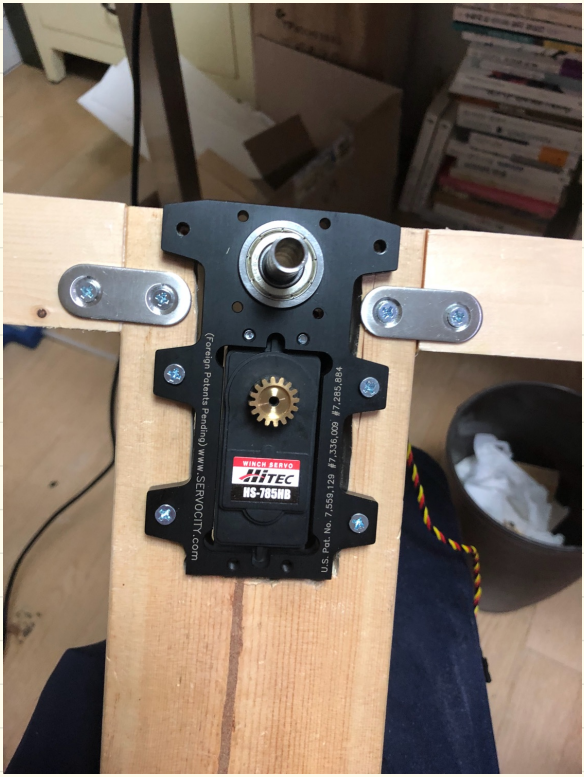


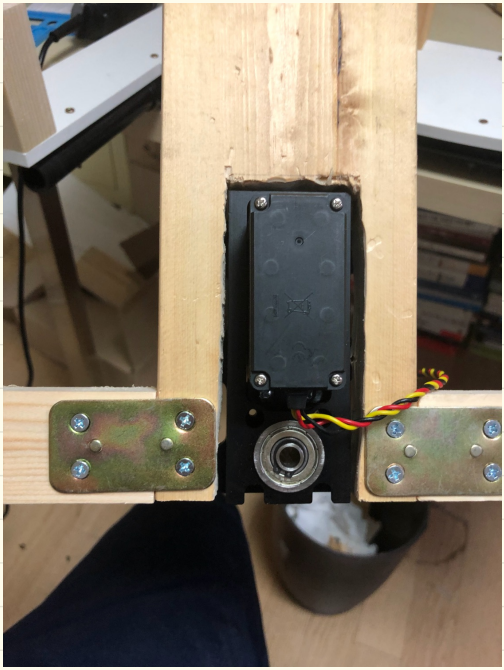
7/28 - Build day!

- Screwed all the boards on the PVC structure
- Glued + screwed the wood blocks on proper places.



Wheel Structures





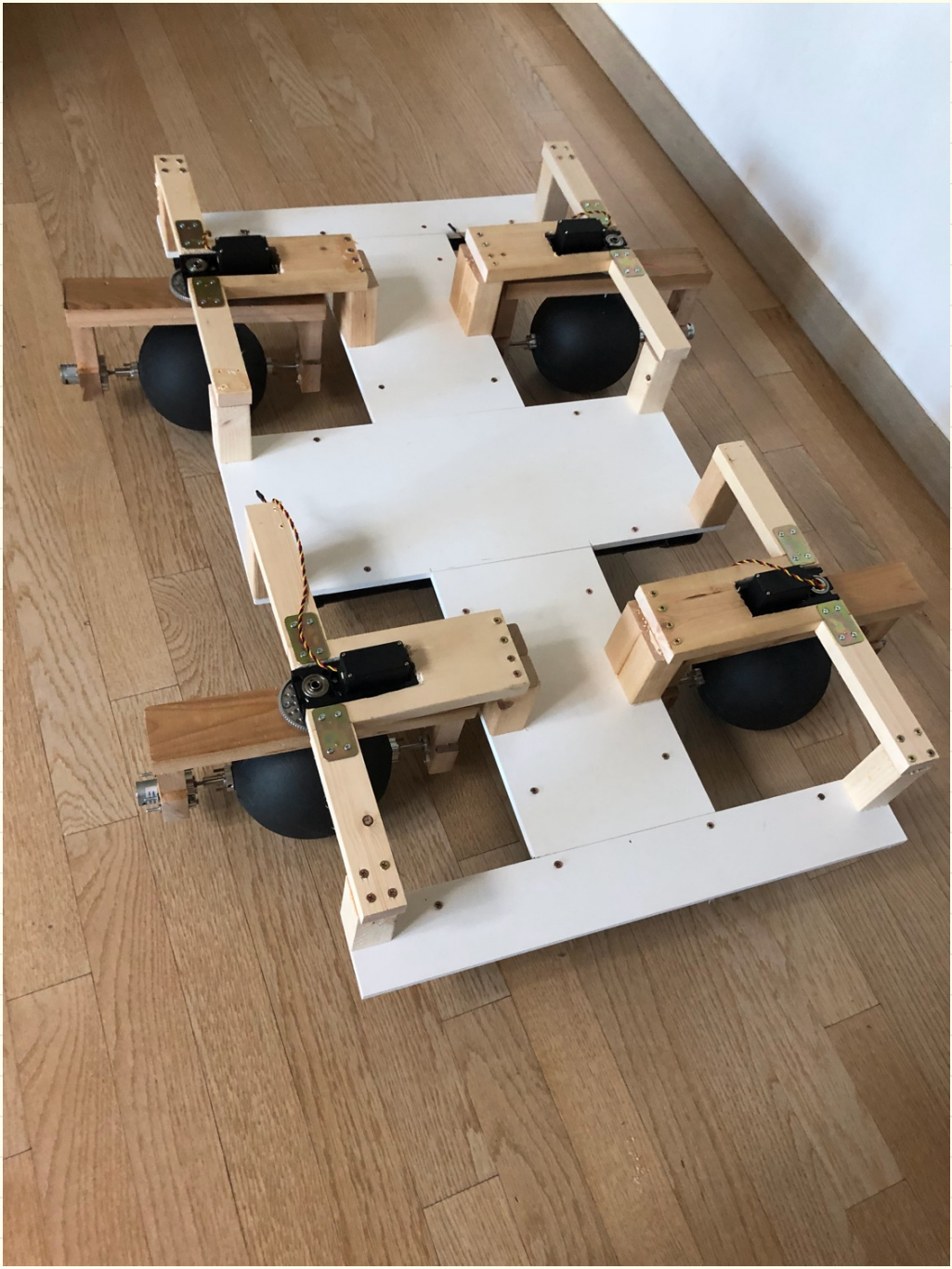
- Two of them done
- Used brackets to make the joint stronger

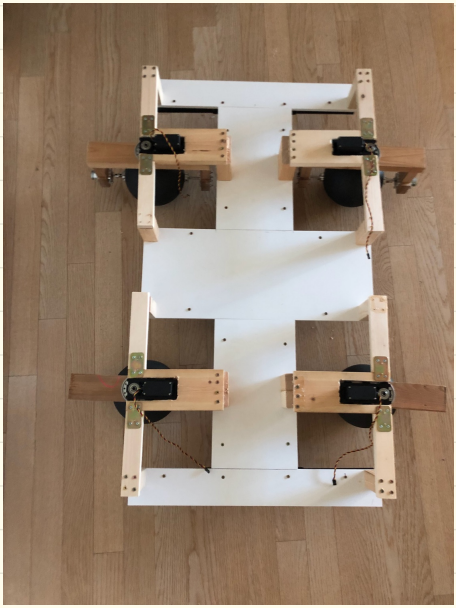
7/29 - Building Complete!

- (More Images below)
- Finished building the orbitron structure
  - four wheel structures
  - Foldable structure
  - Foamer Board
  - Supported with PVC pipe

To-Do:

- Wiring
  - ↳ Use zipties
  - ↳ Soldering
- Coding
  - ↳ Xbee configuration
  - ↳ C# app.



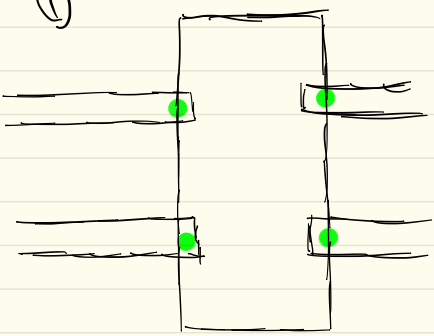


* Foldable Structure

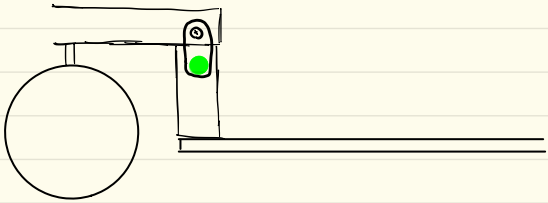
① Unscrew 4 wood screws from the bottom

② Unscrew 4 machine screws on the wheel structures.

①

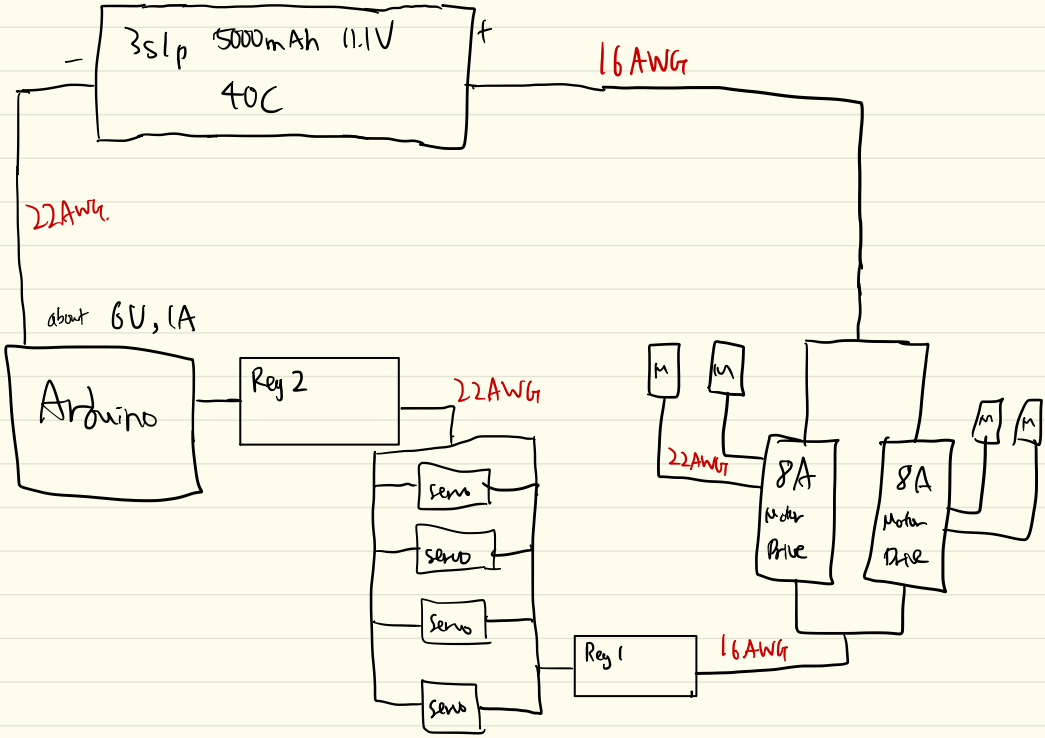


②

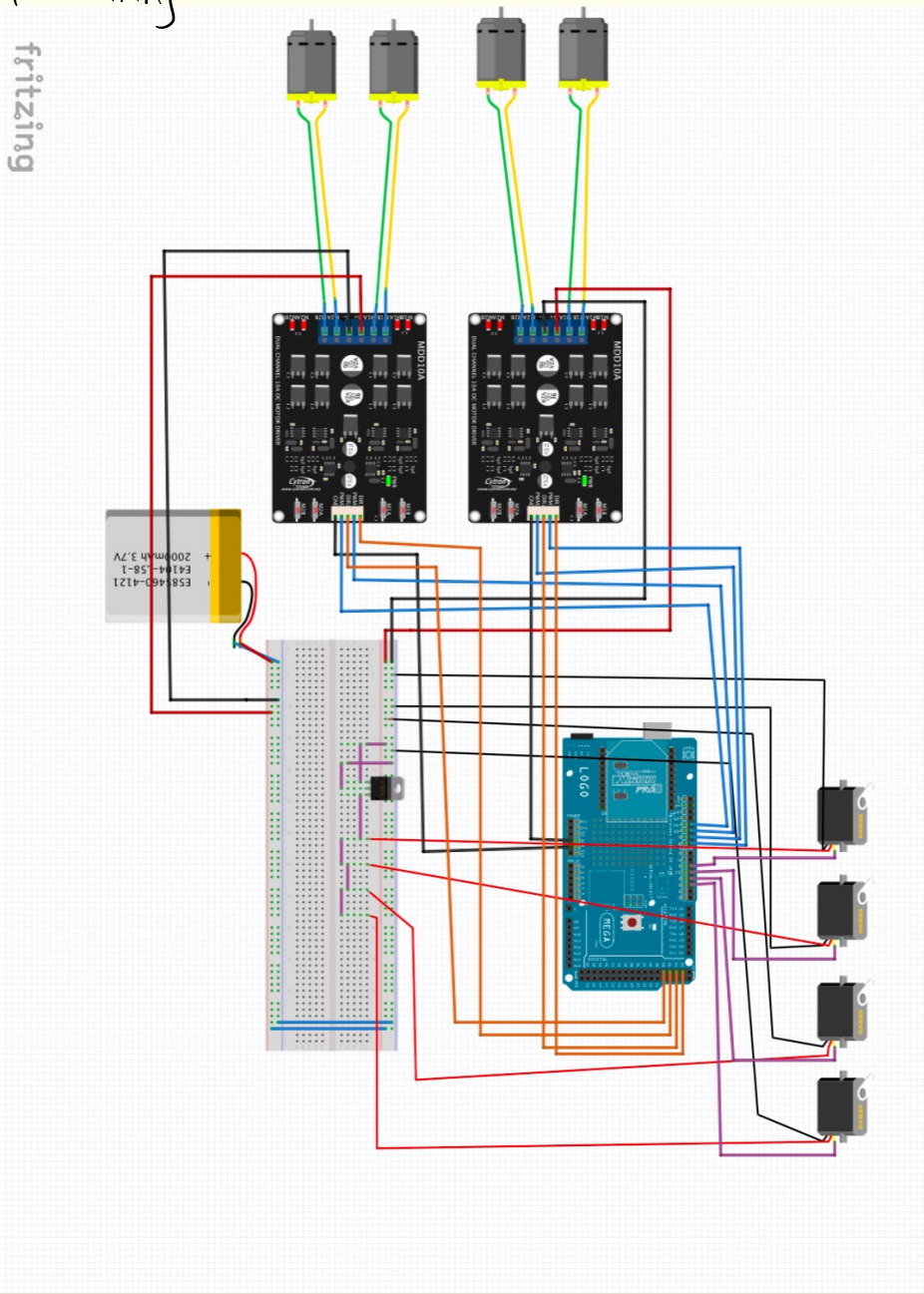


8/9 - Mr. Choi Questions List

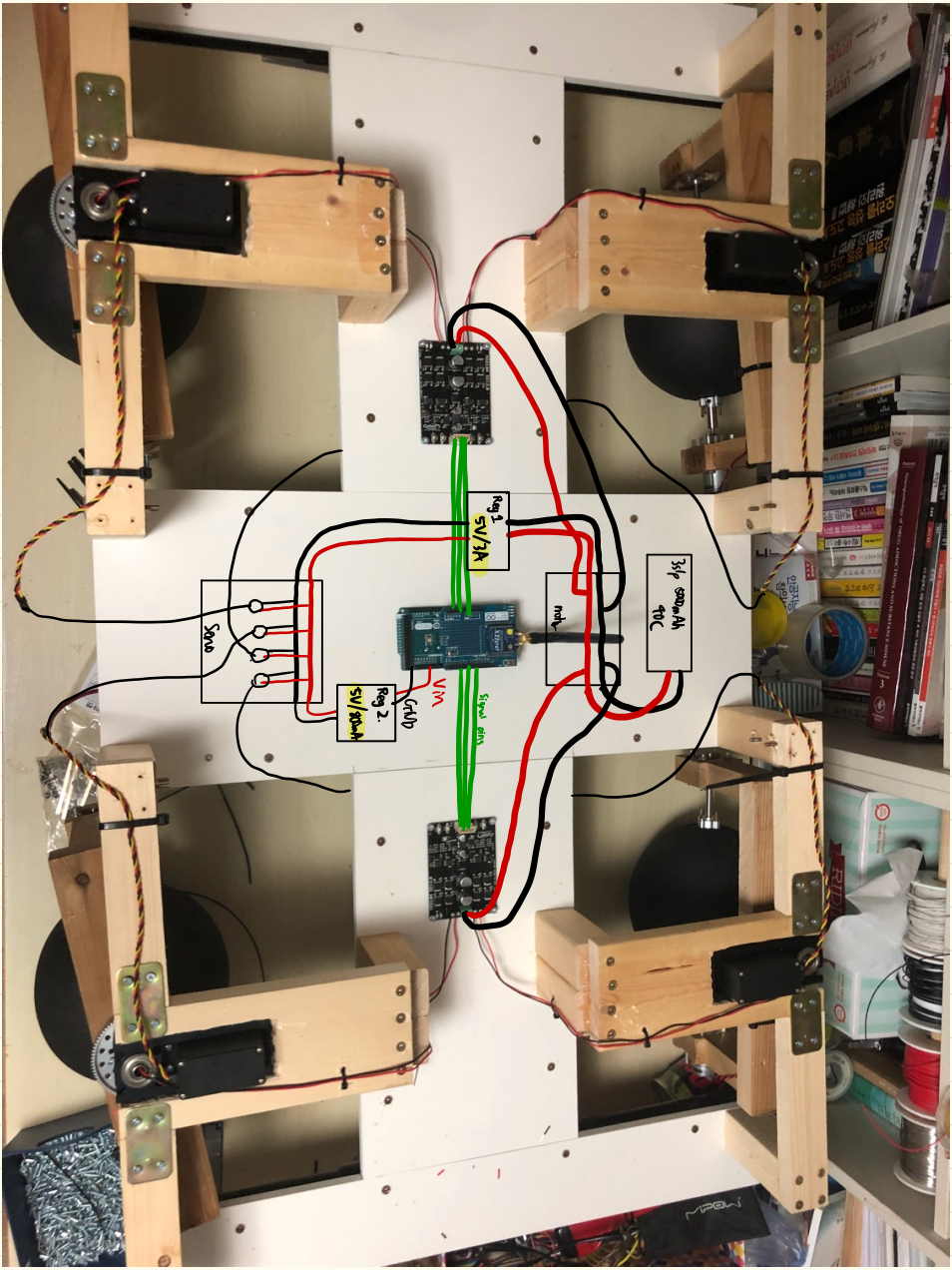
- 3s1p 5200mAh 40C LiPo Battery
  - ↳ how much amps? (current)
    - ↳ A: depends / 필요한 만큼 씀
- How to organise the regulators?
  - ↳ A: use two
- Wire Gauge: I used 22AWG, how thick should it be to handle all the currents?
  - ↳



8/9 - Wiring



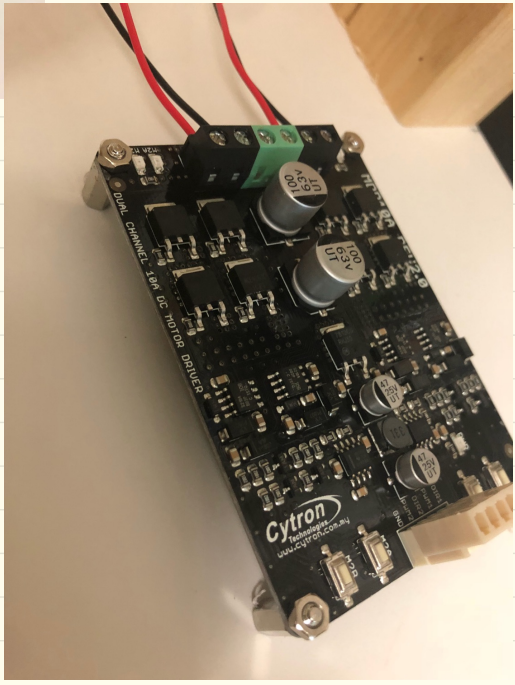
8/9 → edited 8/11

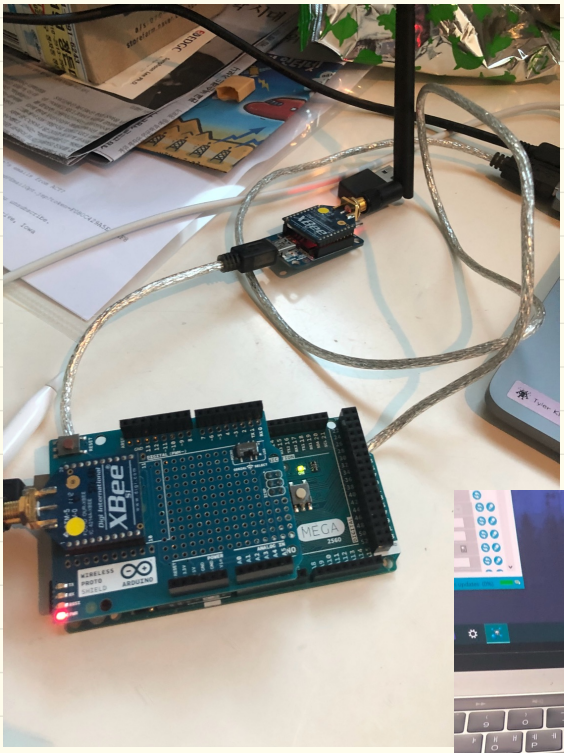


8/11

- fixed the Arduino/MDD10A onto board
  ↳ with PCB standoffs

- Received
  : 16AWG Silicon wire 3m
  : LiPo Battery
  : Imax B6 charger + cable x2
  : M3 machine screw x50

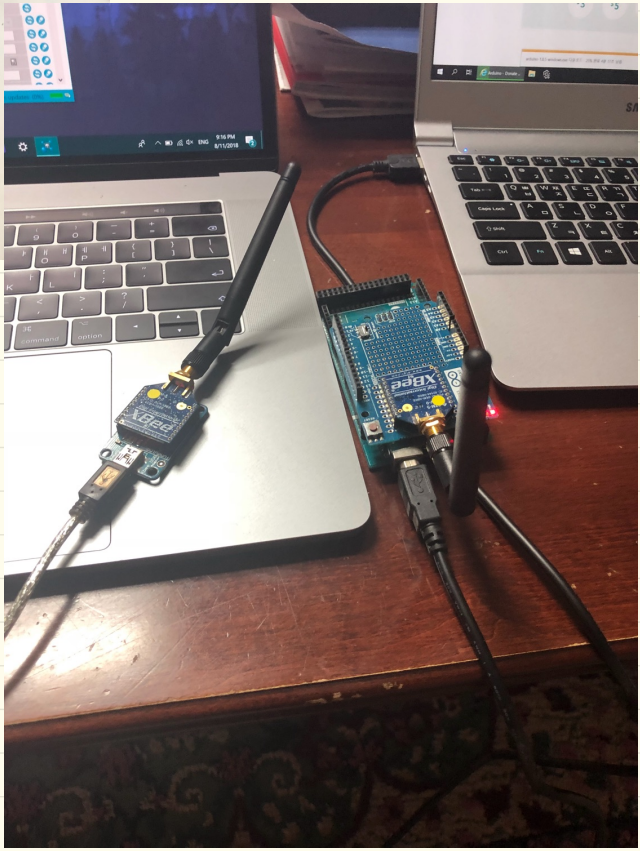




← Configured & paired the transmitter and the receiver (Arduino Mega 2560)

↳ XCTU program

	Baud Rate	ID
Coordinator:	9600	3022
End point:	9600	3022



← enclosure (with one of the project boxes) for the transmitter.

↳ This will be plugged into the computer to transmit signals to the Orbitron wirelessly.

8/12 - Coding.

Added functions:

- Write CMD, Serial, Error functions
- Serial communication
- Orbitron model

To Do:

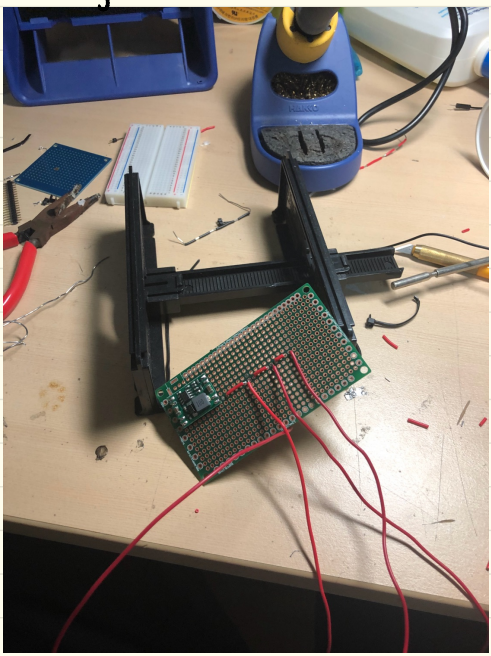
- Rotation mode (Q, E)
  - ↳ Lower speed
- Gradual acceleration (slow (start) → fast → slow (end))

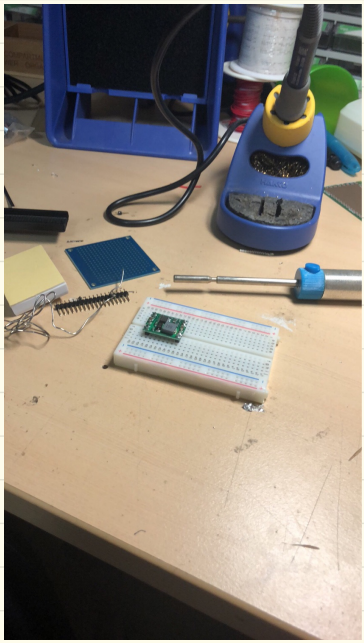
8/14. - wiring done.

← Battery charging
- LiPO BALANCE
- 9.0A
- 5000mAh
- 3S (11.1V)

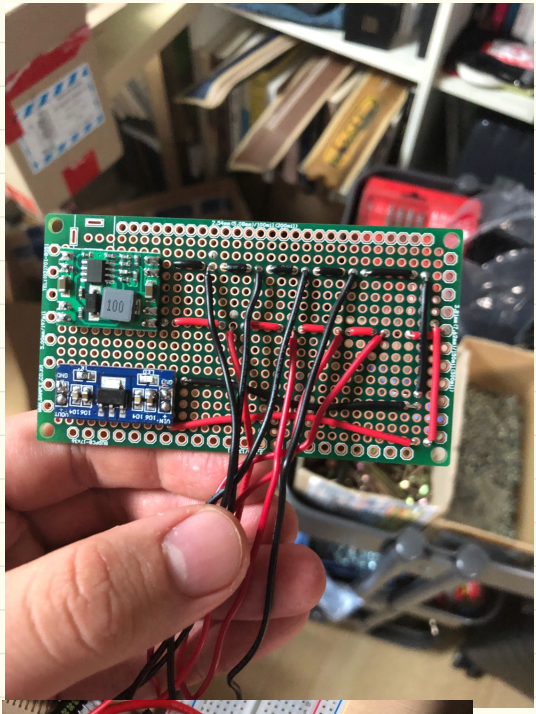
- Wiring 90% finished
- Finished soldering:
  - Regulator boards
  - Central power wire → Arduino

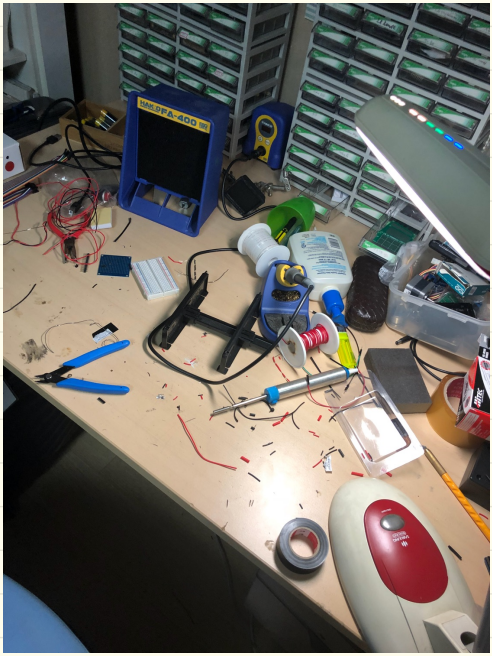
Soldering 1



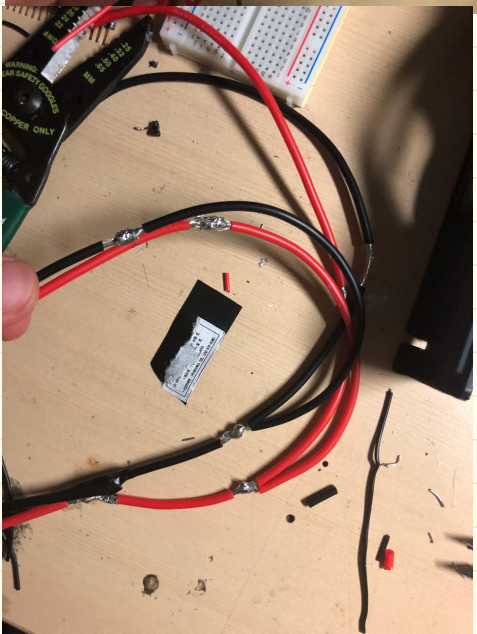


Soldering

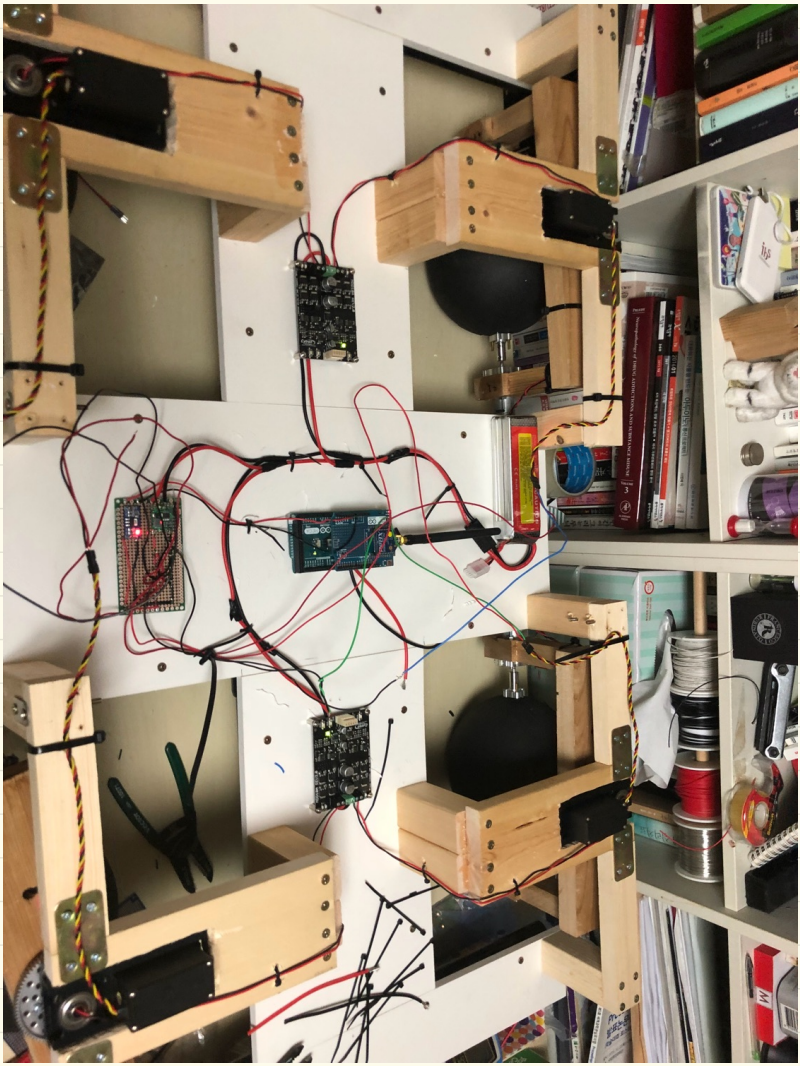




→ Regulator board soldering

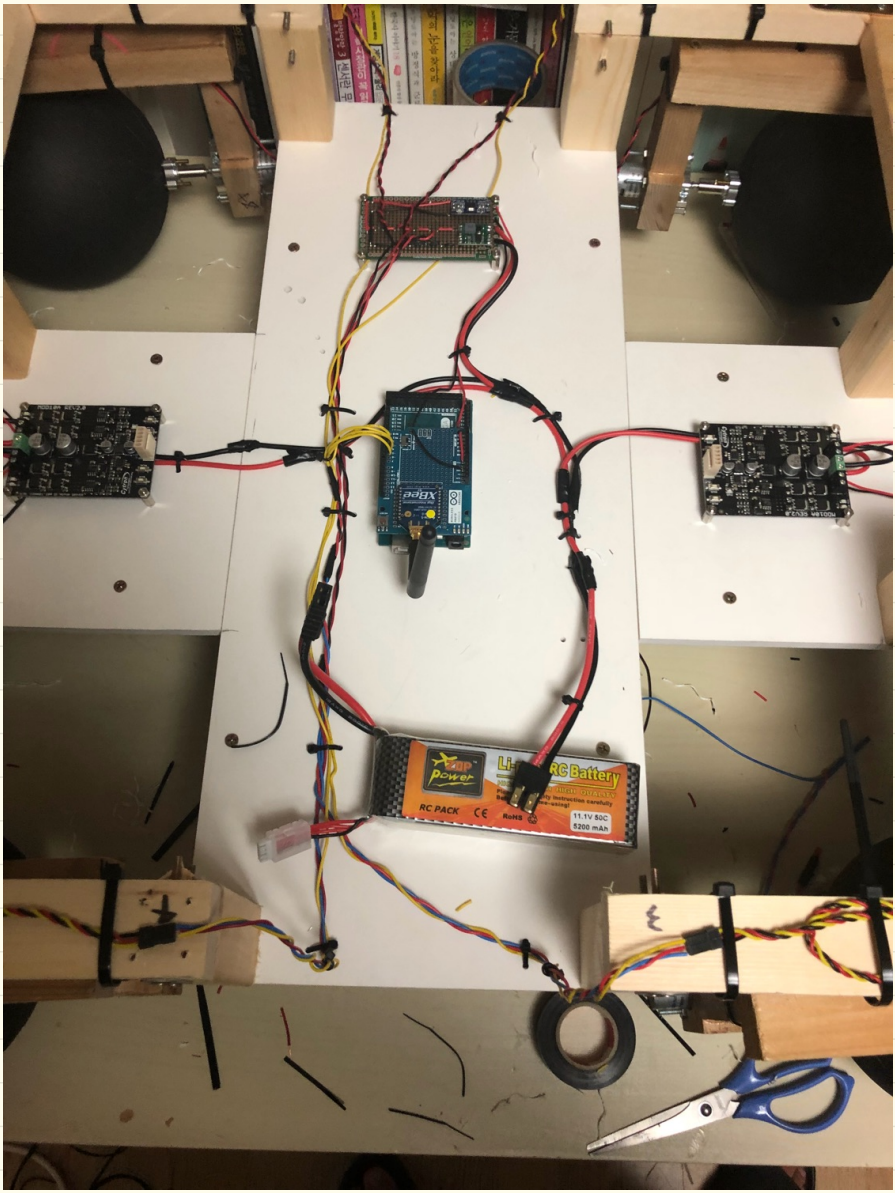


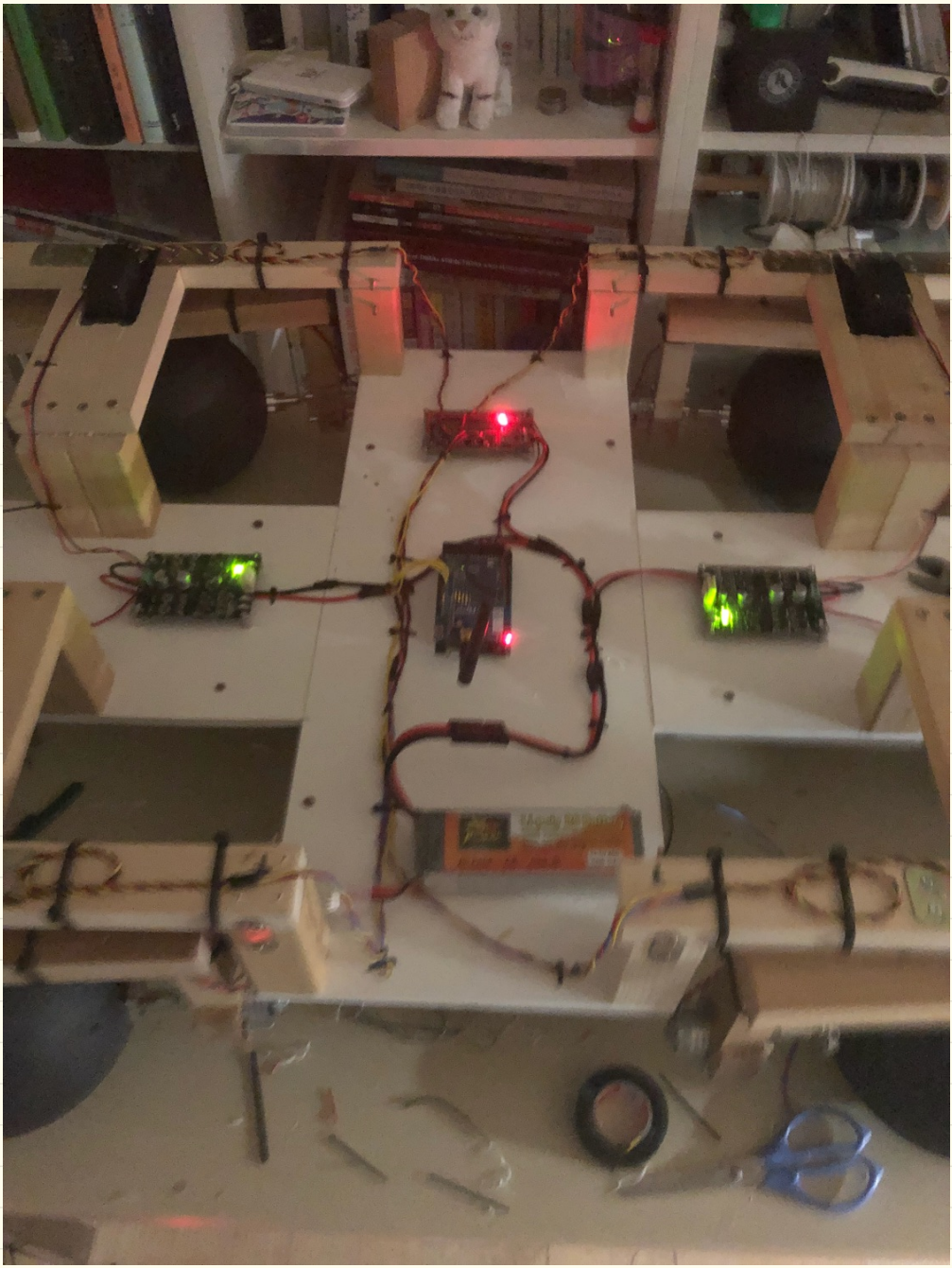
→ Wire soldering

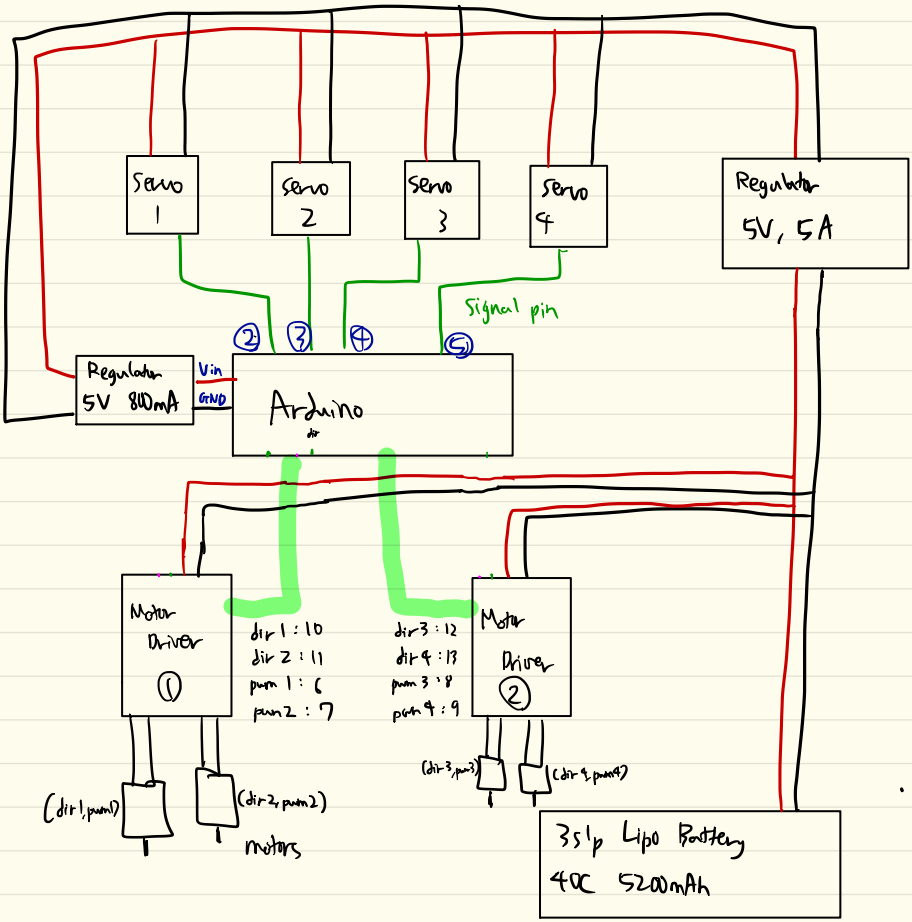


☆ Tested motor torque
↳ IT WORKS!

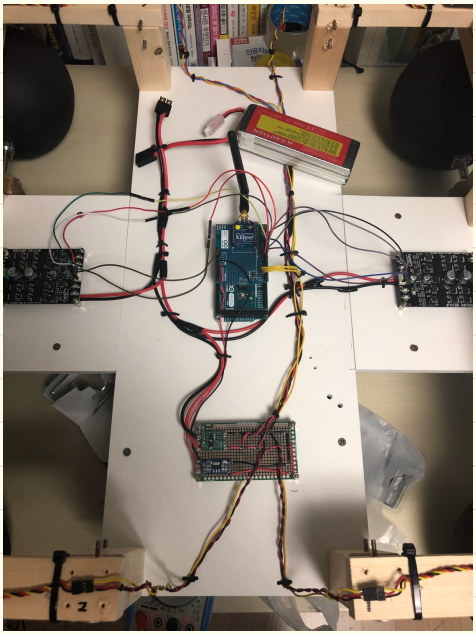
8/15 - Servo Wiring






Servo 1
Servo 2
Servo 3
Servo 4
Regulator 5V, 5A
Signal pin
2
3
4
5
Regulator 5V 810mA
Vin
GND
Arduino
dir
Motor Driver 1
dir 1 : 10
dir 2 : 11
pwm 1 : 6
pwm 2 : 7
dir 3 : 12
dir 4 : 13
pwm 3 : 8
pwm 4 : 9
Motor Driver 2
(dir 1, pwm 1)
(dir 2, pwm 2)
motors
(dir 3, pwm 3)
(dir 4, pwm 4)
3s1p Lipo Battery
40C 5200mAh

8/18

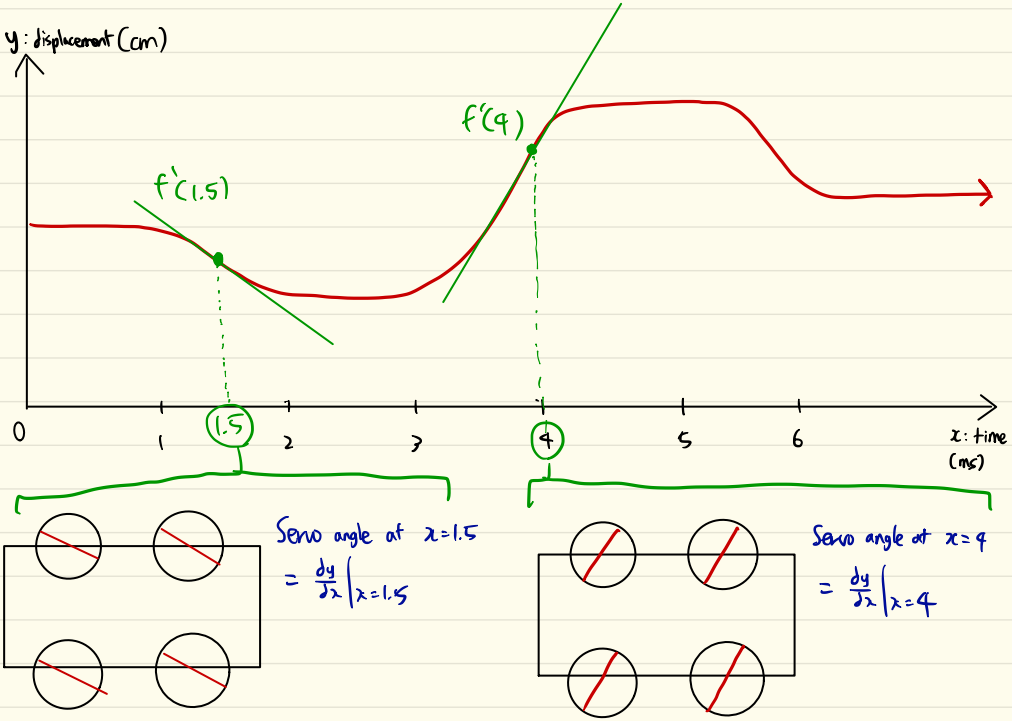


- Organized the Servo PWM wires
- ⊕ the signal pins for the two motor drivers (soldered)

- Bonded the axis/wheel using epoxy putty

↓

This doesn't work



Servo angle at $x = 1.5$

$= \left.\frac{dy}{dx}\right|_{x=1.5}$

Servo angle at $x = 4$

$= \left.\frac{dy}{dx}\right|_{x=4}$

Arduino - Algorithm Plans

Variables

- Direction x4 Speed PWM x4
  - (−) (-255~0) → Backward Speed
  - (+) (0~255) → Forward Speed

- Servo PWM x4
  - PWMMin = 700;
  - PWMMid = 1500; → Default
  - PWMMax = 2300;

input array → [0 , 0, 0, 0, 1500, 1500, 1500, 1500)

loop( ) {

digitalWrite

↳ Keep writing.

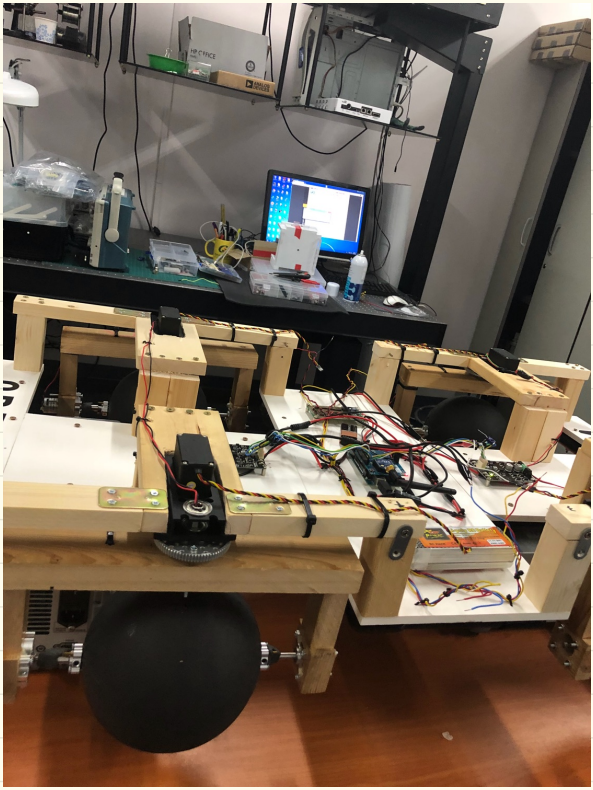
Major Problem Addressed

Observation: The servo motor works fine when controlled independently.
However, when the DC motors spin, all of the four servos rotate in single direction all together. → Then, when the DC motor stops, servos return to their assigned position

Possibilities: Reverse current of the motor affects servos by giving excess current (and causing them to act as continuous motors
↳ Separate Power supply / attach diodes → Nope.

- The PWM signals in Arduino Mega is interrupted → Nope.

8/27 - Gachon Univ.



☆ Tried every possibilities I came up with, but did not work.

↓

Visited Prof. Kim Young-Don to further investigate about the problem and find solutions

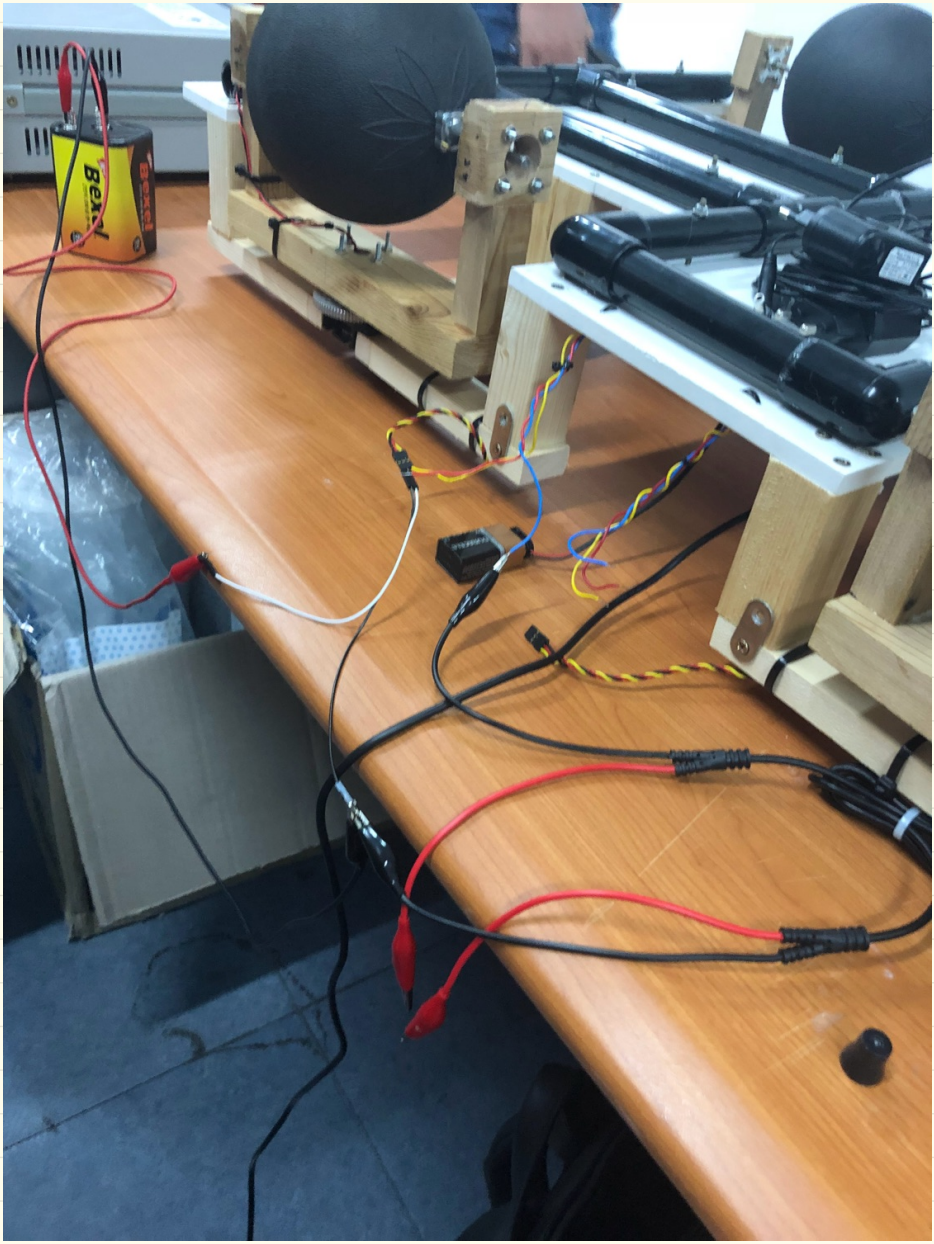
↳ ysdon@gachon.ac.kr

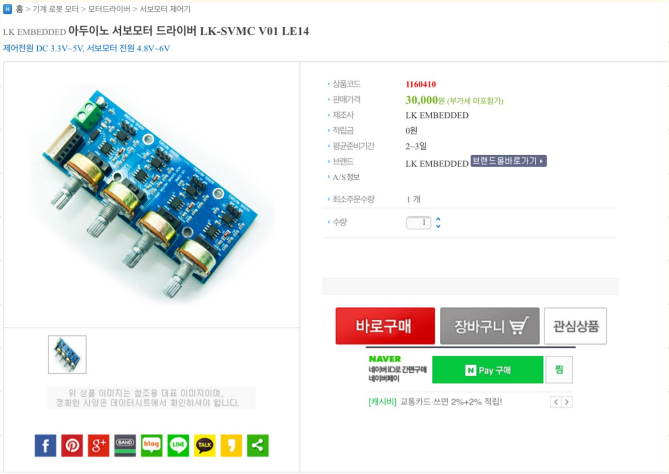
Result → By using oscilloscope, the main problem was the interruption being caused in the power wire of the motor

↓

Suggested attaching an additional 4ch servo driver to separate the PWM signal pins / power supply.

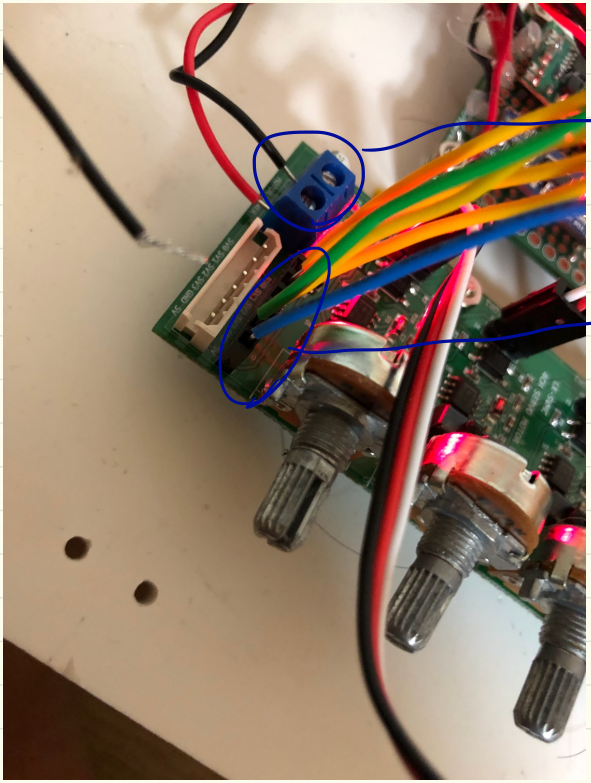
Trying external power supply





* Ctrl Voltage = 3.3 - 5V
* Servo Voltage = 4.8 - 6V
* Modes
  - ↳ Manual → use Potentiometer
  - ↳ Prgrm → use Arduino

↑ Bought the 4ch servo Driver and installed on the Orbitron

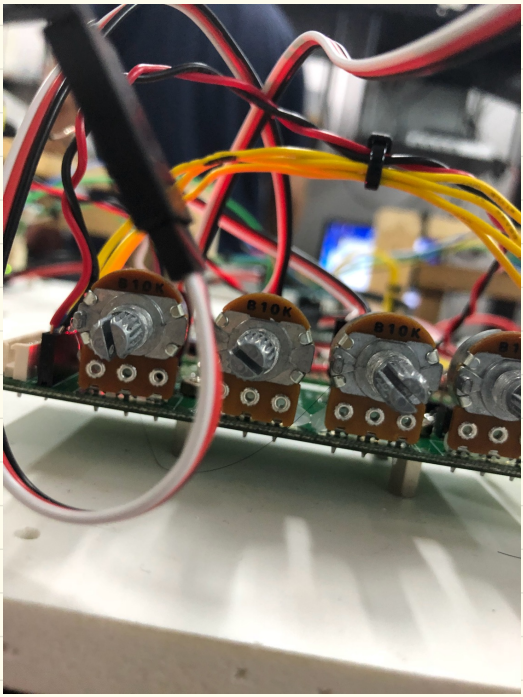


↓

→ Power voltage input : 5V, 1.5A

→ Ctrl pins - 5V (From Arduino)
GND
Servo 0 ~ 3 (pwm pins)

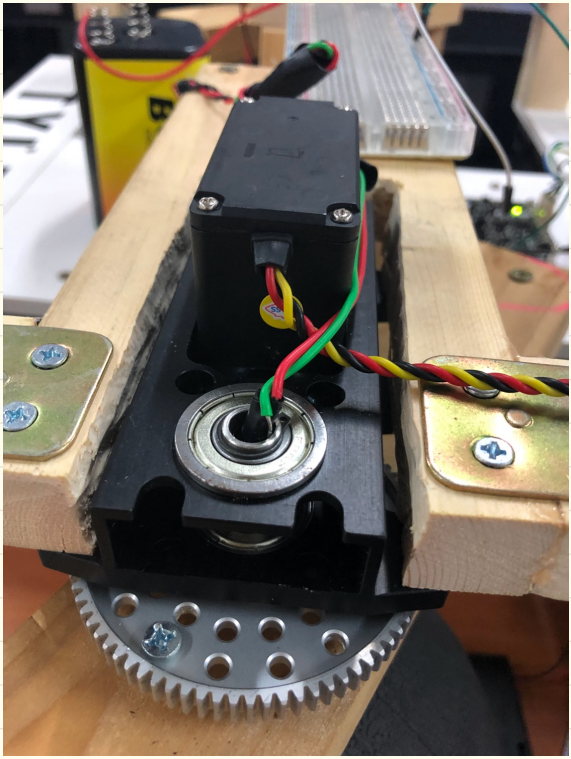
9/1



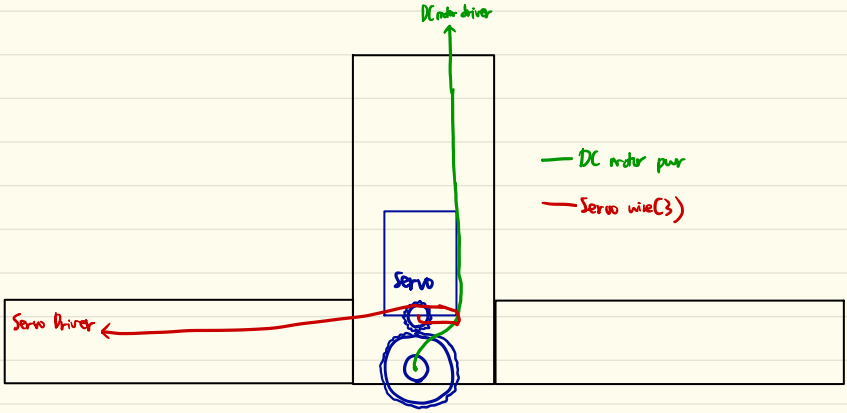
-Visited Prof. Kim's lab once again after observing the same problem.

When we put the DC power wire away from the servo, the noise significantly decreased

* When holding the DC motor wire, there were no noise observed at all



9/3



* When motor spins: ① the reverse current creates high pitch AC noise on the wire
② the noise then creates electromagnetic interference to the servo
③ the servo spins

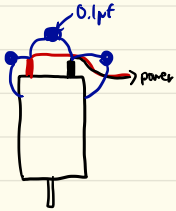
* The amount of noise is different when the direction of the motor changes

* Solution = Find a way to prevent EMI from affecting the servo

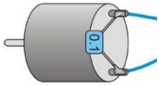
DC Motor.

↳ attach three capacitors to each motors

↳ change the power wire to 2C shielded cable



There are several precautions you can take to help reduce the effects of motor noise on your system:

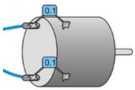


1) Solder capacitors across your motor terminals. Capacitors are usually the most effective way to suppress motor noise, and as such we recommend you **always** solder at least one capacitor across your motor terminals. Typically you will want to use anywhere from one to three **0.1 µF ceramic capacitors**, soldered as close to the motor casing as possible. For applications that require bidirectional motor control, it is very important that you do not use polarized capacitors!

If you use one capacitor, solder one lead to each of the motor's two terminals as shown to the right above.

Typically you will want to use anywhere from one to three **0.1 µF ceramic capacitors**, soldered as close to the motor casing as possible. For applications that require bidirectional motor control, it is very important that you do not use polarized capacitors!

If you use one capacitor, solder one lead to each of the motor's two terminals as shown to the right above.



For greater noise suppression, you can solder two capacitors to your motor, one from each motor terminal to the motor case as shown in the picture to the right.

For the greatest noise suppression, you can solder in all three capacitors: one across the terminals and one from each terminal to the motor case.

Servo Motor

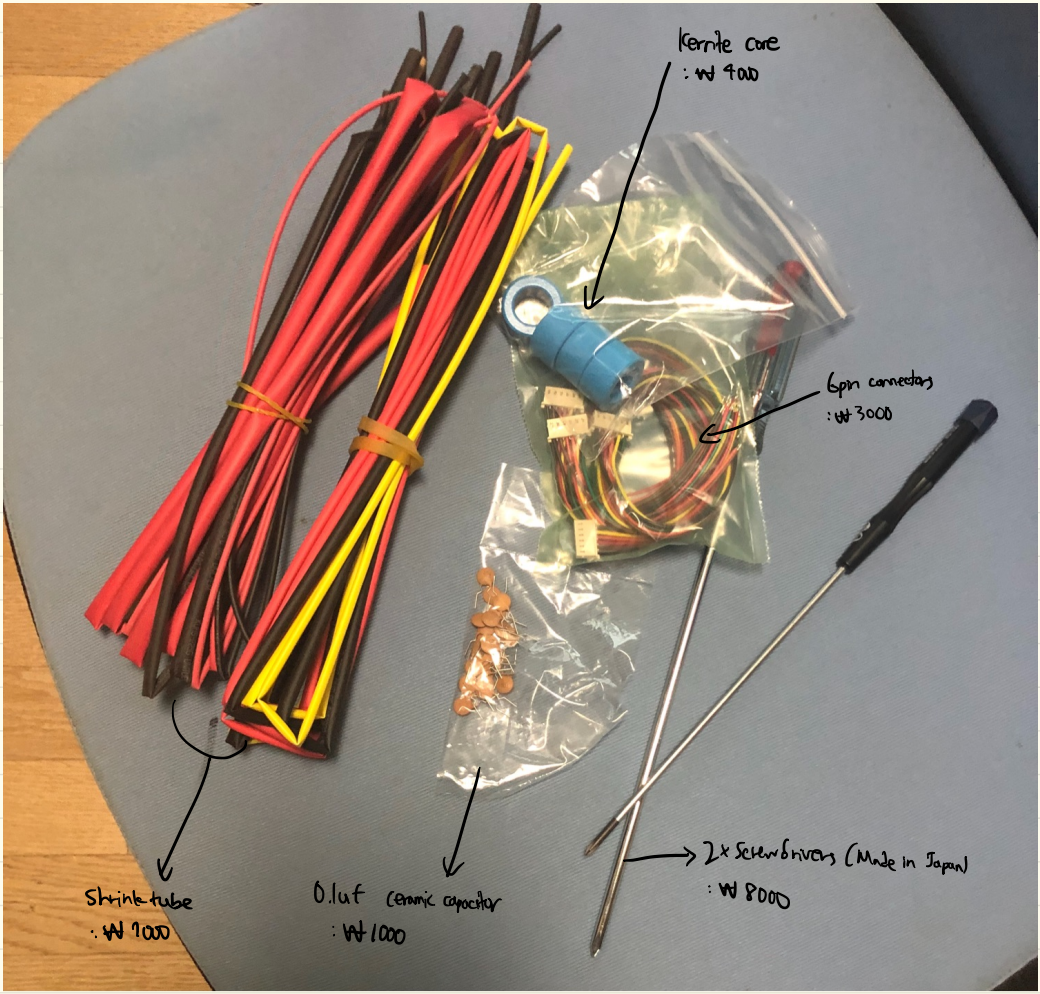
↳ Add Ferrite Core around the servo wires

My servo

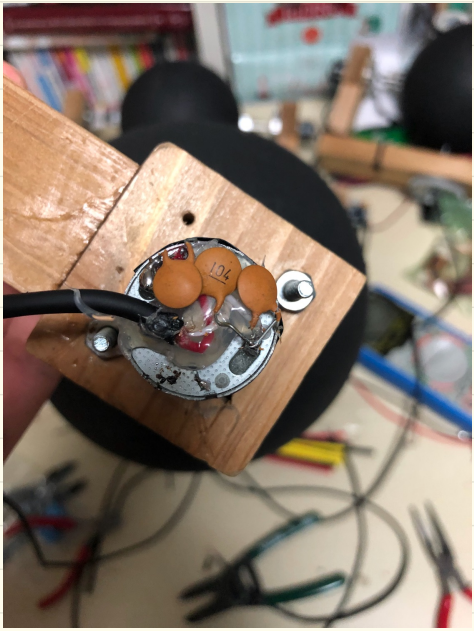
9/5 - Makercity Sewoon

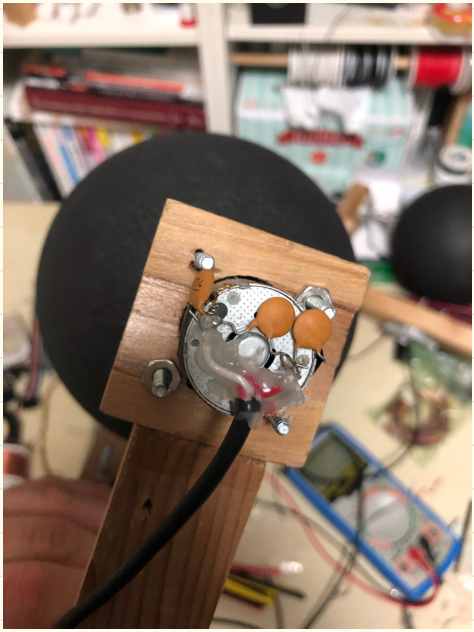
Visited Sewoon Plaza to buy several components

Components



Total: ₩ 23,000 (roughly 20$)



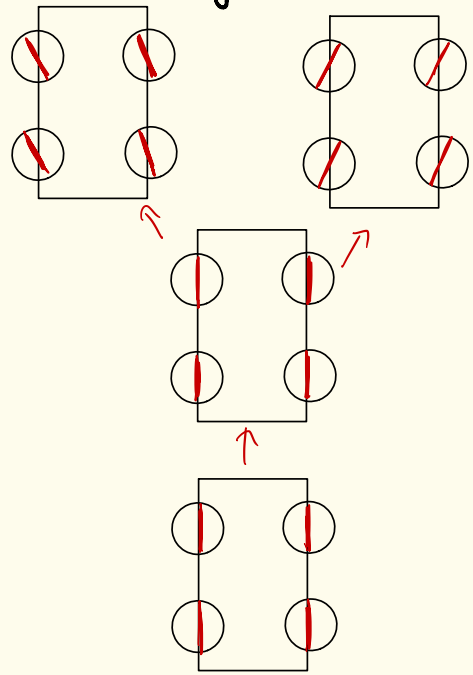


↳ Soldered three ceramic capacitors to the motors, and covered them with glue gun.

↳ Added Ferrite Core.

9/18 Types of Steering Mode

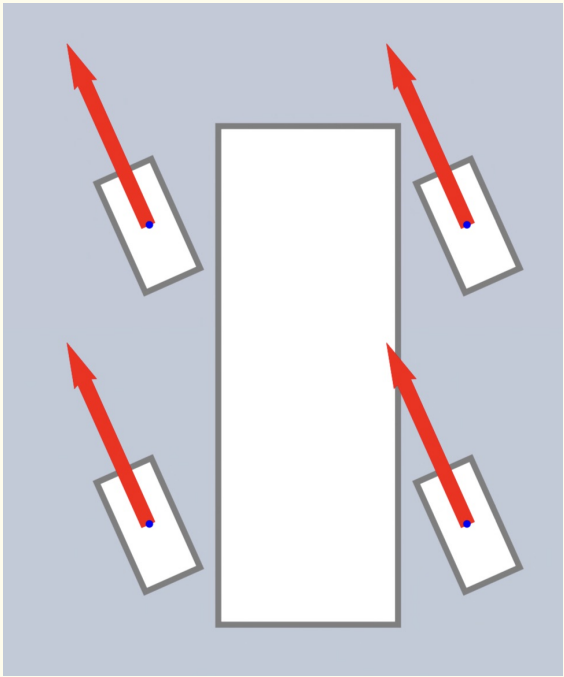
① Crab Steering - Changing Lanes without changing its direction angle



Motor & Servo Movement

↳ Motor: equal to each other

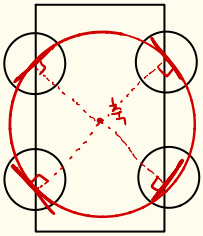
↳ Servo: equal to each other

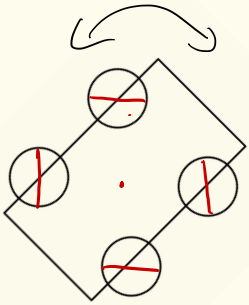


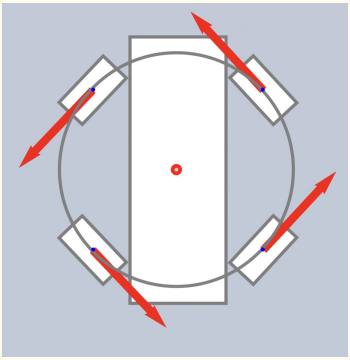
Control Design

→ Shifting the SpaceMouse along a horizontal plane.

② Spinning







Motor & Servo Movement

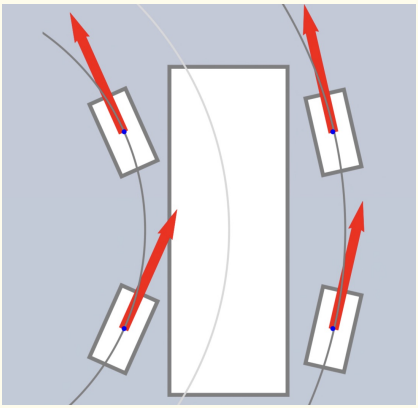
↳ Motor: equal speed for all wheels

↳ Servo: tangent to the "circle"

Control Design

↳  pressing the side buttons

③ AFRS (Active Front Rear Steering)



Motor & Servo Movement

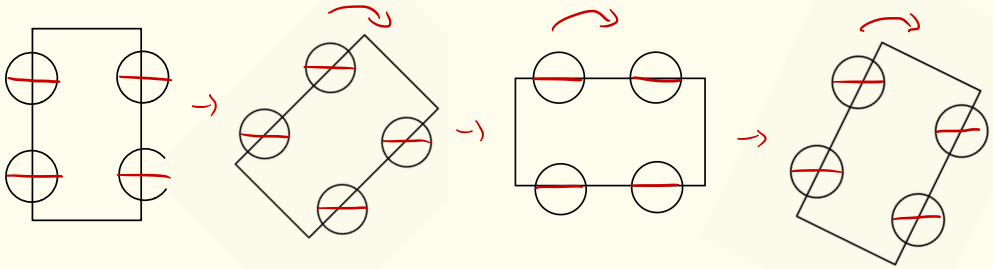
↳ Motor: outer wheel's speed > inner wheel's speed

↳ Servo: tangent to the circle

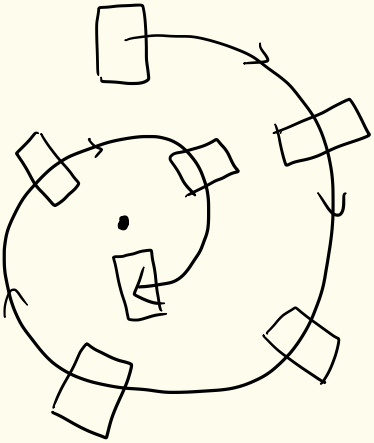
Control Design

Twisting the mouse will change the radius of curvature

(3) → Moving + Crab Steering



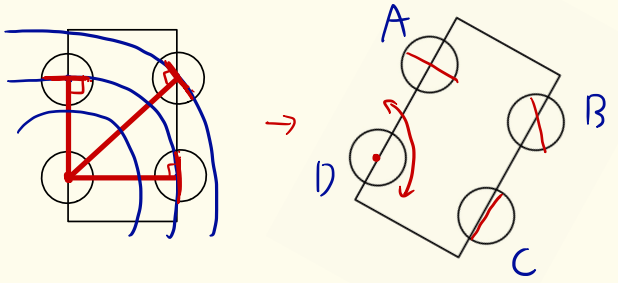
(4) - Spiral



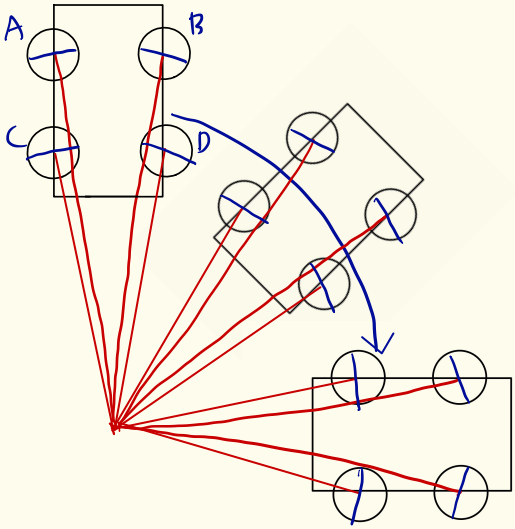
9/19 Other creative Steering modes

① : Axis Rotation

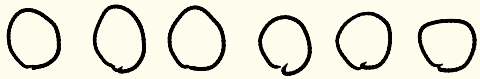
↳ 한 바퀴를 축으로 회전



② : Axis Rotation 2



9/28 - Algorithm Design

SpaceMouse :  – Six variables

↓

Variables.nb

- Calculate Transformed variables

↓

Graphics.nb

- Record the sets of variables
- Show the graphics

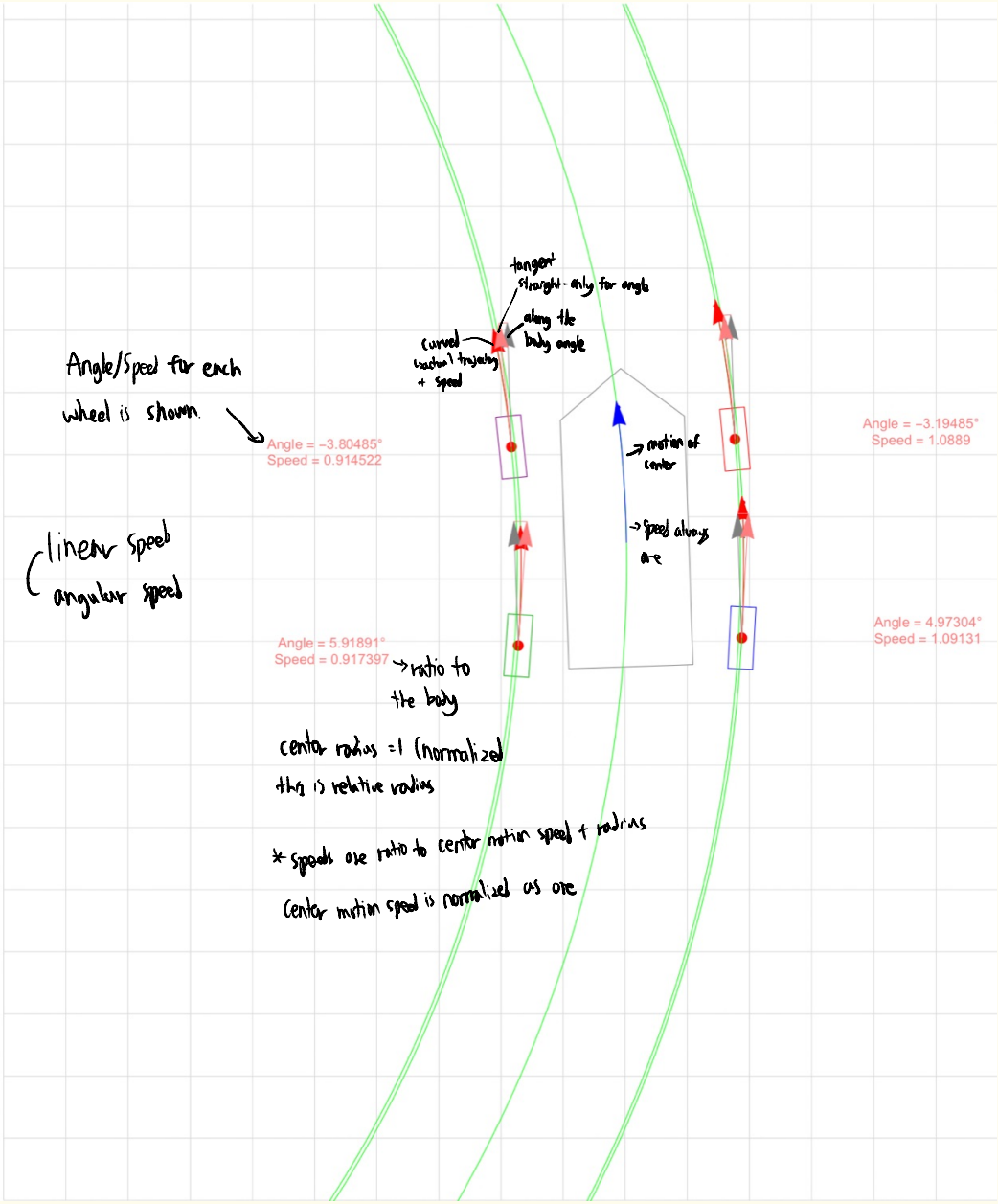
↓

↓

Serial Regulator

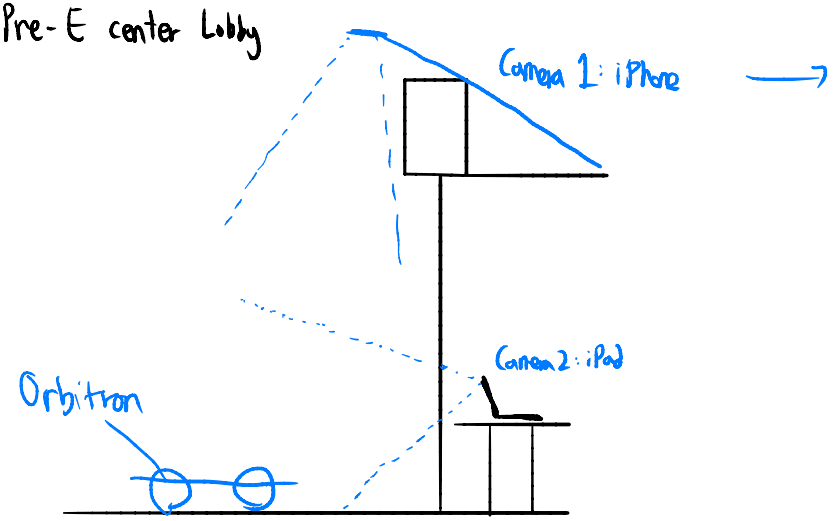
- Calculates the time needed for Orbiter to achieve desired output.
- Wait for that amount of time and send another signal

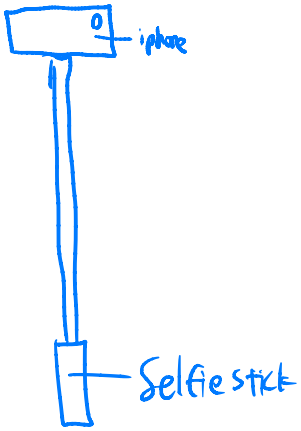
Master Algorithm - Graphics.nb



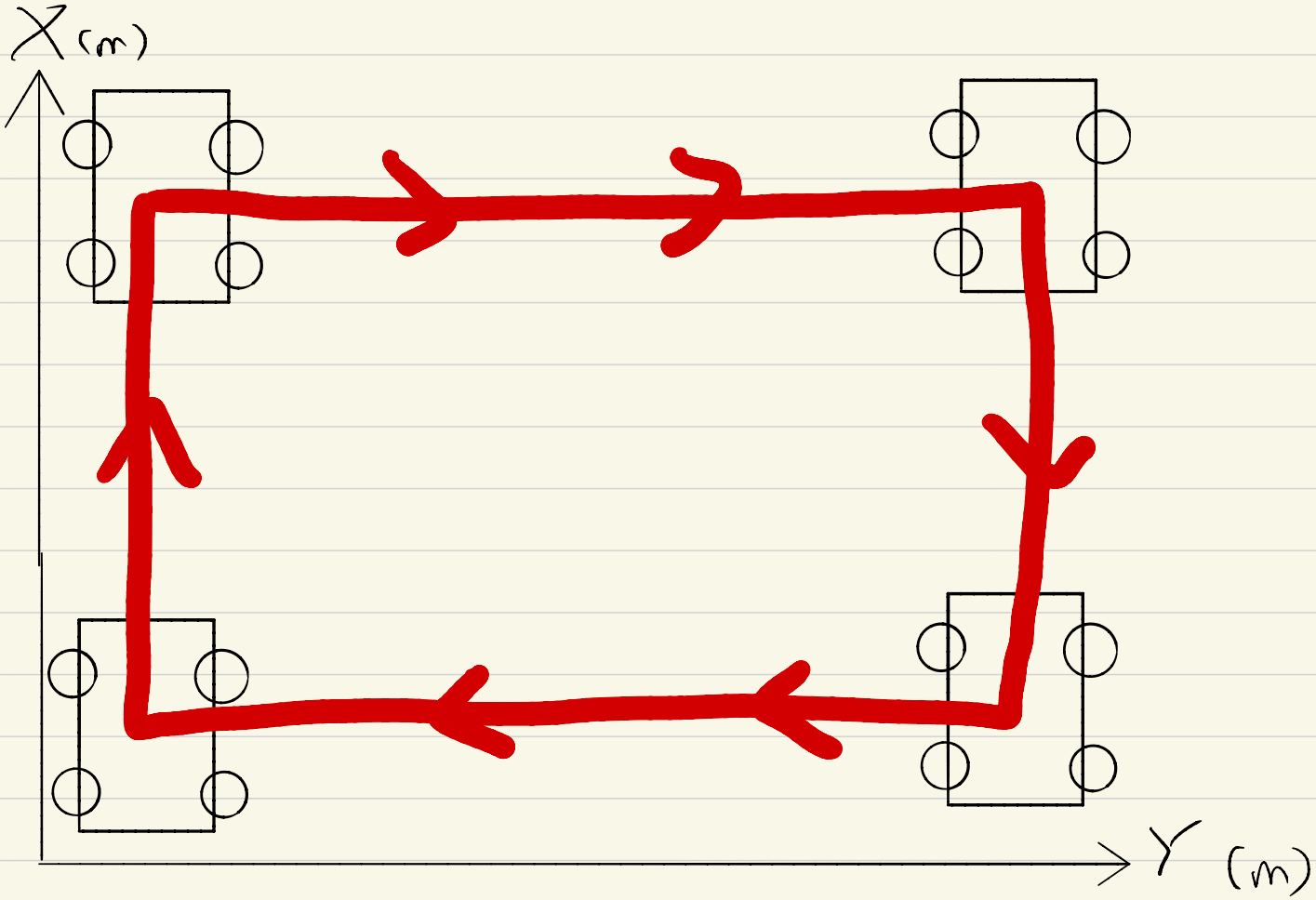
12/1 - Experiment Setup

- Pre-E center Lobby



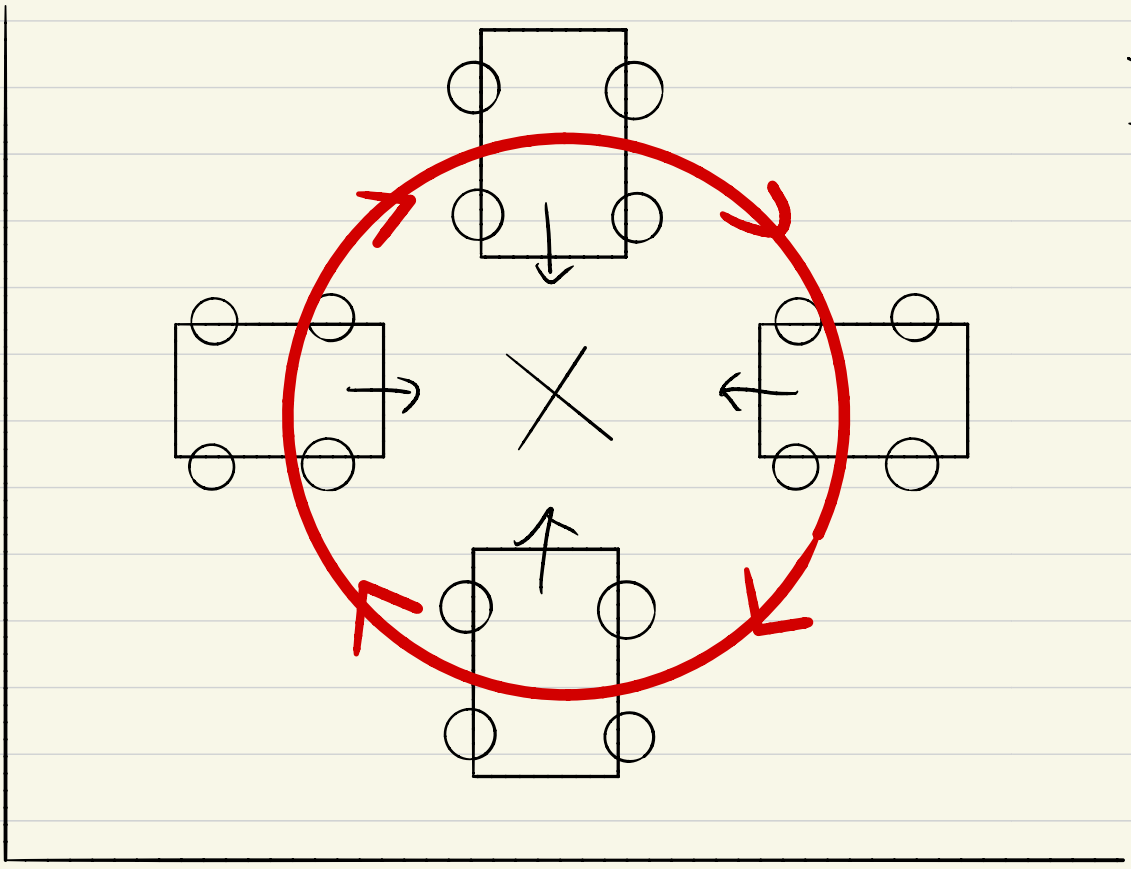


① Rectangular



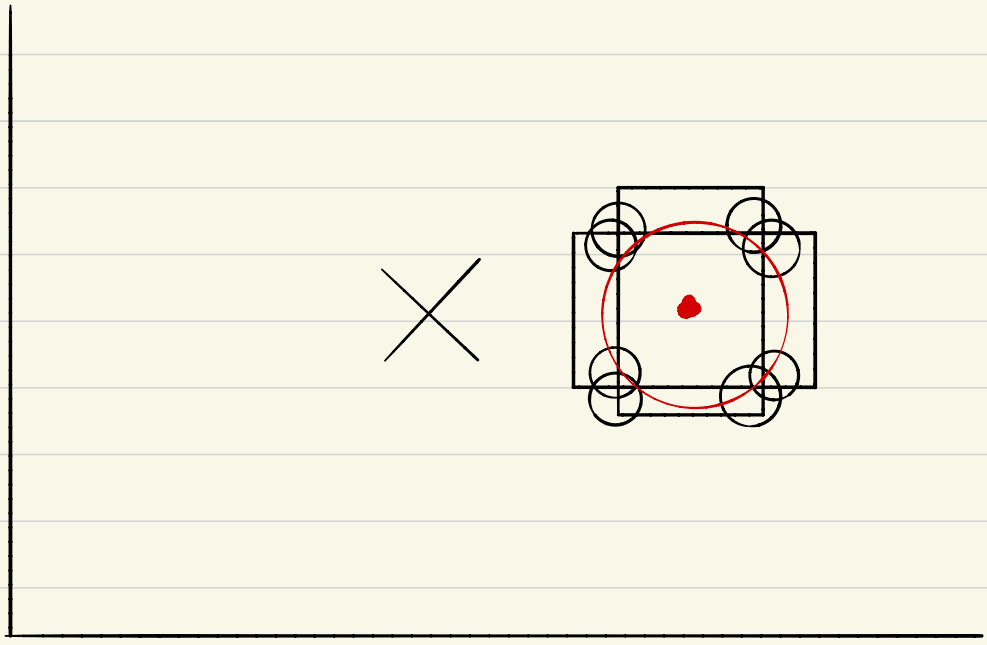
- Crab Steering

② Circular



- Crab Steering
- AFRS

③ Spinning



- Spinning