

[NSCC 2019 Work-Term]

R2D2 Project

Project Owner : Todd Verge
Project Manager : Hyejung Bae(Cathy)
Project Member : Rex Ramos

R2D2 Project Overview

1. Period

- April 29 ~ May 31

2. Goal

- Make a New Dome using 3D printer
- Make some parts move and display LED, LCD

3. Challenge

- Make many parts move
- Look more fancy



* Source - <https://www.amazon.co.uk/Star-Wars-Smart-R2-D2-Playset/dp/B01L93GCT0>

1st Week

1. Period

- April 29 ~ May 3

2. Task

- Research about R2D2 and 3D Printer
- Make a print list
- Print display parts and moving parts first
- Make demo for moving parts and display parts

Research

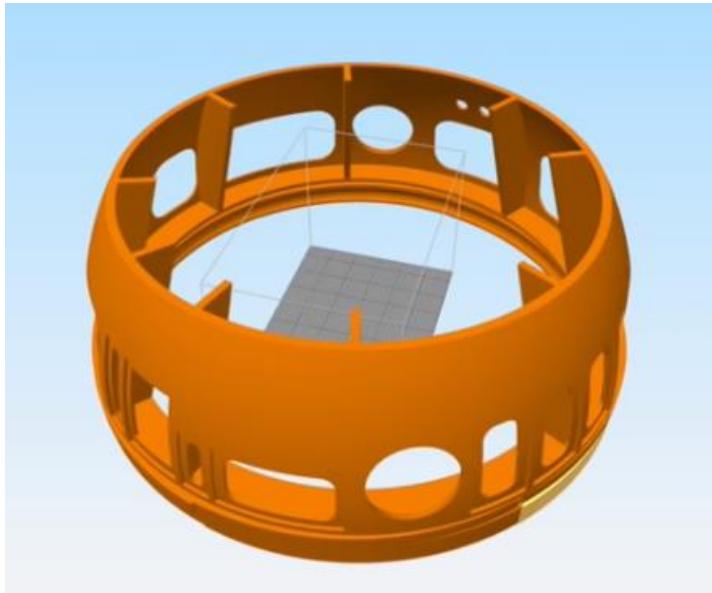
1.R2D2 & 3D printing reference site

- 1) R2D2 Builders club : <http://astromech.net/>
- 2) Mike Baddeley's site: <https://www.thingiverse.com/mrbaddeley/about>
- 3) 3D Printed Droids : <https://www.3dprinteddroids.net/>
- 4) STL file viewer : <https://www.viewstl.com/>
- 5) 3D printer calibration - <https://www.youtube.com/watch?v=JihFYdVnEj0>

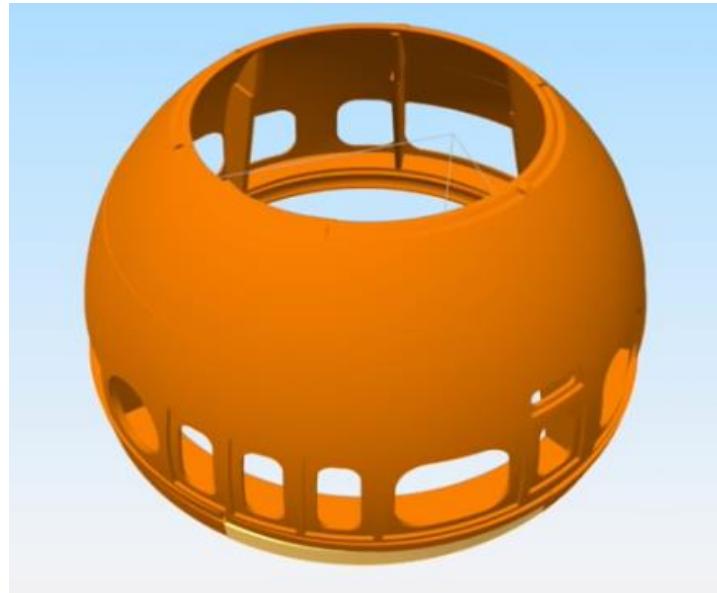
2.R2D2 3d printing file

- 1) Dome parts - <https://www.thingiverse.com/thing:1395937/files>
- 2) Hinges - <https://astromech.technology/construction/s-dome-hinges/>
→ Size is not fitted in Mike Baddeley's Dome after all, so I had to cut a little.
Just use hinge files in Dome parts

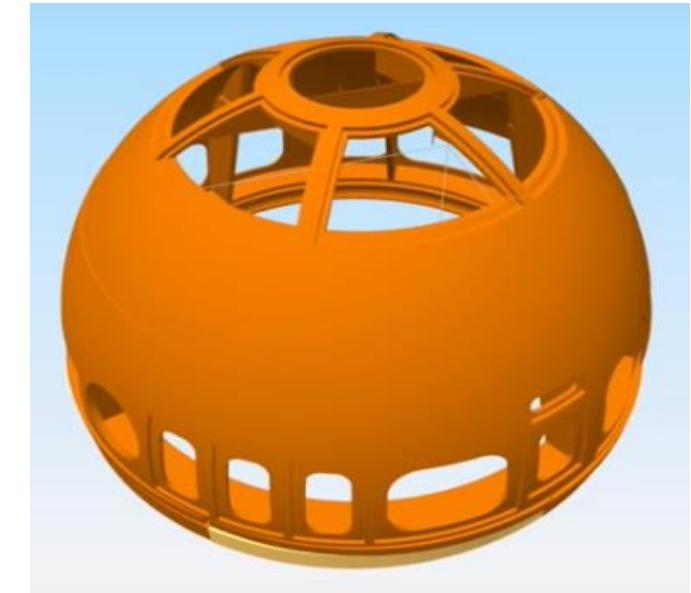
3D Print Overview



Domebase 9pcs



DomePie 6pcs



DomeTop 2pcs

$$\text{Main 17pcs} + \text{Panel 14pcs} + \text{Others 16pcs} + \text{Hinge 36pcs} + \alpha = \text{Total 83pcs} + \alpha$$

$\alpha \approx 6\text{pcs/hinge}$

3D Print List

category	No	File Name	Size	Printed	LongTime	Priority
Holopro	1	1holopro-part1.stl	1307784		0	
	2	2holopro-part2.stl	131584			
	3	3holopro-part3.stl	693884		0	
	4	4holopro-part4.stl	969884		0	
	5	5HoloProv2.stl	948884		0	
	6	6Panel10.stl	94184			
	7	7Panel11.stl	90584			
	8	8Panel12.stl	92884			
	9	9Panel13_lens.stl	119984			
	10	10Panel13.stl	193284			
Panel	11	11Panel14.stl	31884			
	12	12Panel1.stl	119684	5/1		0
	13	13Panel2.stl	64984	5/2		
	14	14Panel3.stl	403084			
	15	15Panel4.stl	684884		0	0
	16	16Panel5.stl	450984			
	17	17Panel6.stl	229384			
	18	18Panel7.stl	163184			0
	19	19Panel8.stl	32284			
	20	20Panel9.stl	240584			
Dome	21	21R2D2DomeBase1.stl	961484		0	0
	22	22R2D2DomeBase2.stl	645484		0	0
	23	23R2D2DomeBase3.stl	426284			
	24	24R2D2DomeBase4.stl	485984			0
	25	25R2D2DomeBase5-B.stl	919184		0	0
	26	26R2D2DomeBase5.stl	754884		0	0
	27	27R2D2DomeBase6.stl	569384		0	0
	28	28R2D2DomeBase7.stl	1136984		0	0
	29	29R2D2DomeBase7_ver_2.stl	1106584		0	0
	30	30R2D2DomeBase8.stl	582084			0
Base	31	31R2D2DomeBase9.stl	1047684		0	0
	32	32R2D2DomePie1.stl	634784			
	33	33R2D2DomePie2.stl	510384			
	34	34R2D2DomePie3.stl	517384			
	35	35R2D2DomePie4.stl	578184			
	36	36R2D2DomePie5.stl	559684			
	37	37R2D2DomePie6.stl	465984			
	38	38R2D2DomePie7_v2.stl	712784		0	
	39	39R2D2DomePie8_v2.stl	817984		0	
	Pie					

□ Printing Progress

Printed	Total	Progress(%)
12	83	14%

*Based on quantity

*Date : 5/2

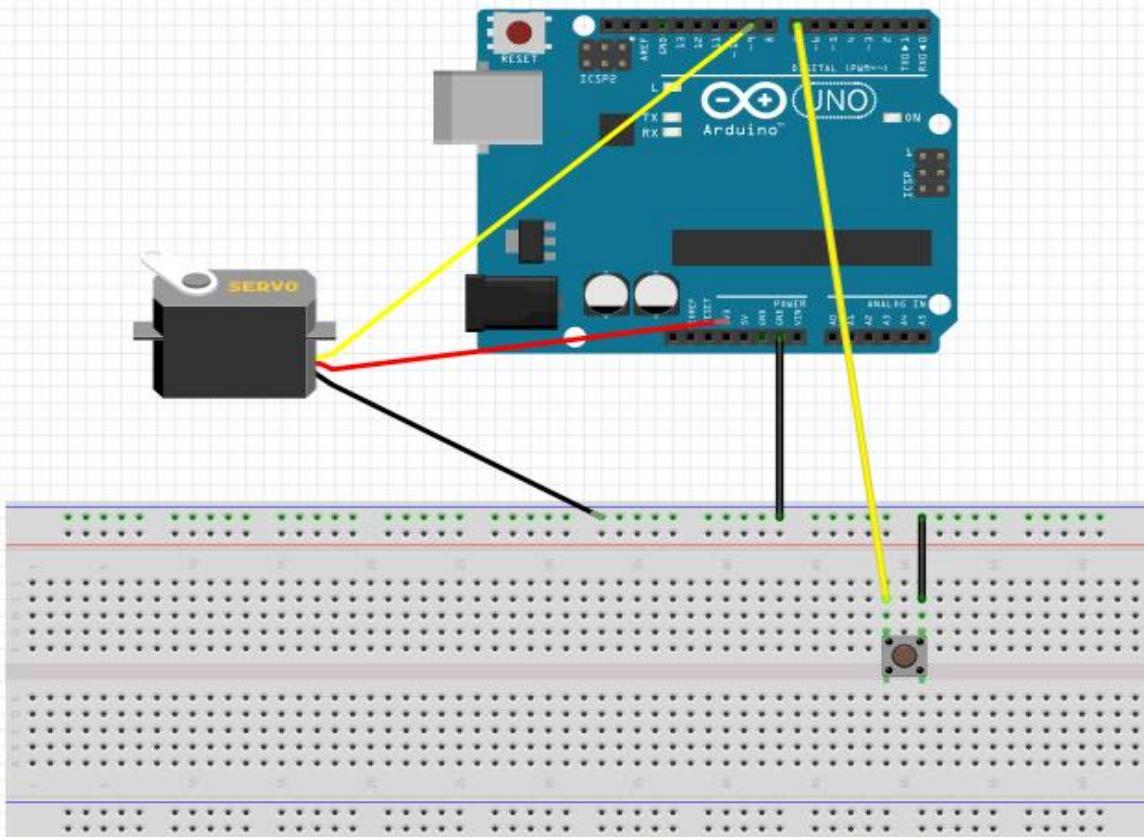


□ Issues

- Difficult to calculate exact print time
- Extruder temperature problem
 - : Failed during 5/1 6pm ~ 5/2 2pm
- 👉 Couldnt't print anything
- 👉 Spent time to troubleshooting
- ➔ Exchanged the extruder(by Brian)

Moving Part - Circuit

- Servo motor



fritzing

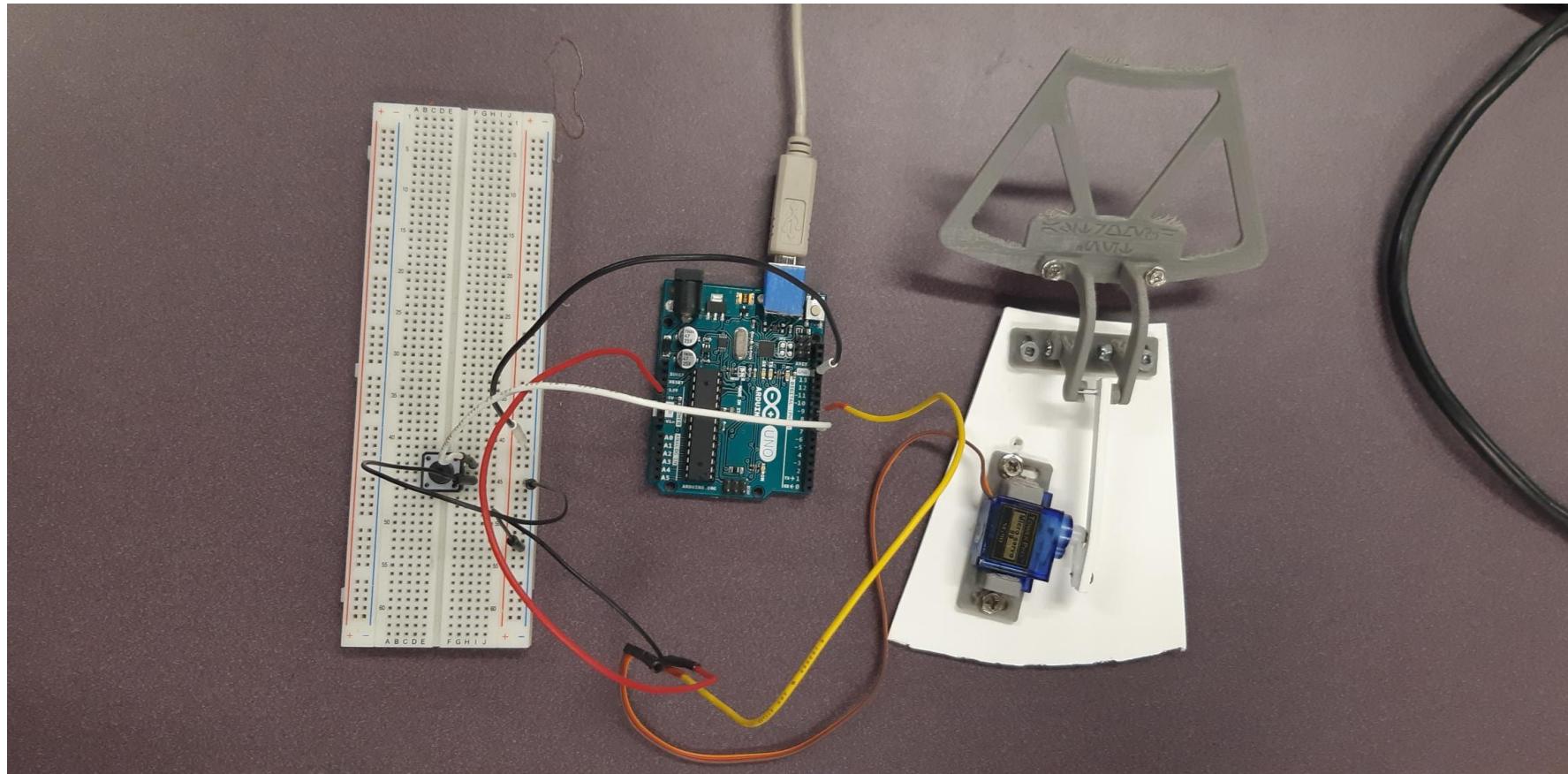
```
#include<Servo.h>
Servo servo;
int sw=7;

void setup(){
  servo.attach(9);
  pinMode(sw,INPUT_PULLUP);
}

void loop(){
  if(digitalRead(sw)==HIGH){
    servo.write(180);
  }
  else{
    servo.write(0);
  }
}
```

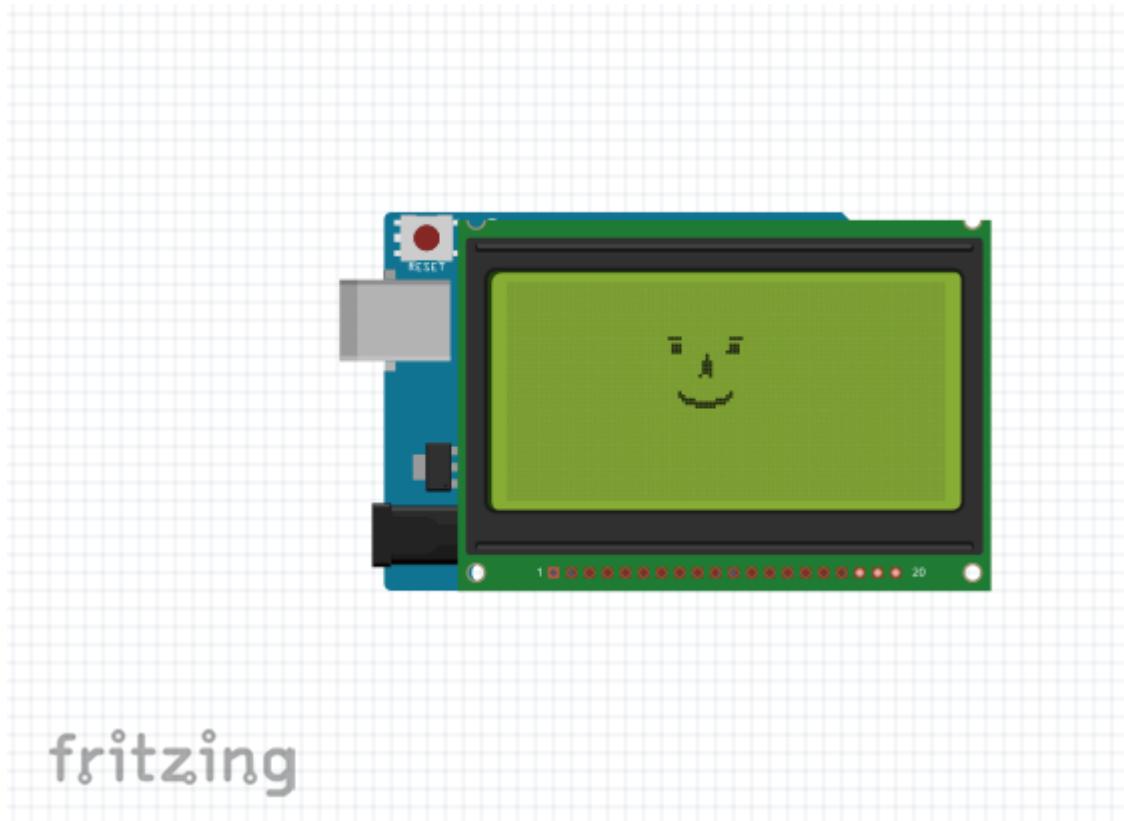
Moving Part - Demo

- Servo motor



Display Part - TFT

- TFT LCD



```
#include <UTFT.h>
extern uint8_t SmallFont[];

// Declare an instance of the class
UTFT myGLCD(ITDB18SP,7,6,5,3,4);
void setup(){
    randomSeed(analogRead(0));

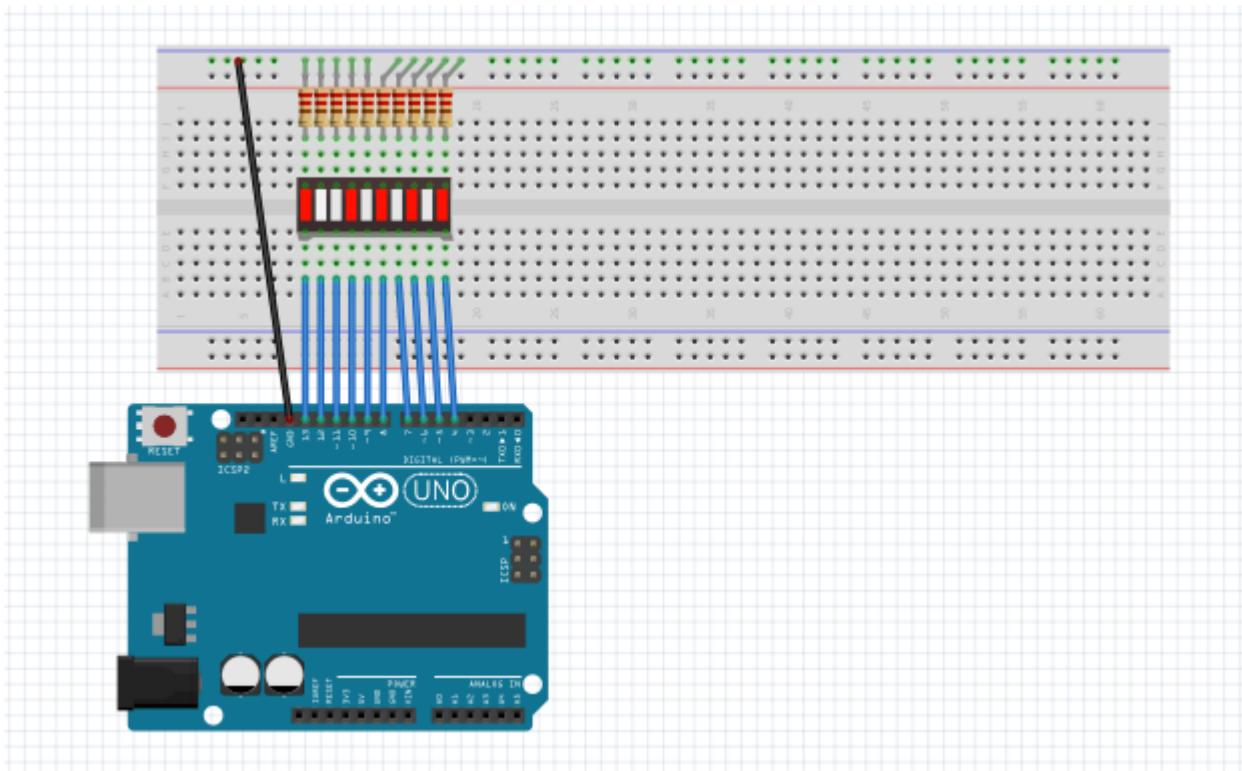
    // Setup the LCD
    myGLCD.InitLCD(PORTRAIT);
    myGLCD.setFont(SmallFont);
}

void loop()
{
    byte buf[126];
    int x, x2;
    int y, y2;
    int r;
```

*Source - http://www.elecfreaks.com/wiki/index.php?title=TFT1.8_LCD_Shield
(filename: UTFT_Demo_128*160_serial.pde)

Display Part – LED

- LED Bar



```
void setup() {  
    pinMode(13, OUTPUT); //define pins as output  
    pinMode(12, OUTPUT);  
    pinMode(11, OUTPUT);  
    pinMode(10, OUTPUT);  
    pinMode(9, OUTPUT);  
    pinMode(8, OUTPUT);  
    pinMode(7, OUTPUT);  
    pinMode(6, OUTPUT);  
    pinMode(5, OUTPUT);  
    pinMode(4, OUTPUT);  
}  
void loop() {  
    unsigned int strobespeed = 150; //change for a different strobe speed  
    digitalWrite(4, HIGH);  
    delay(strobespeed);  
    digitalWrite(4, LOW);  
    digitalWrite(5, HIGH);  
    delay(strobespeed);  
    digitalWrite(5, LOW);  
    digitalWrite(6, HIGH);  
    delay(strobespeed);  
    digitalWrite(6, LOW);  
}
```

*Source - <http://www.learningaboutelectronics.com/Articles/10-segment-LED-bar-graph-circuit-with-an-arduino.php>

Plan for 2nd week

1. Period

- May 6 ~ May 10

2. Plan

- Print progress up to 40%
- Make a plan how to put together (glue/welding, painting)
- Make an idea(at least 2) for fancy R2D2 and apply them for displaying

3D Print List

3D printing List						
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	3	holopro-part3.stl	693884		0	
	4	holopro-part4.stl	969884		0	
	5	HoloProv2.stl	948884	5/6	0	
	6	Panel10.stl	94184	5/9		
	7	Panel11.stl	90584			
	8	Panel12.stl	92884			
	9	Panel13_lens.stl	119984			
	10	Panel13.stl	193284			
Panel	11	Panel14.stl	31884	5/9	0	
	12	Panel1.stl	119684	5/1		0
	13	Panel2.stl	64984	5/2		
	14	Panel3.stl	403084	5/9		
	15	Panel4.stl	684884		0	0
	16	Panel5.stl	450984			
	17	Panel6.stl	229384			
	18	Panel7.stl	163184	5/7		0
	19	Panel8.stl	32284	5/9		
	20	Panel9.stl	240584	5/9		
Dome	21	R2D2DomeBase1.stl	961484	5/4	0	0
	22	R2D2DomeBase2.stl	645484	5/4	0	0
	23	R2D2DomeBase3.stl	426284	5/8		0
	24	R2D2DomeBase4.stl	485984			0
	25	R2D2DomeBase5.B.stl	919184	5/8	0	0
	26	R2D2DomeBase5.stl	754884		0	0
	27	R2D2DomeBase6.stl	569384	5/9	0	0
	28	R2D2DomeBase7.stl	1136984		0	0
	29	R2D2DomeBase7_ver_2.stl	1106584		0	0
	30	R2D2DomeBase8.stl	582084			0
Pie	31	R2D2DomeBase9.stl	1047684	5/7	0	0
	32	R2D2DomePie1.stl	634784			
	33	R2D2DomePie2.stl	510384			

□ Printing Progress

Printed	Total	Progress(%)
26	83	31%

*Based on quantity

*Date : 5/10

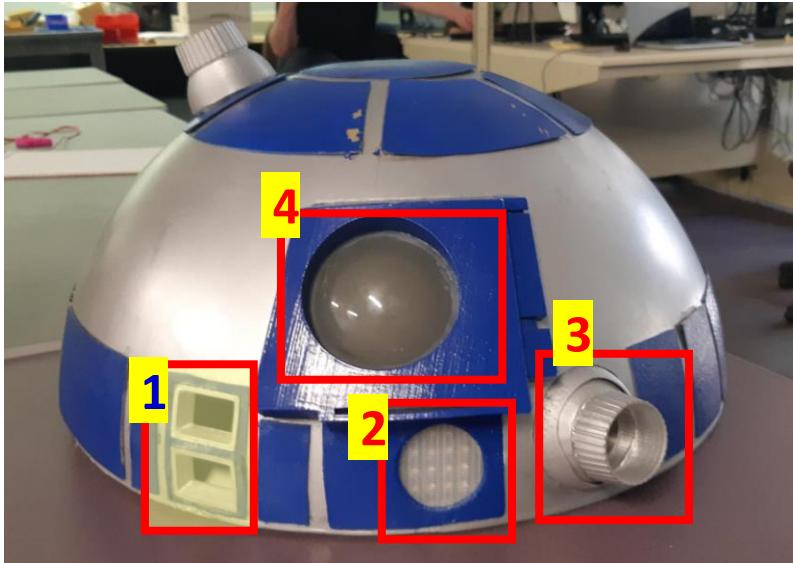


□ Issues

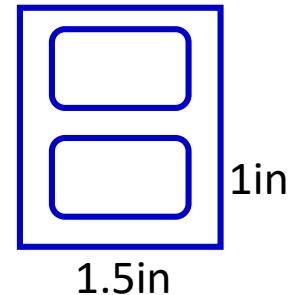
- Printed big size first(dome base part)
: took a lot of time
- Started printing panel as blue color
- Need extra tape

Plan for Display

Front Logic Display



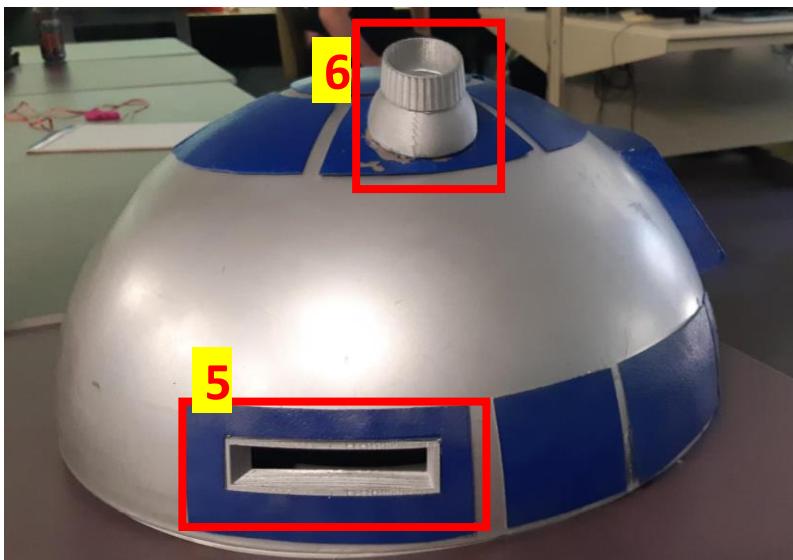
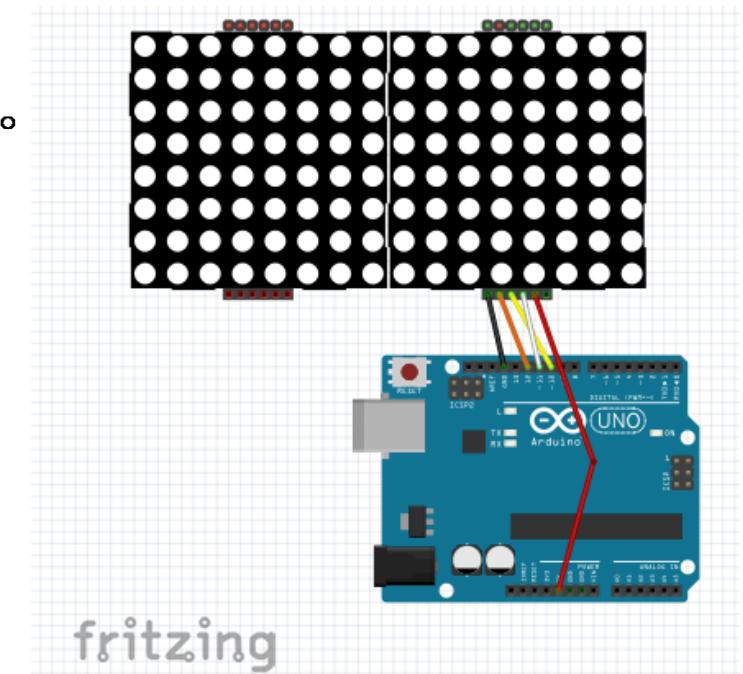
1. Name : Front Logic display



- 2 squares (1.5inch x 1inch)

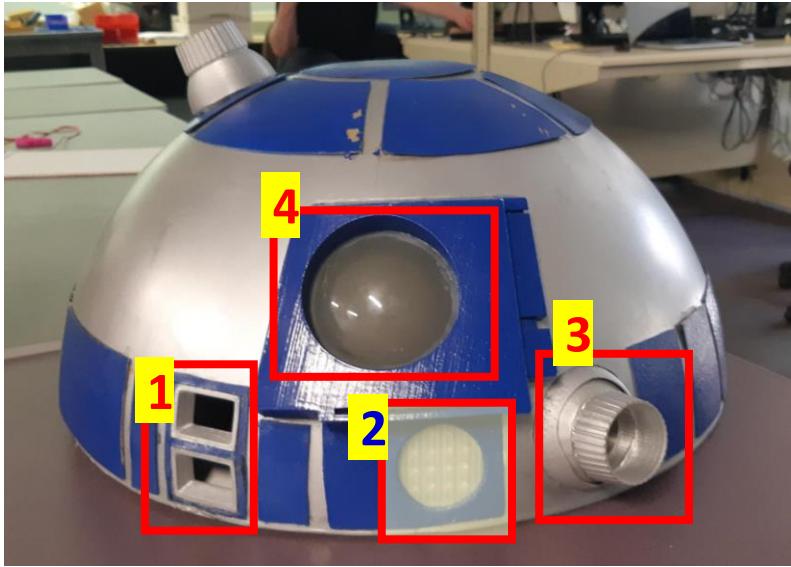
2. How to display

- 1) LED Matrix
: Generate scattered
LED light randomly

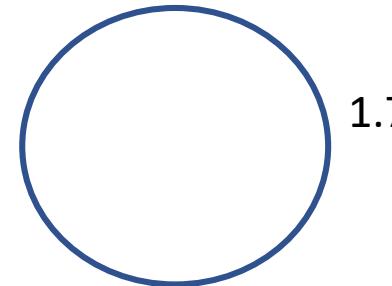


Plan for Display

Processor State Indicators(PSI)



1. Name : Processor State Indicators(PSI)



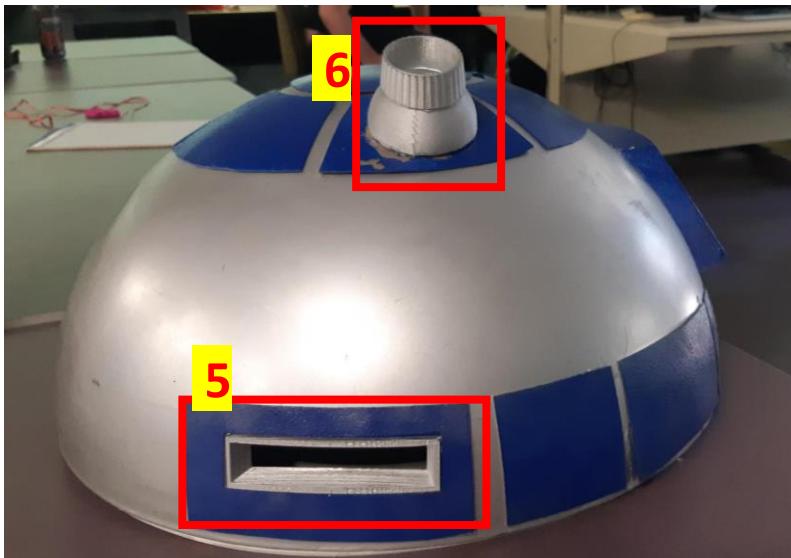
1.7in

- Diameter : 1.7inch

2. How to display

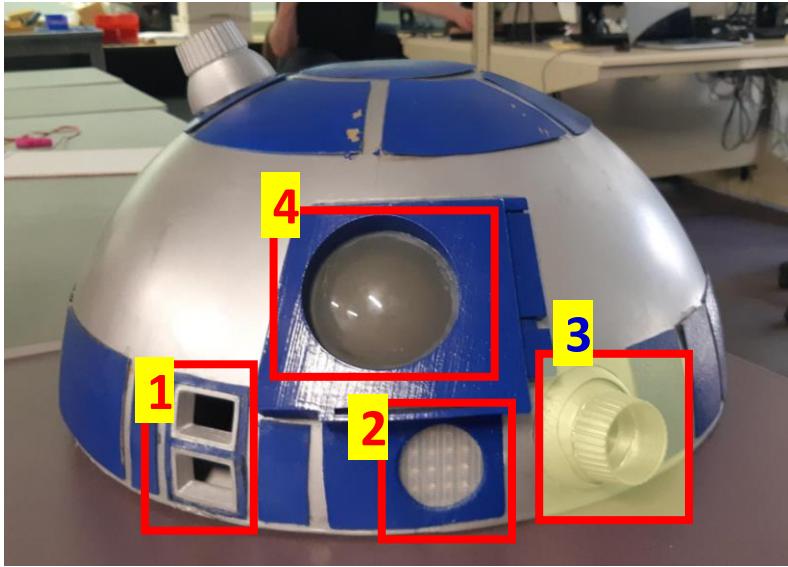
1) RGB LED

- Use original one
- Keep changing color



Plan for Display

Holoprojector(side)



1. Name : Holoprojector (Side)



- Size : 1.5inch

Ex) Hologram (OLED)



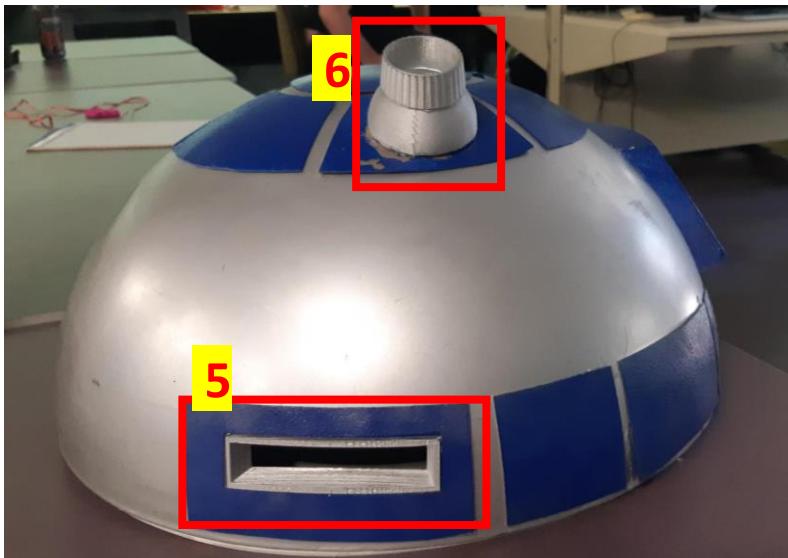
2. How to display

- 1) TFT LCD Display
: Random Display



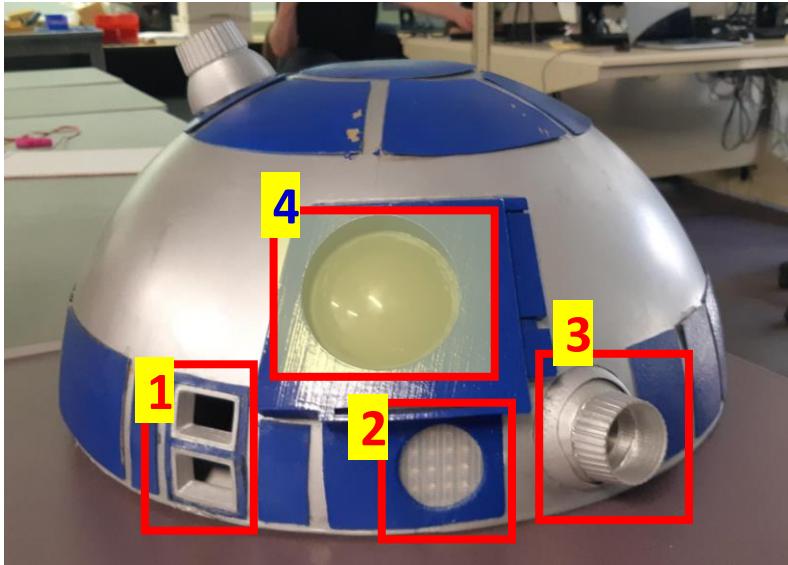
3. Idea (with Orlin, Neil, Rex)

- 1) Attach Convex/Concave Lens or Magnifier
- 2) Making move

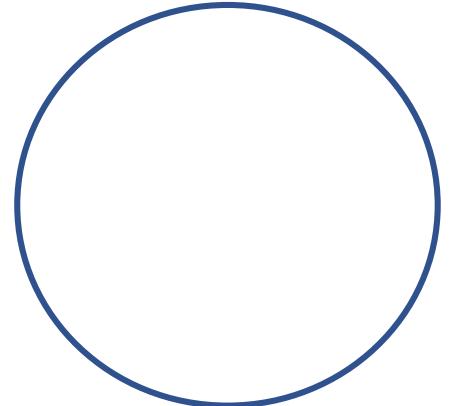


Plan for Display

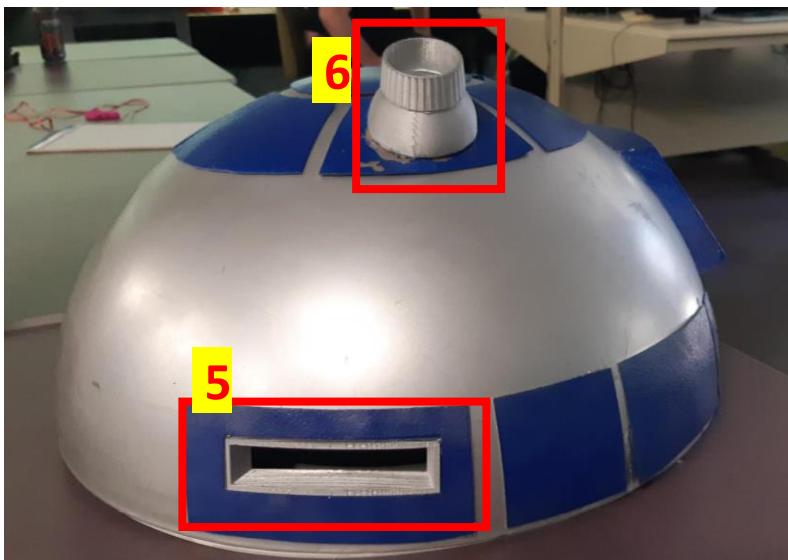
Radar Eye



1. Name : Radar Eye



- Diameter : 3inch



2. How to display

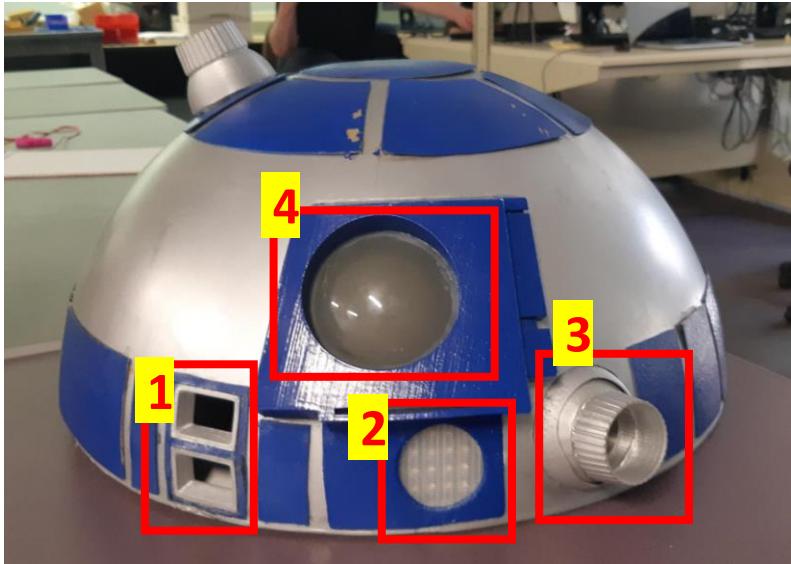
1) Attach plastic dome

3. Idea

- Light?
- Camera?

Plan for Display

Rear Logic Display



1. Name : Rear Logic Display

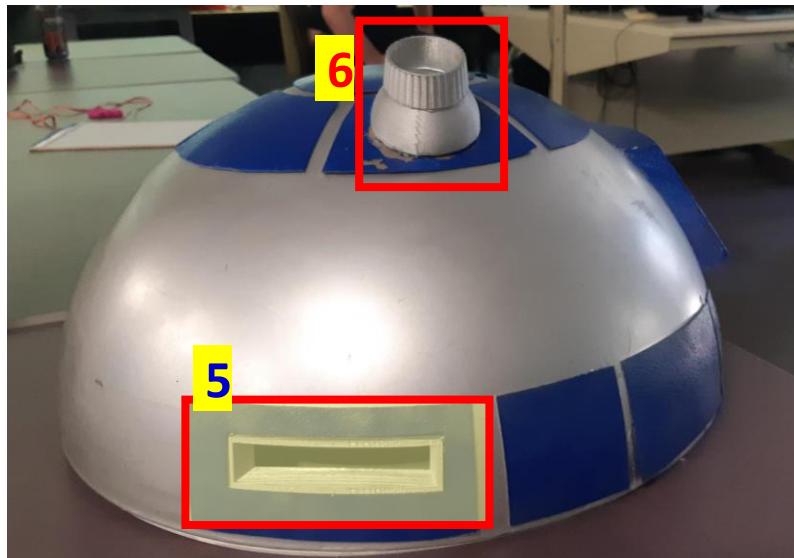
4.3in



- Size : 1.5inch

2. How to display

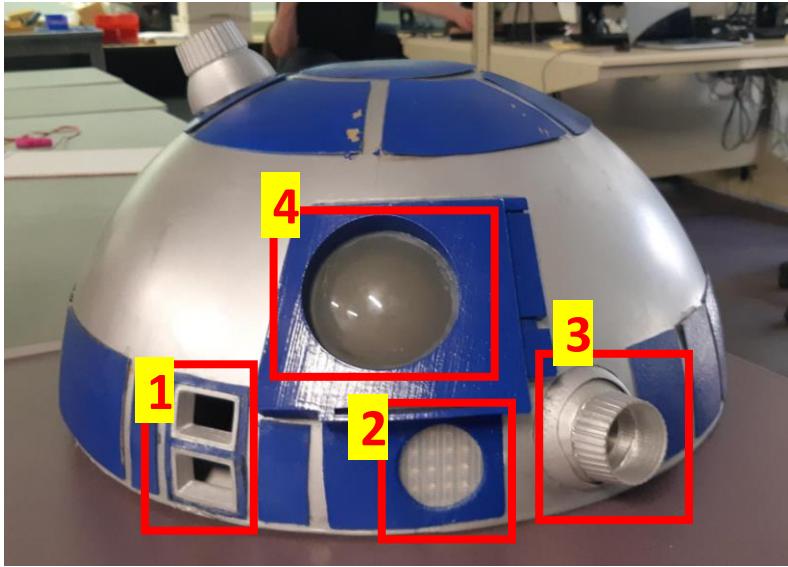
- 1) LED will arrive at May 13th
- 2) NeoPixel(RGB LED)



<https://www.adafruit.com/?q=neopixel&p=2>

Plan for Display

Holoprojector(upper)



1. Holoprojector (Upper)



- Size : 1.5inch

2. Ideas about how to display (by Rex)

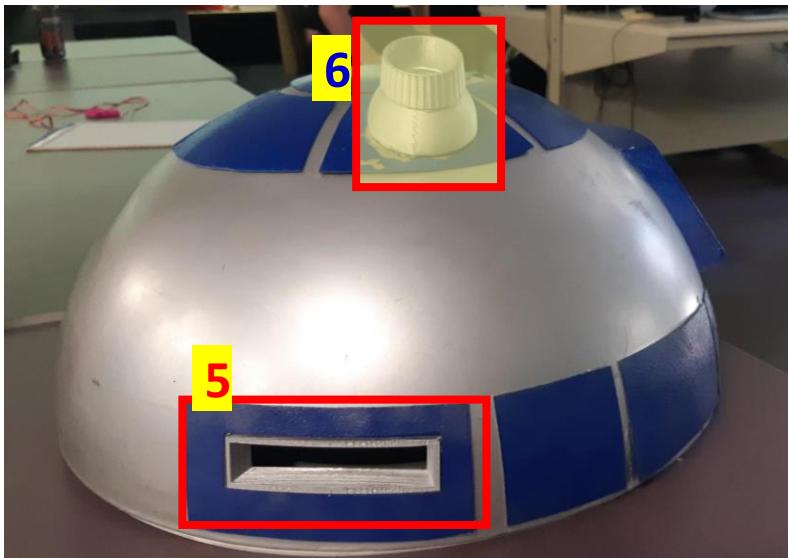
1) Use Lithonia LED Lighting (12v, 0.23amp)

- ① Only LED
- ② Add Convex or Concave Lens

: [Link](#)

- ③ Attach something to make color
ex) cellophane(risk to burn?)

2) Use spotlight

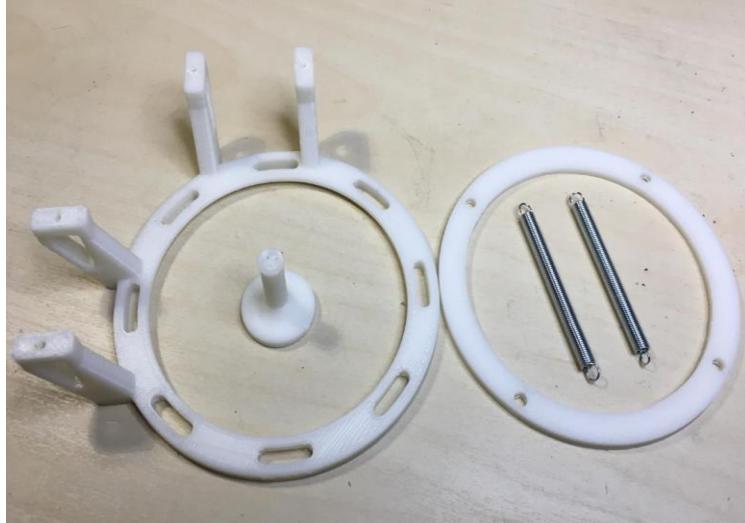


Plan for Moving Parts

Holoprojector

1. Parts : 2servo motors, plastic pieces, 2 springs

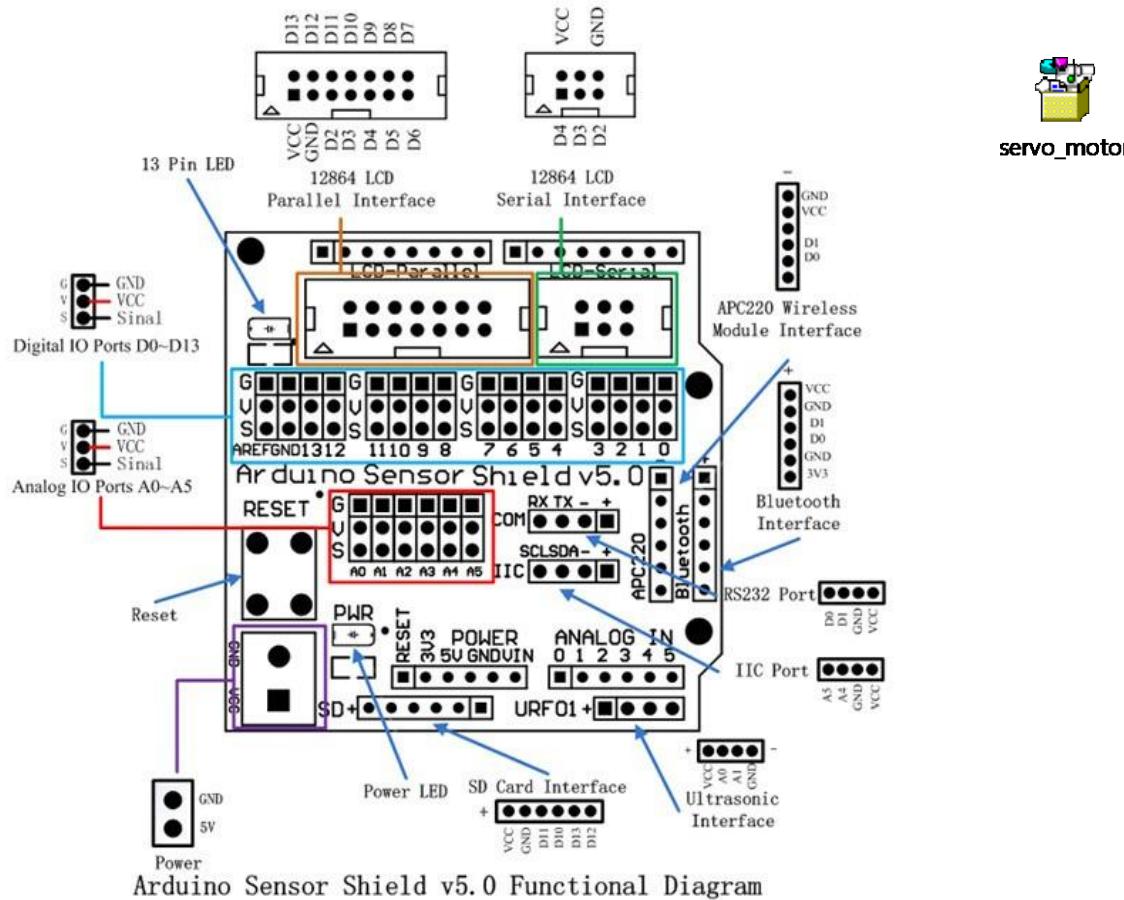
- Plastic Pieces : Print using 3D printer
- 2 Spring : need alternative one



Plan for Moving Parts

Total

1. Multi-Motor control using by sensor shield
 - 11 panels or 9 panels / 1 holoprojector



Arduino Sensor Shield v5.0 Functional Diagram

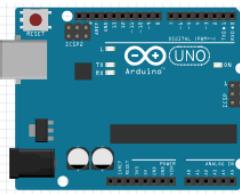
Design how to work

Plan 1

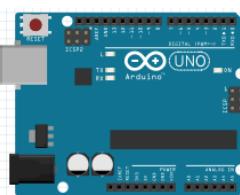
DOME

[3 Arduino + 1 Raspberry Pi]

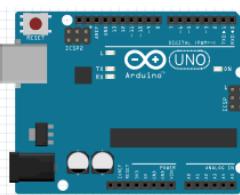
Servo
Motors
(11ea)



TFT-LCD

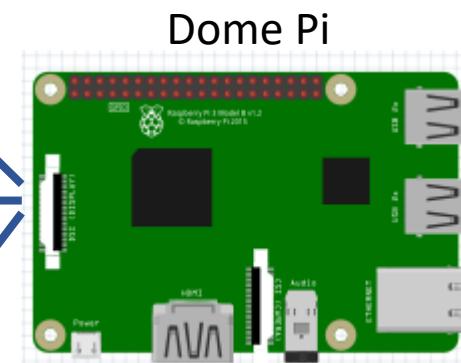


LED Matrix

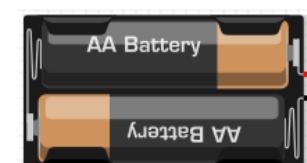


LED Display

LCD Display

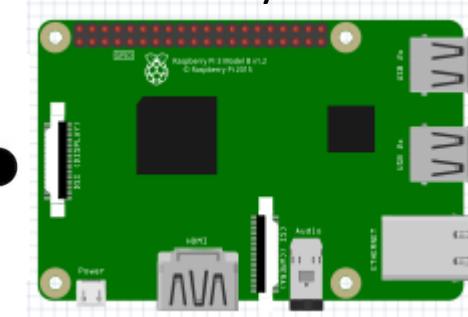


Power



BODY

Body Pi



Remote
Controller



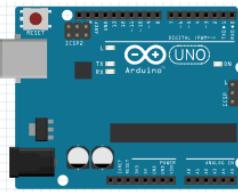
Design how to work

Plan 2

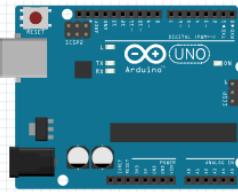
DOME

[3 Arduino (+ wifi modules) + Raspberry Pi]

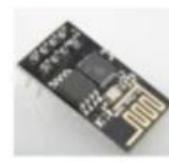
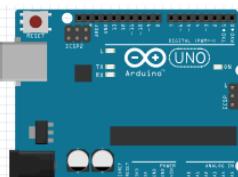
Servo
Motors
(11ea)



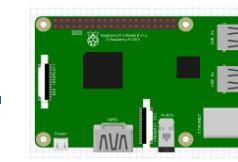
TFT-LCD



LED Matrix



LED Display



LCD Display

Wireless
Connection

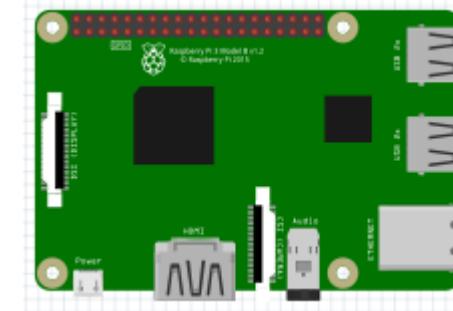


Power



BODY

Body Pi



Remote
Controller



Remote Controller Button

P3

- Use pygame program



Plan for Appearance

Part I . Assembly

1. Material : PLA (filament) - Organic material like corn starch and sugar cane
2. Parts : Filler, Sand Paper/Sanding Machine, Epoxy resin, Superglue



✓ Filler

✓ Sand Paper/ Sanding Machine

✓ Epoxy

✓ Super Glue

Plan for Appearance

Part I . Assembly



1. pre-fix parts (Supurglue)



2. Fixing Dome (Epoxy Resin)



4. Make it smooth(Sander)



3. Filling gaps between parts (Filler)

<https://www.youtube.com/watch?v=3WcUO5BmH0w&feature=youtu.be>

Plan for Appearance

Part II. Painting

1. Parts : 5~6 sprays(Primer, PainterTouch, Metallic, Crystal Clear Enamel, Rub n Buff, Blue Pearl)



1. Filling some imperfection (Primer)



2. Black base coat (PainterTouch)
: Helpful for metallic paint



3. Silver coat (Metallic spray)

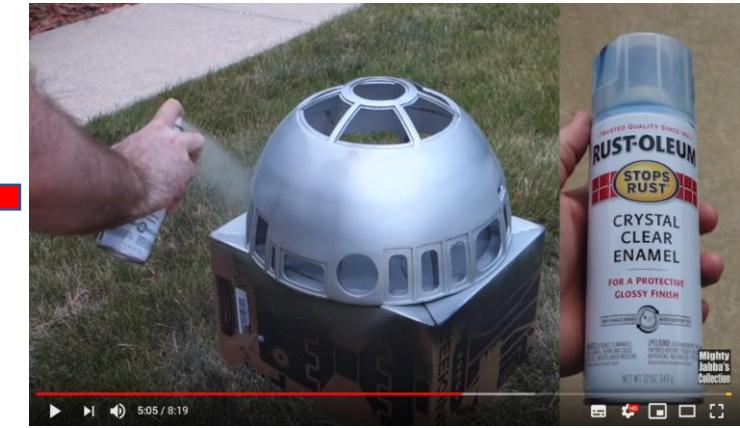


6. Blue Pearl coat for panel
(Blue spray)



5. Wax with aluminum powder
(Rub n Buff) look metallic!!

<https://www.youtube.com/watch?v=3WcUO5BmH0w&feature=youtu.be>



4. Protect the paint, make it more glossy
(Crystal Clear Enamel)

Plan for 3rd week

1. Period

- May 13 ~ May 17

2. Plan

- Finish printing for main dome part → start to assembly
- Design electronic part for dome and connection with body
 - : How to connect Raspberry Pi with Arduino
 - : How to connect 2 Raspberry Pi
 - : How to control Dome by remote controller
- Display using RPi LCD display
- Brain storming for another idea (Camera, Sound)

3D Print Progress

3D printing List

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	15	Panel4.stl	684884	5/16	0	0
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	23	R2D2DomeBase3.stl	426284	5/8		0
	24	R2D2DomeBase4.stl	485984	5/13		0
	25	R2D2DomeBase5-B.stl	919184	5/8	0	0
	26	R2D2DomeBase5.stl	754884		0	0
	27	R2D2DomeBase6.stl	569384	5/9	0	0
	28	R2D2DomeBase7.stl	1136984	5/9	0	0
	29	R2D2DomeBase7_ver_2.stl	1106584		0	0
	30	R2D2DomeBase8.stl	582084	5/11		0
Pie	31	R2D2DomeBase9.stl	1047684	5/7	0	0
	32	R2D2DomePie1.stl	634784	5/15		
	33	R2D2DomePie2.stl	510384	5/14		
	34	R2D2DomePie3.stl	517384	5/14		

Printing Progress

Printed	Total	Progress(%)
39	83	47%

*Based on quantity

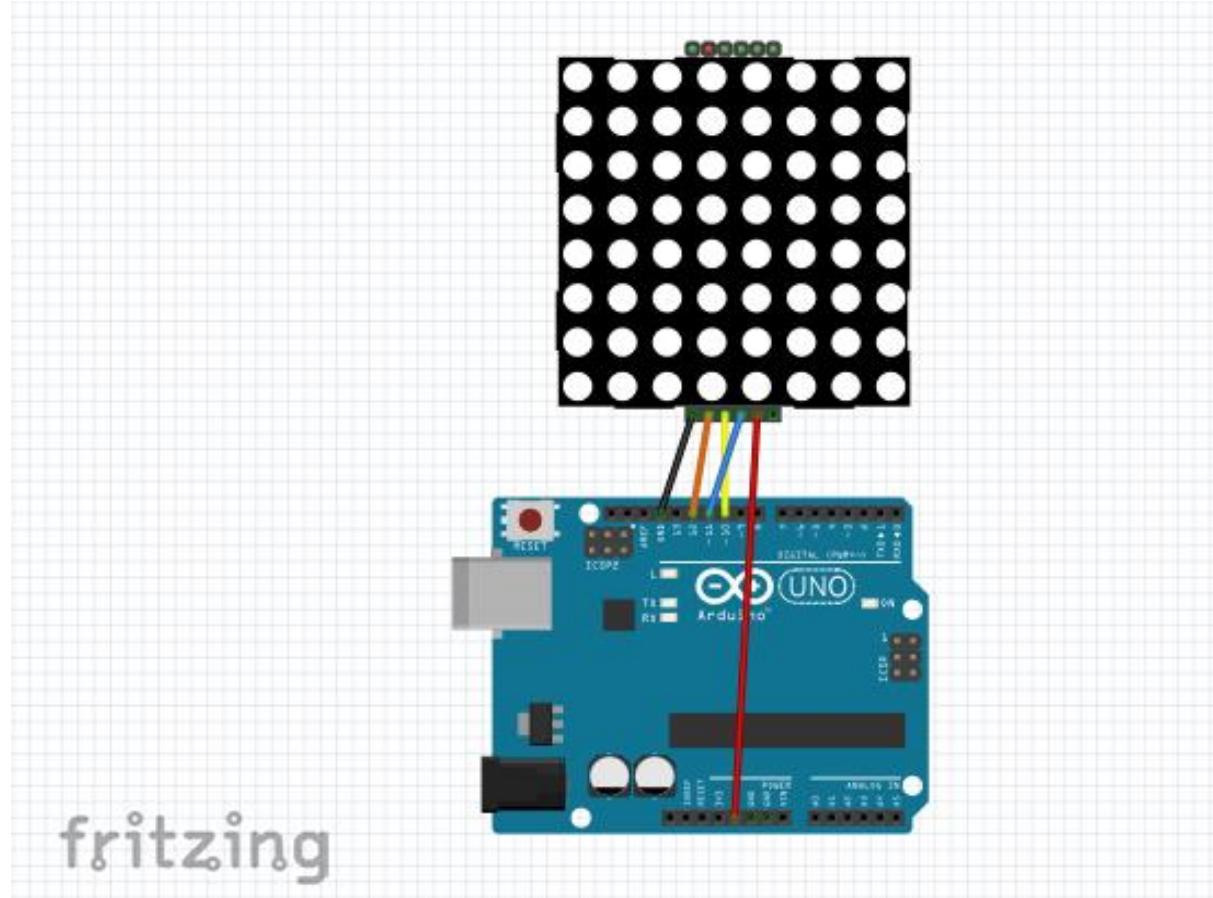
*Date : 5/17



Issues

- Finished printing main dome
- : Started to attach main parts

LED Blinking



[Pin Connection]

5V : 2, 4

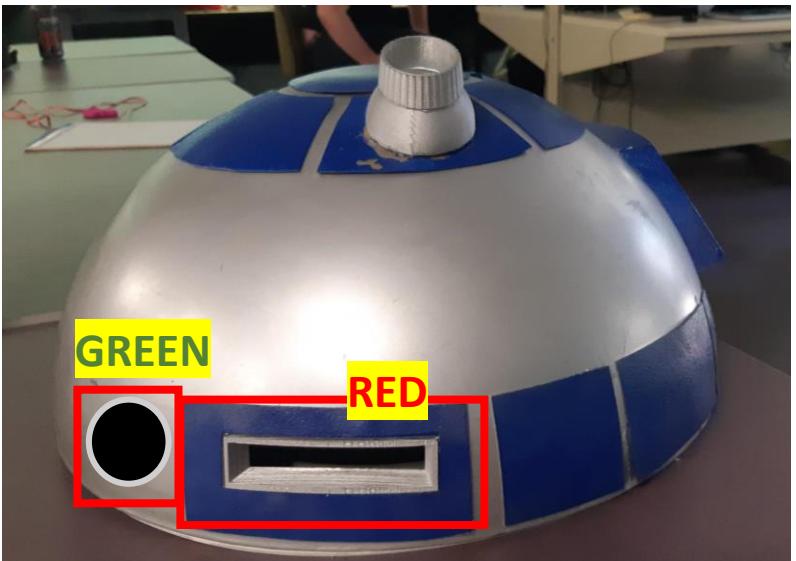
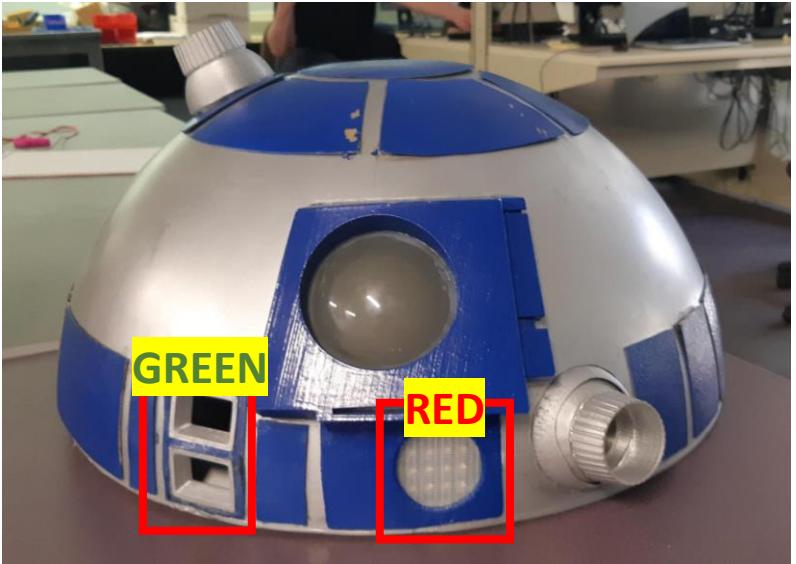
GND : 6, 9, 14, 20, 25

DataInput(MOSI) : 19 (Arduino 12)

SCK(CLK) : 23 (Arduino 11)

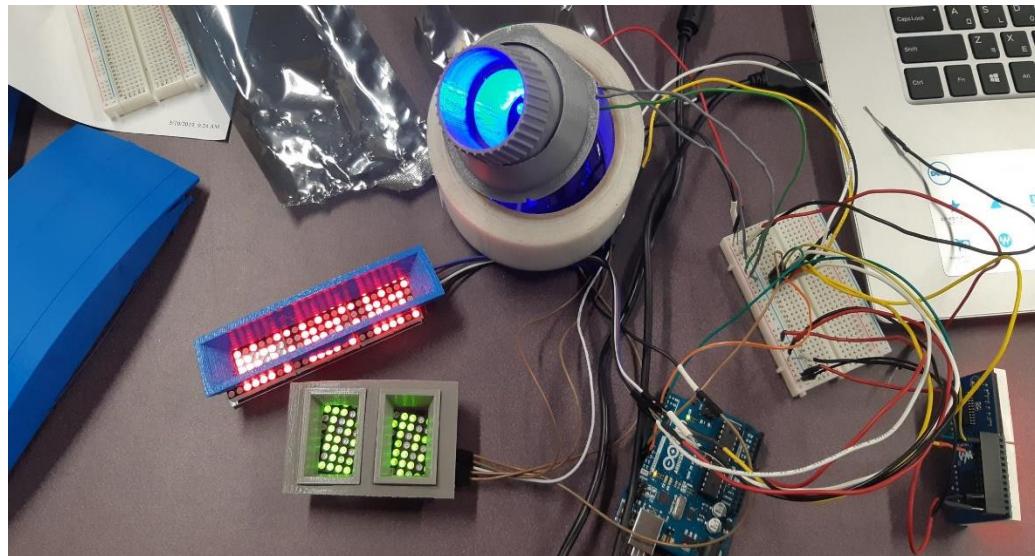
CE0CS : 24 (Arduino 10)

LED Blinking



LED Blinking Display

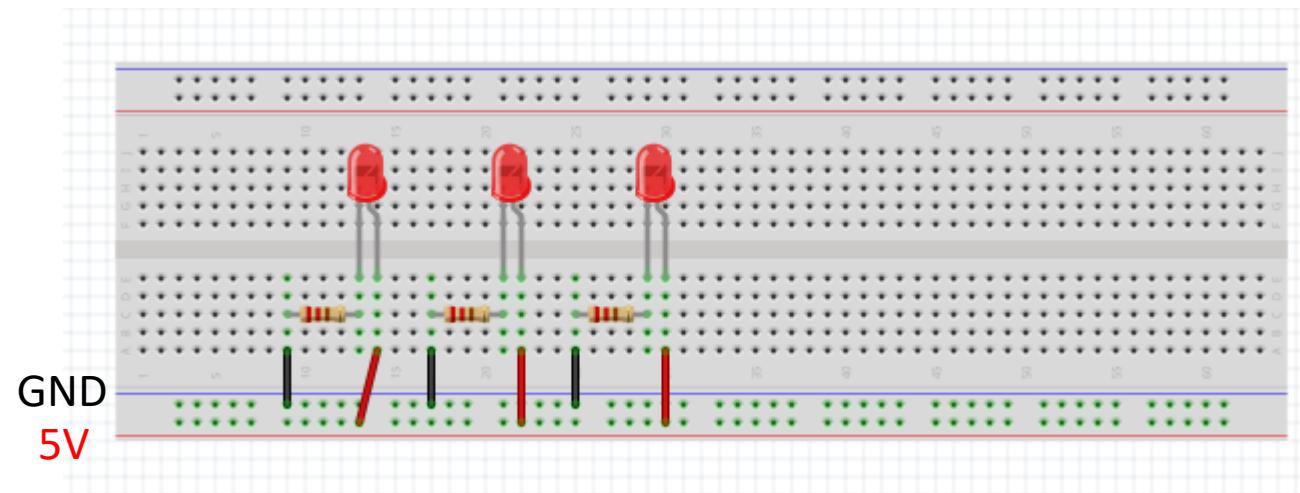
- Make a blink using one Arduino
(RED – GREEN – RED – GREEN)



LED Circuit board

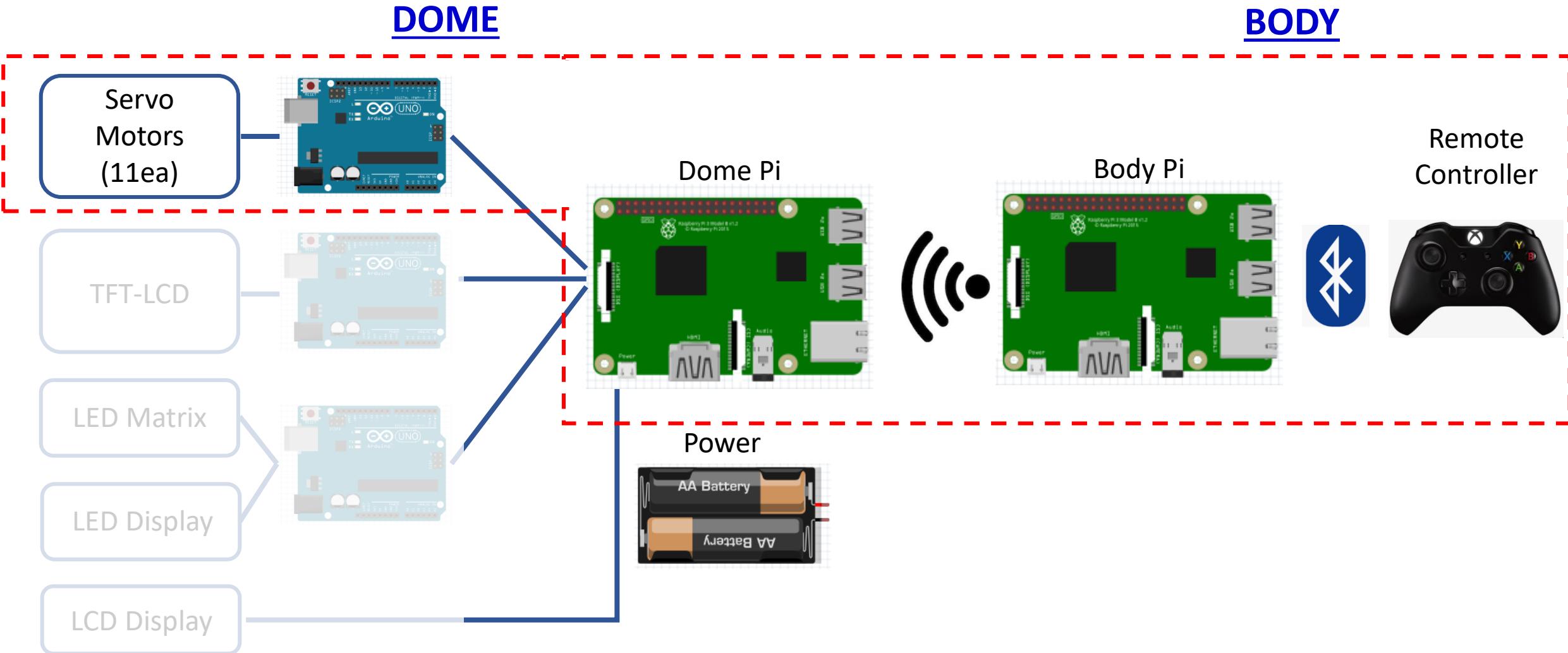


Make an own LED circuit board
(∵ no proper LED size)



Made a Connection

- We made a connection remote controller → Body Pi → Dome Pi → Arduino
- Need to make connection multi Arduino at the same time



For fun) LED Blink using Server

- Make a server and click command → LED Blink

The screenshot shows a web browser window with the URL `172.16.91.60:3000/led`. On the left, there is a sidebar with several blue underlined links: Turn On Red, Turn Off Red, Turn On Green, Turn Off Green, Turn On All, and Turn Off All. To the right of the sidebar is a terminal window titled `pi@soojinPi: ~/led` showing the following log output:

```
pi@soojinPi:~/led
GET /led 304 2.558 ms -
GET /led 304 2.598 ms -
^C
pi@soojinPi:~/led $ nano app.js
pi@soojinPi:~/led $ cd routes
pi@soojinPi:~/led/routes $ nano led.js
pi@soojinPi:~/led/routes $ cd
pi@soojinPi:~ $ cd ~/led
pi@soojinPi:~/led $ DEBUG=led:* npm start

> led@0.0.0 start /home/pi/led
> node ./bin/www

  led:server Listening on port 3000 +0ms
GET /led 304 49.732 ms -
^C
pi@soojinPi:~/led $ DEBUG=led:* npm start

> led@0.0.0 start /home/pi/led
> node ./bin/www

  led:server Listening on port 3000 +0ms
GET /led 200 85.434 ms - 576
GET /stylesheets/style.css 200 12.308 ms - 111
```

For fun) Camera

- Connect camera, take a picture, save videos
- Made streaming service using server

ⓘ 주의 요함 | 192.168.0.112:8080

UV4L Streaming Server

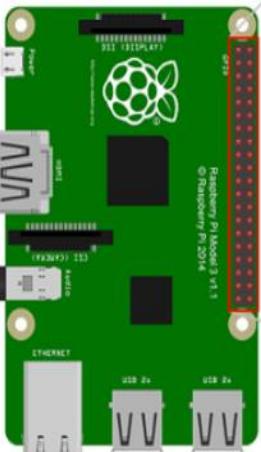


Reference. Information about pin

Raspberry Pi

LED Matrix

TFT LCD 모듈 (ili9341)	라즈베리파이 GPIO
SDO/MISO	MISO (GPIO 09)
LED	GPIO 18
SCK	SCLK (GPIO 11)
SDI/MOSI	MOSI (GPIO 10)
DC/RS	GPIO 24
RESET	GPIO 25
CS	CE 0 (GPIO 08)
GND	GND
VCC	3.3v

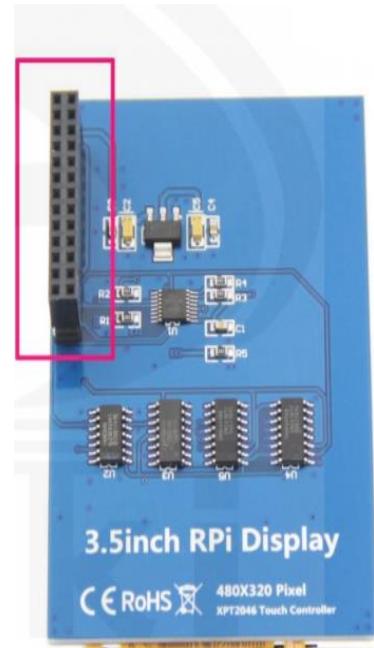


17 – 17 (3.3)
21 – 21 (MISO)
22 – 22 (reset)??
23 – 23 (SCK)
24 – 24 (CEO)
25 – 25 (GND)

Interface

PIN NO.	SYMBOL	DESCRIPTION
1, 17	3.3V	Power positive (3.3V power input)
2, 4	5V	Power positive (5V power input)
3, 5, 7, 8, 10, 12, 13, 15, 16	NC	NC
6, 9, 14, 20, 25	GND	Ground
11	TP_IRQ	Touch Panel interrupt, low level while the Touch Panel detects touching
18	LCD_RS	Instruction/Data Register selection
19	LCD_SI / TP_SI	SPI data input of LCD/Touch Panel
21	TP_SO	SPI data output of Touch Panel
22	RST	Reset
23	LCD_SCK / TP_SCK	SPI clock of LCD/Touch Panel
24	LCD_CS	LCD chip selection, low active
26	TP_CS	Touch Panel chip selection, low active

Description	Pin	No.	No.	Pin	Description
Power input(5V)	5V	2	1	3.3V	NC
Power input(5V)	5V	4	3	SDA	NC
Power GND	GND	6	5	SCL	NC
NC	TX	8	7	P7	NC
NC	RX	10	9	GND	Power GND
NC	P1	12	11	P0	NC
Power GND	GND	14	13	P2	NC
NC	P4	16	15	P3	NC
NC	P5	18	17	3.3V	NC
Power GND	GND	20	19	M1	TP SPI Bus input(MOSI)
TP Interrupt	IRQ	22	21	MO	TP SPI Bus output(MISO)
NC	CE0	24	23	SCK	TP SPI Bus Clock(SCLK)
TP Chip Select	TCS	26	25	GND	Power GND



Plan for 4rd week

1. Period

- May 21 ~ May 24 (May 20th is holiday)

2. Plan

- Finish assembly for main dome part → start to paint
- Make connection multi Arduino at the same time
- Display using RPi LCD display (StarWars Font)
- Making a decision for Radar Eye part (camera or light?)

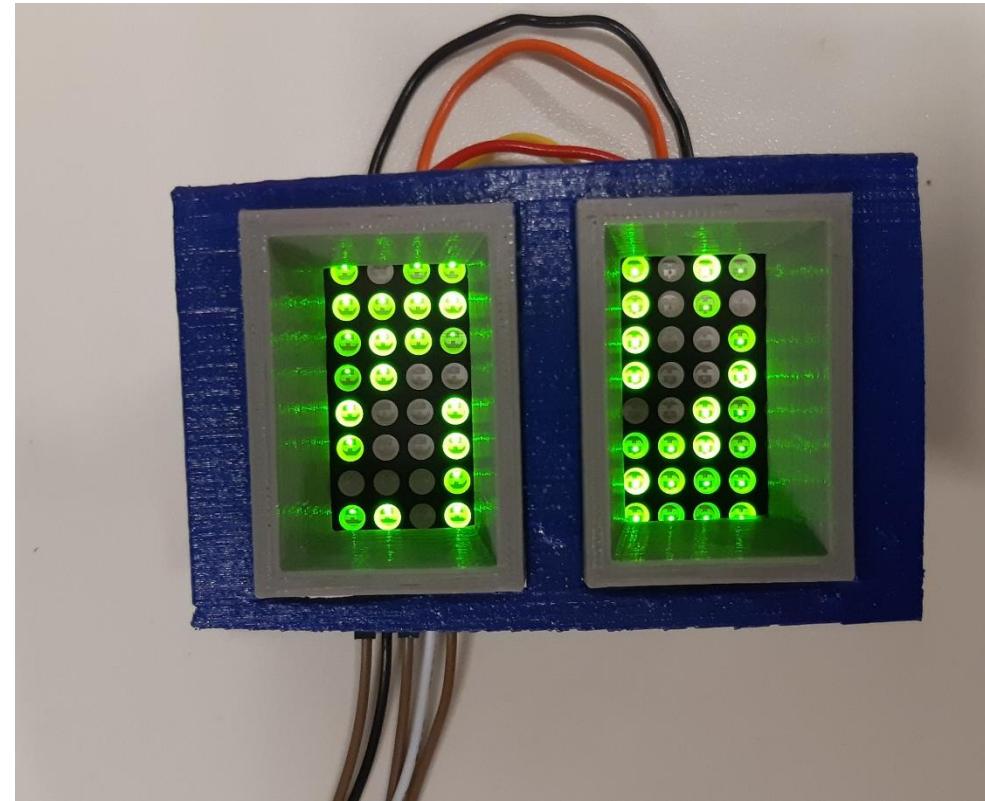
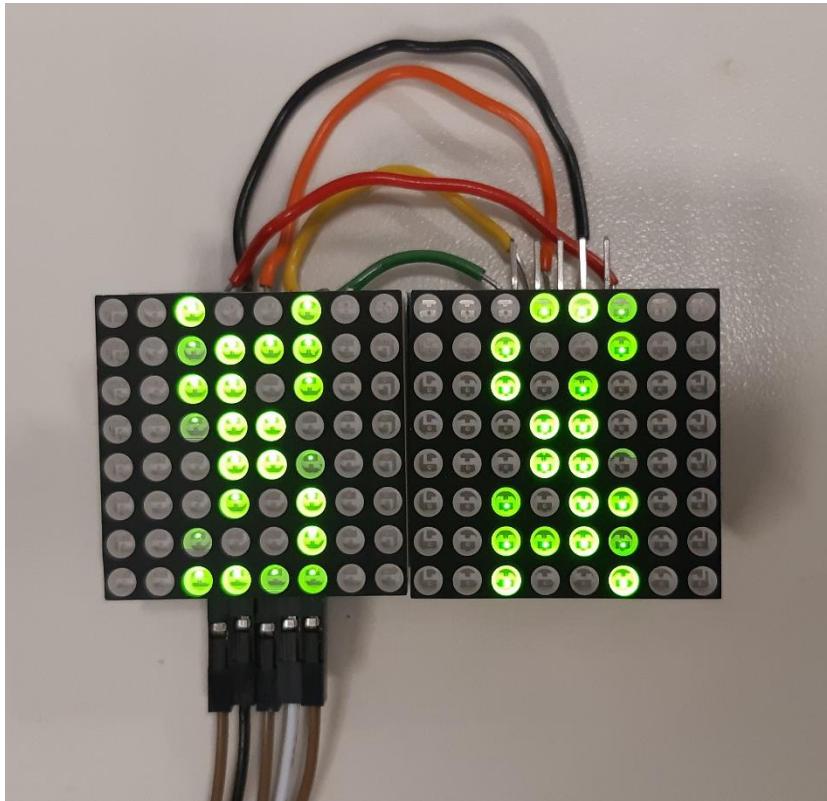
Painting

- Attaching → Filler → Primer



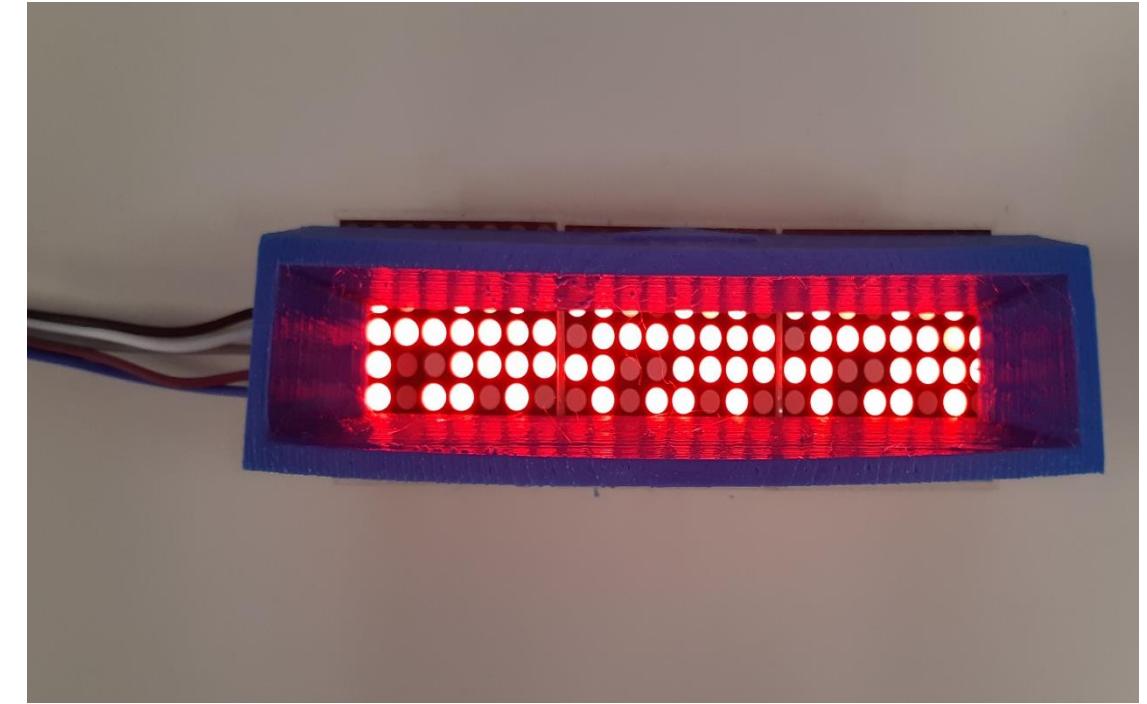
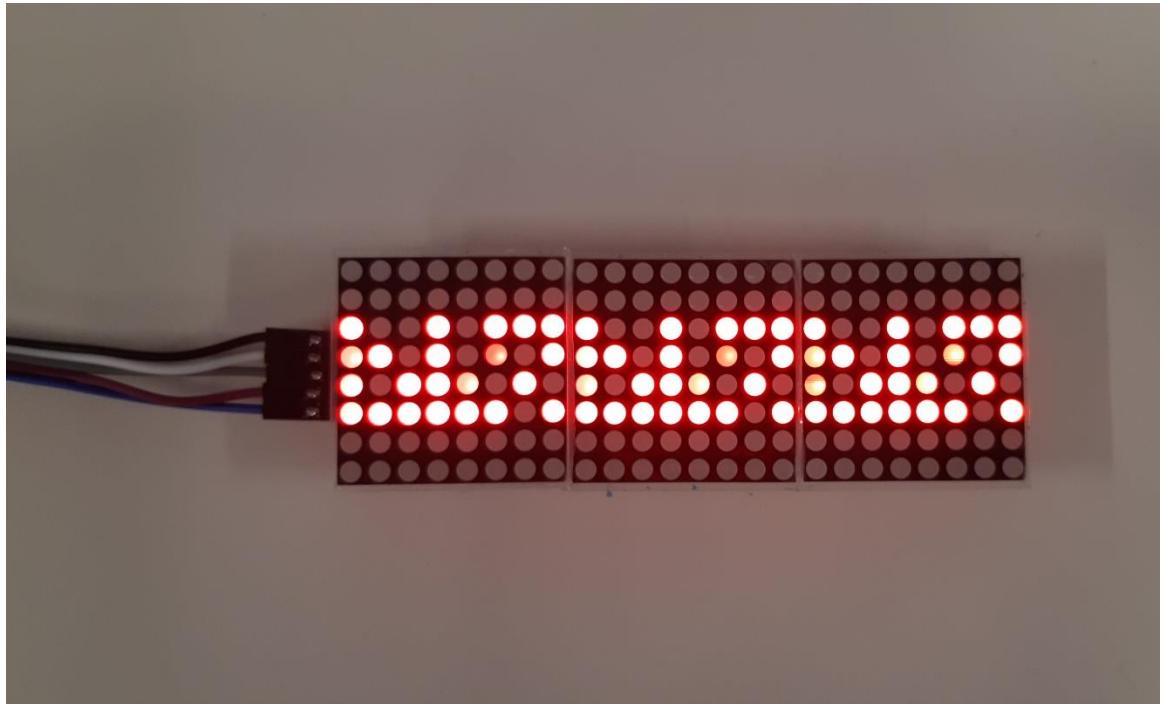
LED Blinking

- Making some parts(edge) which is blocked do not blink (for efficiency)



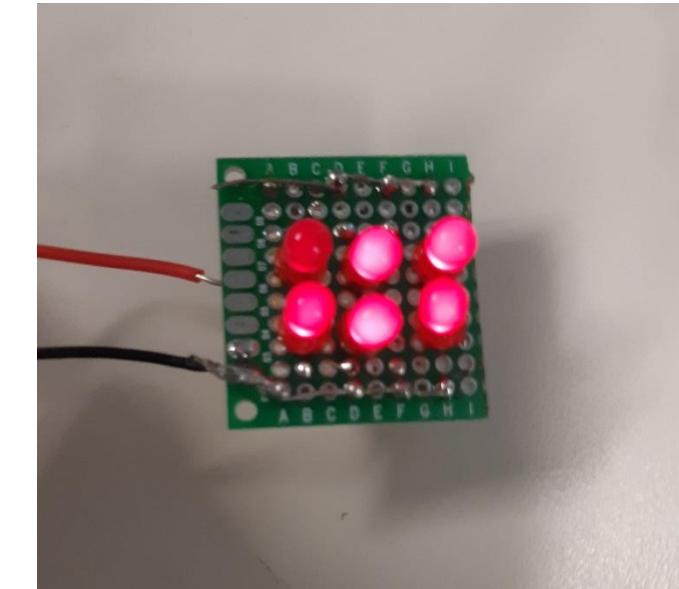
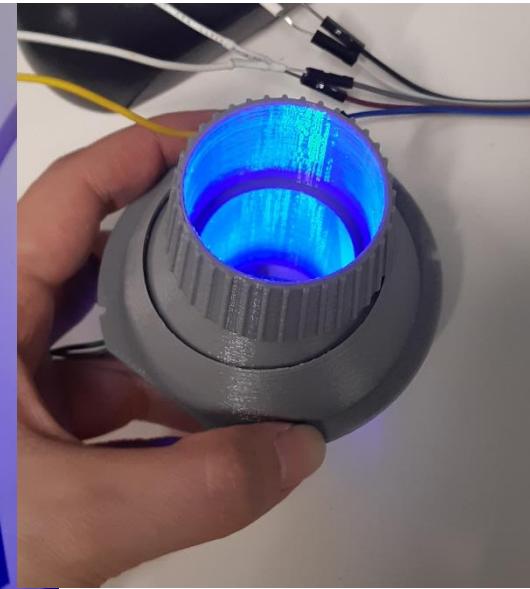
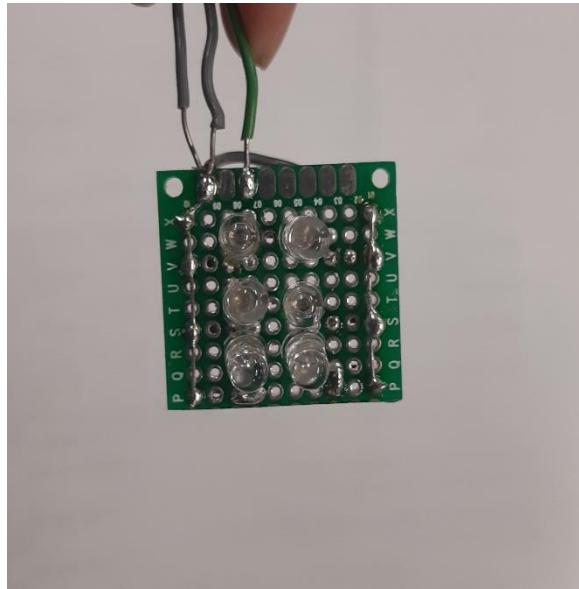
LED Blinking

- Making some parts(edge) which is blocked do not blink (for efficiency)



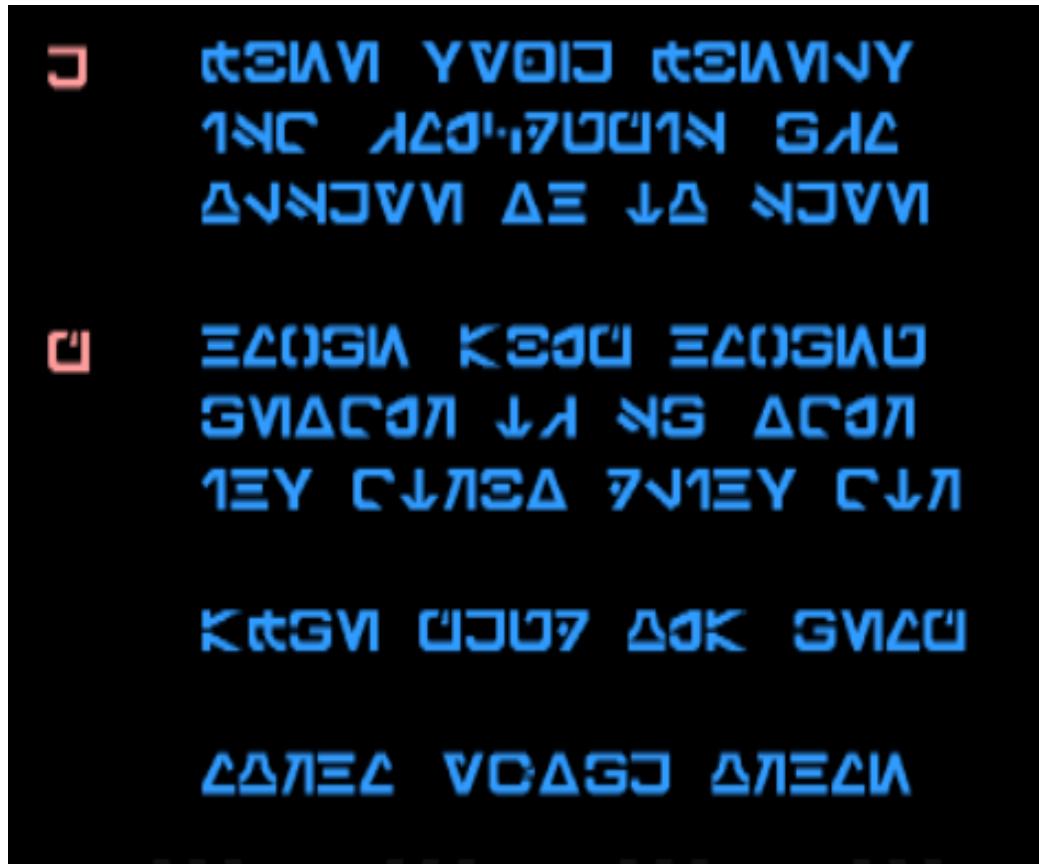
LED Circuit Board

- Making an own circuit board



LCD Display

- Make display(using 3.5" RPI LCD Display)
: Making a video by ppt, and display it



Plan for 5rd week (Final)

1. Period

- May 27 ~ May 31

2. Plan

- Finishing all parts
- Check connection between Dome Pi <-> Body Pi
- Check all of features using remote control

3D Print Progress

3D printing List						
Category	No	File Name	Size	Printed	LongTime	Priority
Holopro	1	holopro-part1.stl	1307784		0	
	2	holopro-part2.stl	131584		0	
	3	holopro-part3.stl	693884		0	
	4	holopro-part4.stl	969884		0	
	5	HoloProv2.stl	948884	5/6	0	5*3ea
	6	Panel10.stl	94184	5/9		
	7	Panel11.stl	90584	5/17		
	8	Panel12.stl	92884	5/21		
	9	Panel13_lens.stl	119984			
	10	Panel13.stl	193284	5/21		
Panel	11	Panel14.stl	31884	5/9	0	
	12	Panel1.stl	119684	5/1	0	
	13	Panel2.stl	64984	5/2		
	14	Panel3.stl	403084	5/9		
	15	Panel4.stl	684884	5/16	0	0
	16	Panel5.stl	450984	5/13		
	17	Panel6.stl	229384	5/17		
	18	Panel7.stl	163184	5/7	0	
	19	Panel8.stl	32284	5/9		
	20	Panel9.stl	240584	5/9		
Dome	21	R2D2DomeBase1.stl	961484	5/4	0	0
	22	R2D2DomeBase2.stl	645484	5/4	0	0
	23	R2D2DomeBase3.stl	426284	5/8		0
	24	R2D2DomeBase4.stl	485984	5/13		0
	25	R2D2DomeBase5-B.stl	919184	5/8	0	0
	26	R2D2DomeBase5.stl	754884		0	0
	27	R2D2DomeBase6.stl	569384	5/9	0	0
	28	R2D2DomeBase7.stl	1136984	5/9	0	0
	29	R2D2DomeBase7_ver_2.stl	1106584		0	0
	30	R2D2DomeBase8.stl	582084	5/11	0	
Pie	31	R2D2DomeBase9.stl	1047684	5/7	0	0
	32	R2D2DomePie1.stl	634784	5/15		

Printing Progress

Printed	Total	Progress(%)
83	83	100%



- We printed 84pcs, total time was approximately 245hours

Movement for Holo Projector

- Movement for holoprojector using servo motor
 - : plan – use 2 motors → change – use 1 motor
(\because Don't have spring, 2 motors are interrupted each other)



Plan



Applied in real

[https://astromech.net/forums/showthread.php?30196-Mowee%92s-HP-control-system-BC-Approved-Continuous-Various-\(Nov-2016\)-Open&p=407390](https://astromech.net/forums/showthread.php?30196-Mowee%92s-HP-control-system-BC-Approved-Continuous-Various-(Nov-2016)-Open&p=407390)

Connection between 2 RPi

1. Connection by wifi

- Made a connection by wifi, they talk to each other UDP address and PORT
- But, Original body raspberry pi was 2 version, so it doesn't have wifi module
So we changed plan (using ADHOC)

2. Connection by static ip (ADHOC)

- Made a connection by ADHOC

R2D2

