电子科技大学
格拉斯哥学院
Glasgow College, UESTC

Lab Notebook

by

Team 41

Furious

March 25, 2023

Outline

Week 2

2.1：The first group meeting

Recorder: Peng Yankai	**Date:** 2023.03.05

Purpose: Provide a brief overview of the team members, analyze the constitution and requirements of the project, and carry out an initial general task allocation

Introduction:

The aim of this meeting was to establish the foundation for successful collaboration among all the team members during the whole project. By creating an environment conducive to communication, we aim to ensure that all team members feel welcome, involved and aligned with the goals of the project.

Materials:

The PowerPoint of Lecture-1a: Course information

The PowerPoint of Lecture-1b: Design Tasks

Procedures:

1. All team members introduced themselves, sharing their background, experience, and expertise.
2. Project Overview: the three tasks are analyzed, including the main components, objectives and constrains.
3. Preliminary Task Allocation based on the analysis of the project and the skills sets of the team members.

Results:

- Enhanced understanding between teammates.
- Gain a clear understanding of the project's scope and its expectations.
- Identifies the materials, components, modules to be purchased.
- The team was divided into a car construction sub-team, a communication sub-team and a clerical sub-team according to the task. The specific composition of the team members is shown in the table below:

car construction team	Wang Ruiqi, Wang Jiaqi, Li RuiXuan, Liu Jingrui, Guo Yixiao
communication team	Peng Yankai(Leader), Zhang Jinyang, Li Yusen
Clerical team	Zeng Yu, Luo Jiaqi

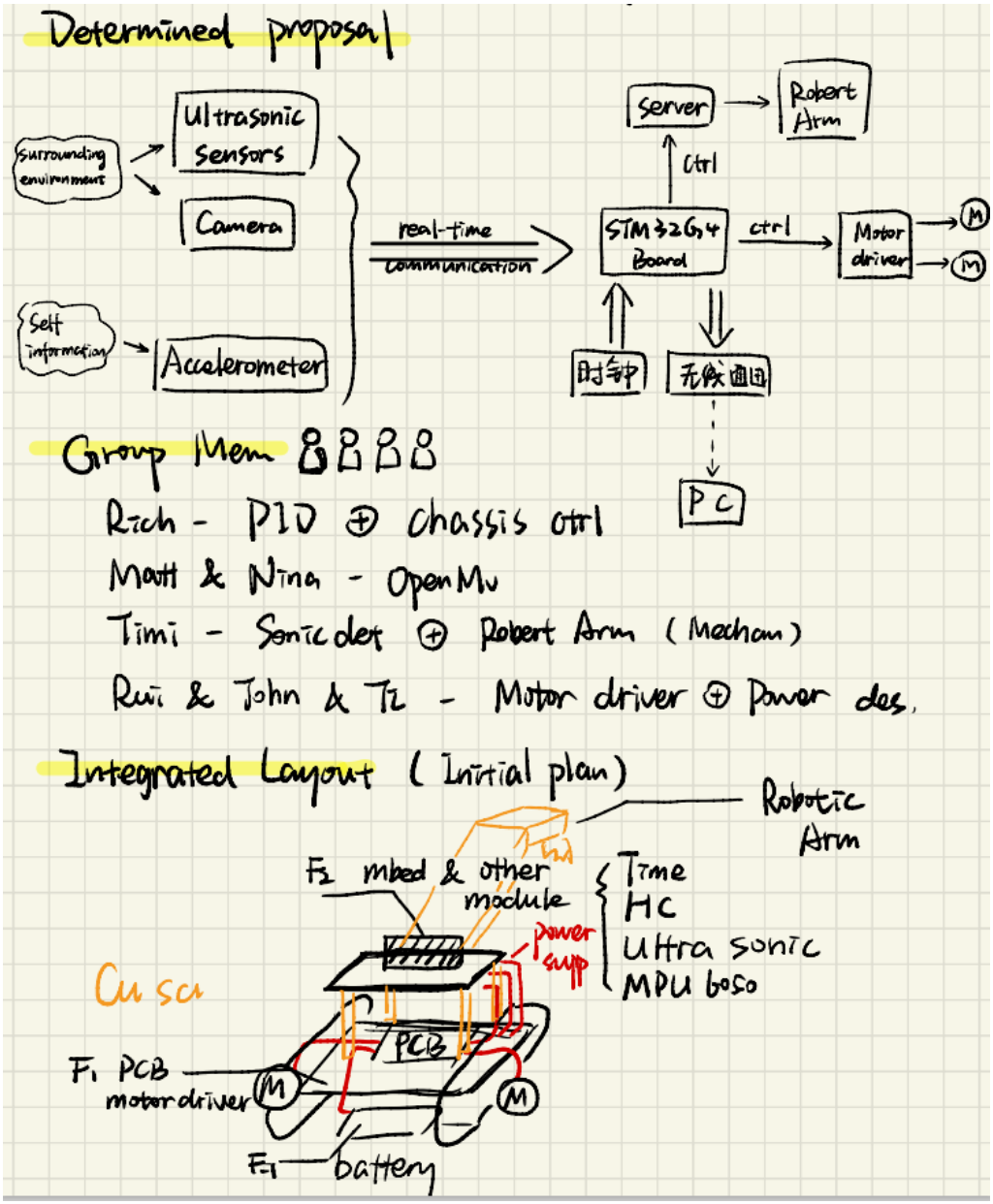
Signature:

Witness signature:

2.2：Hardware Subgroup First Meeting

Recorder: Liu Jingrui	**Date:** 2023.03.05

Purpose: Determined proposal and make the initial plan of integrated layout



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Witness signature:

Week 3

3.1：The second group online meeting

Recorder: Peng Yankai	**Date:** 2023.03.12
Purpose: Each sub-group shares the progress of the past week	

Introduction:

The aim of this meeting was to let each group reports on the progress of the past week, so that the whole group can have a better understanding of the overall progress of the project.

Materials:

components, modules used by each group.

Procedures:

1. Sharing of the car construction sub-group
2. Sharing of the communication sub-group
3. Q&A and free discussion
4. Planning for the next week

Results:

- Informed of the work of the car construction sub-group:
  1) Complete the assembling the car's chassis and the implementation of the motor drive.
  2) Realize the communication between the car and the Mbed by using UART protocol.
  3) Realize ultrasonic distance measurement.
  4) DCDC buck regulator circuit design
  5) Power supply system design
  6) Complete the code of OpenMV pid so that Mbed can control motors for ball tracking.
- Informed of the work of the communication sub-group
  1) Specific solutions for wireless communication are identified.
  2) Complete the soldering of the module pins.
- Q&A and free discussion
  1) Discussed the structure of the initial report and what it consists of.
  2) Discussed the trigger mechanisms for wireless communication.
- Planning for the next week
  1) Porting the results to the G474 series Mbed
  2) Complete the communication module
  3) Start to write the initial report

Signature:

Witness signature:

3.2：Research and design of motor driver and power supply circuit

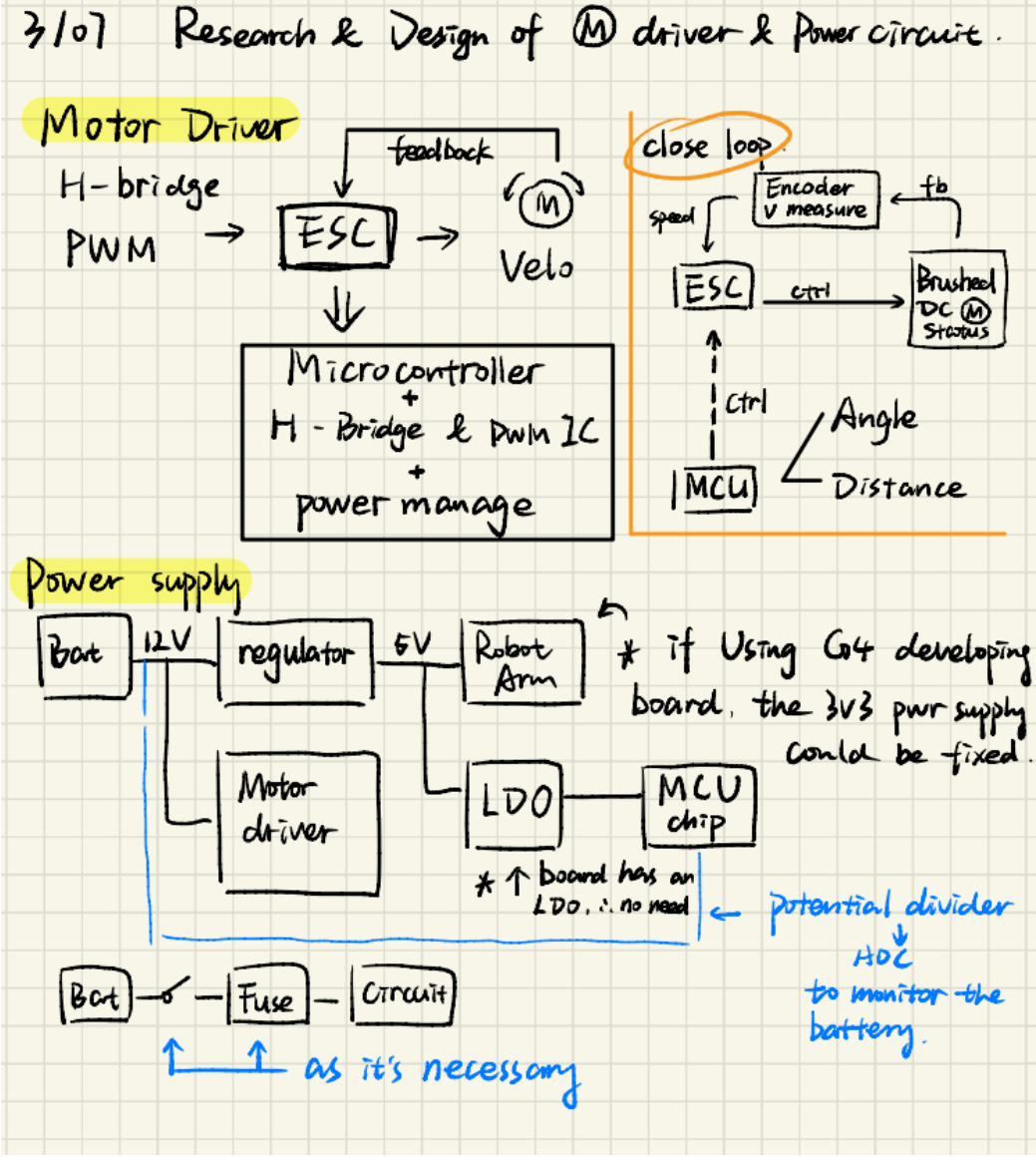
Recorder: Liu Jingrui	**Date:** 2023.03.07

Purpose:

Do relevant research about motor drive circuits and switching power supply circuits.

Have a brief understanding of the task.

Construct a top structure design block of the two parts.



Result:

Developed s basic structure of the two circuits.

Communicated with Rich to arrange the system power supply proposal.

Signature:

Witness signature:

3.3：Idea formulation of patio 2-task 2

Recorder: Guo Yixiao	**Date:** 2023.03.11

Purpose: Achieve the task 2 in patio 2, which is to release the table tennis into a basket.

Introduction:

To find an available solution of task 2, I first search the information of materials from Taobao.com. After investigation, the first scheme is to use a mechanical arm with 3 degrees of freedom. The basket is like a trash bin. The height of a trash whose diameter is 25cm is about from 260mm to 280mm. The diameter of a table tennis ball is about 4mm and the weight is about 2.6g.

Materials:

The digital servo:
Torque: 15kg
The model: TBS2701
Number: 3
Cost: 210RMB
The power supply: a 5V battery
Cost of battery:40RMB

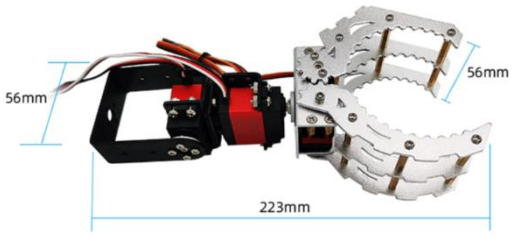


Figure 1. The mechanical arm

Procedures:

1. Researching and selecting the most appropriate servo
2. Analyze and calculate the height of basket and the power supply (choose batteries)

Results: I identified the solution and purchased materials

Signature:

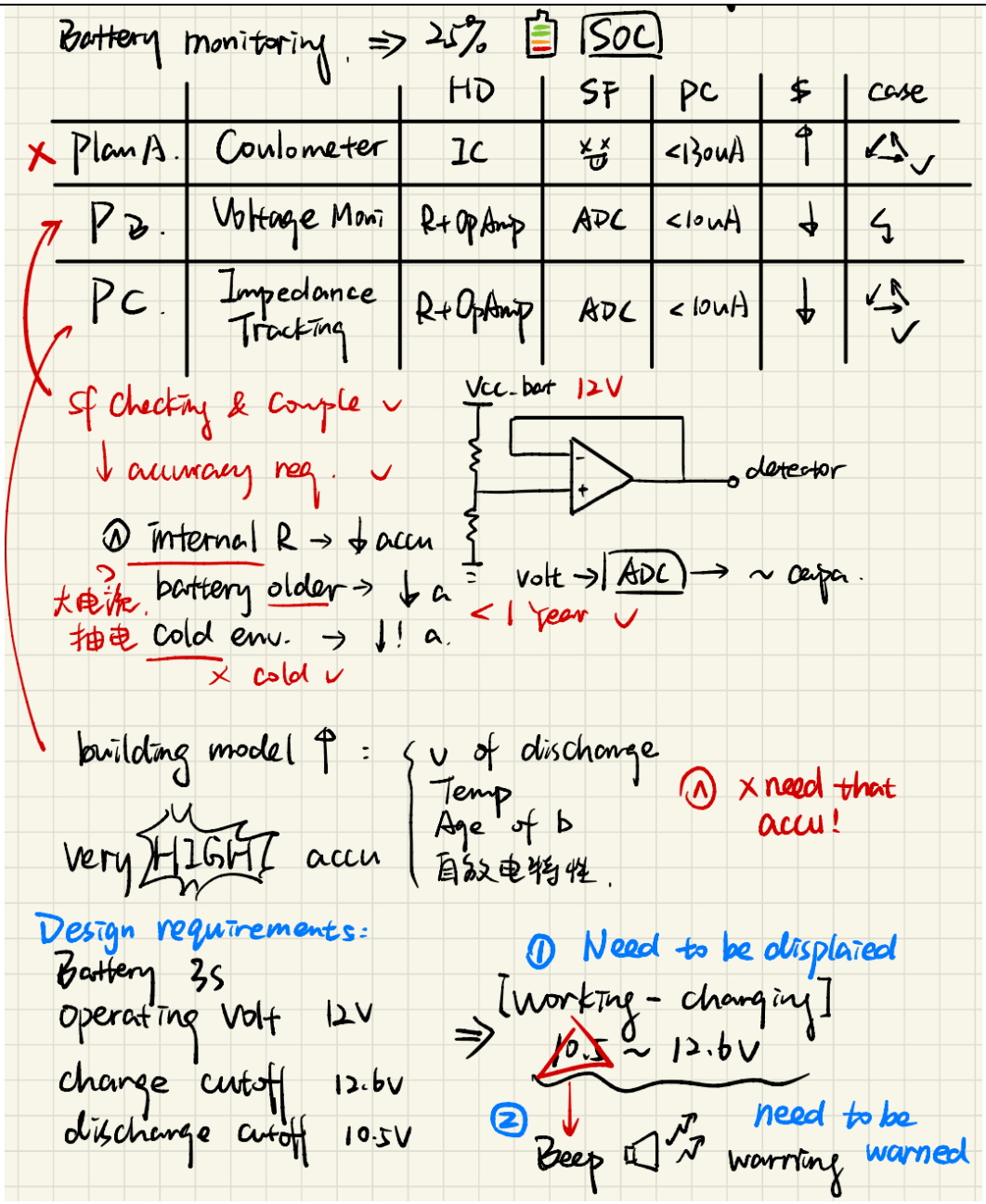
Witness signature:

3.4：Designing plans for battery monitoring

Recorder: Liu Jingrui	**Date:** 2023.03.11

Purpose:

Come up with plans for monitoring the battery level.
Compare plans and make decisions.
Modify the proposed solution.



Result:

Finally decided to use a potential divider and on-chip ADC for battery monitoring.

The safe voltage value should be limited to 10.5~12.6 V in order to protect the battery and keep its lifespan.

As a result, a buzzer should be added to the circuit for warning.

Signature:

Witness signature:

3.5：Chassis Construction

Recorder: Wang Ruiqi	**Date:** 2023.03.11

Purpose: Construction of chassis

Introduction:

As the base and one of the most critical components for the movement of the car, it would be constructed firstly.

Materials:

- Crawler chassis
- 12V battery

Procedures:

Firstly, I decided to use the crawler chassis, which is more suitable for the patios and tasks, and 12V battery, which is used as the general power of the robot, as the raw materials. Then, they were integrated.

Results:

Successfully completed the construction of chassis.

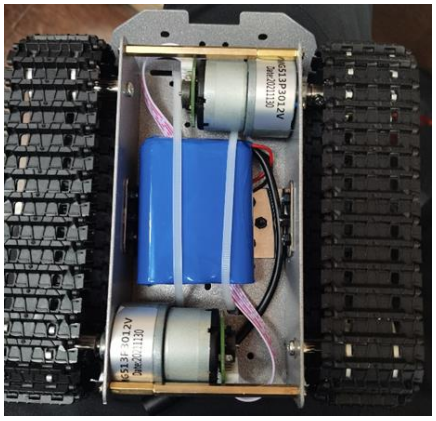


Figure 1. Crawler chassis and battery

Signature:

Witness signature:

3.6：OpenMV-Line Tracking (path extraction)

Recorder: Wang Jiaqi	**Date:** 2023.03.11

Purpose: Recognize the feature of the path

Introduction:

The aim of this work is to realize the function of recognize the path by using the camera and image processor. Therefore, OpenMV cam H7 plus, which is an embedded machine vision camera and OV5640 sensor, which is a high-performance 5-megapixel CMOS image sensor, are adopted by our group.

Materials:

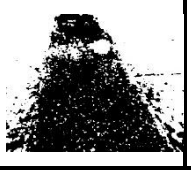
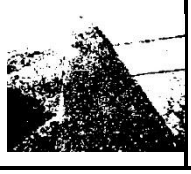
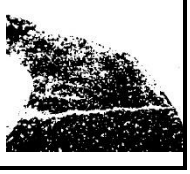
OpenMV cam H7 plus

OV5640 sensor

Procedures:

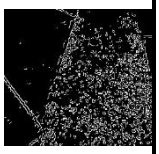
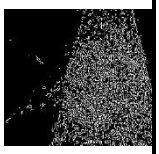
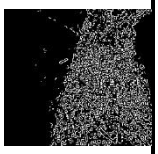
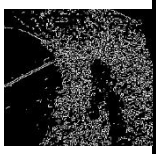
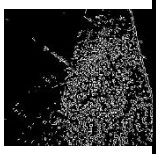
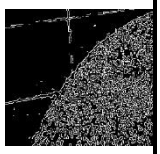
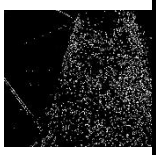
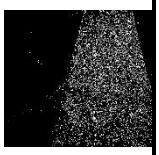
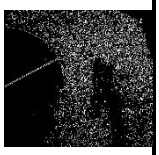
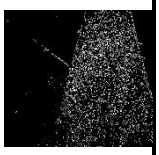
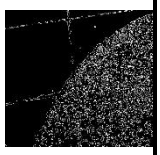
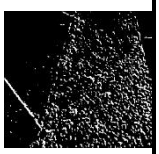
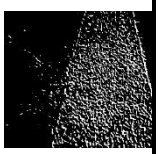
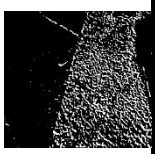
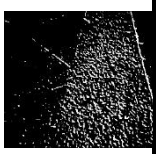
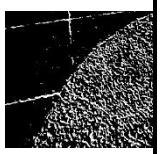
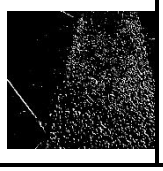
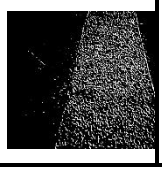
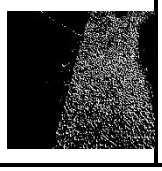
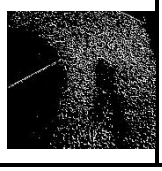
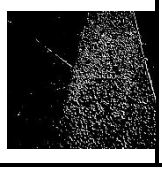
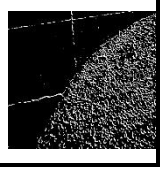
1) Set up the hardware: Connect the OV5640 camera module to the OpenMV Cam H7 Plus board.
2) Write a Python script using the OpenMV IDE.
3) Upload the script to the OpenMV Cam H7 Plus, and run the program.
4) Adjust the parameters and the algorithm to get better performance.

Results: For color analysis, different sections of the track have quite different colors. In addition, under different lighting conditions the camera could capture images with different ranges of pixel values. This brings great difficulty to path extraction based on color analysis.

	Fig.7_V1	Fig.27_V1	Fig.33_V1	Fig.0_V1	Fig.26_V1
Origin (QVGA)					
BIQNARY (QVGA)					
DST (QVGA)					
DST-BI (QVGA)					

The performance of Canny and Sobel operators are compared as follows, in view of there are less noises produced by Canny operator, we preliminarily decided to accept the Canny operator.

However, after initial testing, it seems that the Canny operator requires a longer processing time, and we will keep track of this issue in future work.

	Fig.69_V4	Fig.22_V4	Fig.25_V4	Fig.40_V4	Fig.21_V4	Fig.51_V4
Origin (QVGA)						
Canny (QVGA)						
Canny (VGA)						
Sobel (QVGA)						
Sobel (VGA)						

Selection of Image size:

Effect of image size on frame rate (running the entire program):

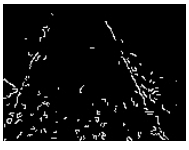
VGA(480*640)---6~7dps

QVGA(240*320)--20~22dps

QQVGA(120*160)-38~42dps

Considering the reaction time required for tracking, VGA size is not accepted since the QVGA output image is also of good quality (shown in the chart above).

As shown in the chart below, the QQVGA images lead to disastrous outputs. This has been proven by conducting brute force search on the two args of the Canny operator.

	Fig.8_V2	Fig.27_V2	Fig.44_V2	Fig.23_V2
Origin (QQVGA)				
Canny (QQVGA)				

Signature:

Witness signature:

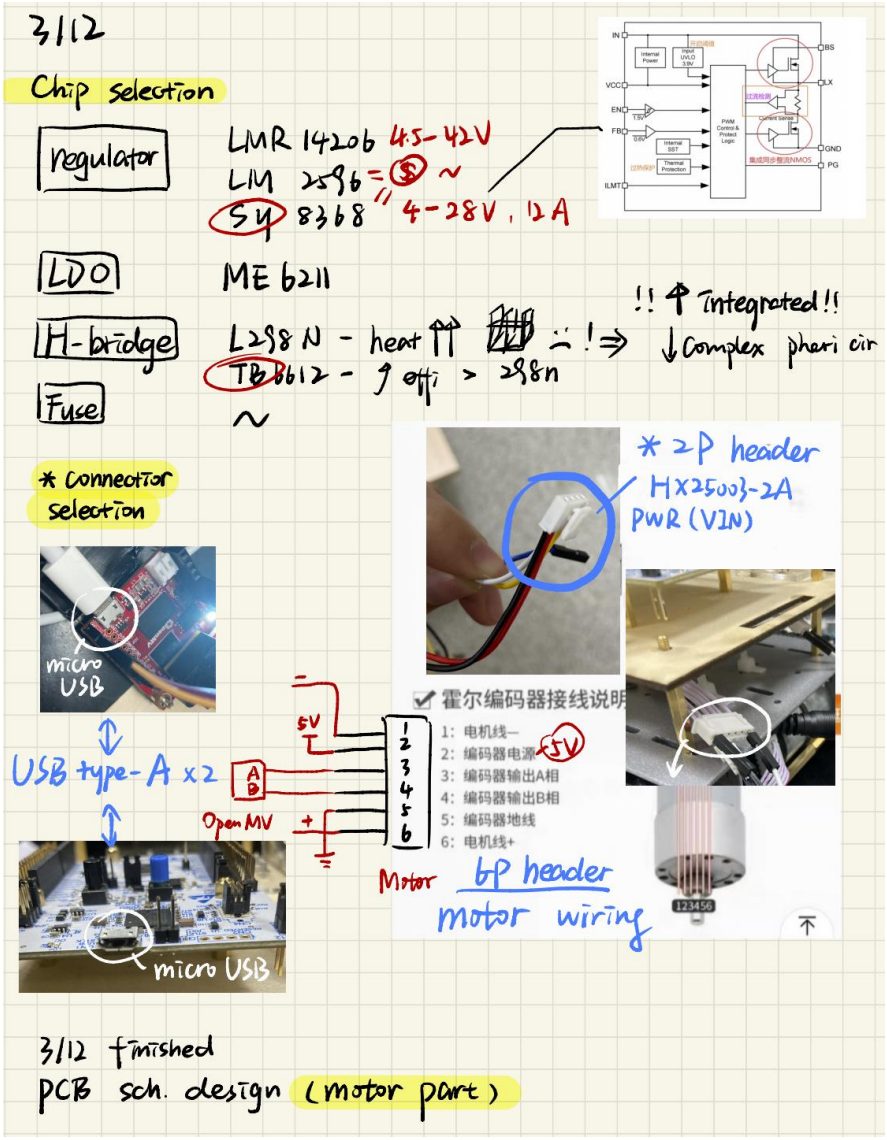
3.7：Components Selection of PCB

Recorder: Jingrui Liu	**Date:** 2023.03.12

Purpose:

Select the appropriate chips and packaging for PCB designing.

Make sure that all the connector's packaging is consistent with our current components.



Results:

Created my own packaging lib and added the used components.

Design sch of the motor driver part.

Signature:

Witness signature:

3.8：Stepper Motor

Recorder: Wang Ruiqi	**Date:** 2023.03.12-2023.03.13
Purpose: Control the speed of the motor	

Introduction:

The aim of this work is to control the speed of the motor and thus further control the speed of the car, which was realized by outputting PWM signals with different duty cycles to ENA and ENB. It constituted two components, which are stepper motor and motor driver. A stepper motor is an open-loop control motor that converts electrical pulse signals into angular displacement or linear displacement, also known as a pulse motor. Control motor speed. A motor driver can apply voltage to the motor, the larger the voltage, the fast the motor rotates.

Materials:

MG513 Stepper motor

L298N Motor Driver (L298N is just temporary substitution of PCB, which will be replaced in later experiment.)

Figure 1. MG513

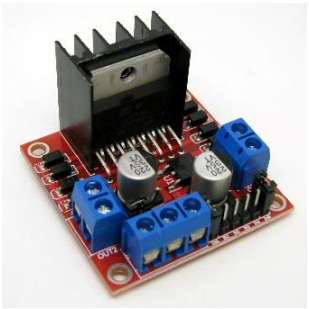


Figure 2. L298N

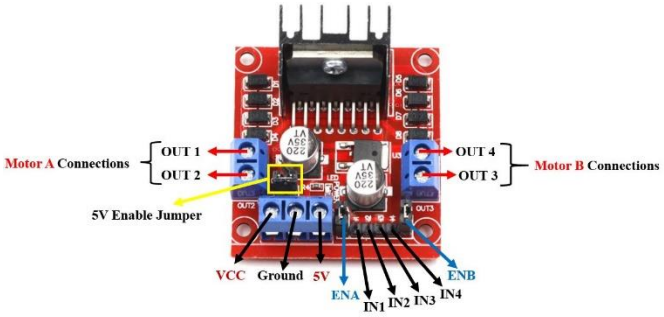


Figure 3. Interface of L298N motor driven module

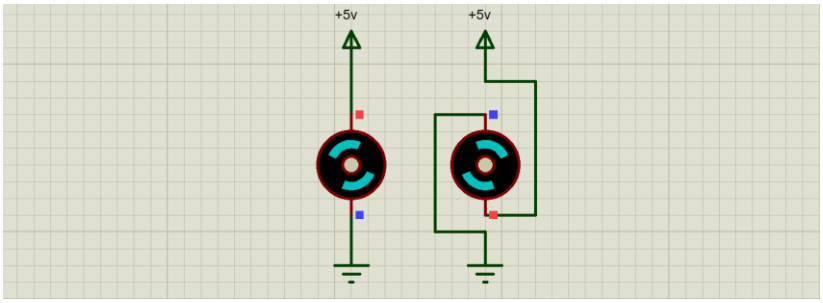


Figure 4. Control the rotating direction of the motor

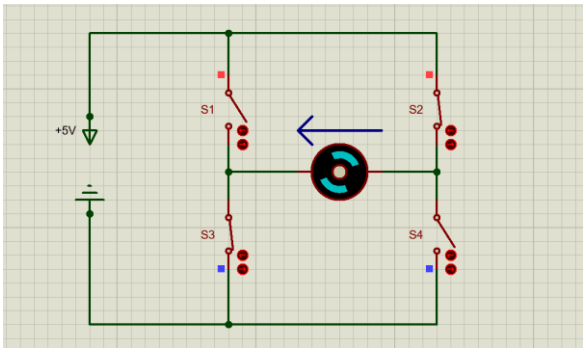


Figure 5. H bridge driver

Procedures:

At the beginning, I identify the stepper motor connections and connect the motor to the L298N motor driver. Then, connect the L298N motor driver to the microcontroller. To realize the function, I program the microcontroller.

Results: Successfully realize the speed control of the motor.

Signature:

Witness signature:

Week 4

4.1：The third group online meeting	
Recorder: Peng Yankai	**Date:** 2023.03.19
Purpose: Summary of last week and plan for next week	
Materials: components, modules used by each group. **Procedures:** 1. Sharing of the car construction sub-group 2. Sharing of the communication sub-group 3. Planning for the next week	
Results: ● Informed of the work of the car construction sub-group: 1) Completion of ultrasonic ranging and status display module 2) ● Informed of the work of the communication sub-group 1) Complete the construction of communication module and successfully test the device ● Planning for the next week 2) Continue to write the initial notebook 3) Continue to complete the construction of the car	
Signature:	
Witness signature:	

4.2：Mechanical arm: conduct the experiment and analyze the results	
Recorder: Guo Yixiao	**Date:** 2023.03.14
Purpose: Testing whether the robot arm can meet the task requirements.	
Introduction: I have made a preliminary test of the mechanical arm and have found some reasons which cause the arm unable to work. **Materials:** Dupont wires, digital servo (TBS2701), metal claw, table tennis ball, MCU **Procedures:** 1. Conduct the power supply, testing the servo 2. Compare the table tennis ball and the metal claw 3. Calculate the general cost	
Results:	

1. Due to the limited amount of current that the Dupont wire can conduct, the mbed is underpowered, the servo cannot be driven.
2. The metal claw is too big to capture the table tennis ball stably
3. The cost is too much

Discussion:

To solve the problem, I use a smaller servo, change the type of claw, which is more stable and Choose cost-efficient elements, compare more items on Taobao.

Signature:

Witness signature:

4.3：Ultrasonic ranging

Recorder: Wang Ruiqi | **Date:** 2023.03.15

Purpose: measure the distance by using ultrasonic range

Introduction:

The purpose of this work was to realize the function of measuring the distance between the car and objective. I achieved the task by using ultrasonic range module HC-SR04

Materials:

HC-SR04

Mbed microcontroller (it will be substitute finally by customized PCB)

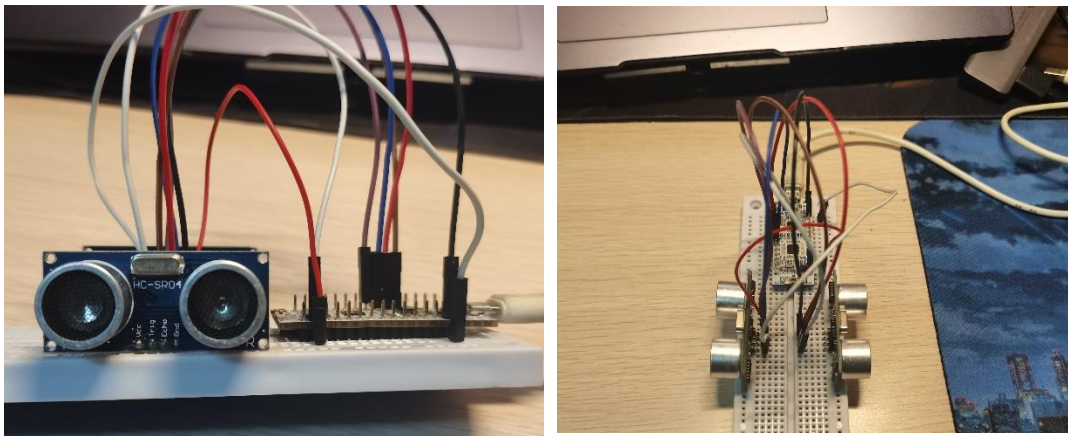


Figure 5,6. mbed and HC-SR04

Procedures:

1) Use the IO port TRIG to trigger ranging and give a high-level signal of at least 10us.
2) The module automatically sends eight 40khz square waves, and automatically detects whether there is a signal.
3) If there is a signal return, a high level is output through the IO port ECHO, and the duration of the high level is the time from the ultrasonic wave to its return. Test distance = (high level time * speed of sound (340M/S))/2.

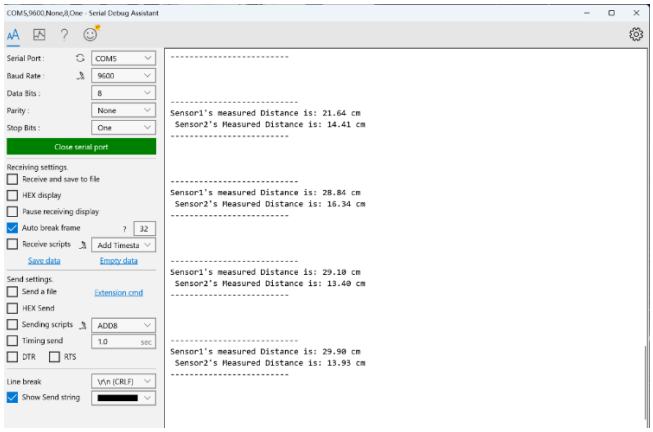


Figure 1. Print out the measurement results

4.4：Choose New Components for patio 2-task 2

Recorder: Guo Yixiao	Data: 2023.03.15

Purpose:

The second scheme is using little servo (can capture the table tennis is ok), a lighter and cheaper mechanical arm has enough length.

Introduction:

After summarizing the results of last testing, I have chosen these new components by some detailed research

Materials:

New components:

1. sg90 servo
2. acrylic mechanical arm
3. a 3-D printed claw, 3-fingers

The digital servo:

The model: sg90

Number: 1

Drive voltage: 5V

Control signal: PWM

PWM period: 20ms

PWM pulse width: 0.5ms~2.5ms for 0~180

Procedures:

1. Research and select the new servo
2. Printed a suitable claw by 3-D printing
3. Calculate the PWM period and pulse width

Results: Finally, I got the more appropriate servo and claw with lower cost

Discussion: We should use PWM control signal and the power supply supposed to be 5V

Signature:

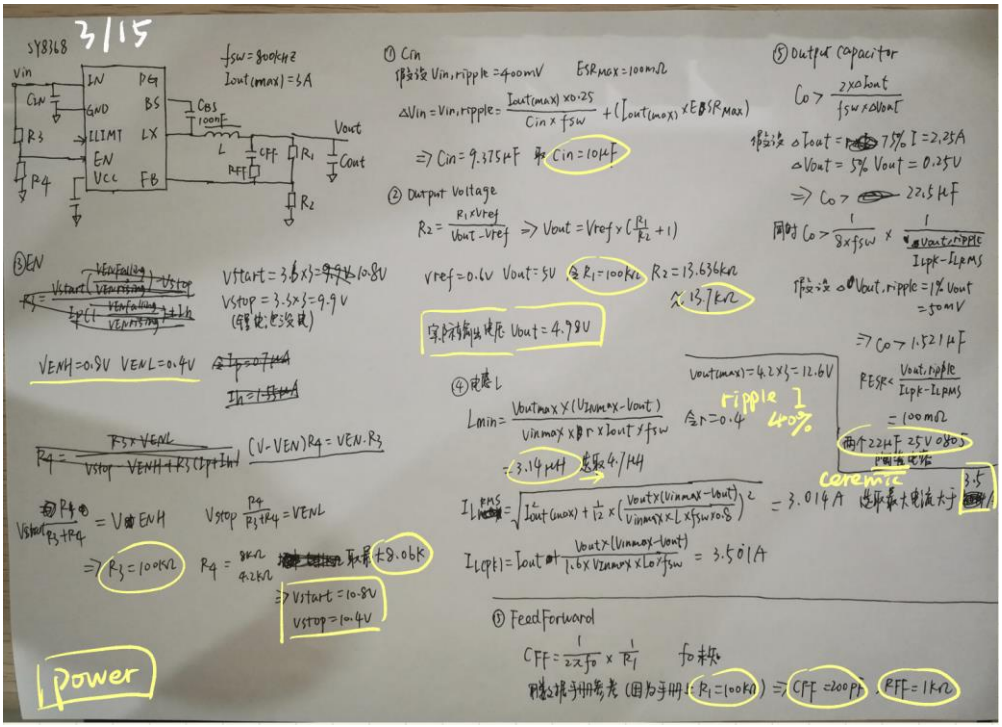
Witness signature:

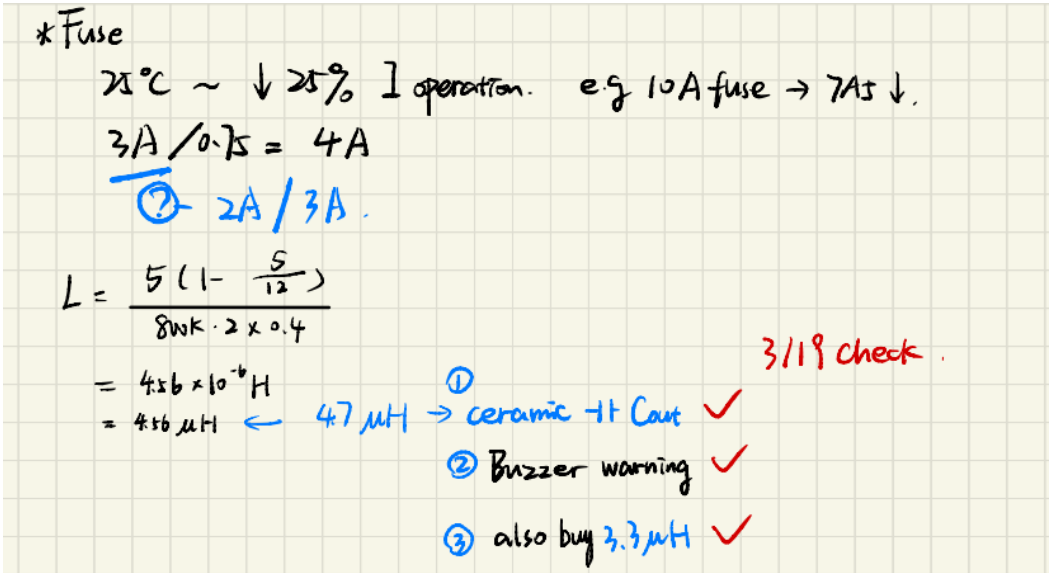
4.5: Key value decision

Recorder: Liu Jingrui	**Date:** 2023.03.15

Purpose: Calculate the values of related components of our switching power supply circuit.

Process & Results:





Decided all the key values for components (decoupling capacitor, inductor, bypass capacitor, feedback resistors).

As the inductor is chosen slightly higher than the computing result, the filter capacitor should be chosen as two parallel connected ceramic capacitors.

Signature:
Witness signature:

4.6：LCD display

Recorder: Wang Ruiqi	**Date:** 2023.03.16
Purpose: To display the task execution status of our robot car	

Introduction:

The ST7735 TFT display is a 1.8-inch display with a resolution of 128×160 pixels and can display a wide range of colors (full 18-bit color, 262,144 shades). The display uses the SPI protocol for communication and has its own pixel-addressable frame buffer which means it can be used with all kinds of microcontroller.

Materials:

1.8-inch ST7735 TFT display

Display a picture useing LCD

Figure 2 1.8-inch ST7735 TFT display

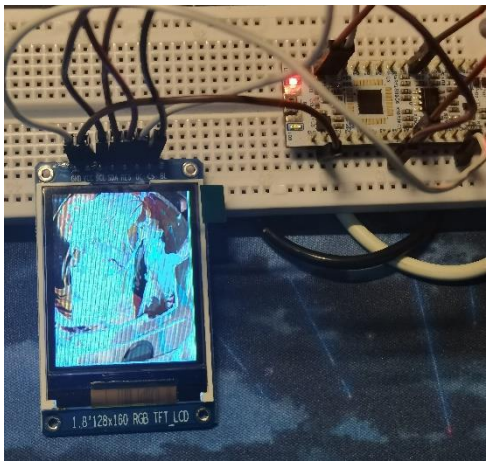


Figure 3 Display a picture using LCD

Procedures: I connect the ST7735 TFT display to microcontroller and then program the microcontroller with the help of some libraries.

Results: The LCD can display a picture. After the car is completed, it will be tested

Signature:
Witness signature:

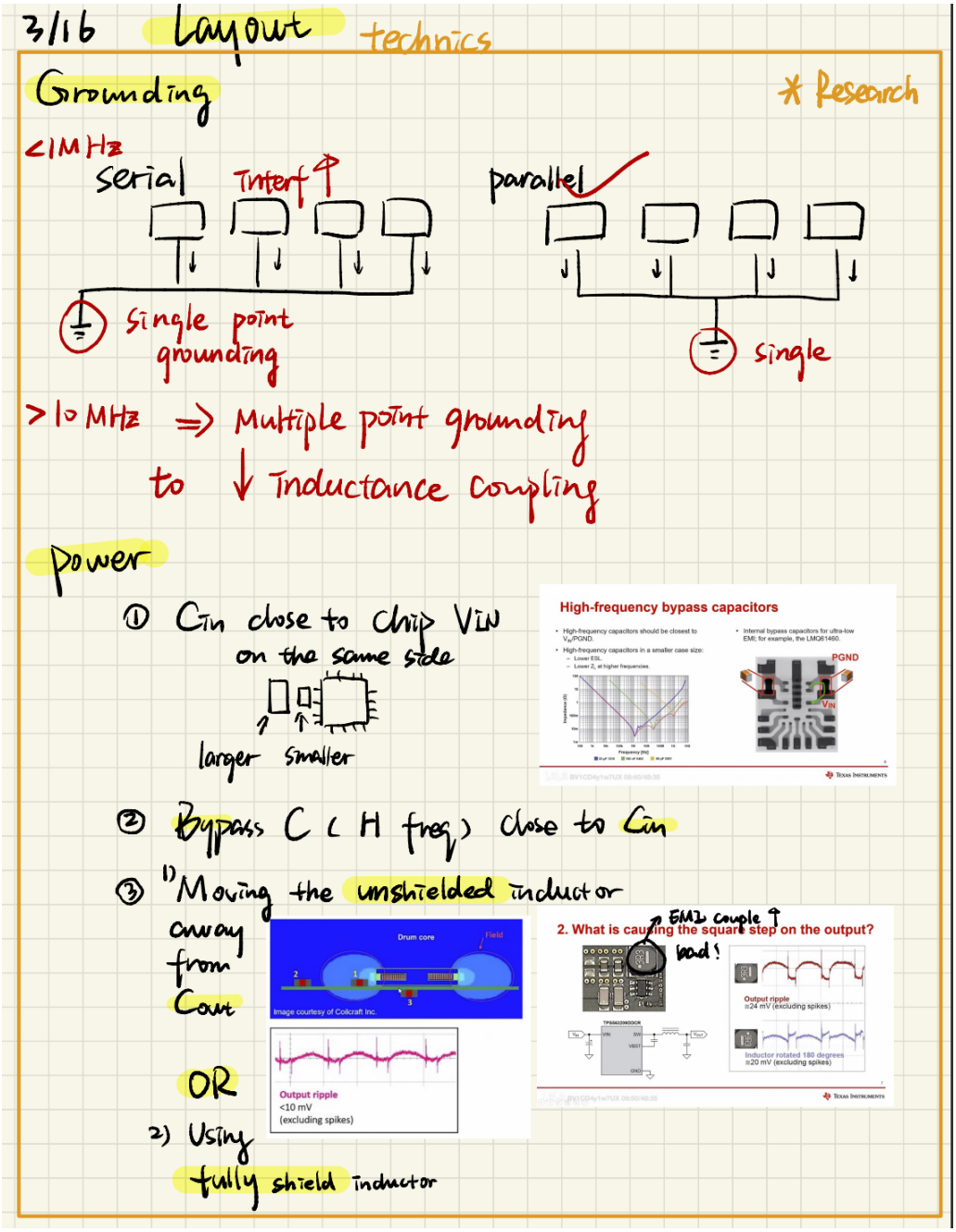
4.7：Research the Technics of PCB Layout

Recorder: Liu Jingrui	**Date:** 2023.03.16

Purpose:

Learn the basic rules of PCB layout.

Finish the first design version of the schematic of our motor driver board.



3) poly under Inductor → ground plane ① ↑ capacitance

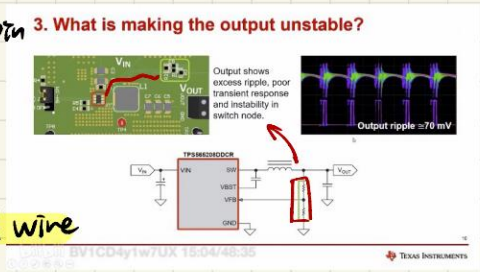
4) using High SRF → lowest parasitic capacitance & ↓

④ 1) FB resistors close to FB pin

2) Away from Inductor & switch node

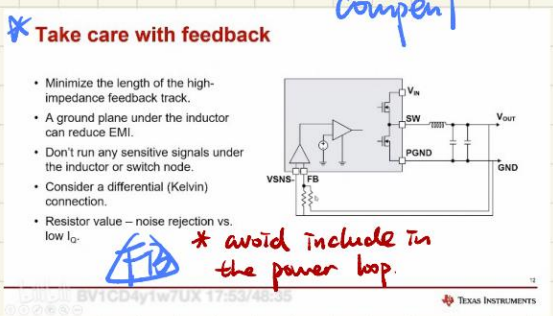
3) If necessary → Differencial wire

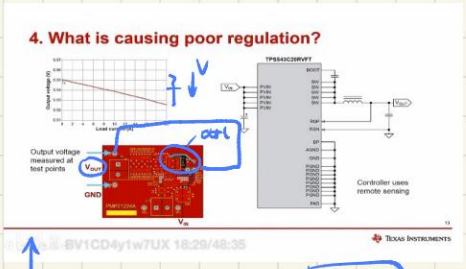
4) 10 ~ 100 kΩ is better to resist Interf!



⑤ FB trace con to output

Compen ↑





↑ should connect to REAL Vout directly !! (& away from L)

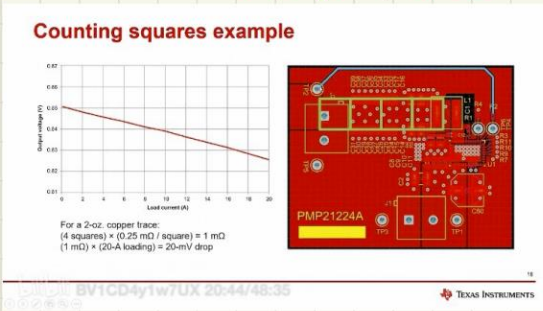
* at filter ⊣ at best

⑥ $R = \frac{\rho \times l}{T \times l} = \frac{\rho}{T}$ (Cu)

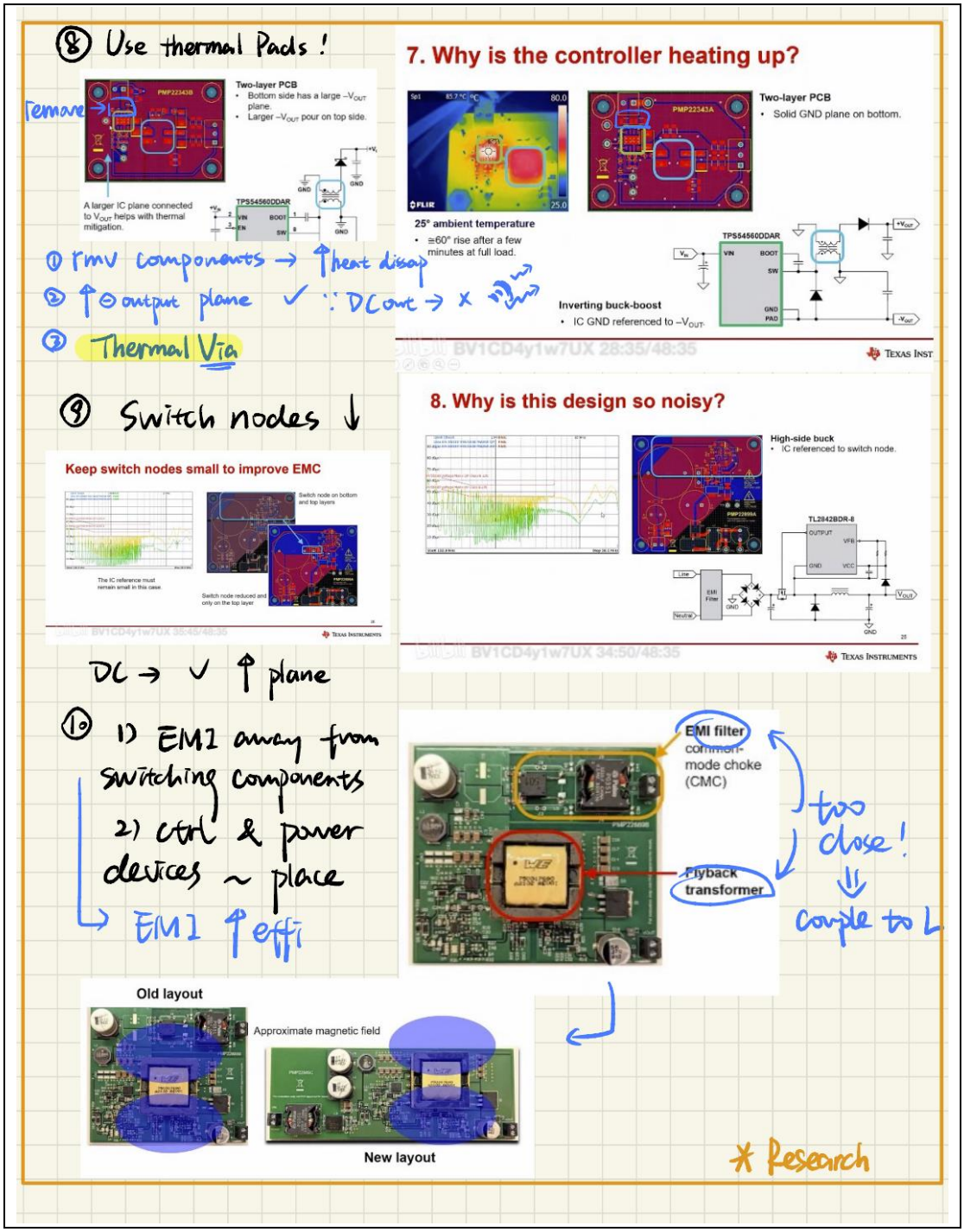
Causing Vout drop ↓ ⇒

⑦ Full power output !

⑦



* Research


⑧ Use thermal Pads !
Two-layer PCB
Bottom side has a large –VOUT plane.
Larger –VOUT pour on top side.
A larger IC plane connected to VOUT helps with thermal mitigation.
① rmv components → ↑heat dissip
② ↑⊖output plane ✓ ∵DCout → ×
③ Thermal Via
7. Why is the controller heating up?
Two-layer PCB
Solid GND plane on bottom.
25° ambient temperature
≅60° rise after a few minutes at full load.
Inverting buck-boost
IC GND referenced to –VOUT
TPS54560DDAR
Texas Inst
⑨ Switch nodes ↓
Keep switch nodes small to improve EMC
8. Why is this design so noisy?
High-side buck
IC referenced to switch node.
TL2842BDR-8
Texas Instruments
DC → ✓ ↑ plane
⑩ 1) EMI away from switching components
2) ctrl & power devices ~ place
↳ EMI ↑effi
EMI filter
common-mode choke (CMC)
Flyback transformer
too close!
couple to L
Old layout
Approximate magnetic field
New layout
* Research

Focus

① H di/dt trace

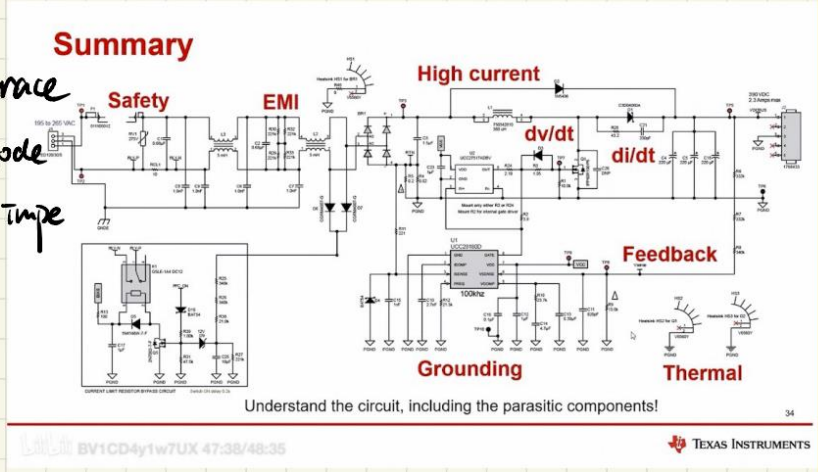
② H dv/dt node

③ Sensi high impe node

④ Thermal

⑤ grounding

Sum



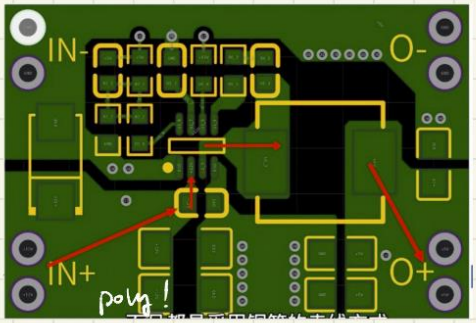
PCB Layout Guidelines (9)

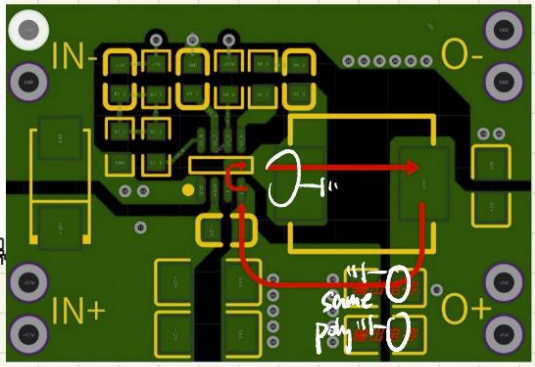
Efficient PCB layout is critical for stable operation. For best results, refer to Figure 8 and follow the guidelines below:

1. Keep the connection of the input ground and GND as short and wide as possible.
2. Keep the connection of the input capacitor and IN as short and wide as possible.
3. Place the VCC capacitor as close to VCC and GND as possible.
4. Make the trace length of VCC - VCC capacitor anode - VCC capacitor cathode - IC GND as short as possible.
5. Ensure that all feedback connections are short and direct.
6. Place the feedback resistors and compensation components as close to the IC as possible.
7. Route SW away from sensitive analog areas, such as FB.

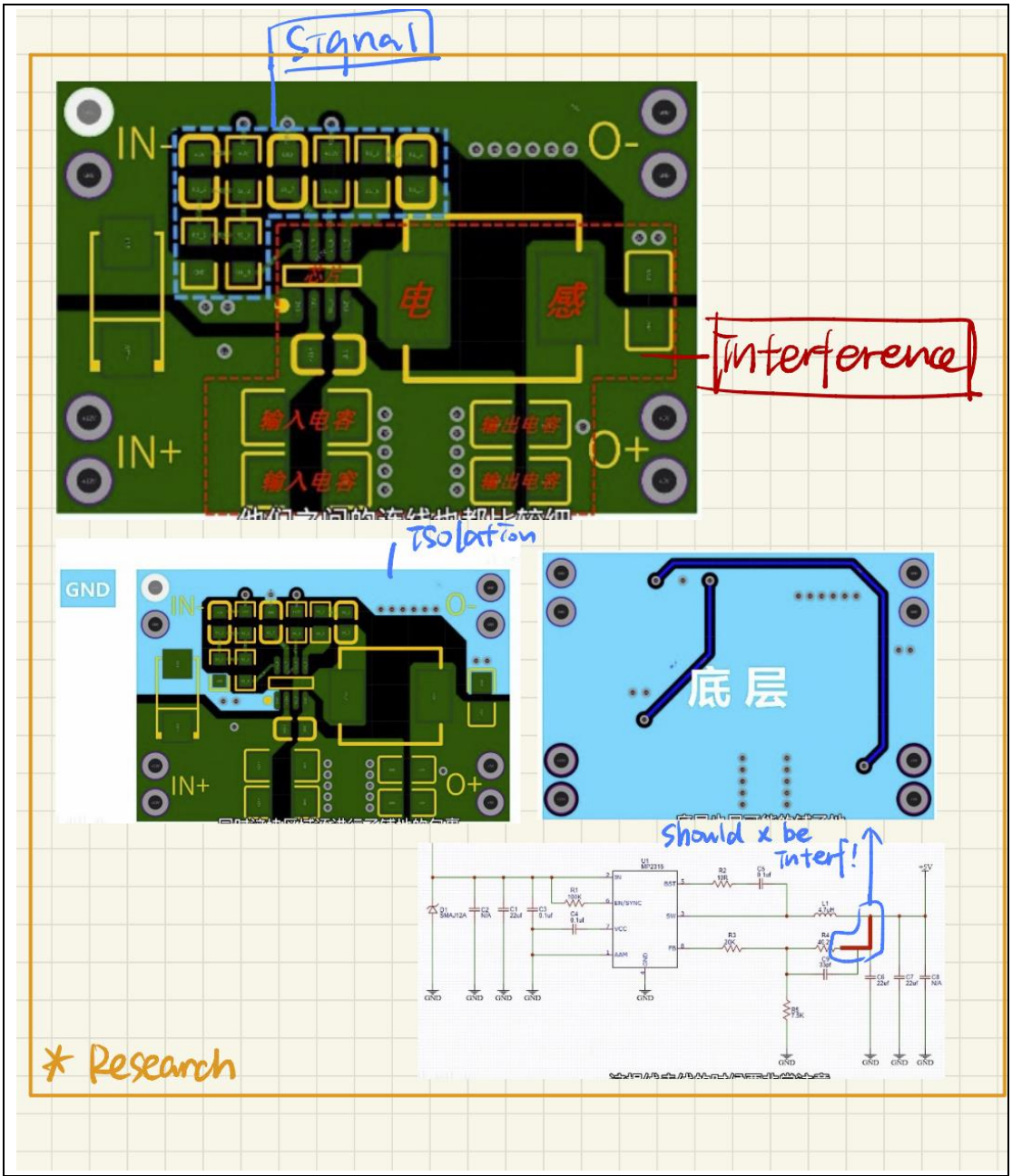
NOTE:

9) The recommended layout is based on Figure 9 on page





* Research



Results:

3/16 Complete PCB motor_driver.sch 1.0

↑ only { ① pwr supply 12-5V
② driver TB6612

Signature:

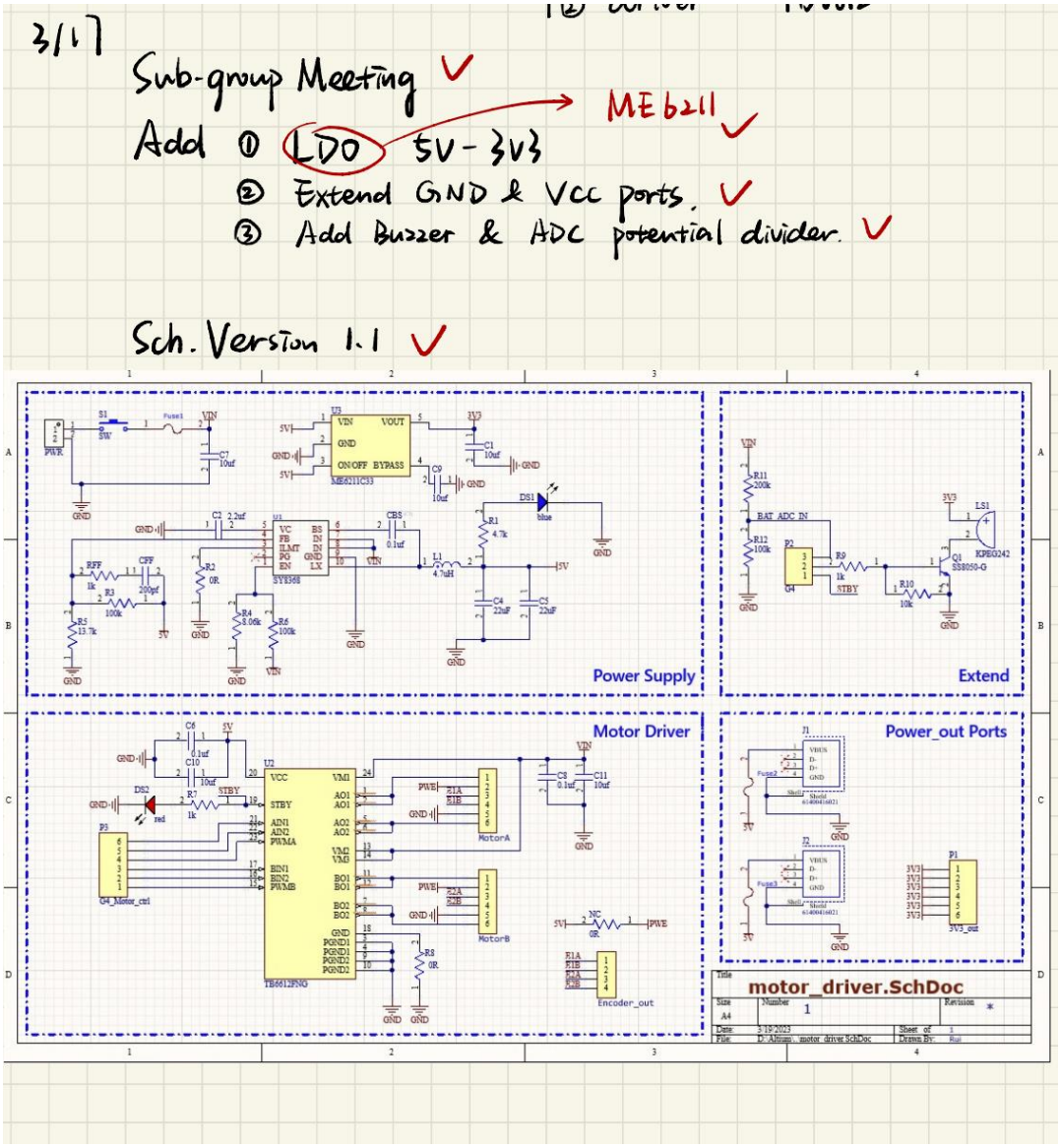
Witness signature:

4.8：Updating the power supply design

Recorder: Liu Jingrui	Date: 2023.03.17

Purpose:

Add 6 3V3 output ports on the designed PCB.



Results:

Using ME6211 as LDO to output good 3v3 supply.

Updated to sch 1.1.

4.9：Analyze the experiment results and make scheme3 of task 2

Recorder: Guo Yixiao	**Date:** 2023.03.17

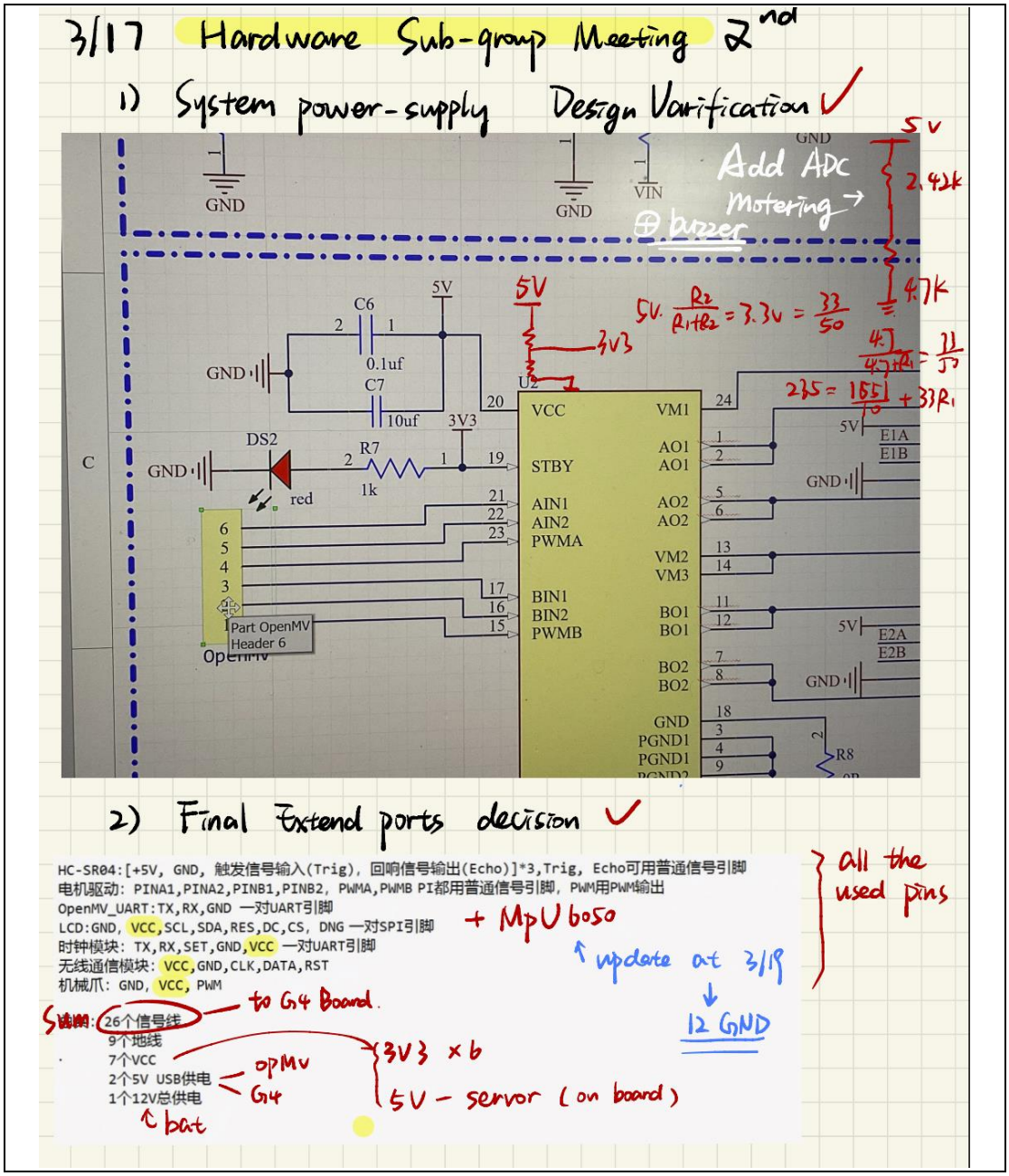
Purpose: Fix the PVC on the robot

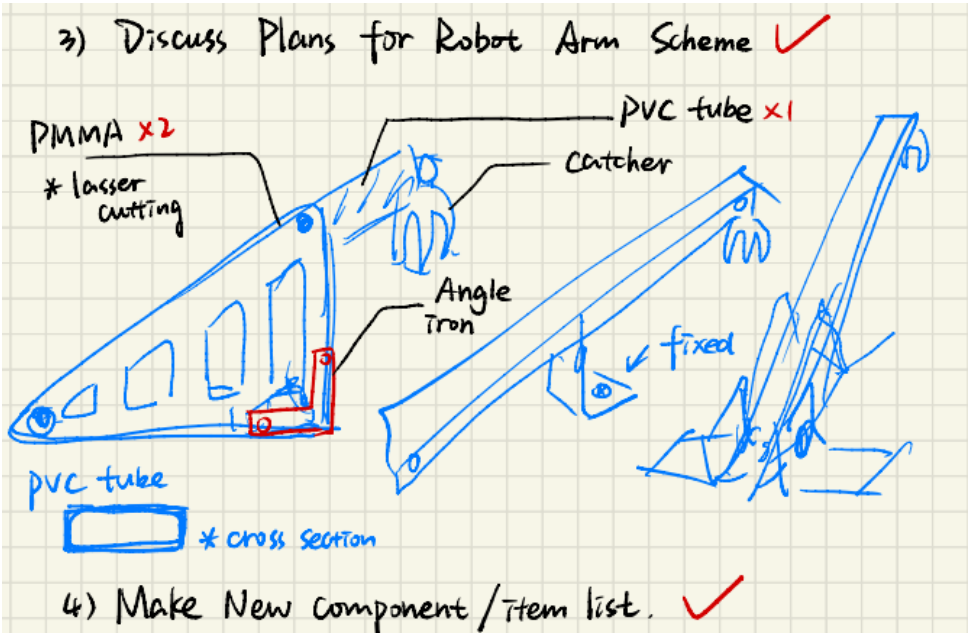
Introduction:

I have assembled a new arm by the chosen new components. After testing again I found that

although the last problems were solved, something new occurred **Materials:** 3-D printed claw, digital servo (SG90), Dupont wires, planks, PVC tube **Procedures:** 1. Test the stability of the claw 2. Verify whether the motor can be driven by mbed
Results: The claw is enough to capture the table tennis stably. The sg90 servo can be driven through Dupont wire directly by mbed. The acrylic mechanical arm is not hard enough and the joints are not stable. And if want to reach the height, must have more layers on the robot. **Discussion:** I have made a scheme3: create a structure like crane use a PVC tube to lift the claw. Design a plane and two wooden triangles, use shelf brackets to fix.
Signature:
Witness signature:

4.10：Hardware 2nd Subgroup Meeting	
Recorder: Liu Jingrui	**Date:** 2023.03.17
Purpose: Discuss and verify the system power supply proposal. Decide the extended ports for all the peripherals. Brain storm for the robotic arm scheme.	


3/17 Hardware Sub-group Meeting 2nd
1) System power-supply Design Varification ✓
GND
GND
VIN
Add ADC
Motering →
buzzer
5V
2.43k
4.7k
C6
0.1uf
C7
10uf
3V3
DS2
R7
1k
red
U2
VCC
STBY
AIN1
AIN2
PWMA
BIN1
BIN2
PWMB
VM1
AO1
AO1
AO2
AO2
VM2
VM3
BO1
BO1
BO2
BO2
GND
PGND1
PGND1
E1A
E1B
E2A
E2B
R8
Part OpenMV
Header 6
2) Final Extend ports decision ✓
HC-SR04:[+5V, GND, 触发信号输入(Trig), 回响信号输出(Echo)]*3,Trig, Echo可用普通信号引脚
电机驱动: PINA1,PINA2,PINB1,PINB2, PWMA,PWMB PI都用普通信号引脚, PWM用PWM输出
OpenMV_UART:TX,RX,GND 一对UART引脚
LCD:GND, VCC,SCL,SDA,RES,DC,CS, DNG 一对SPI引脚
时钟模块: TX,RX,SET,GND,VCC 一对UART引脚
无线通信模块: VCC,GND,CLK,DATA,RST
机械爪: GND, VCC, PWM
+ MpU 6050
update at 3/18
12 GND
all the used pins
to G4 Board.
26个信号线
9个地线
7个VCC
2个5V USB供电
1个12V总供电
opMv
G4
bat
3V3 x6
5V - servor (on board)



Results:

Decided on the final power-supply plan.

Clarified and listed all the required ports.

Updated the components bill.

Come up with great solutions for the robotic arm.

Signature:

Witness signature:

4.11：OpenMV Neural network model realization

Recorder: Wang Jiaqi	**Date:** 2023.03.18

Purpose: Implement the neural network model to OpenMV

Introduction: OpenMV is equipped with a neural network model deployment platform EdgeImpulse, supporting TensorFlow models. In our project, the model MobileNetV2 is used for initial testing.

Materials: OpenMV

Procedures:

At the beginning, I identify the stepper motor connections and connect the motor to the L298N motor driver. Then, connect the L298N motor driver to the microcontroller. To realize the function, I program the microcontroller.

Results: Successfully realize the speed control of the motor.

Signature:

Witness signature:

4.12：Communication between mbed and OpenMV

Recorder: Wang Ruiqi	**Date:** 2023.03.17-2023.03.18

Purpose: Mbed communicate with OpenMV using UART

Introduction:

The communication of Mbed and OpenMV can be realized using UART. OpenMV performs image recognition and calculate different duty cycle values of PWM based on PID algorithm. Through UART, OpenMV transmit the duty cycle values to mbed and mbed then control the speed of stepper motor.

Materials:

OpenMV

Nucleo L432KC

Procedures:

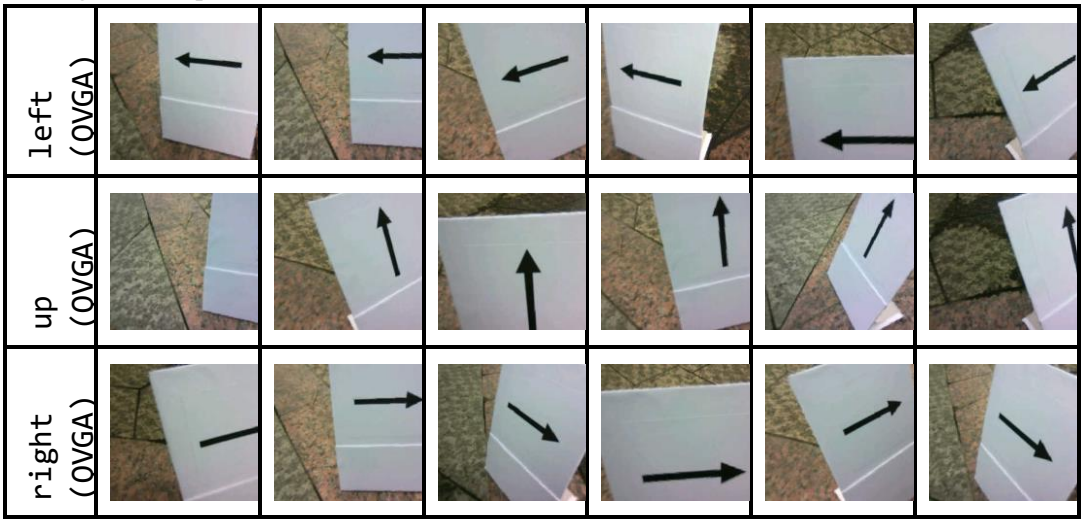
1) Construct the model to TensorFlow Lite format and quantize the model
2) Transfer the model to the OpenMV Cam
3) Upload the script to the OpenMV Cam

Results: Several basic settings of the neural net and training process are shown as below

```
30
31  INPUT_SHAPE = (160, 160, 3)
32
33  base_model = tf.keras.applications.MobileNetV2(
34      input_shape = INPUT_SHAPE, alpha=1,
35      weights = WEIGHTS_PATH
36  )
37
38  base_model.trainable = False
39
40  model = Sequential()
41  model.add(InputLayer(input_shape=INPUT_SHAPE, name='x_input'))
42  # Don't include the base model's top layers
43  last_layer_index = -3
44  model.add(Model(inputs=base_model.inputs, outputs=base_model
        .layers[last_layer_index].output))
45  model.add(Reshape((-1, model.layers[-1].output.shape[3])))
46
47  model.add(Flatten())
48  model.add(Dense(classes, activation='softmax'))
49
```

```
51
52  BATCH_SIZE = 4
53  EPOCHS = args.epochs or 20
54  LEARNING_RATE = args.learning_rate or 0.000015
55  train_dataset = train_dataset.batch(BATCH_SIZE, drop_remainder
        =False)
56  validation_dataset = validation_dataset.batch(BATCH_SIZE,
        drop_remainder=False)
57  callbacks.append(BatchLoggerCallback(BATCH_SIZE,
        train_sample_count, epochs=EPOCHS))
58
59  model.compile(optimizer=tf.keras.optimizers.Adam(learning_rate
        =LEARNING_RATE),
60                loss='categorical_crossentropy',
61                metrics=['accuracy'])
62  model.fit(train_dataset, validation_data=validation_dataset,
        epochs=EPOCHS, verbose=2, callbacks=callbacks)
```

training set examples:



Online training and testing results:

Discussion:

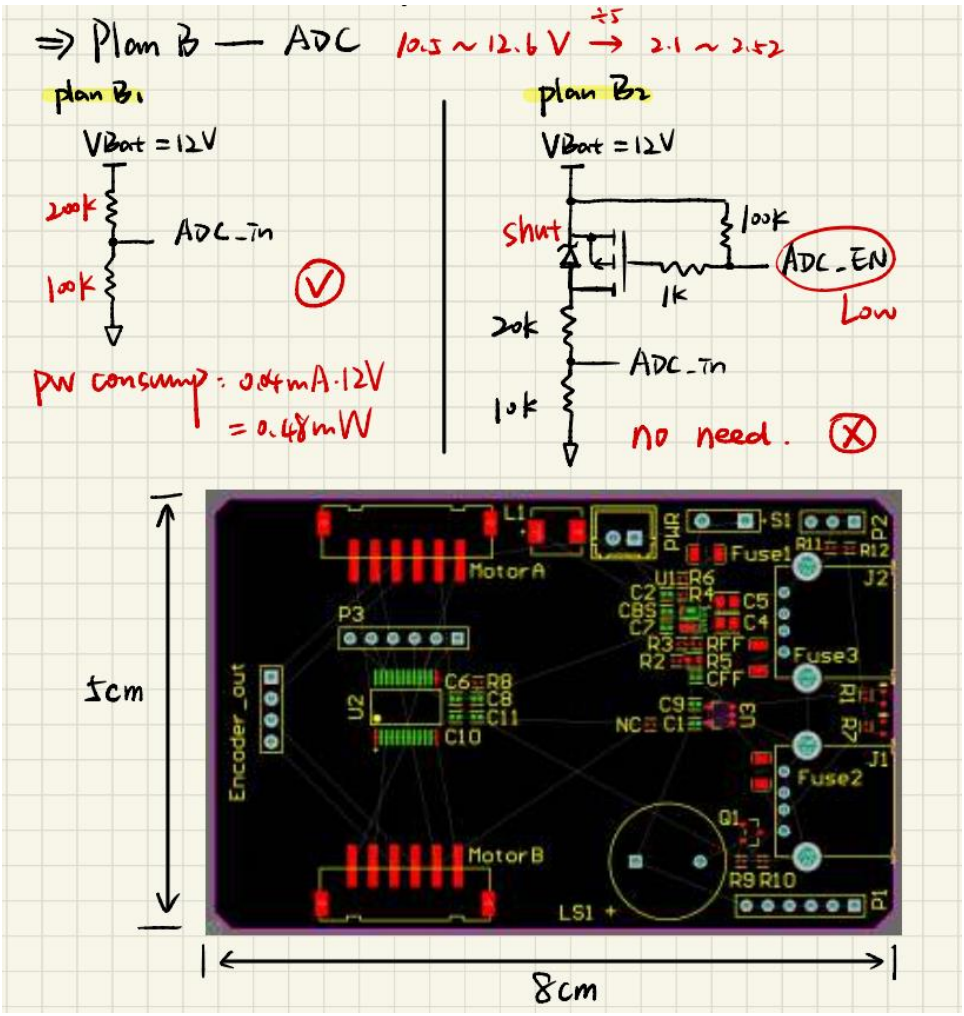
1) In practice, the network sometimes get confused between left and right.
2) An alpha of 1.0 is used for MobileNetV2 currently, resulting in a processing time of approximately 0.6 sec for each image.

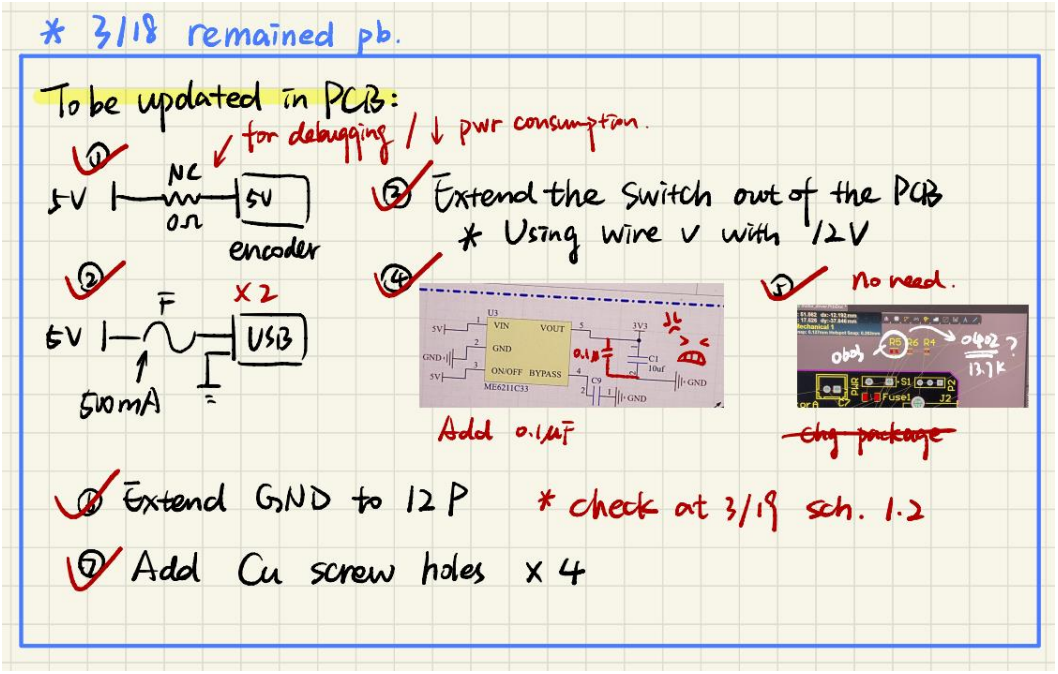
Signature:

Witness signature:

4.13：Design battery Monitoring & PCB layout

Recorder: Liu Jingrui	**Date:** 2023.03.18
Purpose: Finish the initial PCB layout.	





Results:

Showed the initial layout to our HD group members and got feedback.

Listed all the remained problems (has been checked and solved on 3.19).
Signature:
Witness signature:

4.14：DS1302 time clock module

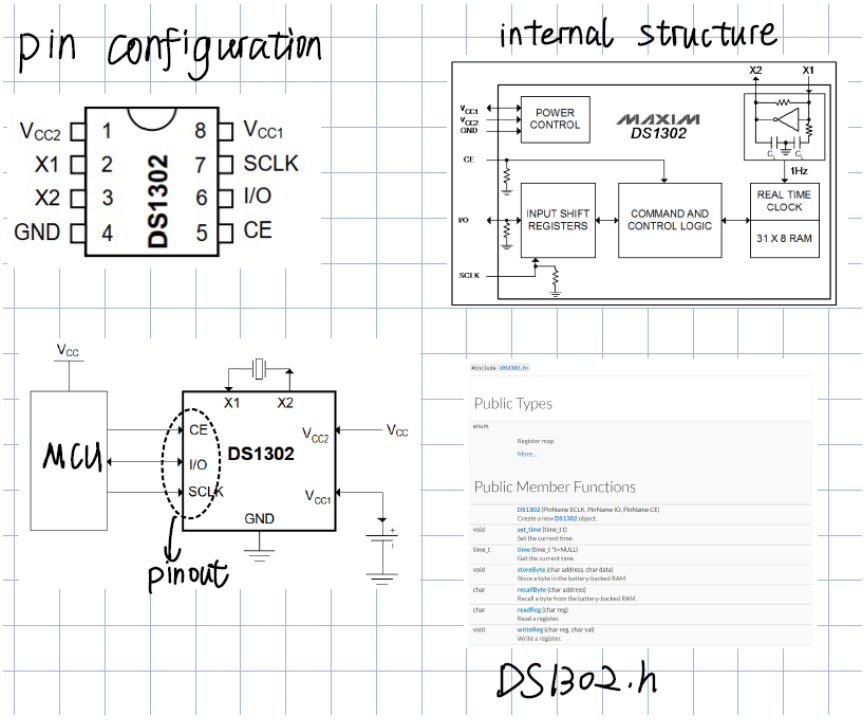
Recorder: Zhang Jinyang	**Date:** 2023.3.18

Purpose: Set the initial time for the RTC module.

Materials: The time module DS1302, laptop, and one L432KC.

Procedures:

The DS1302 module was first attached to the MCU, L432KC. Then, I compiled the time setting program on the Keil Studio. The time was initialized by using the “set_time” function, which is in the library file “DS1302.h”, with the UNIX timestamp. The library file of DS1302 was import to the IDE from the Internet. I had tested that the RTC module was ticking after the power from the MCU is off. In this situation, the clock is powered by the battery on the module.



Results:

By applying the serial port debugging assistant, the message could be displayed easily on the laptop. Running the test program, the current time was printed on the screen for each second.

Discussion:

After the initial setting, the clock was keep ticking. However, the time recorded by the module was not accurate when the clock is running for a long-time interval.

Signature:

Witness signature:

4.15：HC-12 wireless communication module

Recorder: Zhang Jinyang	Data: 2023.3.19

Purpose:

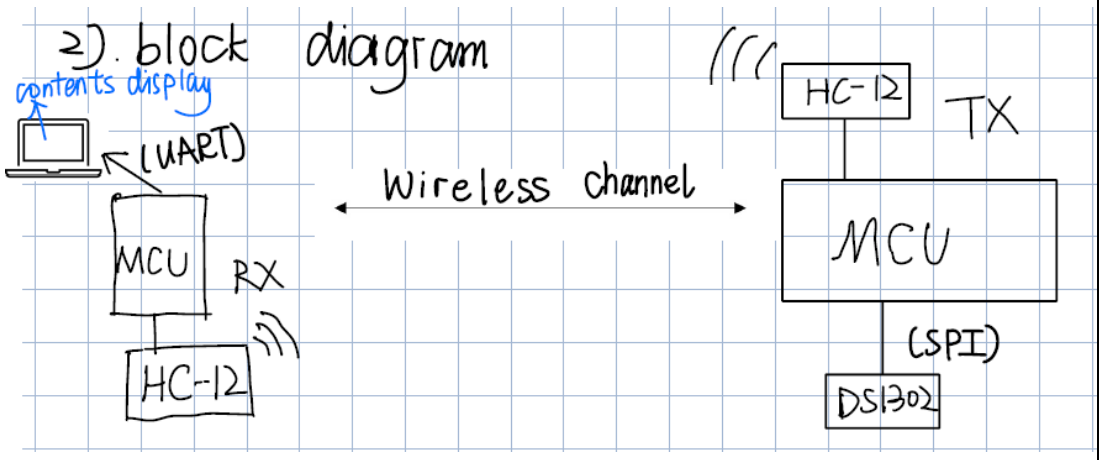
Test the HC-12 comm. modules if the message could be sent and received successfully

Materials:

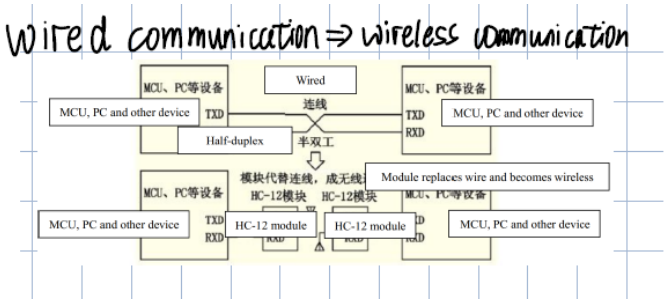
The time module DS1302, laptop, two L432KC, and two HC-12 modules.

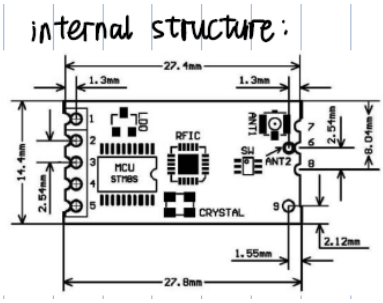
Procedures:

First, I connected the devices as shown in the diagram below. In the testing process, we chose to utilize the L432KC as the MCU at the transmission end. In the send program, a AnalogIn pin was defined to check if there is a control signal. This signal is from the other device.



HC-12:





Results:

When the AnalogIn pin was attached to the Vcc pin, the message was sent to the receive end from the send end. Then, the message was displayed on the PC's screen.

```
Team 41: Furious

Li Ruixuan; Wang Ruiqi; Peng Yankai; Guo Yixiao; Luo Jiaqi; Li
Yusen; Liu Jingrui; Zeng Yu; Zhang Jinyang; Wang Jiaqi

Date:2023/3/19 (SUN)

Current time:22:36:52
```

Discussion:

The method of display the massage should be well considered.

Signature:

Witness signature:

Week 5

5.1：The fourth group online meeting	
Recorder: Peng Yankai	**Date:** 2023.03.22
Purpose: Discussion of the initial report and work allocation	
Introduction: After completing the first draft of the report, I would like to invite comments from all group members. Besides, since the work of communication had completed, the members of communication subgroup can be allocated to car construction group to accelerating the process. **Materials:** Draft version of initial report **Procedures:** 1. Pointed out the inappropriate parts of the initial reports. 2. Allocated new work to the communication subgroup.	
Results: 1) Obtain suggestions for revising the report. 2) Assigning the commissioning of accelerometers to communication sub-groups ● Q&A and free discussion 3) Discussed the structure of the initial report and what it consists of. 4) Discussed the trigger mechanisms for wireless communication. ● Planning for the next week 1) Planning for the online meeting 2) Continue the construction of the car	
Signature:	
Witness signature:	

5.2：Design of different layers of robot	
Recorder: Wang Ruiqi	Date: 2023.03.19-2023.03.20
Purpose: design multiple layers to install different parts	
Introduction: The robot is composed of main control board, different sensors and motors to finish different tasks. Therefore, our robot needs multiple layers to install different parts. I chose to use laser cutter to cut the bottom plates of different layers and 3D printer to print out the mounting bracket of OpenMV (OpenMV need to be fixed at 45° inclined downward). **Materials:** 3D Modelling Software: SolidWorks (For modelling)	

3D Printing Software: AutoLaser(For laser cutting)

3D printer

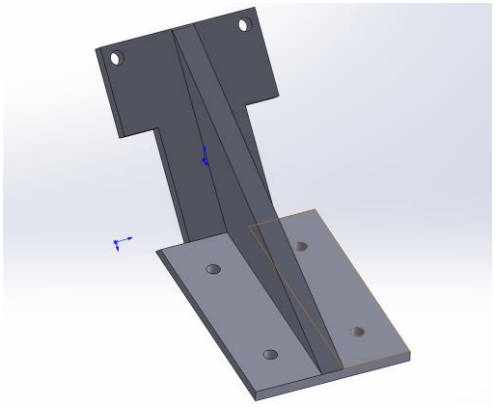


Figure 1. The 3D modle of the mounting bracket

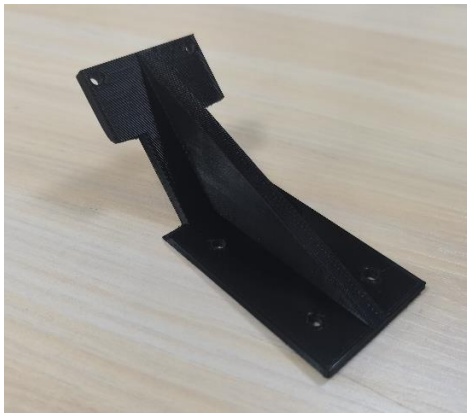


Figure 2. The 3D print result

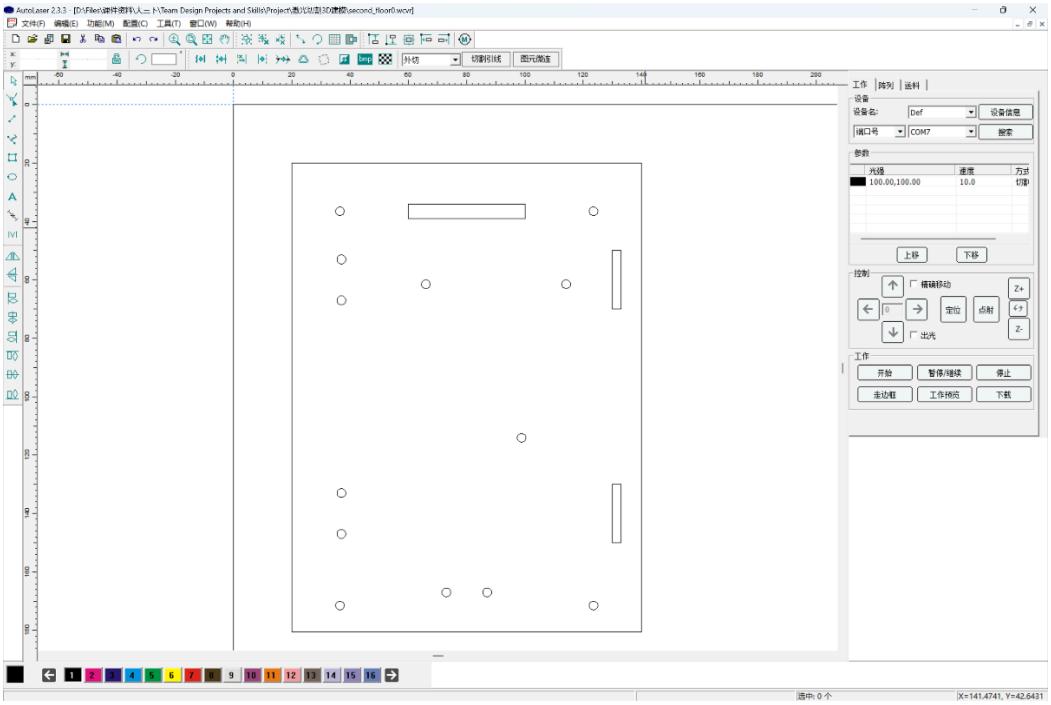


Figure 3. The second floor of robot

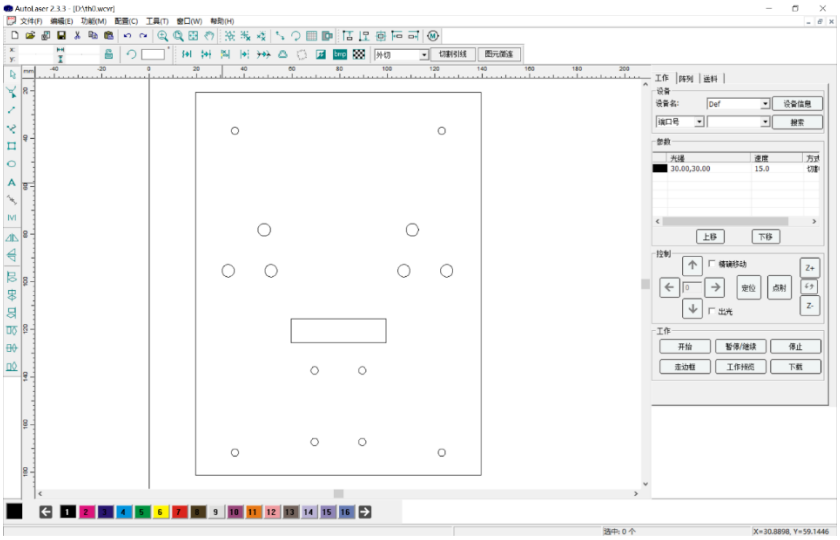


Figure 4. The third floor of robot

Procedure: At first, I use SolidWorks to construct the 3D model and then exporting 3D models. Then, Using AutoLaser to slice the model into layers suitable for the printer. Finally, using 3D printer to print the model.

5.3：Updating and Perfecting

Recorder: Liu Jingrui	**Date:** 2023.03.19-2023.03.20

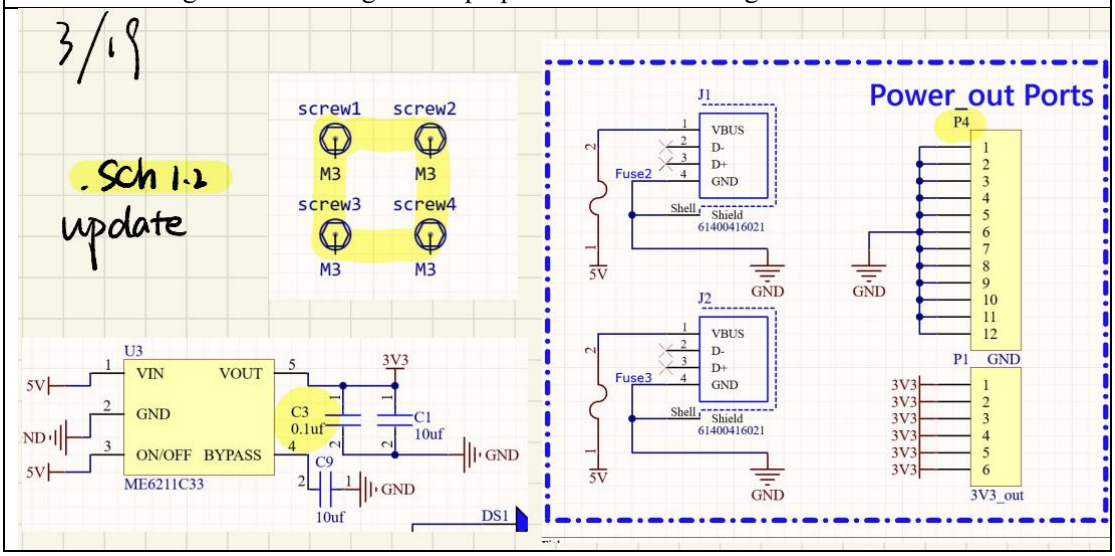
Purpose:

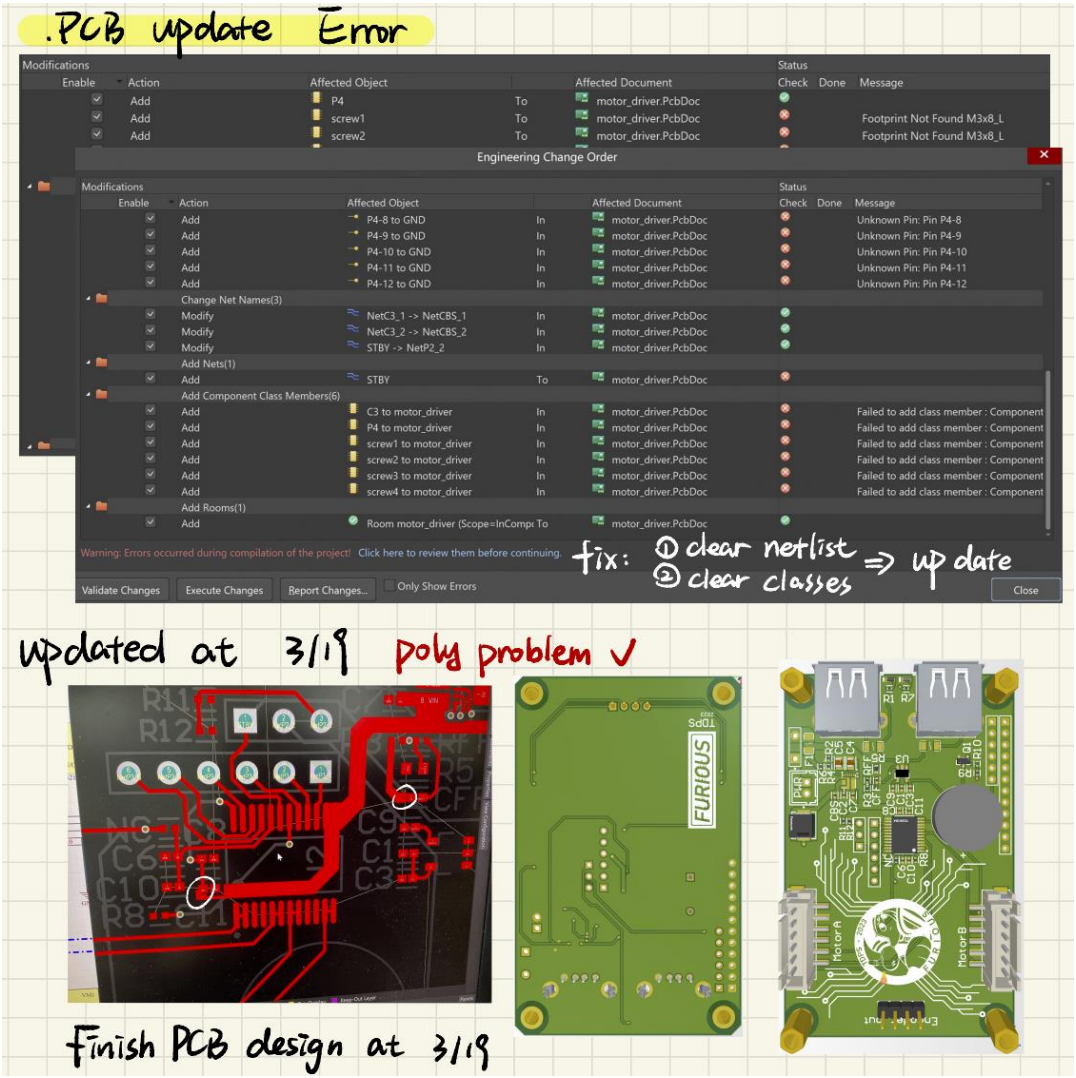
Solve the remained problems in 3.18.

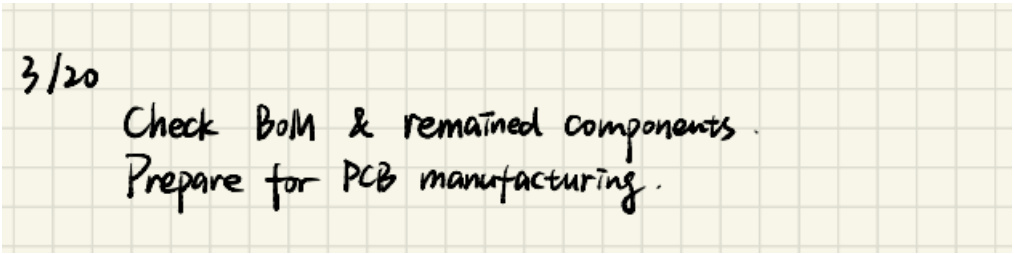
Finish the PCB design.

Check BoM and my components.

Check the design of the PCB again and prepare for manufacturing.







Signature:

Witness signature:

5.4: Subsequent processing of the Canny image

Recorder: Wang Jiaqi	**Date:** 2023.03.25

Purpose: Optimize the performance of the OpenMV

Introduction: We have ideas on subsequent processing of the Canny image: dilate & erosion using different kernels; calculating ROI standard deviation or mean value over the entire image, or specific areas, each ROI has a size of 10*10, splitting the image into 32*24 areas.

Materials:

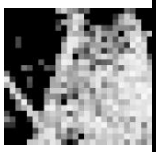
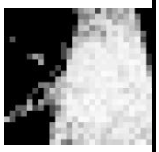
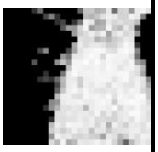
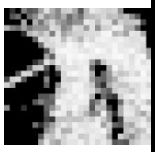
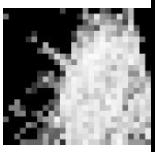
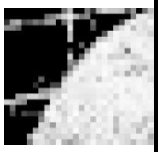
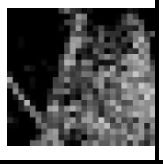
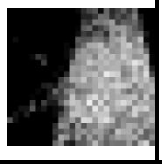
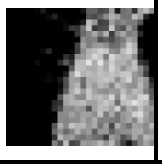
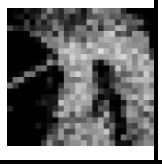
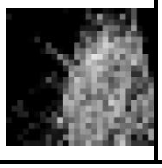
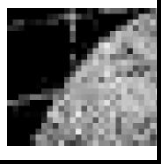
OpenMV cam H7 plus

OV5640 sensor

Procedures:

1. Try different kernels
2. calculating ROI standard deviation or mean value
3. adjusting the parameters and then repeat step 1 and 2

Results: The standard deviation and mean value of the image is shown as follows; it should be noted that these calculations could lead to a lower dps.

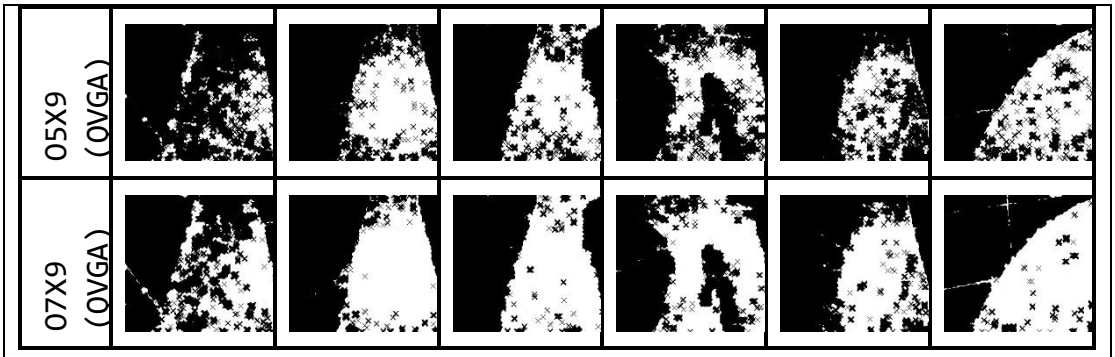
	Fig.69_V4	Fig.22_V4	Fig.25_V4	Fig.40_V4	Fig.21_V4	Fig.51_V4
stdev (QVGA)						
mean*2 (QVGA)						

For the dilation and Erosion method, we used circle kernels for dilation and 'X' size kernels for erosion, in order to minimizing noises while preserving the track. The kernels and outputs are shown as follows.

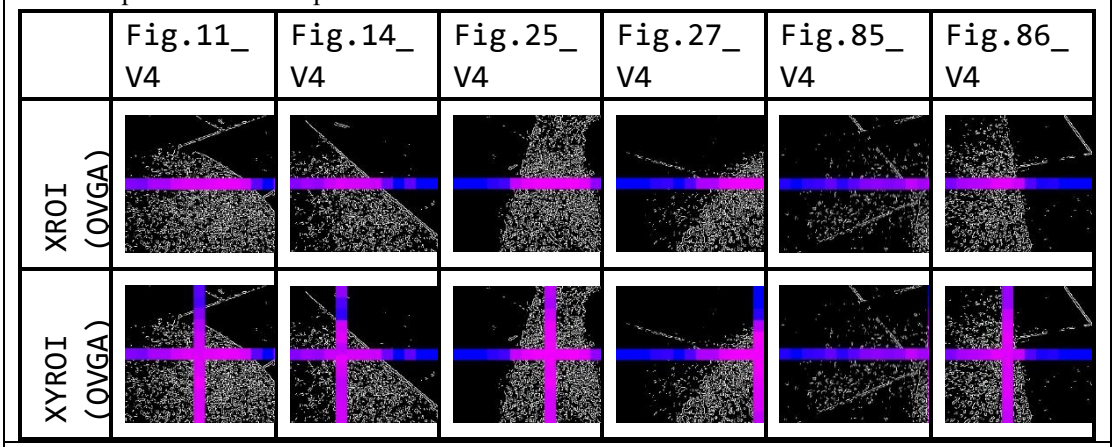
```
Kernel05 = np.array([[0, 1, 1, 1, 0],
                     [1, 1, 1, 1, 1],
                     [1, 1, 1, 1, 1],
                     [1, 1, 1, 1, 1],
                     [0, 1, 1, 1, 0]], dtype = np.uint8)

Kernel07 = np.array([[0, 0, 1, 1, 1, 0, 0],
                     [0, 1, 1, 1, 1, 1, 0],
                     [1, 1, 1, 1, 1, 1, 1],
                     [1, 1, 1, 1, 1, 1, 1],
                     [1, 1, 1, 1, 1, 1, 1],
                     [0, 1, 1, 1, 1, 1, 0],
                     [0, 0, 1, 1, 1, 0, 0]], dtype = np.uint8)
```

```
KernelX9 = np.array([[1, 0, 0, 0, 0, 0, 0, 0, 1],
                     [0, 1, 0, 0, 0, 0, 0, 1, 0],
                     [0, 0, 1, 0, 0, 0, 1, 0, 0],
                     [0, 0, 0, 1, 0, 1, 0, 0, 0],
                     [0, 0, 0, 0, 1, 0, 0, 0, 0],
                     [0, 0, 0, 1, 0, 1, 0, 0, 0],
                     [0, 0, 1, 0, 0, 0, 1, 0, 0],
                     [0, 1, 0, 0, 0, 0, 0, 1, 0],
                     [1, 0, 0, 0, 0, 0, 0, 0, 1]], dtype = np.uint8)
```

	Fig.69_V4	Fig.22_V4	Fig.25_V4	Fig.40_V4	Fig.21_V4	Fig.51_V4



The methods above all have large consumptions of computing power, leading to a frame rate around 7dps. We came up with a method which utilizes the image information in a more efficient way, that is, compute the standard deviation of a line of ROIs with a pre-set distance to the bottom of the image, then take the deviation value as mass and compute the location of the centroid on the x-axis (this process may be modified by introducing the mean value of each ROI as auxiliary weights for the standard deviation value), then list a new line of ROIs along a vertical line with its x-axis location set to be the same as the centroid. The standard deviation value of these ROIs could help us control the speed of wheels on both sides.



Signature:

Witness signature: