



2020.6.17

# Final report

BOOKMAN  
SDM5002

Team  
members:

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贾明臻  
王青青

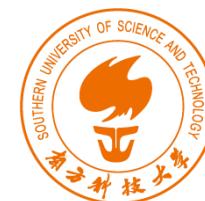


# Introduction

## Litchi



Litchis in SUSTech



Factors may destroy a litchi's life:

Temperature



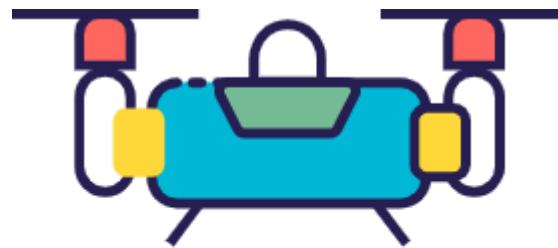
Weather



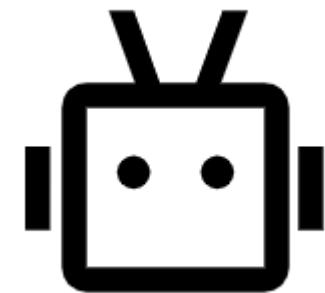
# Current plant protection method:



Human labor



Drone



Robot

## Introduction

### Plant Protection Method



Human labor



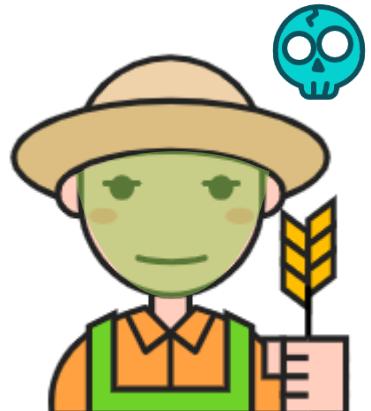
Sun exposure

Most common method currently

Farmer need to endure:



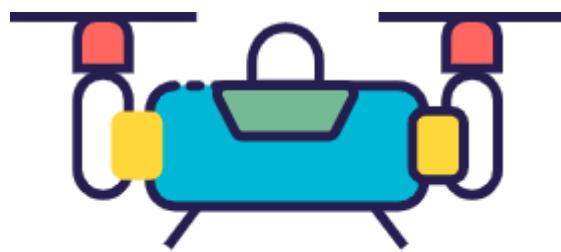
Long hours working



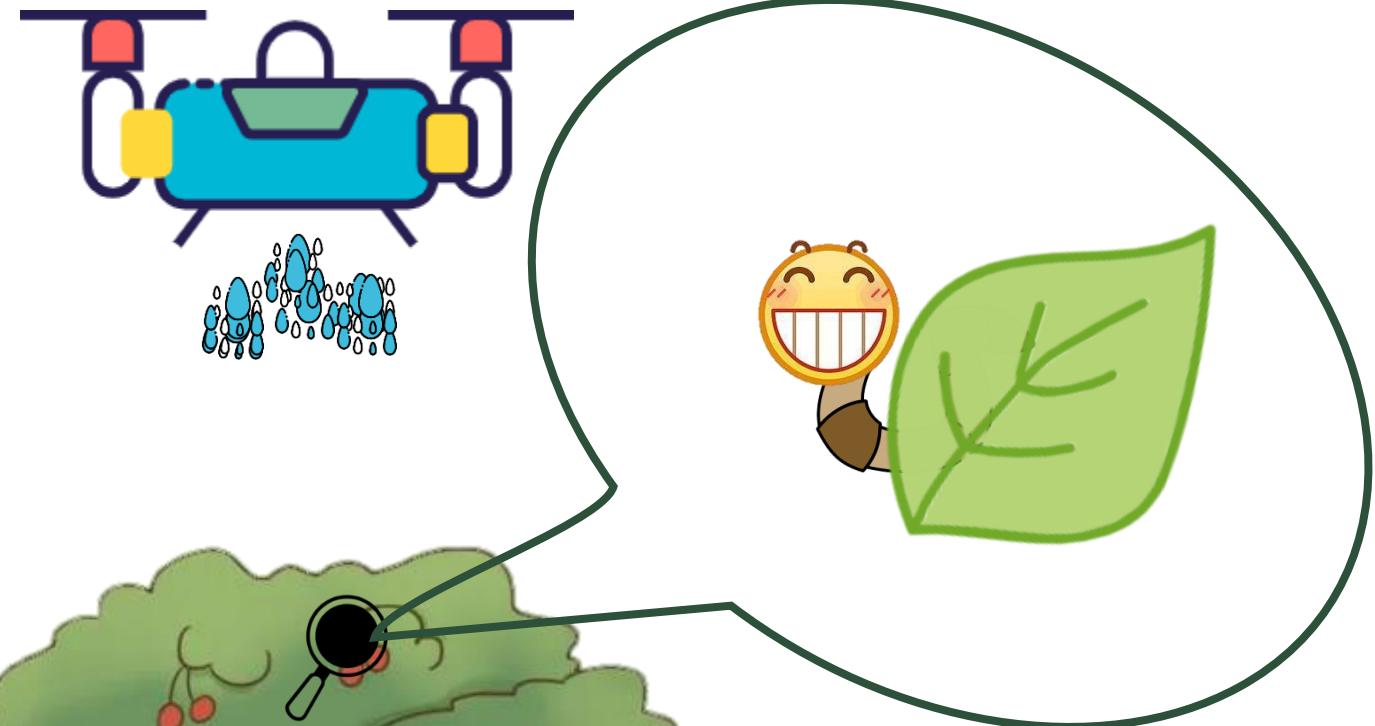
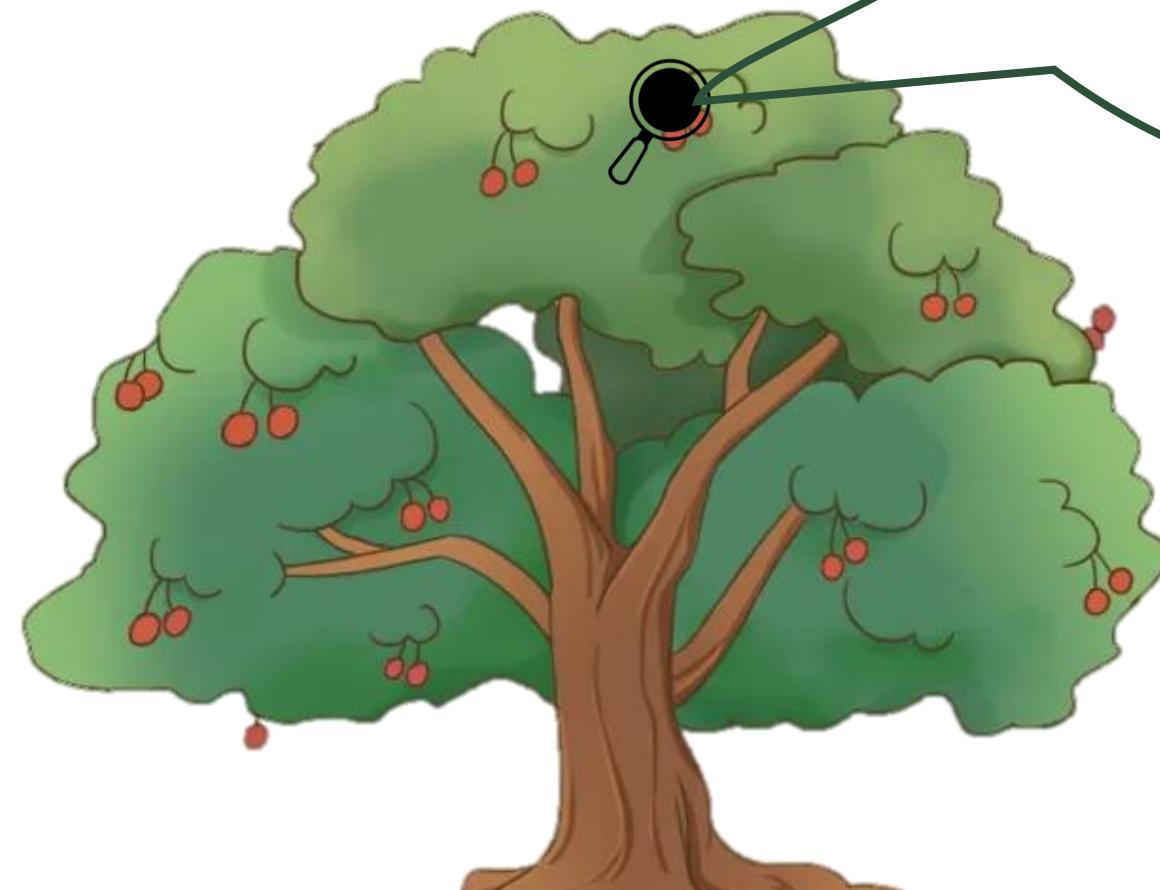
Toxic pesticide

# Introduction

## Plant Protection Method

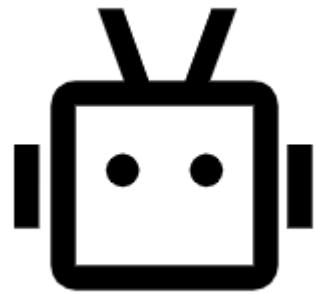


Drone

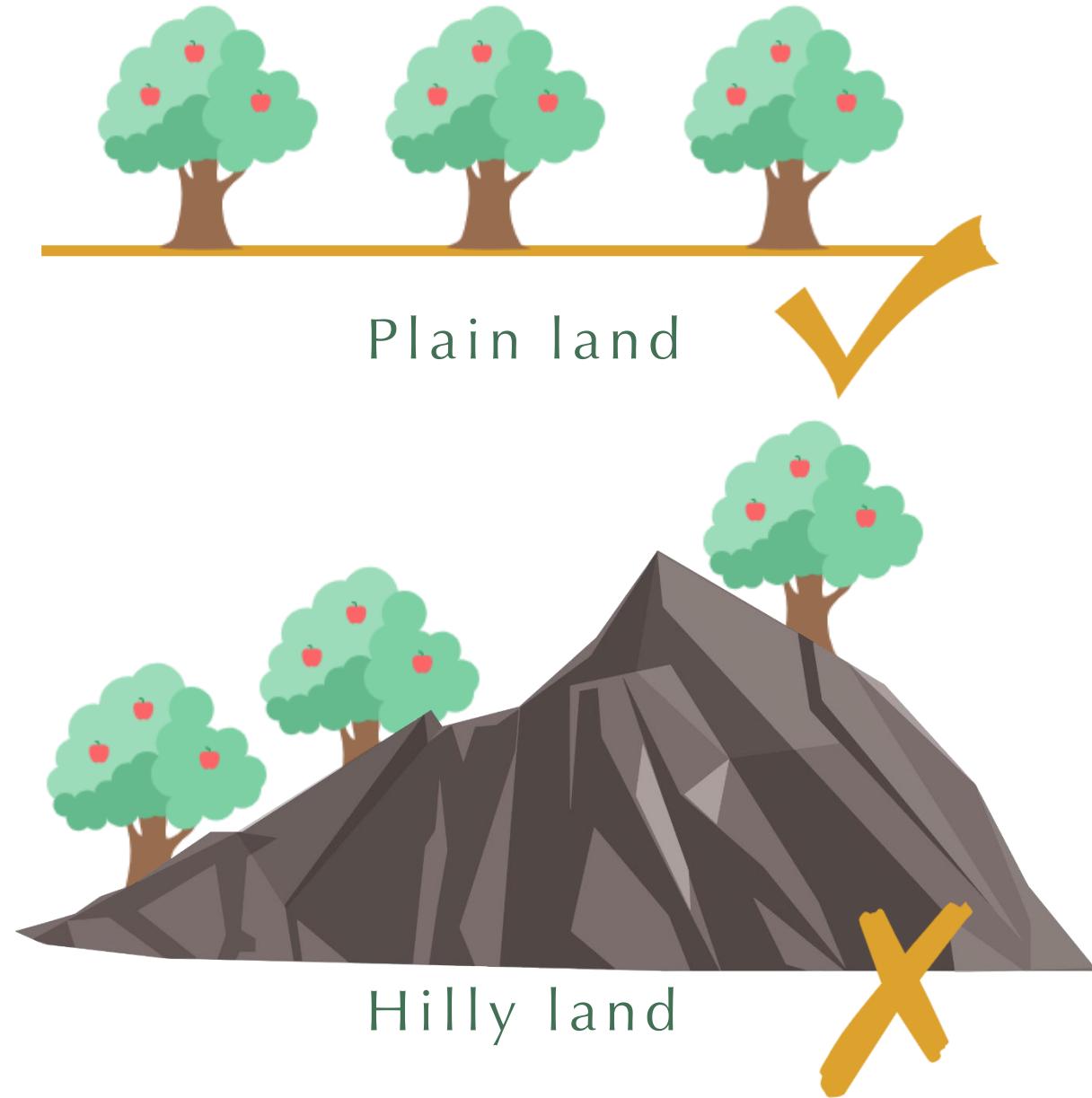


# Introduction

## Plant Protection Method



Robot

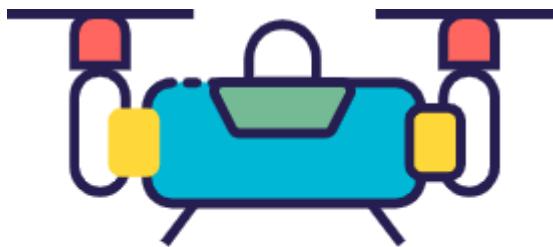


## Introduction

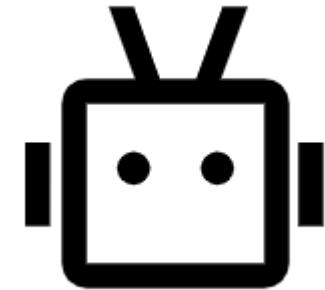
### Objective



Human labor



Drone



Robot

Objective:

Design a **mobile robot** that can achieve plant protection in **hilly land**

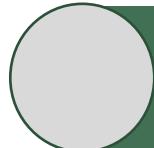
# Expected Functions



High topographic adaptability



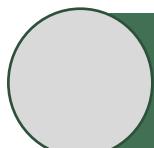
Convenient resupply



Remote control



Real-time image transmission



GUI

# Personal Duty



Project Management



Structure design——Moble robot



Structure design——Base station



Embedded control



Communication



GUI



B O O K M A N



Individual contribution

# STRUCTURE DESIGN

Mobile robot

Qingyu LIU

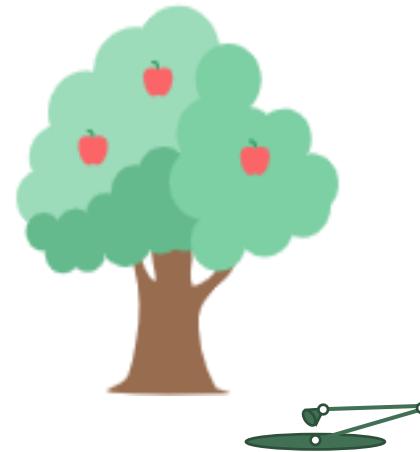


## Pests



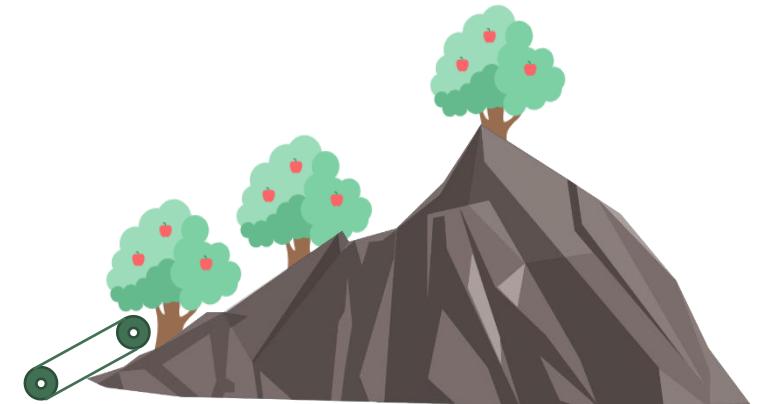
Spray System

## Trees



Robotic Arm

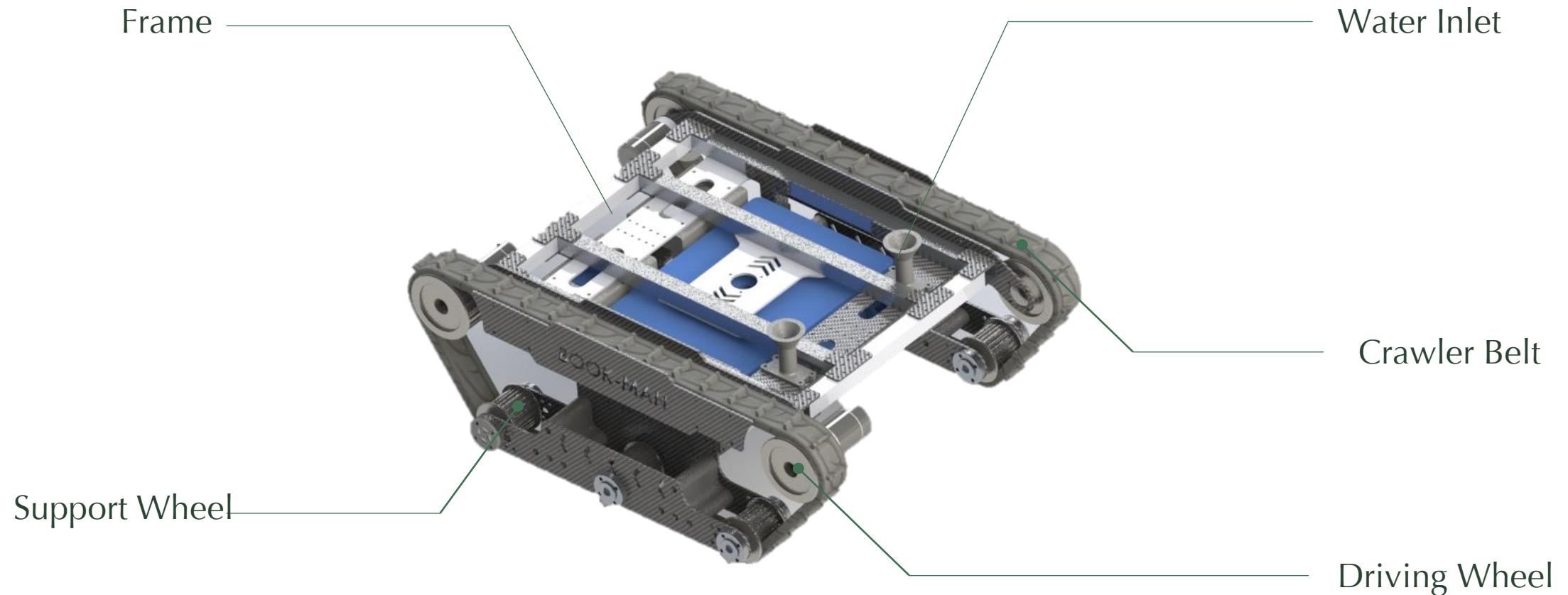
## Mountain



Track Chassis

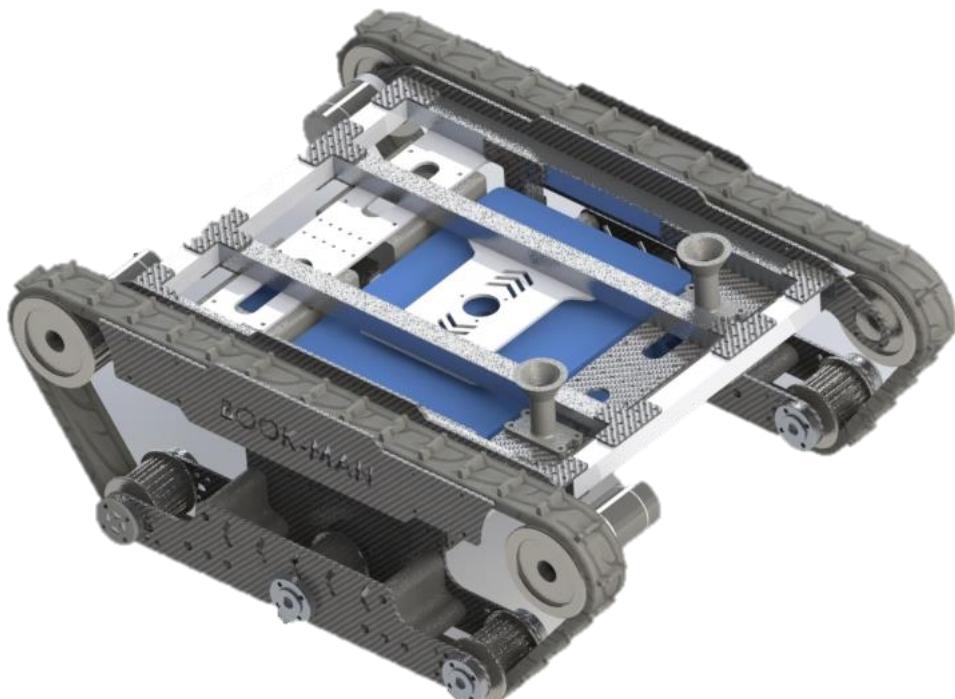
# Structure Design

## Track Chassis



# Structure Design

## Track Chassis



Weight

**18.1Kg**

Specification

600×470×220mm

Driving Wheel

8M-30AF-40×20mm

Support Wheel

8M-17AF-40×20mm

Crawler Belt

8M-40-1336mm

Driving Motor

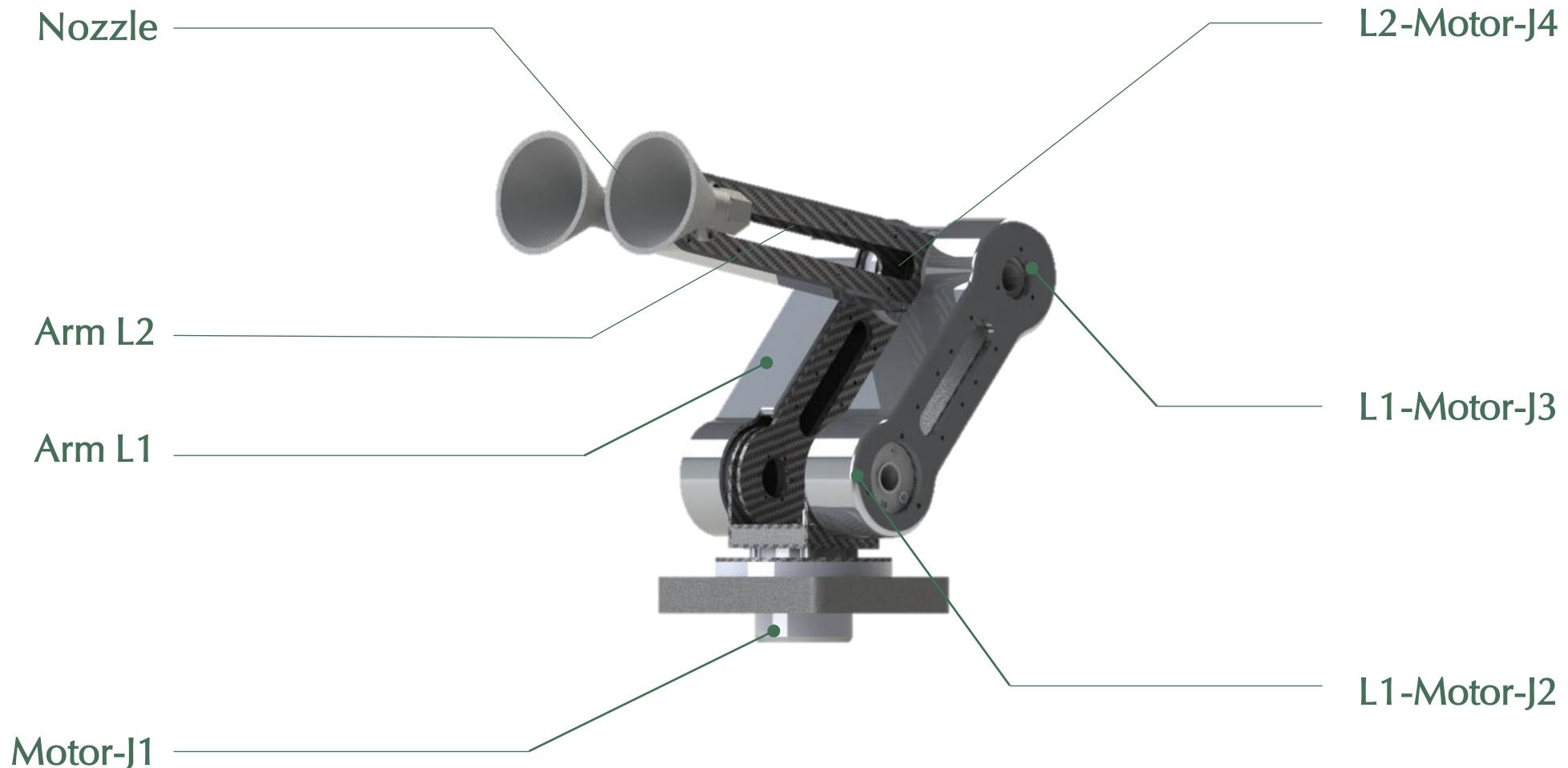
M3508

Climbing Angle

$40^\circ$  (max)

# Structure Design

## Robotic Arm



# Structure Design

## Robotic Arm



Weight

3.1Kg

Specification

180×260mm

Number of Free  
Degree

4

Motor J1-J3

GM 6020

Motor J4

2006

Transmission  
Wheel

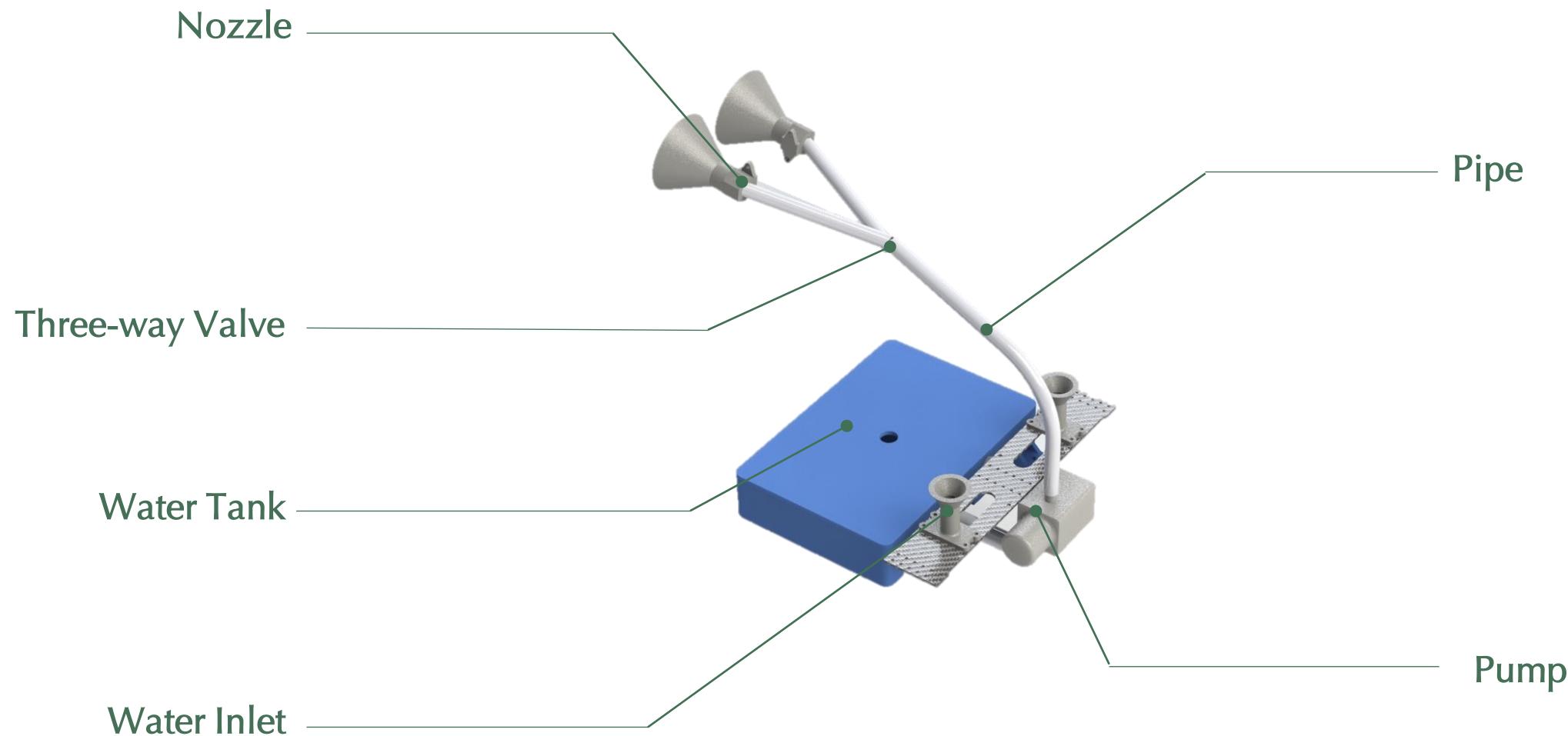
3M-16AF-10

Transmission belt

3M

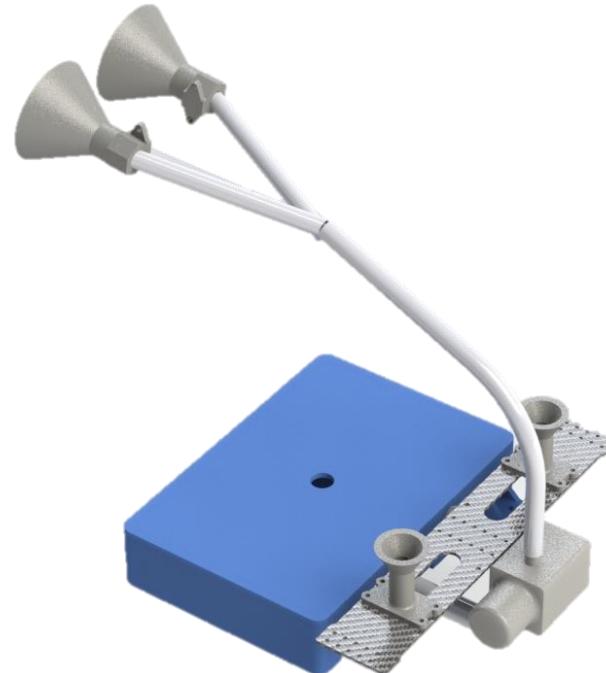
# Structure Design

## Spray System



# Structure Design

## Spray System



Weight

0.5Kg

Specification

210×260×56mm

Water Storage Volume

3L

Pump Pressure

4.5Kg

# Structure Design

## Product Iteration



BOOK-MAN V1

- Determine the track movement method
- Determine the layout structure
- Determine the spray method

- Change the track support structure
- Change the structure of the robot arm
- Designed the water storage system



BOOK-MAN V2



BOOK-MAN V3

- Change the track design structure
- Complete design spray system
- Design the remaining structures

# Structure Design

## Parameter



Name

*BOOK-MAN*

Weight

*21.1Kg*

Specification

*600 × 470 × 400mm*

Climbing Angle

*40°<sub>(max)</sub>*

Water Storage Volume

*3L*

Pump pressure

*4.5Kg*

Number of Free Degree

*4*

B O O K M A N



Individual contribution

# STRUCTURE DESIGN

Base Station

Mingzhen JIA



Base Station

Introduction

Convenient resupply

# Distributed Base Station

Charging 

Solve the problems of: Pesticide supply  at one stroke

Storage 

Base Station  
Structure Design

# Structure Design



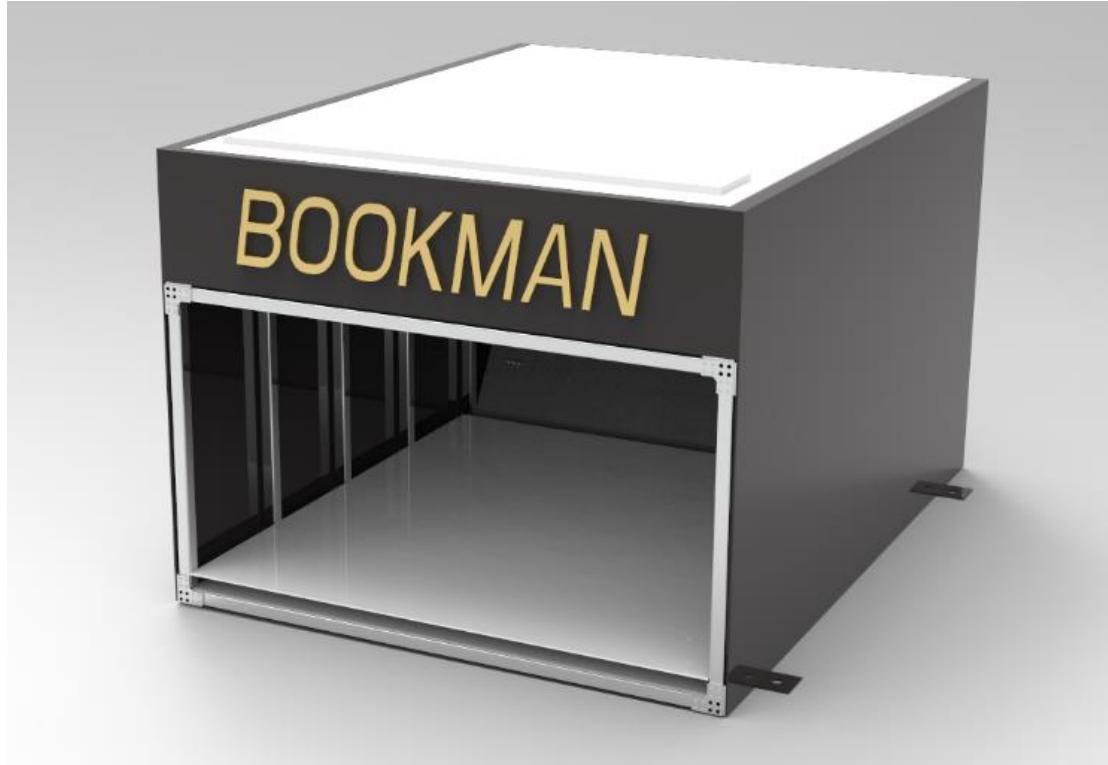
Mopping robot



Garage

Base Station  
Structure Design

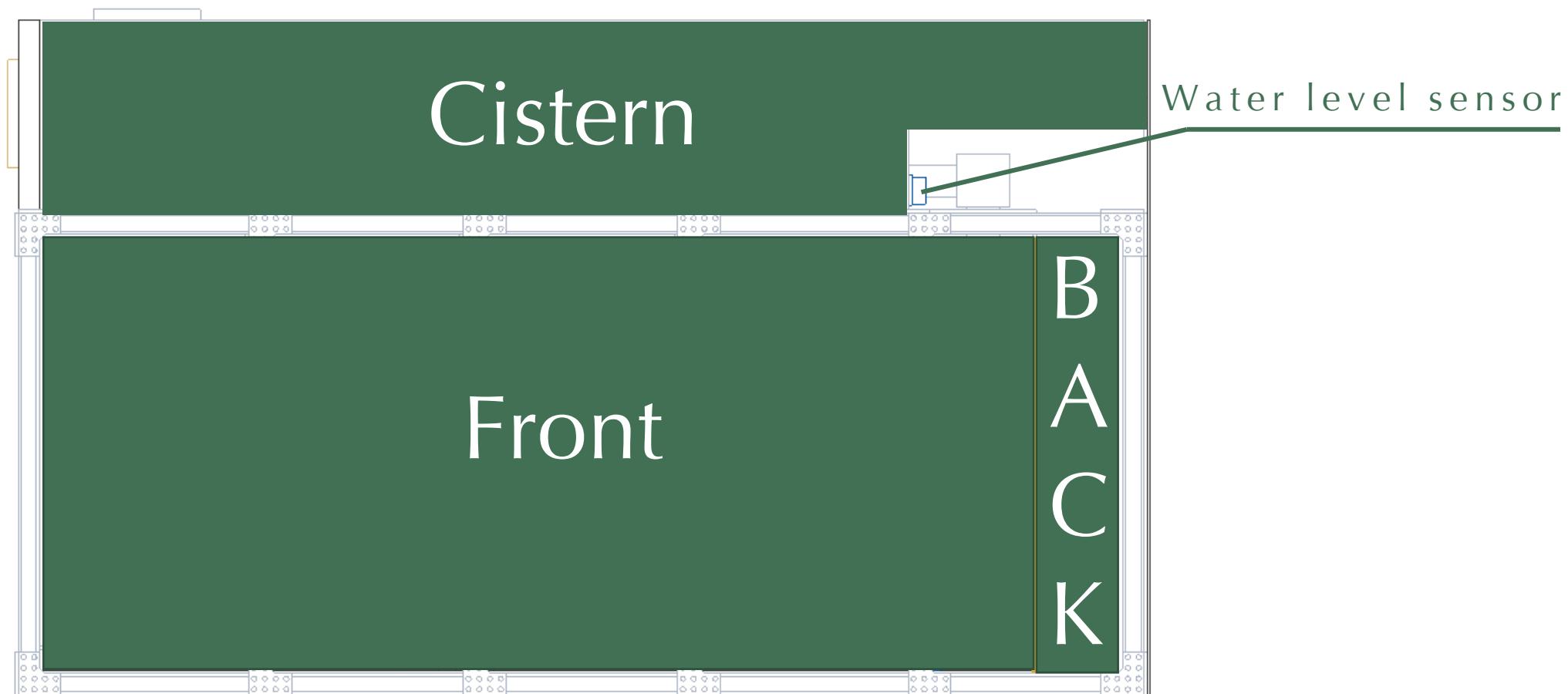
# Structure Design



Base Station

Detail

# Spatial Arrangement



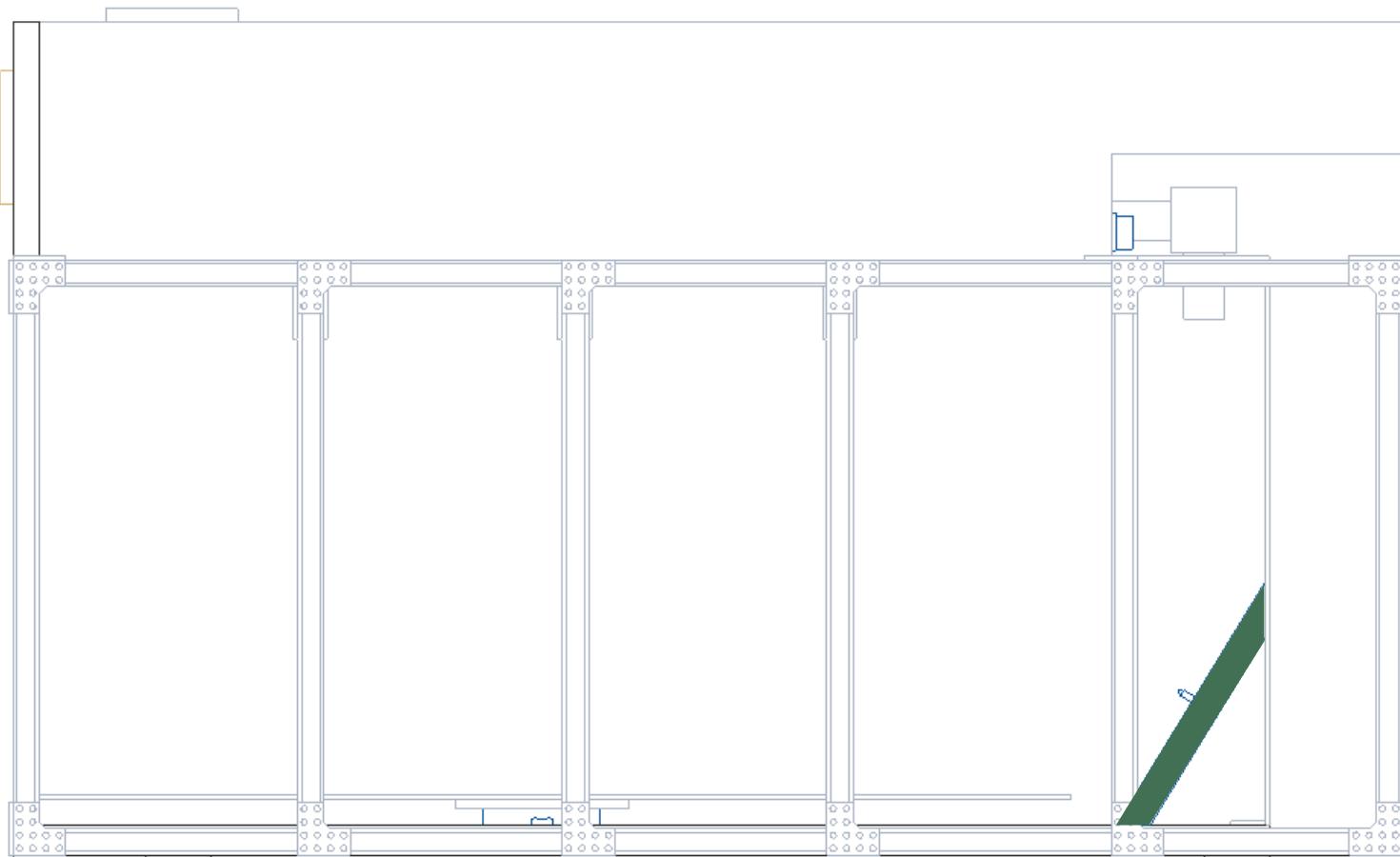
Base Station

Detail

# Charging



Metal contact



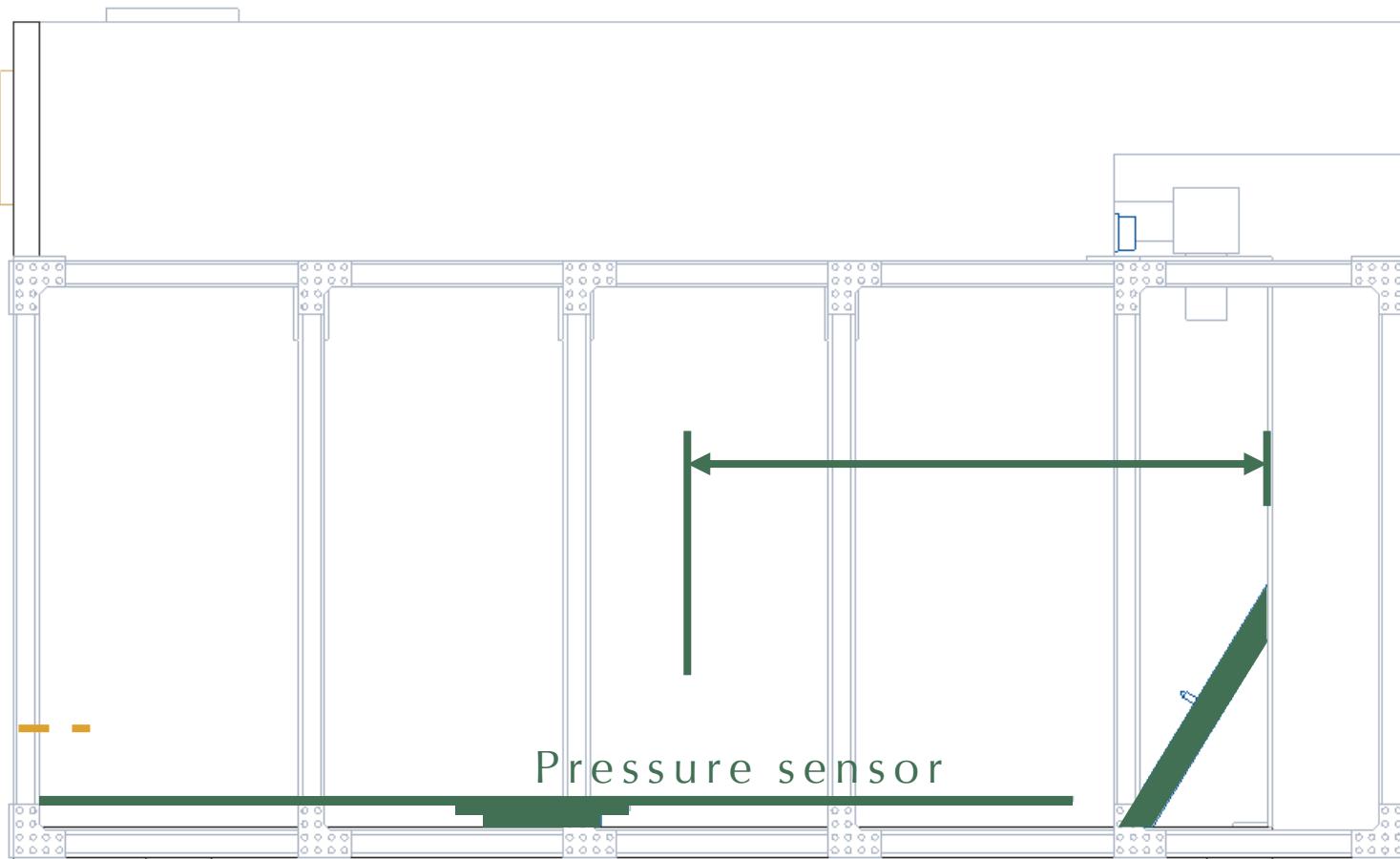
# Alignment

Pressure sensor  
Line patrol  
Ranging sensor

Correct position



—> Dashed orange line indicating the correct alignment path.



Pressure sensor



Individual contribution

# EMBEDDED CONTROL

Qingqing WANG



# Embedded Control

## Project Background



Complex terrain



Many trees,  
many obstacles



Severely degraded  
GPS signal



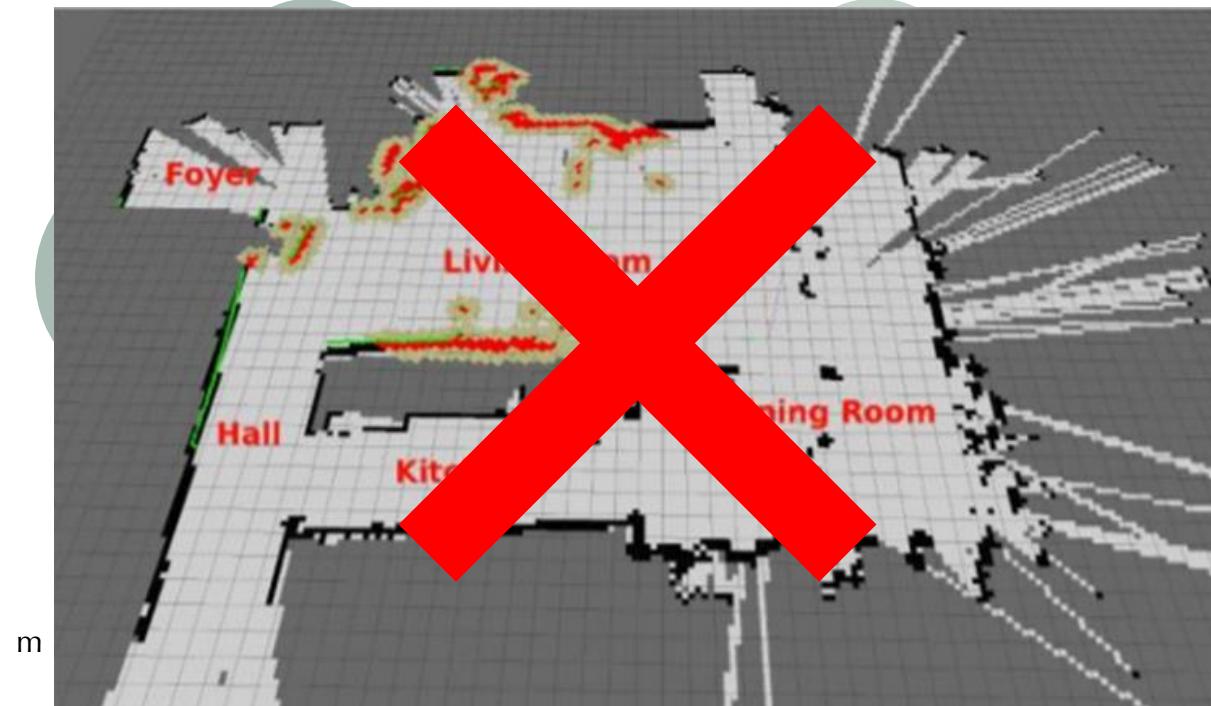
Time 4 months  
¥ 5 0 0 0

# Embedded Control

## Project Background

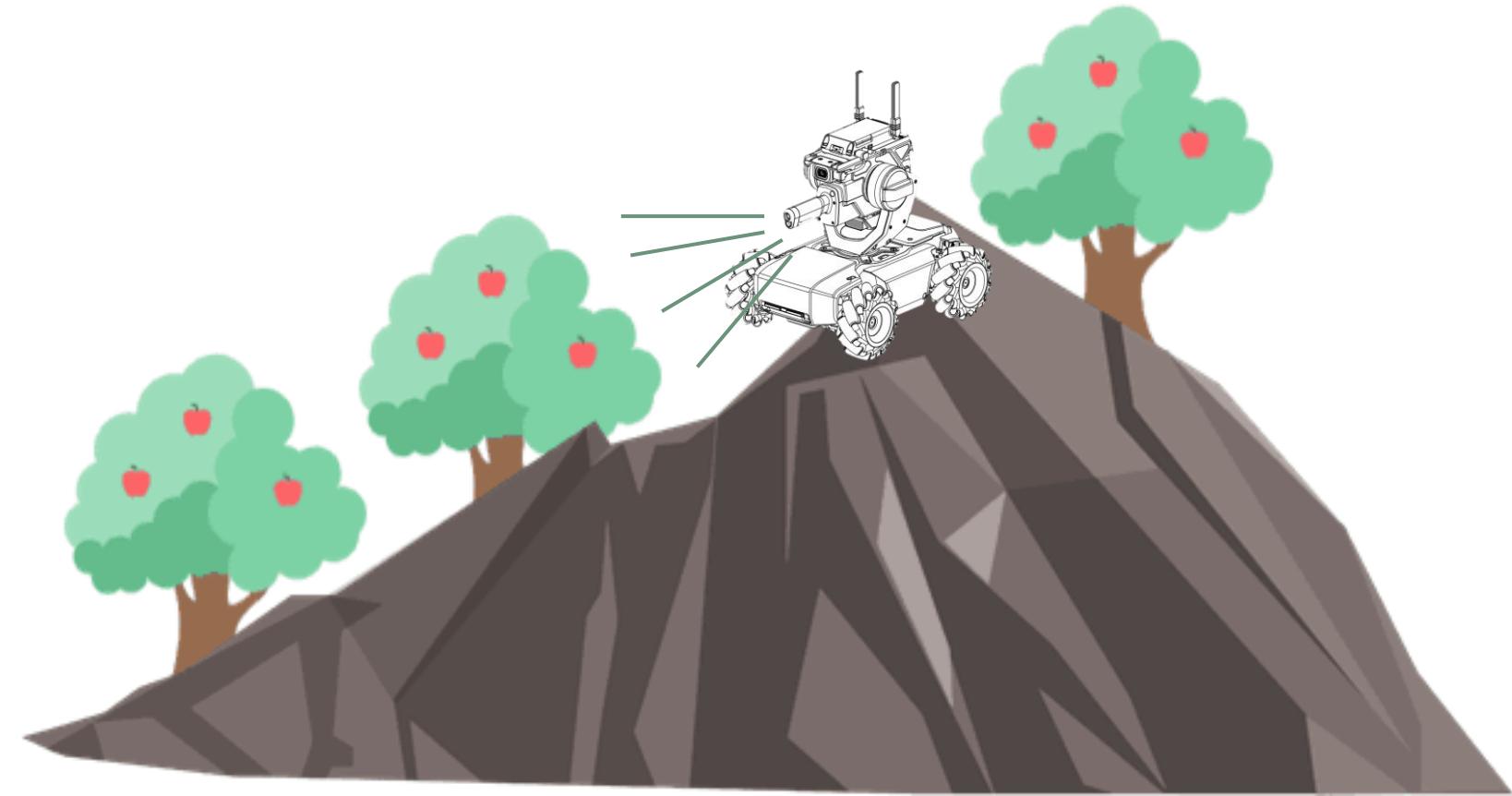


Complex terrain



me 4 months  
¥ 5 0 0 0

# Remote control



# Embedded Control

## Embedded Control

### Control Objectives



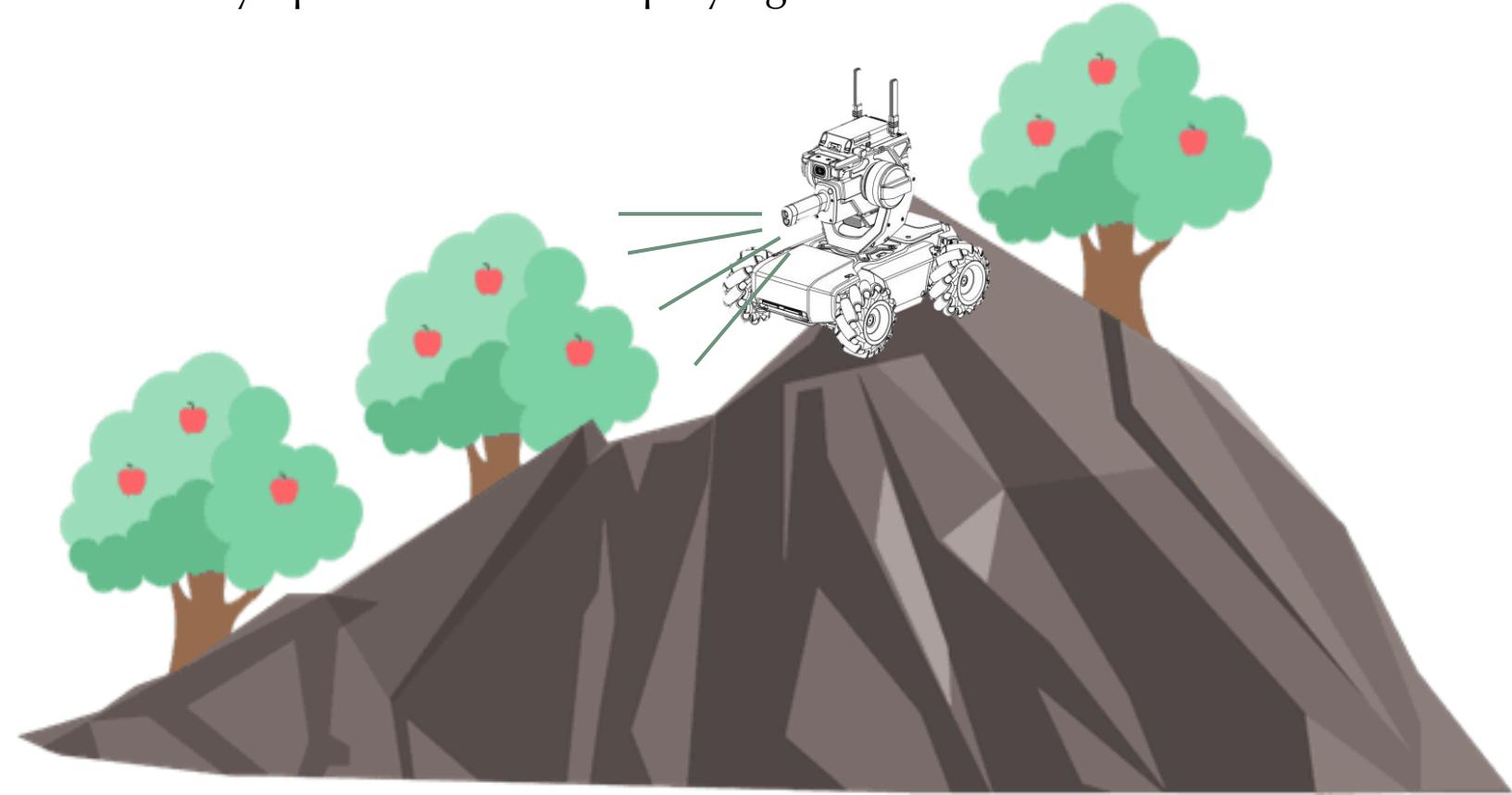
Flexible movement in hilly



Synchronous motor on the same side to prevent track failure



The operator remotely operates the robot spraying at the foot of the mountain

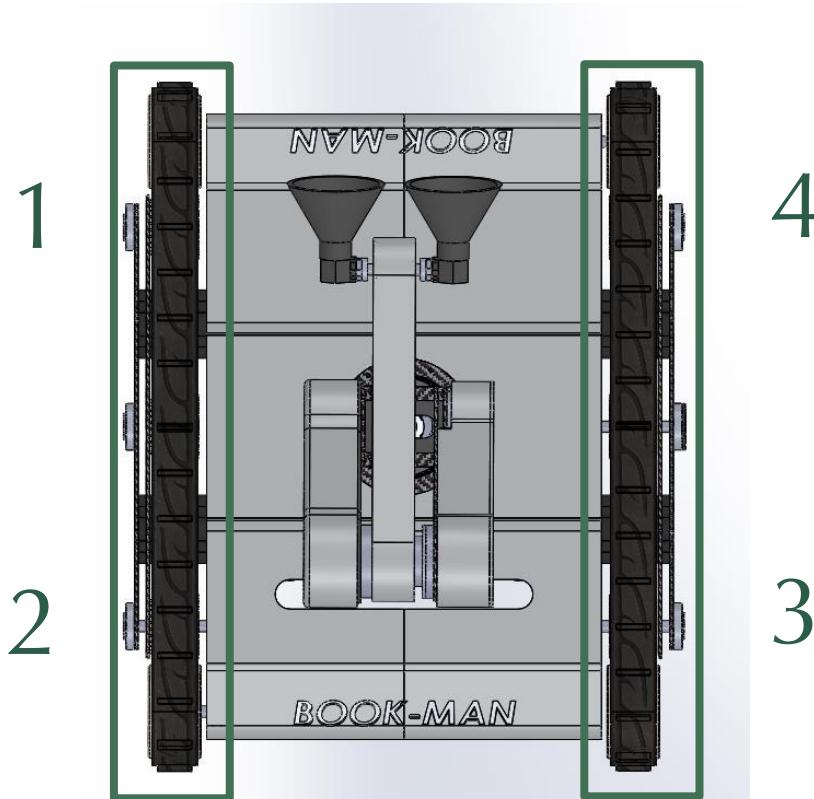


# Embedded Control

## Same-speed Control

Same-speed motor method:

1. the speed ring detects **different same-side motor speeds**
2. one motor **cut off at 0.01us** and follow the same-speed as the slave wheel



```
#include "Chassis_Control.h"

/**
 * @brief 3510电机速度环pid控制
 * @param setValue: 速度设定值
 *          fbValue: 速度反馈值
 *          result: 控制器输出
 *          T: 控制周期
 * @retval None
 */
void Chassis_PidControl(vec4f* setValue, vec4f* fbValue, vec4f* result, float T, u8 dimConVar)
{
    static pid chassisMotor[4];

    static u8 paraLoadFlag = 0;
    u8 indexConVar;

    /* 如果参数没有加载，加载参数，底盘四个电机PID参数默认相同 */
    if(!paraLoadFlag)
    {
        for(indexConVar = 0; indexConVar < dimConVar; indexConVar++)
            TDT_Get_PIDparameters(&chassisMotor[indexConVar], Chassis_Move);
        paraLoadFlag = 1;
    }

    /* 循环dimConVar次，分别进行PID控制 */
    for(indexConVar = 0; indexConVar < dimConVar; indexConVar++)
    {
        /* 设定值 */
        chassisMotor[indexConVar].setValue= setValue->data[indexConVar];

        /* 反馈值 */
        chassisMotor[indexConVar].feedbackValue = fbValue->data[indexConVar];

        /* 偏差 = 设定值 - 反馈值 */
        chassisMotor[indexConVar].error = chassisMotor[indexConVar].setValue -
            chassisMotor[indexConVar].feedbackValue;
        /* 偏差进行积分 */

        chassisMotor[indexConVar].integralError += chassisMotor[indexConVar].error * T;
    }
}
```

# Embedded Control

## Steering Control

```
#include "Chassis_Control.h"

/**
 * @brief 3510电机速度环pid控制
 * @param setValue: 速度设定值
 *          fbValue: 速度反馈值
 *          result: 控制器输出
 *          T: 控制周期
 * @retval None
 */
void Chassis_PidControl(vec4f* setValue, vec4f* fbValue, vec4f* result, float T, u8 dimConVar)
{
    static pid chassisMotor[4];
    static u8 paraLoadFlag = 0;
    u8 indexConVar;

    /* 如果参数没有加载，加载参数，底盘四个电机PID参数默认相同 */
    if(!paraLoadFlag)
    {
        for(indexConVar = 0; indexConVar < dimConVar; indexConVar++)
            TDT_Get_PIDparameters(&chassisMotor[indexConVar], Chassis_Move);
        paraLoadFlag = 1;
    }

    /* 循环dimConVar次，分别进行PID控制 */
    for(indexConVar = 0; indexConVar < dimConVar; indexConVar++)
    {
        /* 设定值 */
        chassisMotor[indexConVar].setValue= setValue->data[indexConVar];

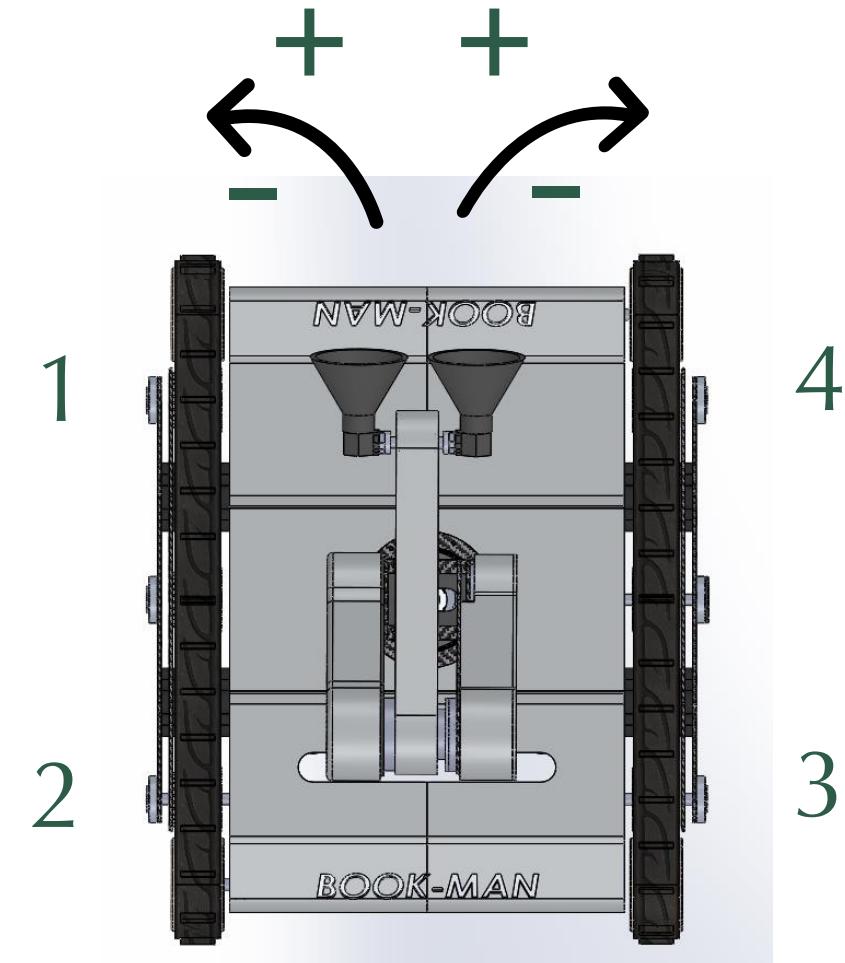
        /* 反馈值 */
        chassisMotor[indexConVar].feedbackValue = fbValue->data[indexConVar];

        /* 偏差 = 设定值 - 反馈值 */
        chassisMotor[indexConVar].error = chassisMotor[indexConVar].setValue -
            chassisMotor[indexConVar].feedbackValue;
        /* 偏差进行积分 */

        chassisMotor[indexConVar].integralError += chassisMotor[indexConVar].error * T;
    }
}
```

Flexible steering control method:

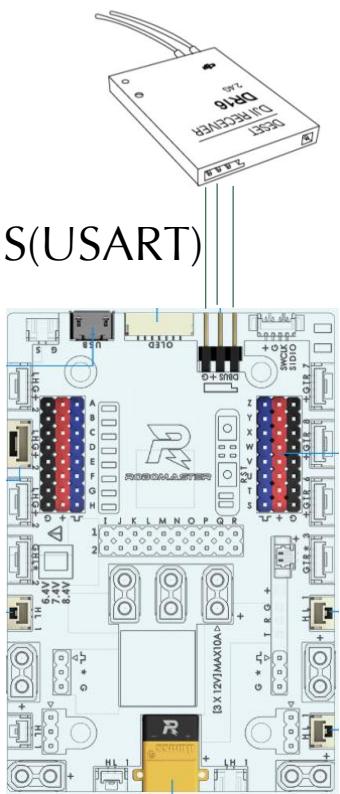
1. **four-wheel drive and**
2. the two-sided **differential control**



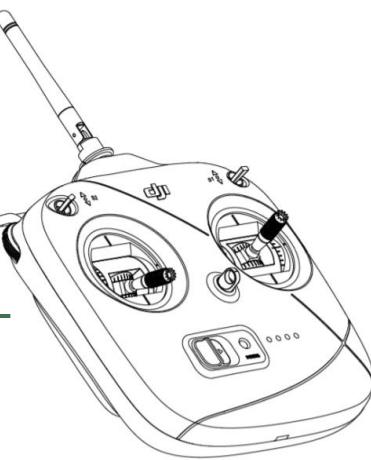
# Embedded Control

## Remote Control

Receiver



2.4GHz



Remote controller

### Major parameters

Operating frequency 2.4G Hz

Communication distance >1000m

Working hours 10h

```
#include "dbus.h"
//DBUS 与串口1复用, RX-PB7
rc NDJ6;
int16_t subus_decode_keboard_buffer[16]; //keyboard data键盘上的数据
unsigned char subus_rx_buffer[18];

void TDT_Dbus_Configuration(void)
{
    USART_InitTypeDef USART_InitStructure;
    GPIO_InitTypeDef GPIO_InitStructure;
    NVIC_InitTypeDef NVIC_InitStructure;
    DMA_InitTypeDef DMA_InitStructure;

    RCC_AHB1PeriphClockCmd(RCC_AHB1Periph_GPIOB |
                           RCC_AHB1Periph_DMA1,ENABLE);
                           // RCC_APB1PeriphClockCmd(RCC_APB1Periph_USART2,ENABLE); 为什么开的串口2
    RCC_APB2PeriphClockCmd(RCC_APB2Periph_USART1,ENABLE);

    // GPIO_PinAFConfig(GPIOA,GPIO_PinSource3 ,GPIO_AF_USART3); 这里是串口3
    GPIO_PinAFConfig(GPIOB,GPIO_PinSource7 ,GPIO_AF_USART1);

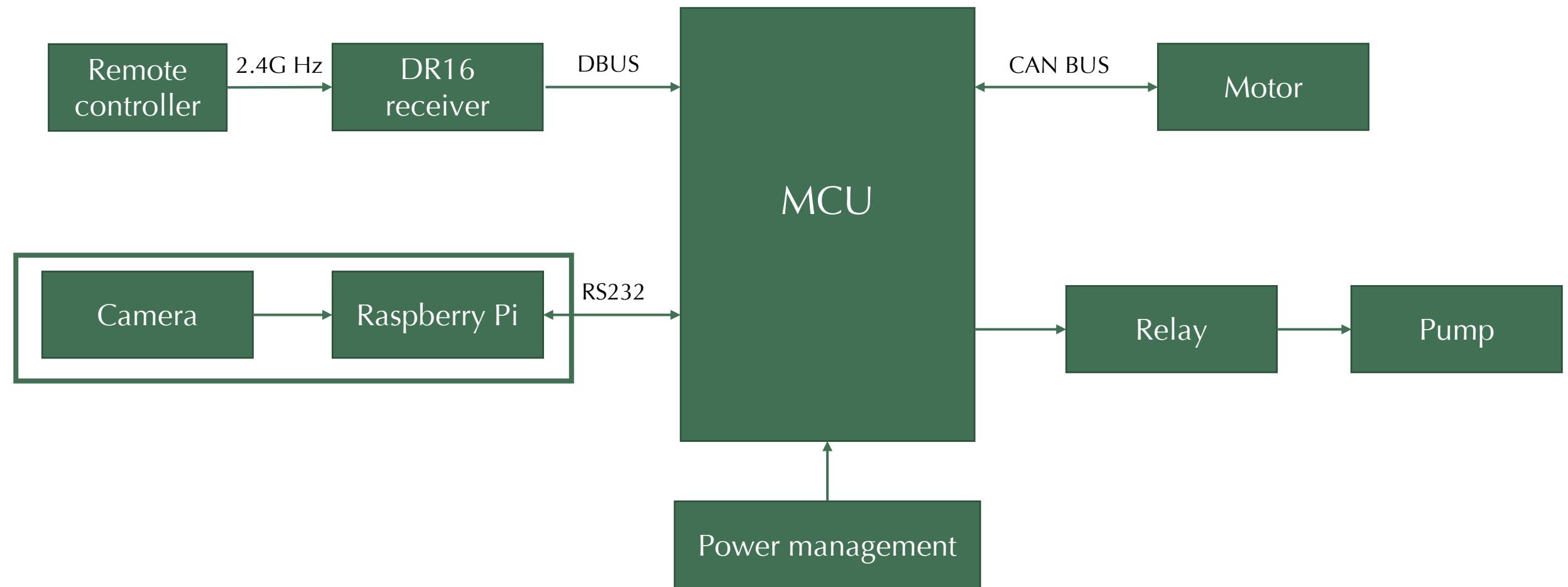
    GPIO_InitStructure.GPIO_Pin = GPIO_Pin_7;
    GPIO_InitStructure.GPIO_Mode = GPIO_Mode_AF;
    GPIO_InitStructure.GPIO_OType = GPIO_OType_PP;
    GPIO_InitStructure.GPIO_Speed = GPIO_Speed_100MHz;
    GPIO_InitStructure.GPIO_PuPd = GPIO_PuPd_NOPULL;
    GPIO_Init(GPIOB,&GPIO_InitStructure);

    USART_DeInit(USART1);
    USART_InitStructureUSART_BaudRate = 100000;
    USART_InitStructureUSART_WordLength = USART_WordLength_8b;
    USART_InitStructureUSART_StopBits = USART_StopBits_1;
    USART_InitStructureUSART_Parity = USART_Parity_No;
    USART_InitStructureUSART_Mode = USART_Mode_Tx|USART_Mode_Rx;
    USART_InitStructureUSART_HardwareFlowControl =
        USART_HardwareFlowControl_None;
    USART_Init(USART1,&USART_InitStructure);

    USART_Cmd(USART1,ENABLE);
```

# Embedded Control

## Hardware Control Block Diagram





Individual contribution

# IMAGE TRANSMISSION

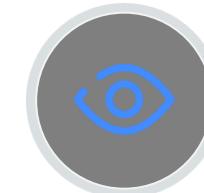
Huixin Ju



# Image Transmission Requirement Analysis

We want  
a pair of eyes

To see:  
Condition of the road;  
Animals as obstacles;  
Or any states preventing from  
going forward.



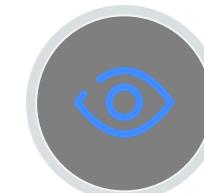
No need of high clarity

- Send basic images.



Real time transmission

- See the current situation of the robot.

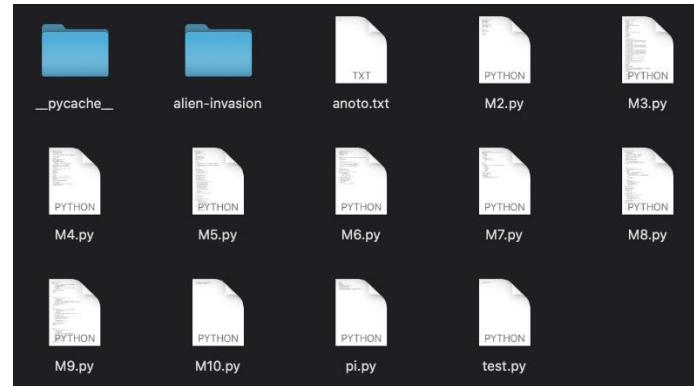


Not much cost

- Lower the cost.

# Image Transmission

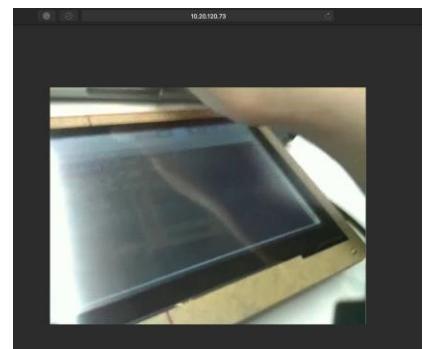
## Learning Process



# Image Transmission Realizing Process

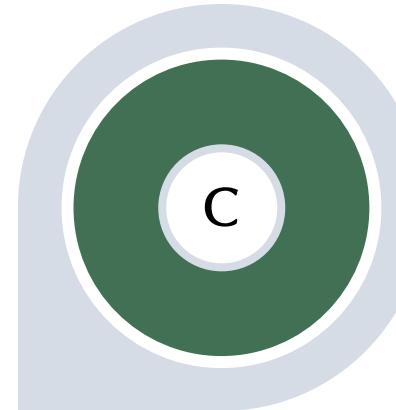


# Image Transmission Limitations



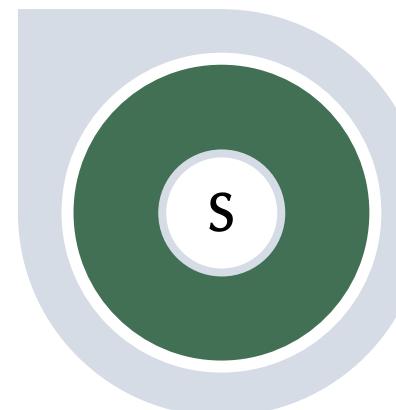
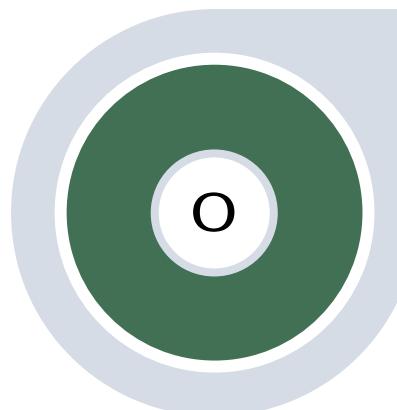
Only able in the same Wi-Fi

Requirement of scale of WI-FI



Operation complexity

Need to startup code



Low Clarity

Unfriend with extension of CV exploration

Stability

Stability of websocket is guaranteed

B O O K M A N



Individual contribution

GUI

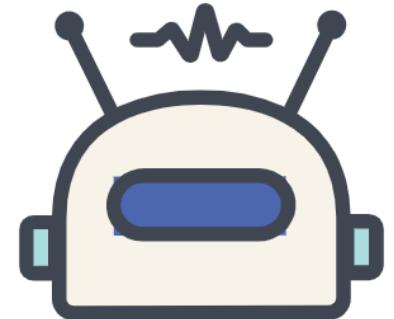
Wei GU





GUI: Graphical User Interface

Display real-time pictures taken by the camera



Display the real-time status of the robot

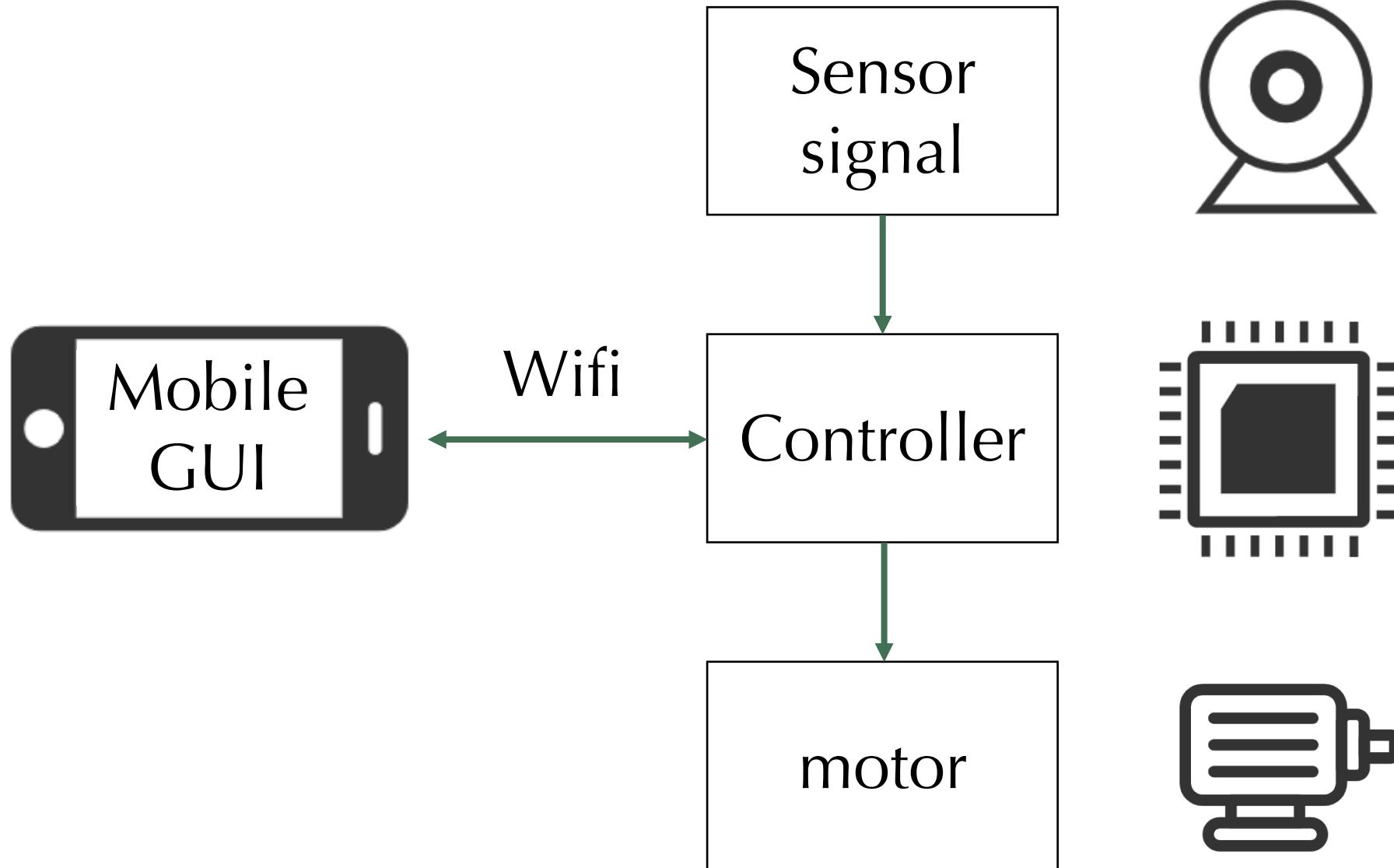


Control the movement of the robot



# GUI

## Working Principle



# GUI

## Expected Interface

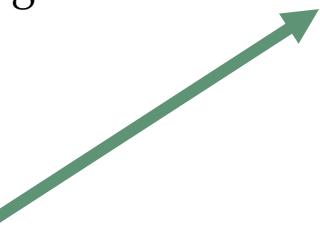
Control movement of robot

Control the height of nozzle

Spray switch

Display the position of robot

Display the remaining water  
and electricity



B O O K M A N



Individual contribution

# Project MANAGEMENT

Xibin CHEN



# Project Management

## Schedule

Drawing Sketches

2020/3/17 2020/3/27 2020/4/5 2020/4/15 2020/4/26 2020/5/8 2020/5/16 2020/6/1

Plan  
Actual Implementation

Design Control Scheme

Supplies Purchasing

Debugging of each sensor module

Design GUI interfacial

Design machine structure

1<sup>st</sup> generation 2<sup>nd</sup> generation 3<sup>rd</sup> generation

Assembly robot

Function test

Achievement presentation

# Project Management

## Budget

Category	Product	Qty	Unit	Ets. Price
Structural component	Screw standard	3	37	111
	Caterpillar band	3	45	135
	Synchronous pulley	12	15	180
	Water tank	1	60	60
	Tanks framework	4	100	400
Electron device	Gear motor	6	50	300
	Servo	5	30	150
	GPS sensor	1	118	118
	Ultrasonic sensor	10	10	100
	Infrared sensor	4	5	20
	Laser distance sensor	1	48	48
	Water level sensor	4	40	160
	Pressure sensor	1	110	110
	Camera	1	980	980
	Raspberry Pi	1	820	820
	Stm32f103	3	40	120
	Gunjet	1	50	50
<b>Total</b>				<b>3862</b>

**Reimbursement Amount:** **¥5000**

**Actual expenses:**

序号	物品/项目名称	规格型号	牌子	数量	单价	总价	用途
No.	Pro.Name	Specification	Brand	Qty	Unit	Ets.Price	Purpose
1	压力传感器	40公斤方称条	zave	1	46	46	课程项目学习
2	压力传感器模块	HX71	zave	2	5	10	课程项目学习
3	红外传感器	EL8-100N	平衡小车之家	2	21	42	课程项目学习
4	超声波传感器	HJ-S00	Risym	7	7	49	课程项目学习
5	热风枪工具	WOWSTICK 1P	小米	1	197	197	课程项目学习
12	<b>总计 Tot</b>					344	

备注:



# Project Management

## Github



BOOK MAN

Repositories 6 Packages People 6 Teams Projects Settings

Find a repository... Type: All ▾ Customize pins New

### Robot-Structure

Crawler robot structure design (including drawings and effect display)

0 0 0 0 Updated 15 hours ago

### Assembly

机器人组装过程

0 0 0 0 Updated yesterday

### Base-station

Base station related files

0 0 0 0 Updated 2 days ago

### Minutes

Discussion results in every week's lab course

0 0 0 0 Updated on 30 Mar

### control

控制框图

0 0 0 0 Updated on 30 Mar

Record every effort...

Keep going...

Never settle...

People 6 >		
Manubu-Yukawa Add files via upload		Latest commit 212e9da 15 hours ago
mobile robot v0.JPG Add files via upload		15 hours ago
3.27 Add files via upload		26 days ago
4.11version Add files via upload		last month
4.22version Add files via upload		last month
5.14version Add files via upload		26 days ago
5.5version Add files via upload		last month
6.9version Add files via upload		2 days ago
renderedGraph.png Add files via upload		2 days ago
mobile robot v3.9.JPG Add files via upload		15 hours ago
robot arm_V1.JPG Add files via upload		15 hours ago

# Project Management

## Follow-up Work

### Add more sensors. Committed to a higher degree of automation.

Add distance sensors to avoid obstacles.

Add cameras for computer vision recognition.

### Integrating AI algorithm.

Accurately identify each fruit tree and automatically generate the disinfection path. On the premise of ensuring comprehensive disinfection, it is faster and more efficient.

### Perfect the design of base station.

A charger.

A reservoir.

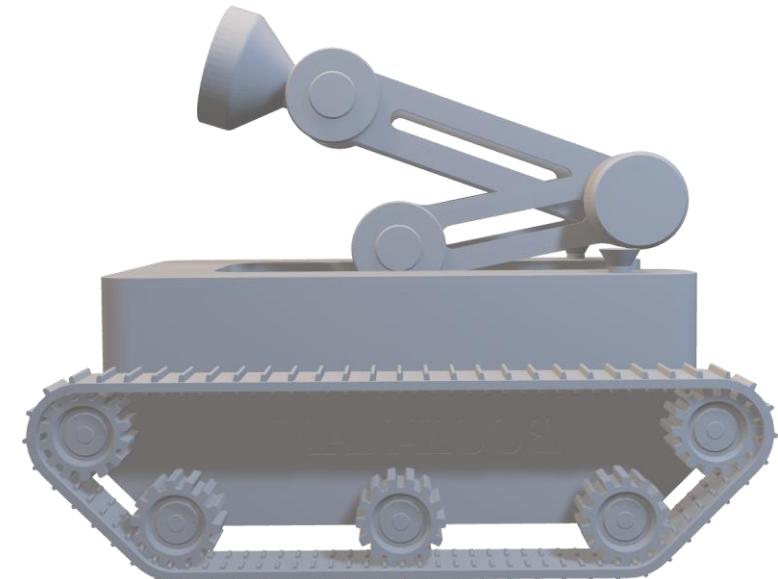
A garage.

(A node.)

### Implement GUI function.

Display work path.

Update robot status from time to time.



# Project Management

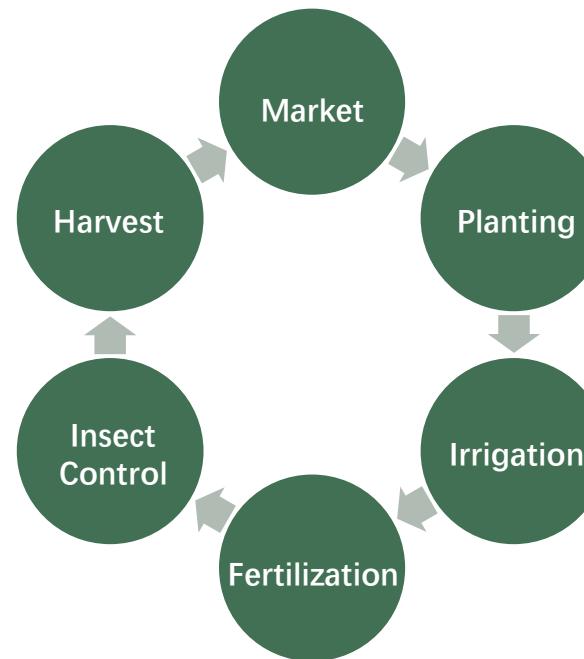
We want to...



Only a trivial starting point...



In the future...



Future

Agriculture



**THANKS!**

**1** robot.

**6** people.

**18** weeks.

**126** days.

01

- Such a beautiful video

02

- Such a satisfactory course project

03

- Such an unforgettable experience

04

- So capable of you