

第五章：Move the chassis

RoboMaster 机器人与人工智能课



C O N T E N T

目 录

1 · 课前思考

2 · 知识储备

3 · 工程实践

4 · 总结反思



波士顿动力公司的Atlas

Bi-legged robots mimic the way humans move upright, which may seem very flexible, but in fact the balance is not good to control. In fact, for most ground mobile robots, stable, flexible movement is not easy.



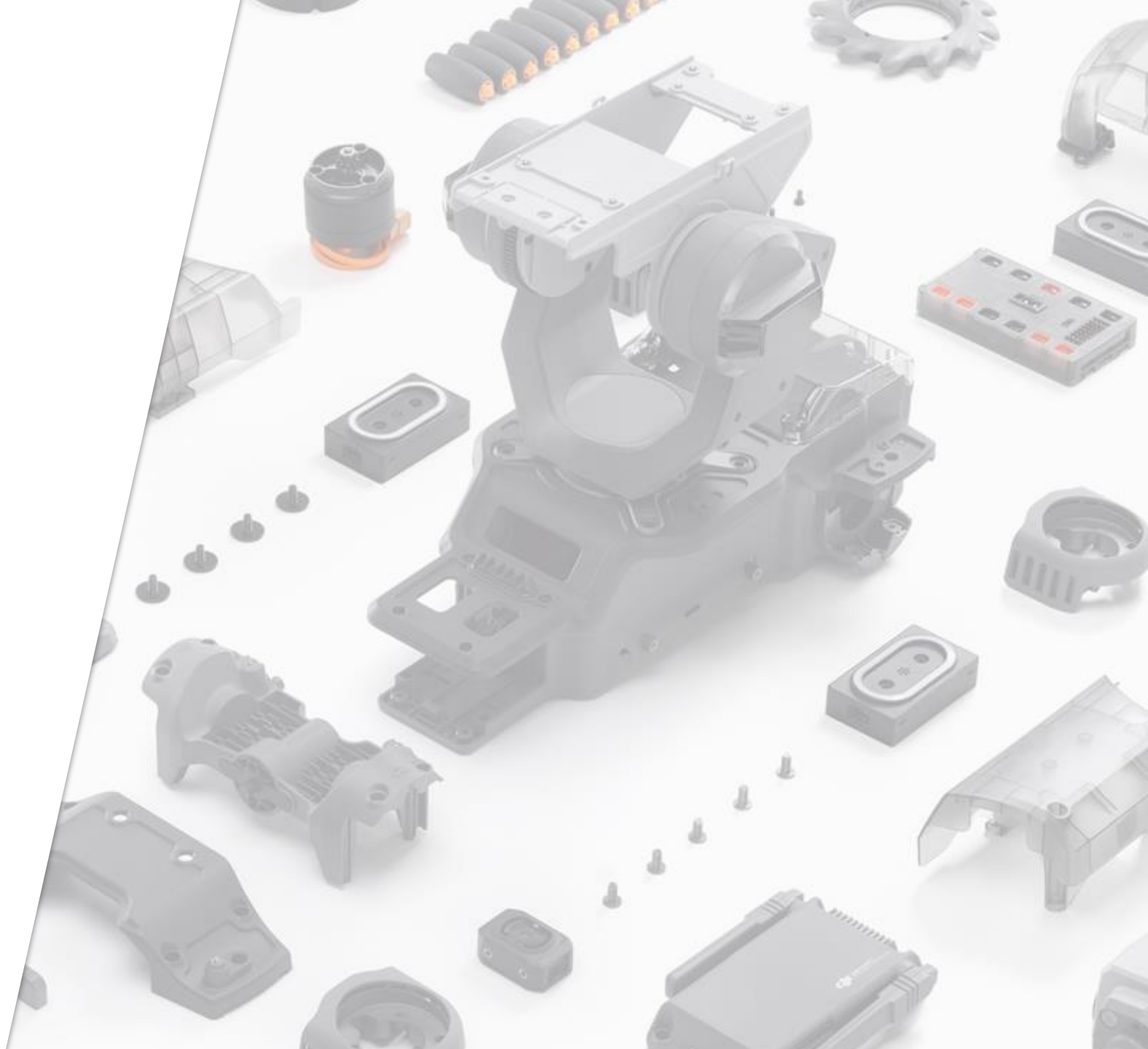
一、课前思考

1. What are the advantages of a robot that advances on wheels and walks on its legs?
2. What are the ways robots move?
3. What would you like to do if you had the opportunity to design a robot chassis?



二、知识储备

1. What is a chassis
2. Robot chassis
3. mecanum wheel



1. 什么是底盘

对于地面移动机器人来说，底盘是非常重要的执行器，通常位于机器人靠近地面的部分。

底盘的定义：移动机器人用于移动的部分通常称为底盘。

底盘的作用：负责机器人的运动和转向，是机器人的执行机构。



1. 什么是底盘

应用案例：

扫地机器人的工作目标是清理地面上的细小垃圾。用户往往会关注它能否灵活移动到各个死角并打扫干净。

在扫地机器人运行过程中，底盘除了要能够朝各个方向移动之外，还要能够跨越高低不同的电线、门槛等。所以扫地机器人的底盘通常会离地面有一定高度，便于底部滚轮移动，同时方便清理垃圾。



2. 机器人底盘

腿足式：自由度高、适应性强
结构复杂、控制难度大



腿足式机器人

轮式：结构简单、越野性好、
移动灵活



四轮全向轮底盘

2. 机器人底盘

履带式机器人：路况适应性好、越障能力强、移动速度较慢



履带式机器人

球形：具有良好的动态和静态平衡性，具有水陆两栖功能



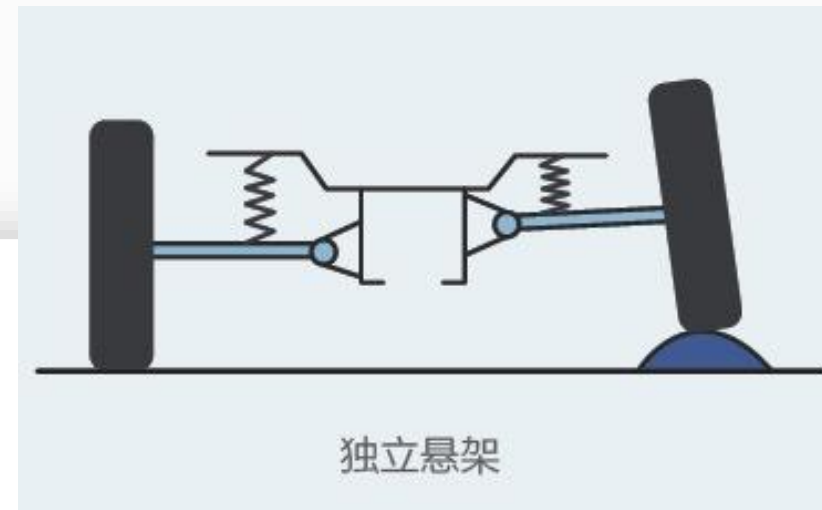
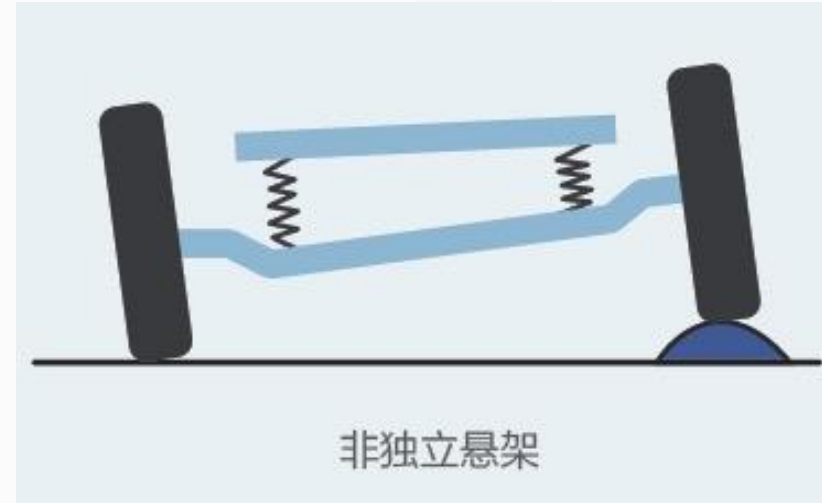
球形机器人

2. 机器人底盘

Chassis suspension is a structure that connects the wheels to the body, which can support and cushion the body.

Non-independent suspension: the advantage is simple construction, low manufacturing costs, easy maintenance, the disadvantage is stability and shock-absorbing effect is poor.

Independent suspension: The advantage is that the wheels on both sides can move independently without affecting each other, and the cushioning and dams are very strong.



3. 麦克纳姆轮

麦克纳姆轮简称麦轮，它是一种具有全向运动特性的轮子。是由瑞典科学家Bengt Erland Ilon于上世纪70年代瑞典麦克纳姆公司发明的。

装配了麦轮的仓储物流车灵活性大幅提高，即便活动空间有限，在使用了灵活运动麦轮后，货物装卸难的问题也能得到解决。



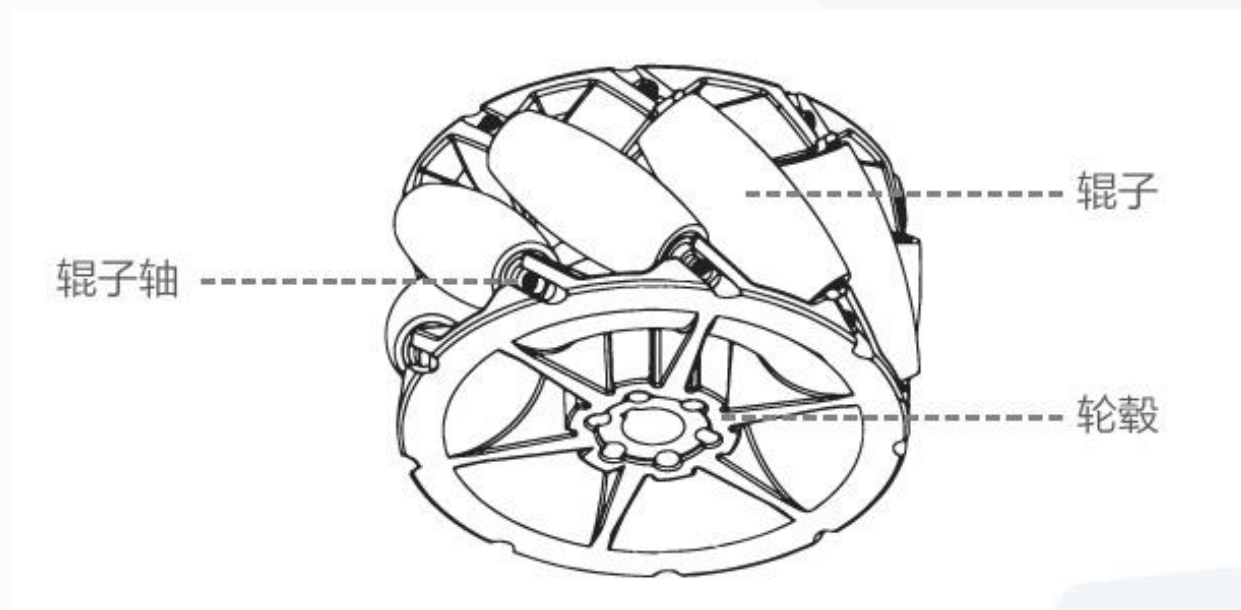
3. 麦克纳姆轮

Wheelchairs fitted with wheels will also make it easier for people with disabilities to travel



3. 麦克纳姆轮

The wheel is mainly composed of wheels, rollers and roller shafts, the wheels are support frames, rollers are arranged in parallel with the angle of the hub angle of 45 degrees.



3. 麦克纳姆轮

The RoboMaster robot has two left wheels and two right wheels. The left and right wheels must be X-shaped in order for the RoboMaster robot to move in all directions.



3. 麦克纳姆轮

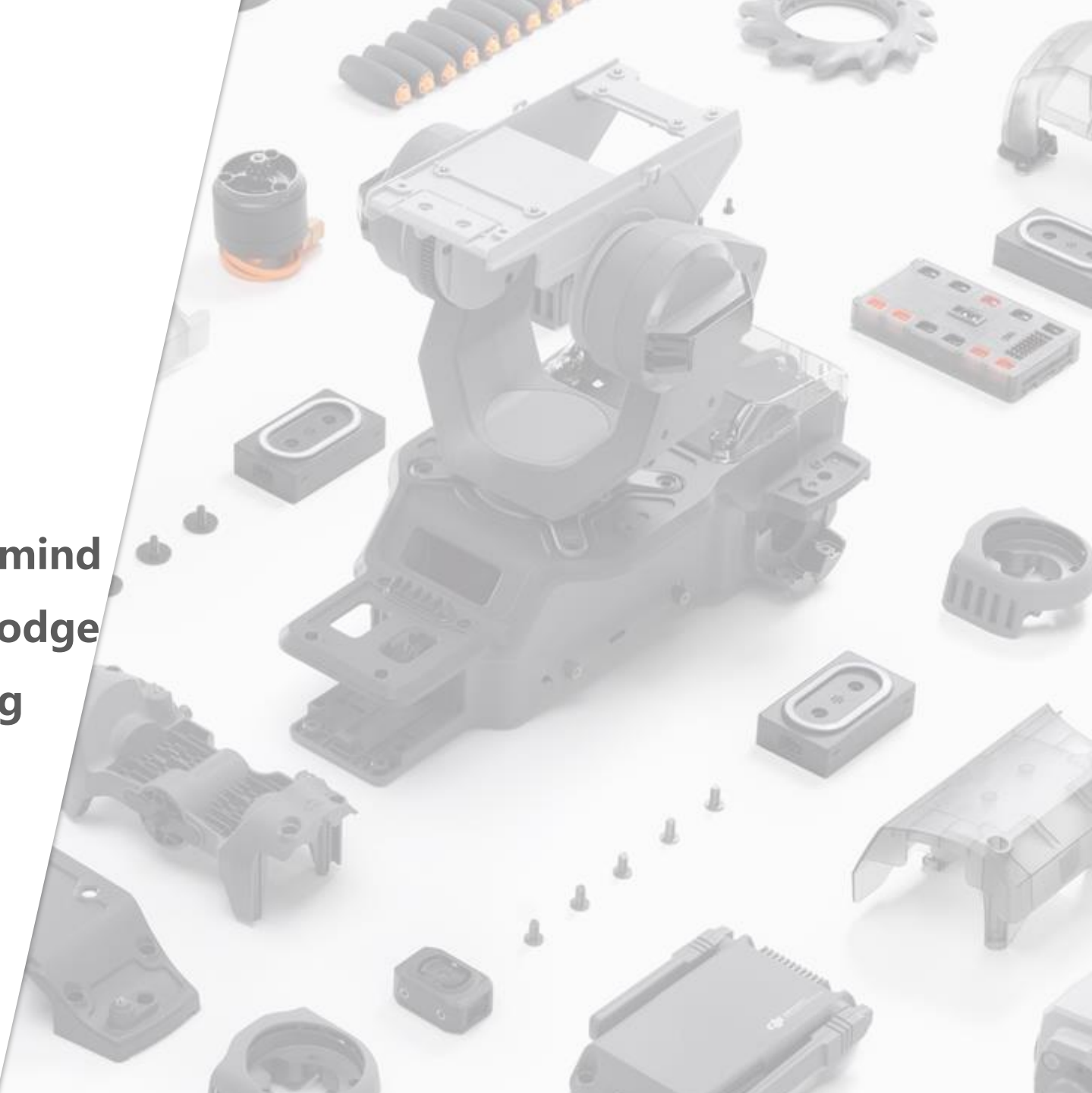
S1 robot's wheel arrangement:
Four mecanum wheels, two left wheels, two right wheels

Mecanum Wheel Force Analysis:
Take the case of S1 panning forward, i.e. all four wheels are moving forward:



三、工程实践

1. Practical knowledge
2. Case: Flexible chassis
3. Explore: Don't be out of your mind
4. Challenge: Brush the pan to dodge
5. Mission Library: Figure Skating



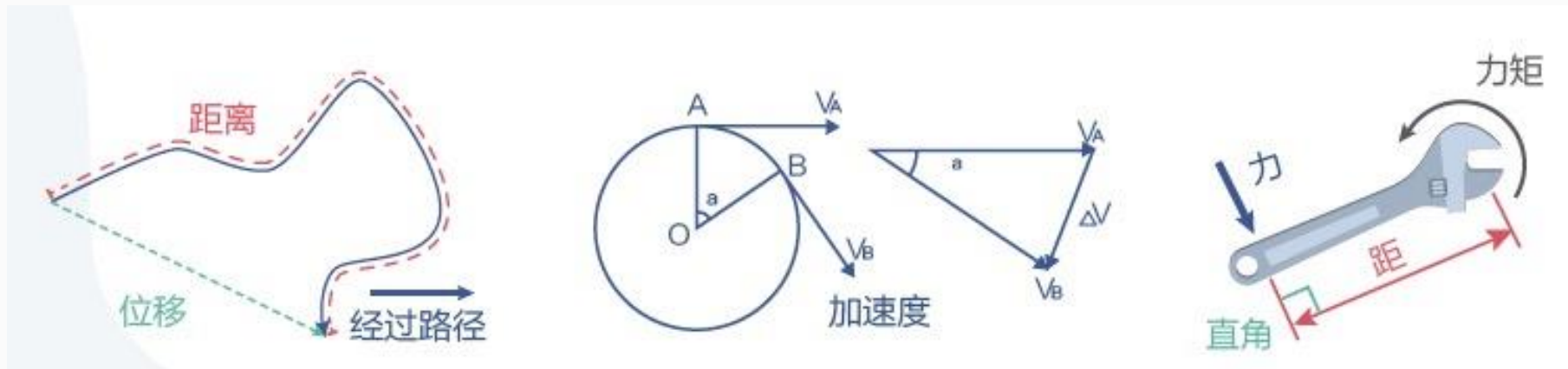
1. 实践知识：标量和向量

Scale: Scalar, also known as purity. Scale refers to physical quantities that have only size and no direction, such as mass, volume, time, rate (Speed), and so on. Some of these measures have negative values, such as temperature.



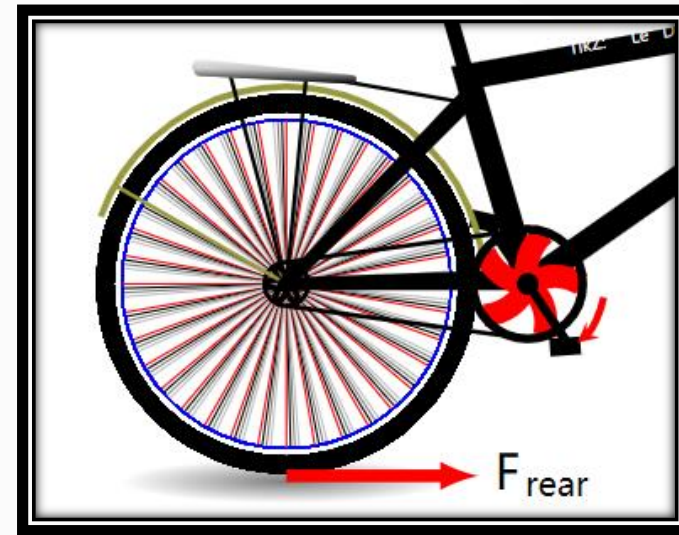
1. 实践知识：标量和向量

Scalar: Scalar, also known as scalar, as opposite to a vector. Scalar refers to the physical quantity of both size and direction. For example, displacement, speed (Velocity), acceleration, force, torque, etc.



1. Practical knowledge: friction

The direction of friction is opposite to the direction of motion of an object. The drive wheels (e.g. bicycles or rear wheels, which are dynamic wheels that actively drive the movement of objects) move relative to the rear, so the friction direction is forward.



1. 实践知识：牛顿三定律

牛顿三定律：

1. 一个物体在没有受到外力作用的时候，该物体的运动速度保持不变（静止或直线匀速运动）；
2. 施加于物体的外力等于此时物体的质量与加速度的乘积（ $F=ma$ ）
3. 当两个物体互相作用于对方时，施加于彼此的力大小相等，方向相反（二力平衡）



1. 实践知识：单个麦轮受力分析

Force is one of the common vectors, S1 robot chassis can achieve all-direction movement can not be separated from "force"

The paper moves 45 degrees to the left, and according to Newton's third law, the mecanum wheel and the ground are applied to each other in the same force size and in opposite directions (force and reaction), so the wheel is subjected to the same size reaction force from the "ground" in the direction of 45 degrees to the front right



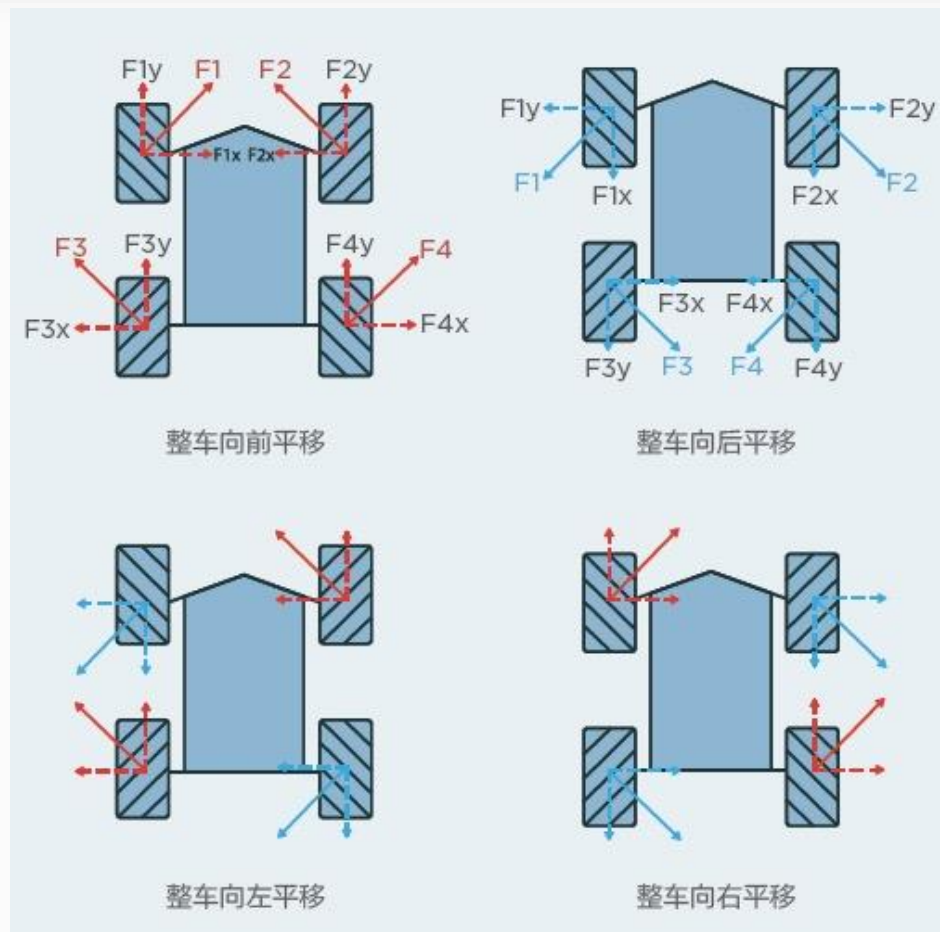
1. Practical knowledge: mecanum single wheel force analysis

When the right-hand wheel is pushed forward by hand, the right-hand wheel is subjected to friction 45 degrees to the front left. The force of a single wheel can be easily analyzed as long as it is judged according to the "the direction of friction of the object is opposite to the direction of motion of the object". The direction of the stick in the picture is the force of the stick in actual contact with the ground (note the perspective relationship)



Practical knowledge: the whole machine force analysis

Note: The red arrow indicates that the wheel is moving forward and the blue arrow indicates that the wheel is turning back



S1机器人向前、向后、向左、向右平移受力分析

Practical knowledge: the whole machine force analysis

The analysis method of rotation is the same, taking S1 robot clockwise rotation as an example, the wheel wheels are decomposed by force as follows:



2. Case: Flexible chassis

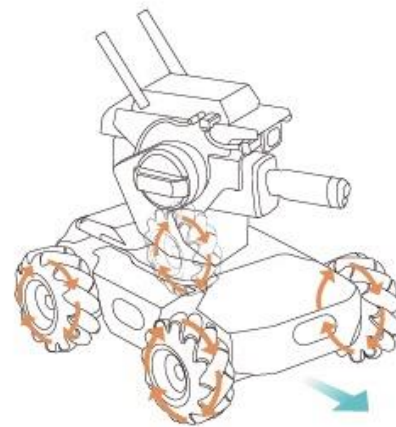


Introduction to the project:
By controlling the speed of the four motors, we can skillfully advance, reverse, accelerate and decelerate the S1.
Now let's take a quick look at the steering pairing of the wheel as the S1 pans in the other direction, and then try to summarize the law.

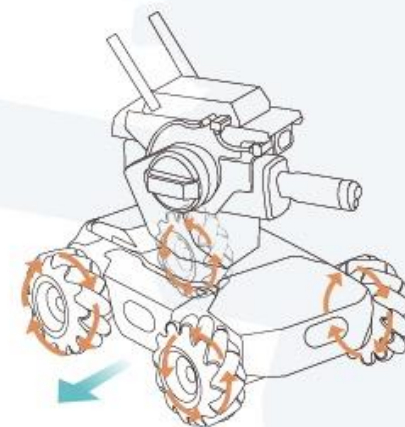
. Case: Flexible chassis

Thought guidance:

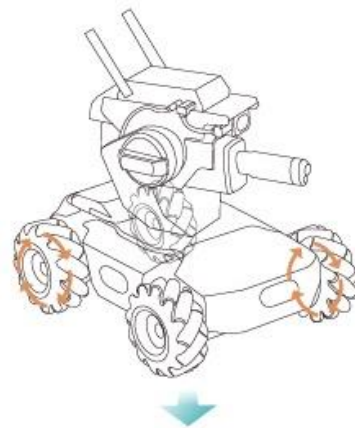
According to the definition of the wheel rotation, under the four pictures, combined with force analysis, in order of the left front wheel, right front wheel, left rear wheel, right rear wheel, write down the three rotation states of the wheel: positive, reverse, do not turn.



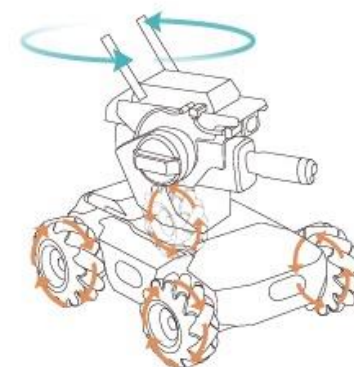
直行: 正、正、正、正



向右平移: _____、_____、_____、_____



向右前方平移: _____、_____、_____、_____

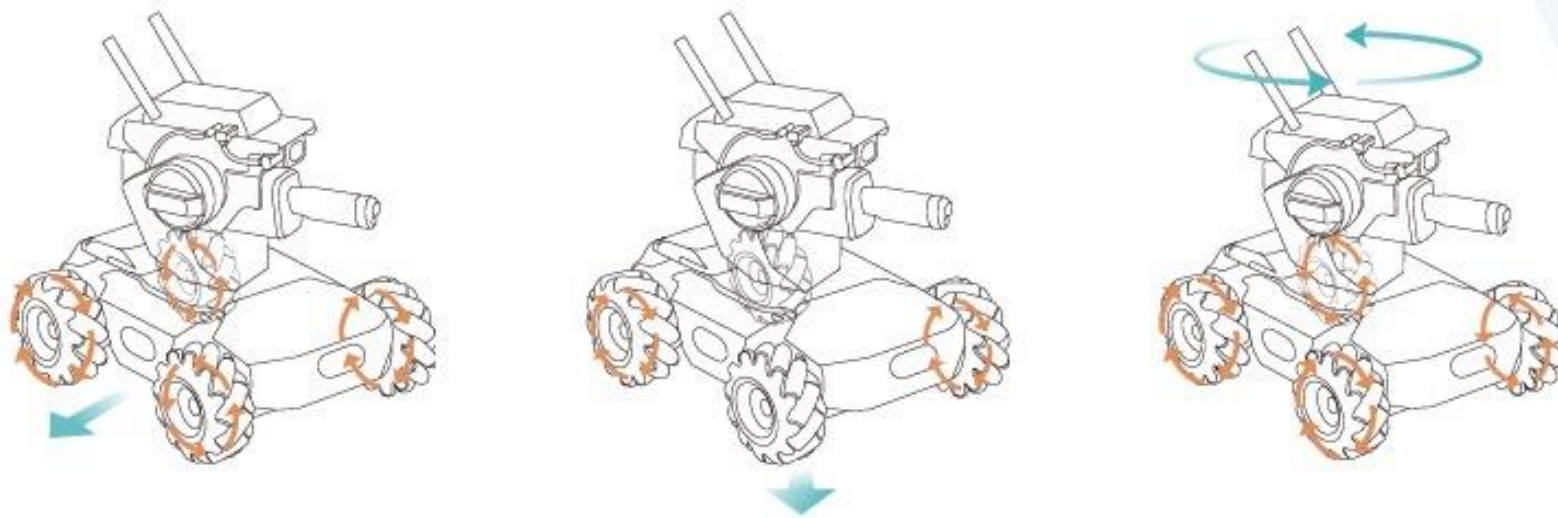


逆时针旋转: _____、_____、_____、_____

2. 案例：灵活的底盘

答案：

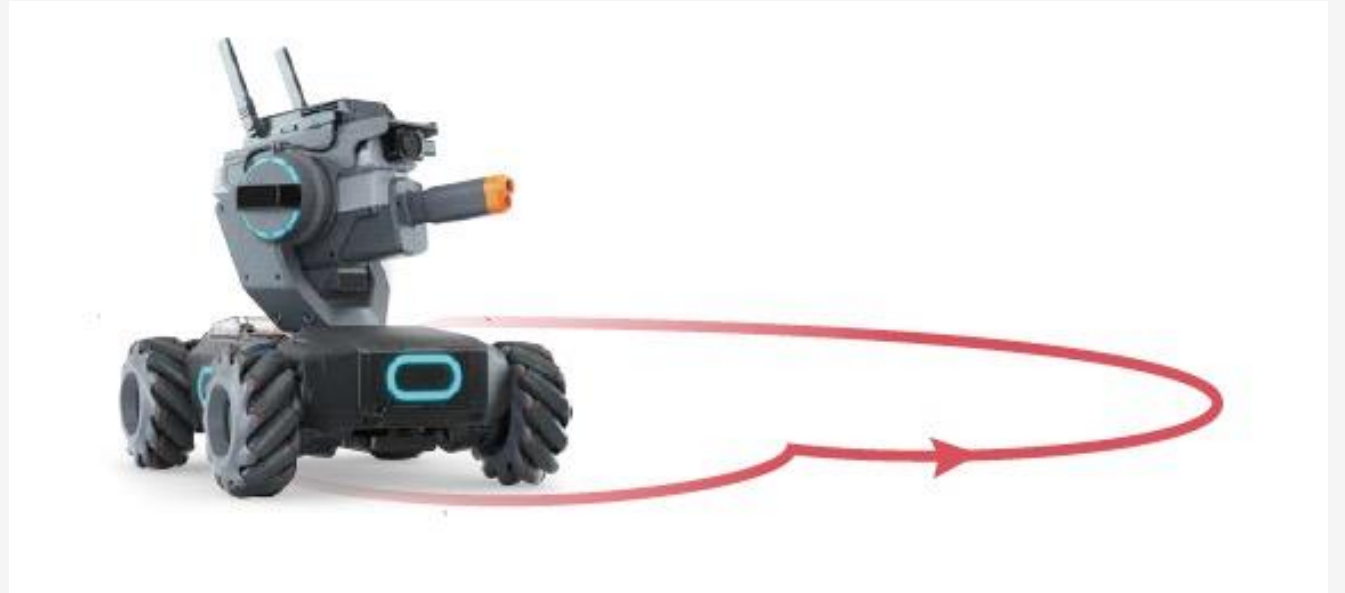
向右平移：正、反、反、正；向右前平移：正、不转、不转、正
逆时针旋转：反、正、反、正



3. Explore: New Maneuverer 别出心裁

Introduction to the project:

Just learned a variety of S1 movement methods. Let explore drawing a heart shape !



3. Explore: New Maneuverer

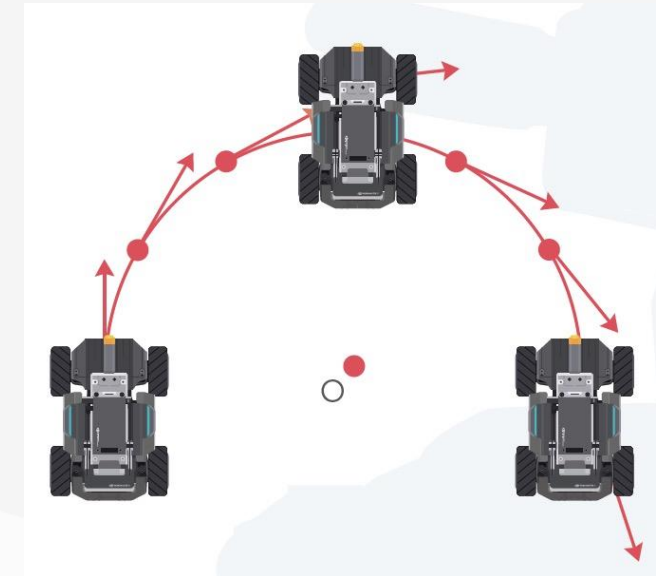
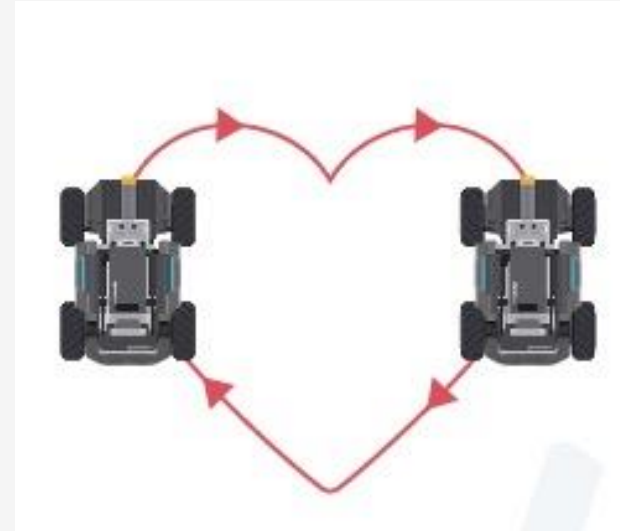
Thought guidance:

Break down the heart shape into a few simple actions, such as the right image:

A heart shape can be thought of as a shape consisting of two half arcs and two slashes.

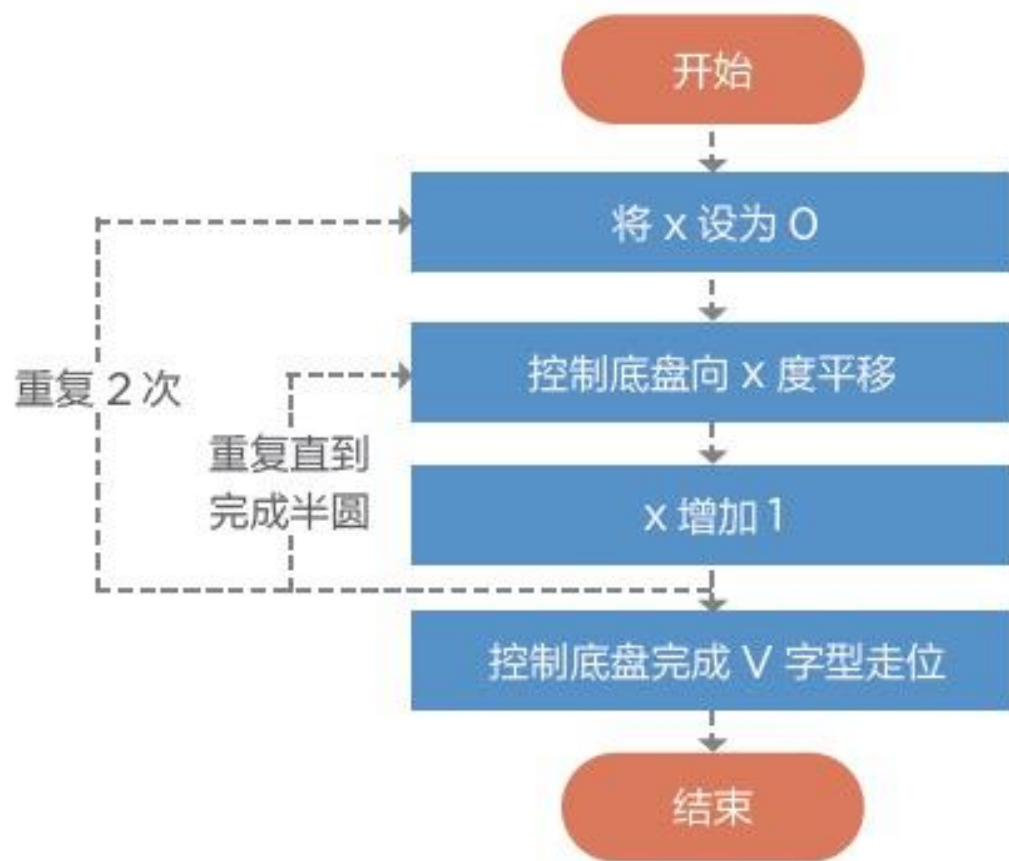
控制底盘以 0.5 米/秒向 0 度平移

he
peed and
angle of the translation, and
we can use loops and variables
to gradually increase the angle
of the translation from 0
degrees to 180 degrees.



3. Explore: New Maneuverer

流程图：



答案：

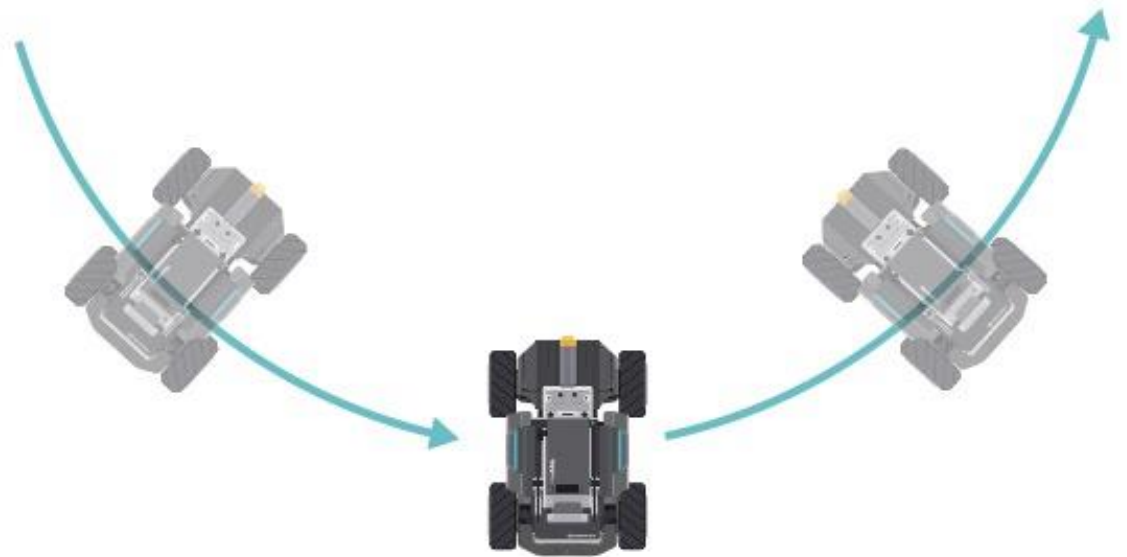


Challenge: Brush the pan to avoid

Introduction to the project:

In the RoboMaster Armor Masters, infantry robots dodge each other's attacks by brushing the pot back and forth quickly and at short distances, because the trajectory is curved, making it difficult for the other side to aim. A mecanum chassis with great mobility is the key to this function.

Programming controls S1 to achieve three consecutive brush-pot dodges to the left, right, and left.



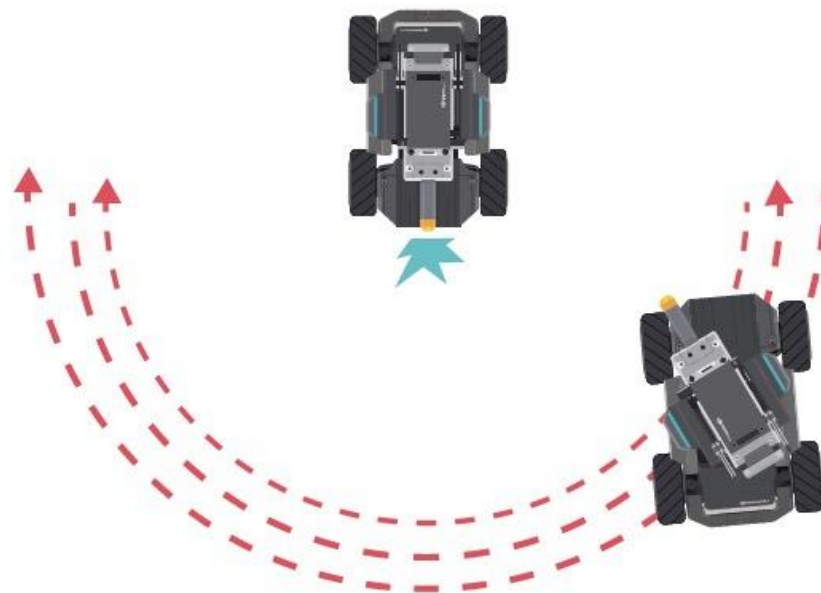
Challenge: Brush the pan to avoid

Thought guidance:

The action of brushing the pot with a simple packaged chassis module

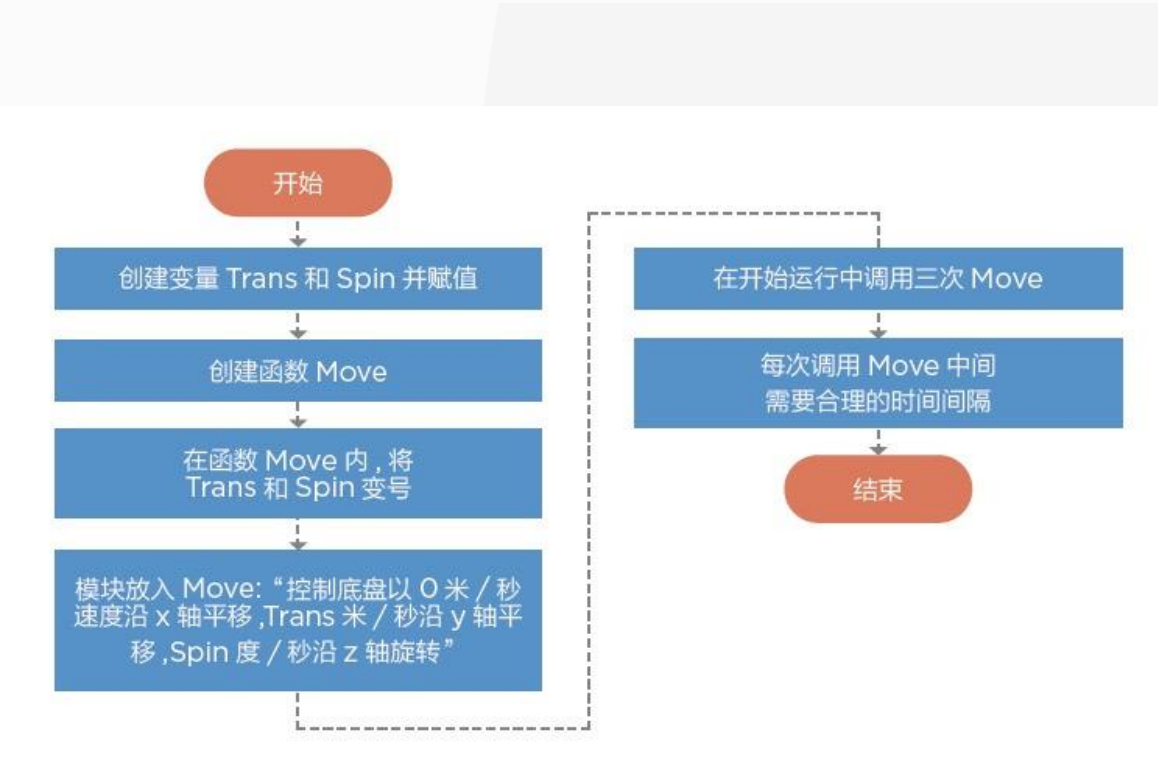
控制底盘以 0.5 米/秒沿x轴平移 0.5 米/秒沿Y轴平移 30 度/秒绕Z轴旋转

may seem complex and can actually be seen as an overlay of the action of horizontal translation and in-place rotation.

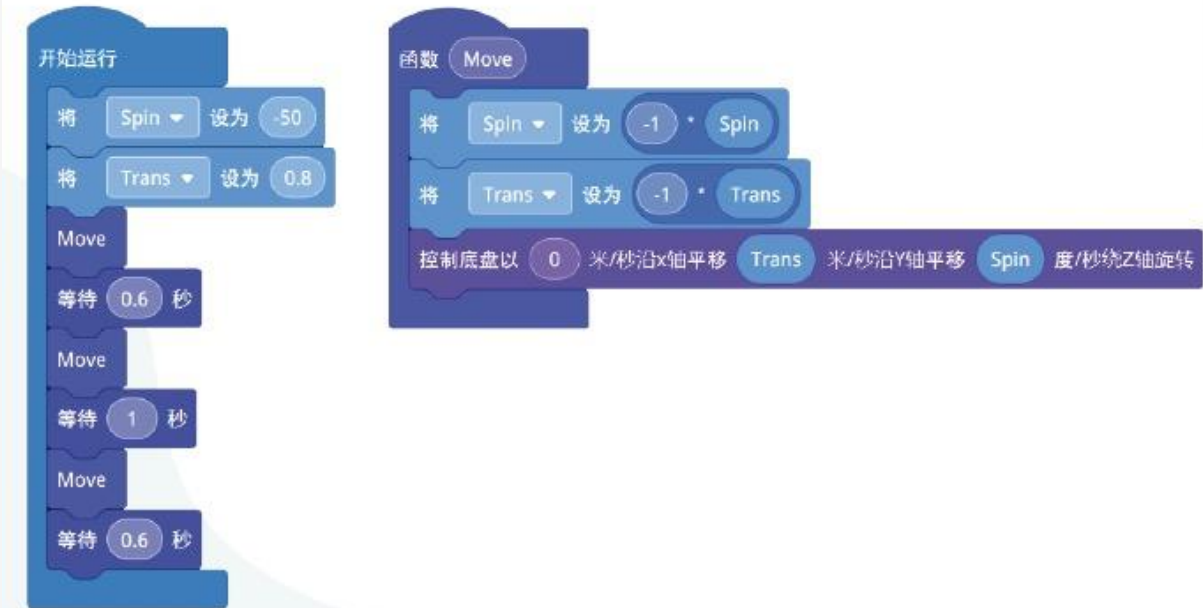


4. Challenge: Brush the pan to avoid

流程图:



答案:

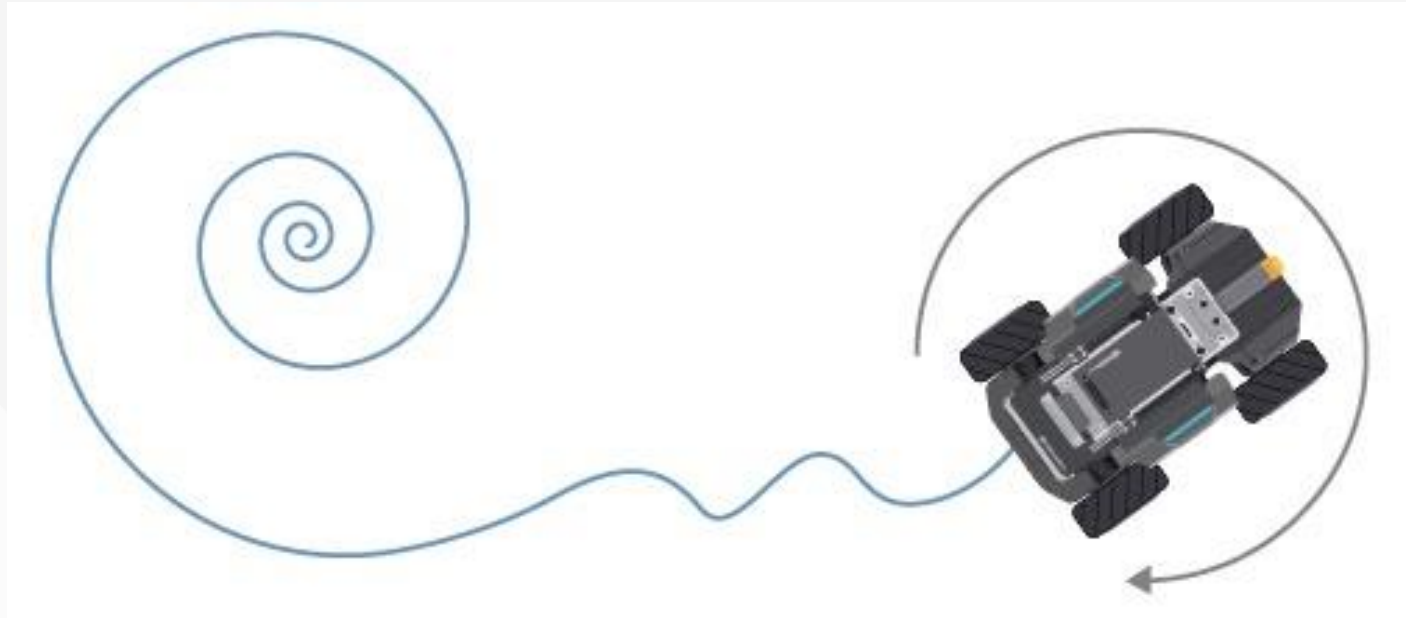


思考: 你能使用 控制麦轮以转速 左前轮 100 右前轮 100 左后轮 100 右后轮 100 转/分转动

模块实现同样的运动效果吗?

Mission Library: Figure Skating

**Introduction to the project:
Programming controls S1 to get out
of the trajectory in the image below.**

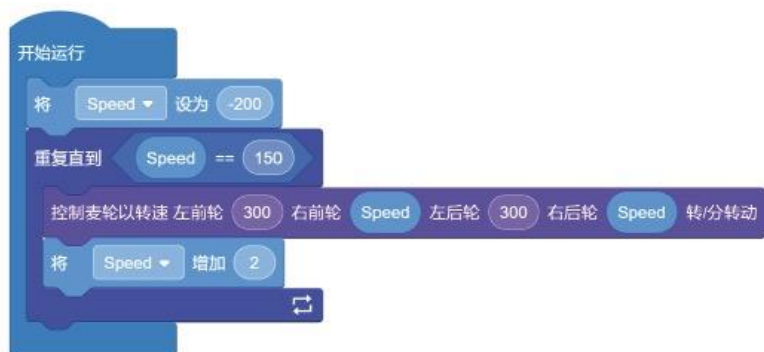


Mission Library: Figure Skating

Thought guidance:

"Drawing threads with a larger and larger radius" requires the S1 robot to rotate from place to place, gradually transitioning to a spiral circle.

“蛇形”前进走位的参考程序如下所示：



原地旋转部分的程序如下：



5. Mission Library: Figure Skating

答案:



Fourth, sum up reflection

1. What have you learned today?
2. What problems have I encountered in my studies?
3. How do you solve these problems?

