

# Chapter 13

## Crazy Racing

The road conditions of the car racing could be very complicated, winding mountain road, dirt road in a dark forest and so on. Can our Maqueen Plus run on such kind of racetrack, give it a go, let's turn Maqueen Plus into a racing robot car!

## Goal

What is PID algorithm?

## Command Learning

### Block Brief

PID switch

PID switch OFF ▼

Maintain the balance of motor speed

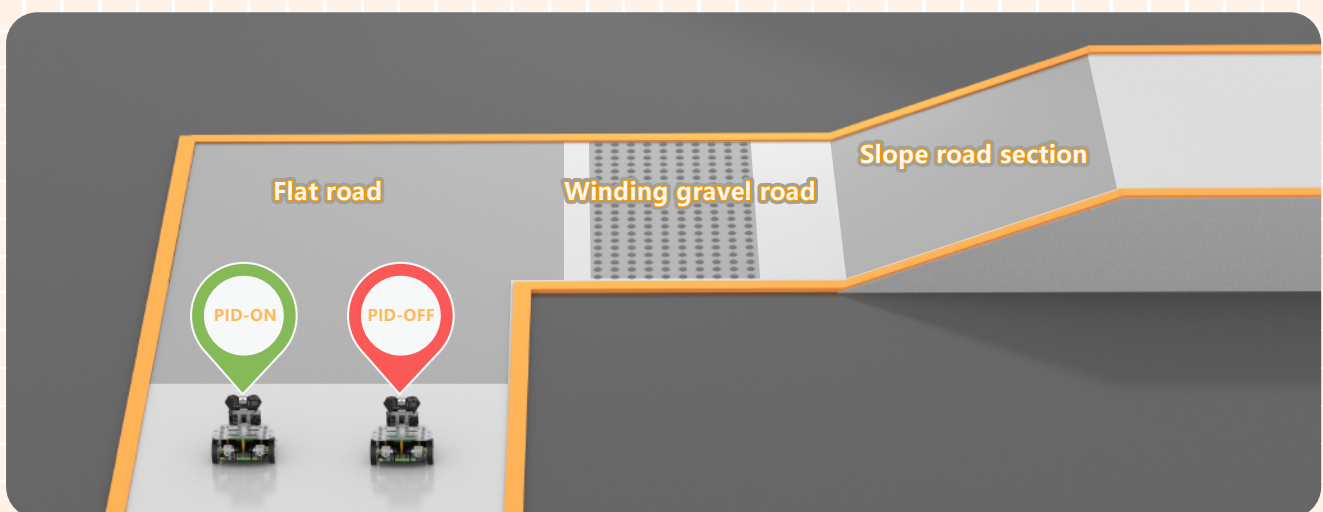
### What is PID algorithm?

PID is the most commonly-used and classical algorithm in control theory. We may not be familiar with its concept, but it can be said surely that we use it in some applications every day, such as, quadcopter, balancing car, cruise control in car, temperature control in 3D printer, thermostatic water heater and so on. When we need to **keep a physical quantity(temperature, speed, balance, etc) in a stable state**, PID must be used. Well, now we know what PID is, let's check the rules of the car racing.

## Hands-on Practice

### Competition Rules:

The speed of the competition is set at 30. The track consists of three different courses: ordinary road; winding gravel road; slope road section. The one who reaches the finish line first wins. The picture below is the route of the competition.



Note:

- 1.The race road needs to be built by yourself.
- 2.Two Maqueen Plus cars are necessary for this project.

Then, we are going to learn how PID works in this game, and see the differences when PID is enabled and disabled.

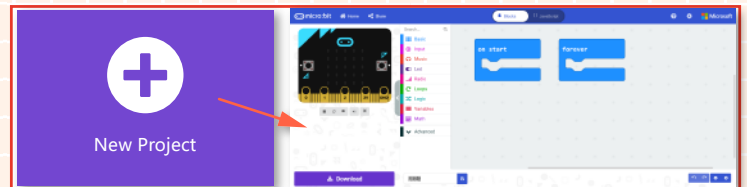
## Maqueen Plus 1-PID Enabled

### Step 1 Create a New Project

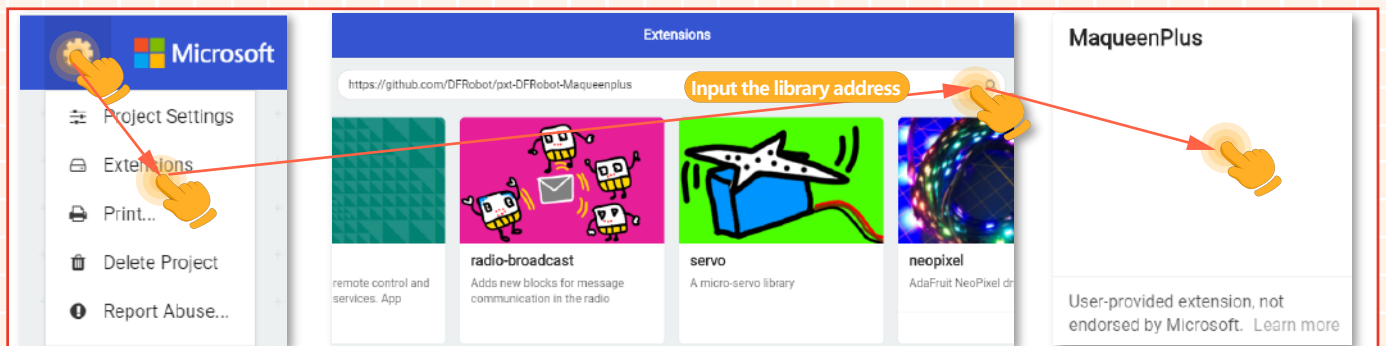
1. Input <https://makecode.microbit.org/> into your browser to enter MakeCode editor.
2. Click "new project" to enter MakeCode programming interface.
3. Add the Maqueen Plus library: <https://github.com/DFRobot/pxt-DFRobot-Maqueenplus>

<https://makecode.microbit.org/>

1. Enter MakeCode editor



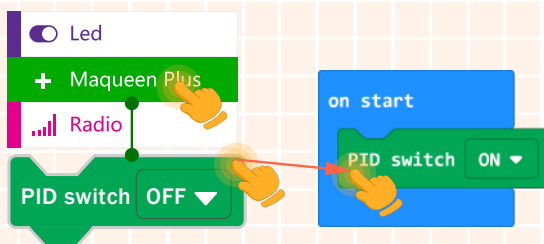
2. Enter programming interface



3. Add the extension library

### Step 2 Programming

1. Turn on the PID switch when the program starts.



#### Knowledge Expansion

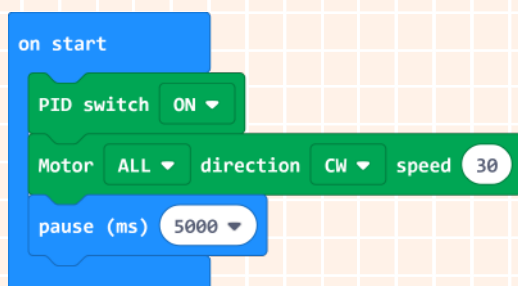
What does PID stand for?

P: proportional, adjust the output proportionally to the error.

D: derivative, responsible for compensating for future error.

I: integral, remove any steady-state error in the system because it accumulates that error over time and compensates for it

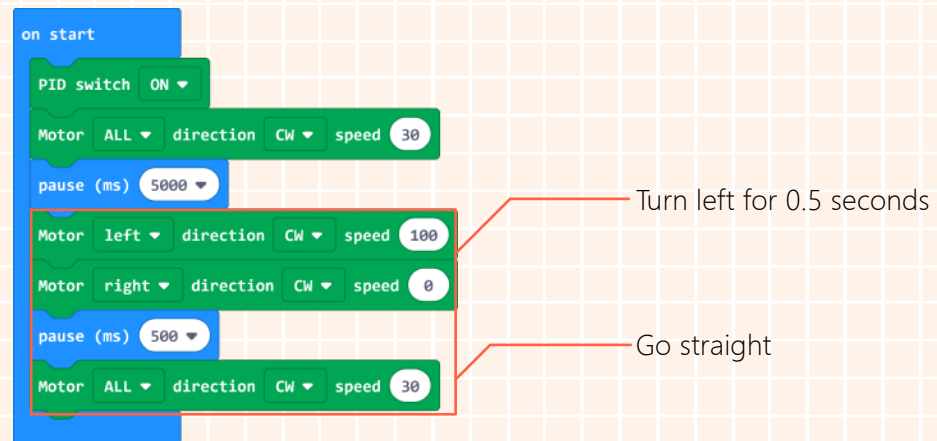
2. In the first course of the race, Maqueen Plus car runs at the speed of 30 for 5s.



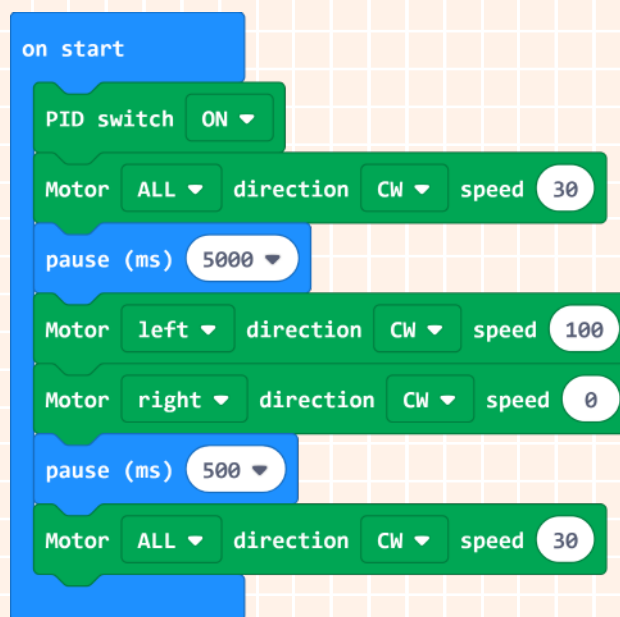
#### Knowledge Expansion

Note: set motor speed and pause time

3. Before the second course, Maqueen Plus1 needs to turn right and then go straight to the ending point.



4. The complete program is shown below:

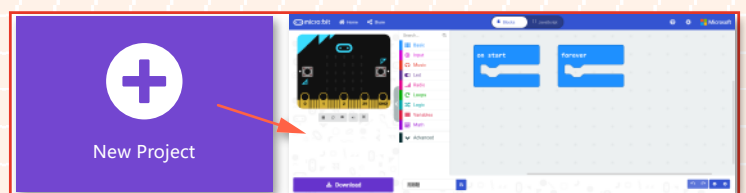


5. Name your project as "Crazy Racing 1-PID enabled", and download the program to Maqueen Plus1.

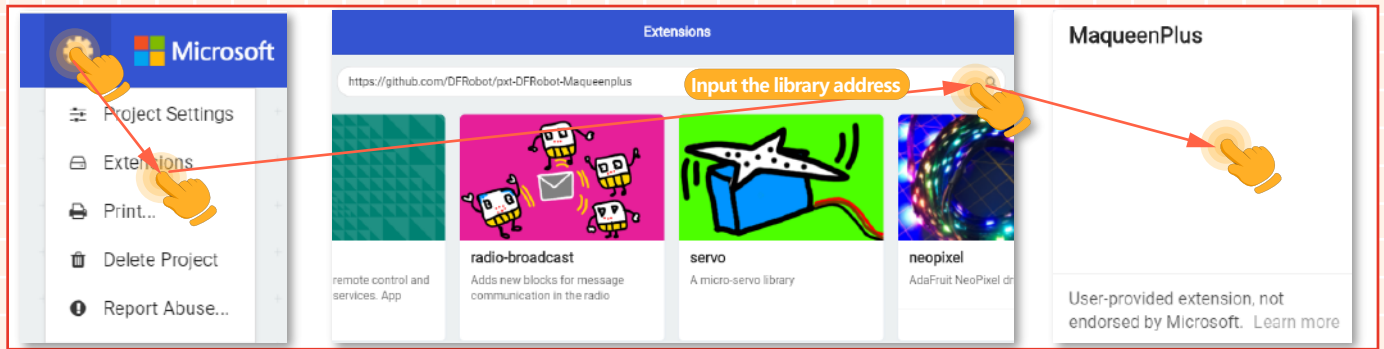
Maqueen Plus-PID Disabled 

<https://makecode.microbit.org/>

1. Enter MakeCode editor



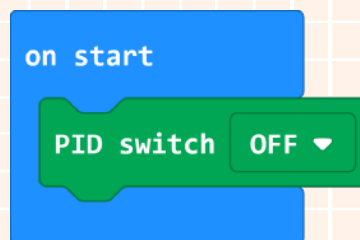
2. Enter programming interface



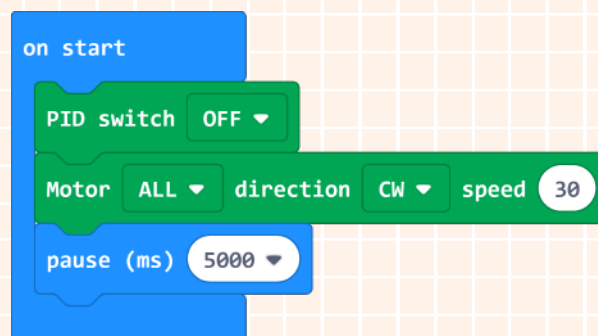
3.Add the extension library

## Step 2 Programming

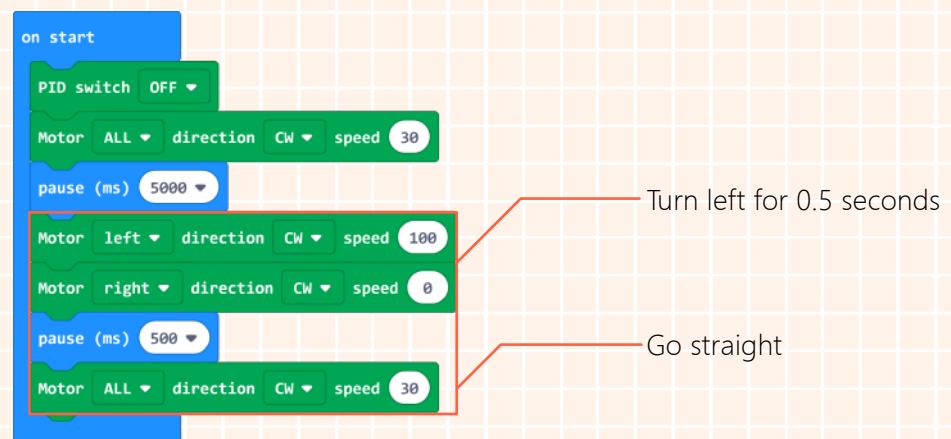
1.Turn off the PID switch when the program starts.



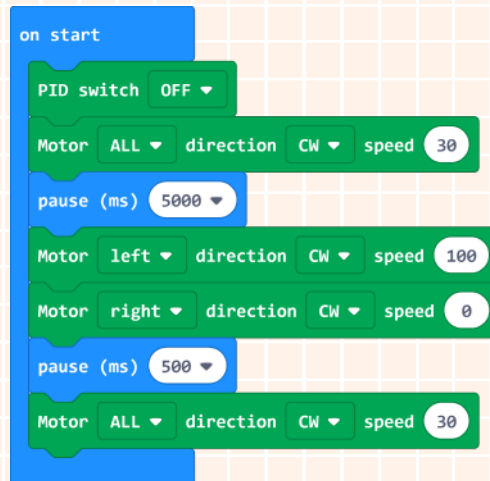
2.Maqueen Plus runs at the speed of 30 for 5s in the first course.



3.Before the second course, Maqueen Plus 2 needs to turn right and then go straight to the ending point.



4.The entire program is shown below:



5 .Name your project as "Crazy Racing 2-PID disabled", and download the program to Maqueen Plus 2.

## Effect Display



After the above steps, put the car on our track and turn on the switches of the two Maqueen Plus cars at the same time. Then we can see:

At the first racecourse: both cars move forward at a slow and same speed.

At the second racecourse: after both cars turn right and come to the track with sand and stone obstacles, the car 1(PID enabled) is still moving; the race car 2(PID disabled) stopped when encountering obstacles.

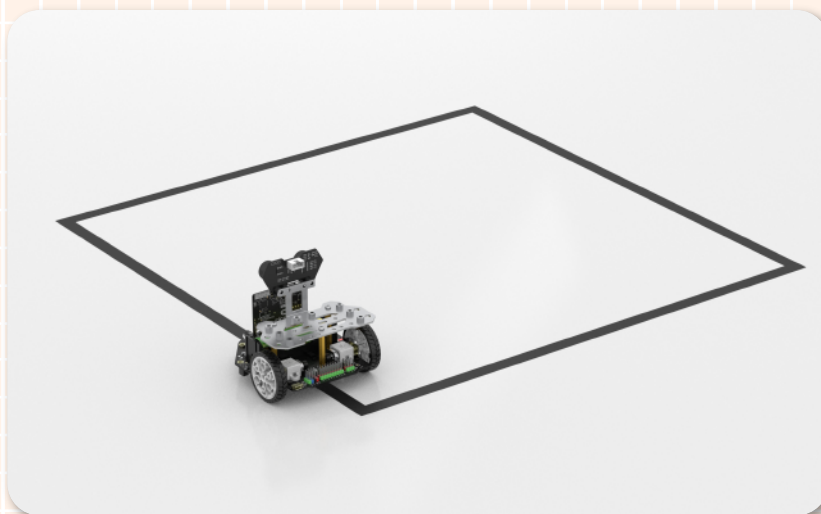
At the 3rd racecourse: in the slope, race car 1 can continue to drive; the race car 2 still stay where it met the obstacle.

Eventually, the race car 1(PID enabled) wins.

## Think & Explore



Since we have knew the advantage of PID: maintain the motor balance of the car and make the car move stably. Next, think about how to help the car to race on a square track.



Tips: two parts for the racecourse: go straight and turn 90 degrees. Enable PID to allow the Maqueen Plus car to move steadily on the track.