

Basic course ---8.Tracking

!Note:

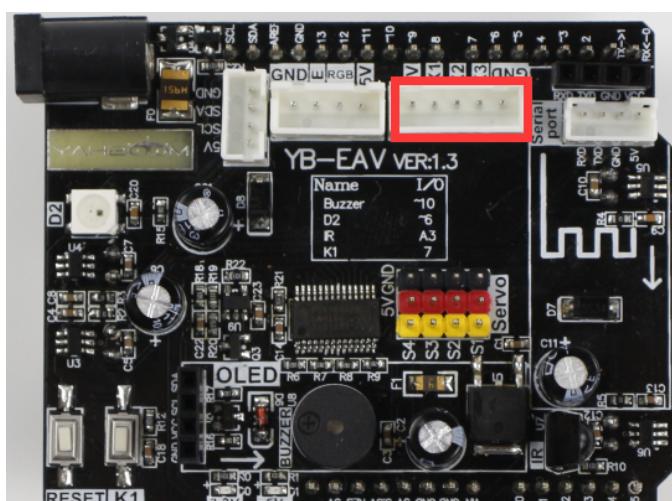
1. In order to avoid the interference of sunlight on infrared sensor, we need to carry out this experiment indoors.
2. In this experiment, you may need to modify the parameters in the program, please read the fifth part carefully.
3. The width of the black track is 1.6cm.
4. Because the battery has over-current protection, the speed of the car should not exceed 150 during using, it is fast enough.

1. Learning goal

In this lesson, we will learn how to use tracking module.

2. Preparation

2.1 The position of the tracking sensor port on the expansion board. As shown below.



2.2 The pin of UNO board is connected the pins on the expansion board .

3.Principle of experimental

The basic principle of the tracking sensor is to use the reflective nature of the object.

Our experiment is to tracking the black line. When the infrared light is emitted to the black line, it will be absorbed by the black line. When the infrared light is emitted to the other color line, it will reflected to the infrared receiver tube.

From the hardware interface manual, we can know that ultrasonic module are driven by Pin A0,A1,A2.

Classification	Function	The number of Drive chip PCA9685	Drive Method	Connection with CPU	Uno board
Left Motor	Left front motor forward	LINB(13)	PCA9685	I2C_SDA/I2C_SCL	A4/A5
	Left front motor reverse	LINA(12)			
	Left rear motor forward	RINB(15)			
	Left rear motor reverse	RINA(14)			
Right Motor	Right front motor forward	LED10			
	Right front motor reverse	LED11			
	Right rear motor forward	LED8			
	Right rear motor reverse	LED9			
Servo	Control S1	LED0	Uno board drive directly	A0 A1 A2 12	11 7 A3 0 1 6 10
	Control S2	LED1			
	Control S3	LED2			
	Control S4	S1 (3)			
LOGO light	Control bluelight	LED7			
Tracking sensor	Left tracking sensor		Uno board drive directly	A0 A1 A2	11 7 A3 0 1 6 10
	Middle tracking sensor				
	Right tracking sensor				
Ultrasonic sensor	ultrasonic Echo Ultrasonic RGB light			A0 A1 A2 12 7 A3	11 7 A3 0 1 6 10
Key	K1				
IR	IR control				
Bluetooth interface	RX TX				
On board RGB Light	RGB Light on expansion board				
Buzzer	Control buzzer				

3. About code

We need provided three codes for this experiment.

TrackingSensorTest.ino Tracking_test.ino Tracking_PID_v1.ino

4. Compiling and downloading code

4.1 We need to open the code file by Arduino IDE software. Then click "√" under the menu bar to compile the code, and wait for the word "**Done compiling**" in the lower left corner, as shown in the figure below.

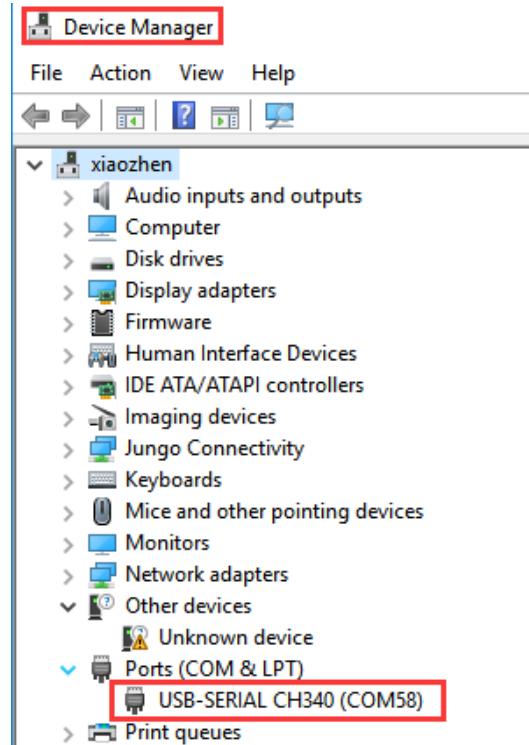
The screenshot shows the Arduino IDE interface. The title bar reads "Ultrasonic_Ranging | Arduino 1.8.5". The menu bar includes File, Edit, Sketch, Tools, and Help. Below the menu is a toolbar with various icons. The main area displays the code for "Ultrasonic_Ranging". The code includes a header file inclusion, variable declarations, and a multi-line comment block. At the bottom of the code editor, there is a progress bar and a status message "Done compiling." A red box highlights the "Done compiling." message.

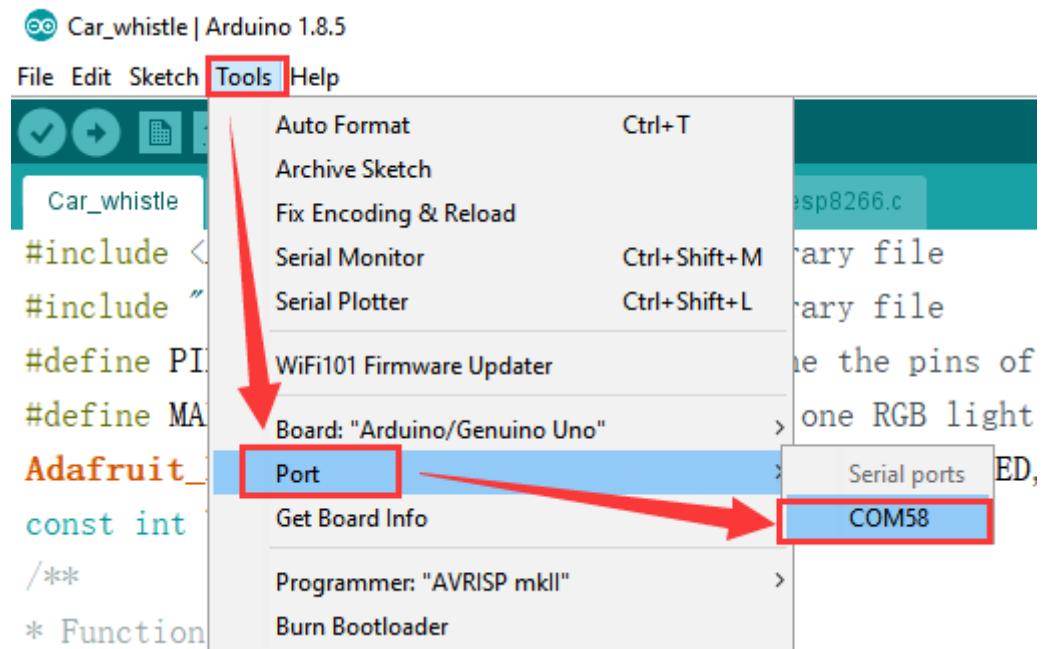
```
#include <Adafruit_PWMServoDriver.h>
Adafruit_PWMServoDriver pwm = Adafruit_PWMServoDriver(0x40);
const int SingPin = 13;
float distance;

/**
 * Function      setup
 * @author        liusen
 * @date          2017. 07. 25
 * @brief         Initial configuration
 * @param[in]      void
 */

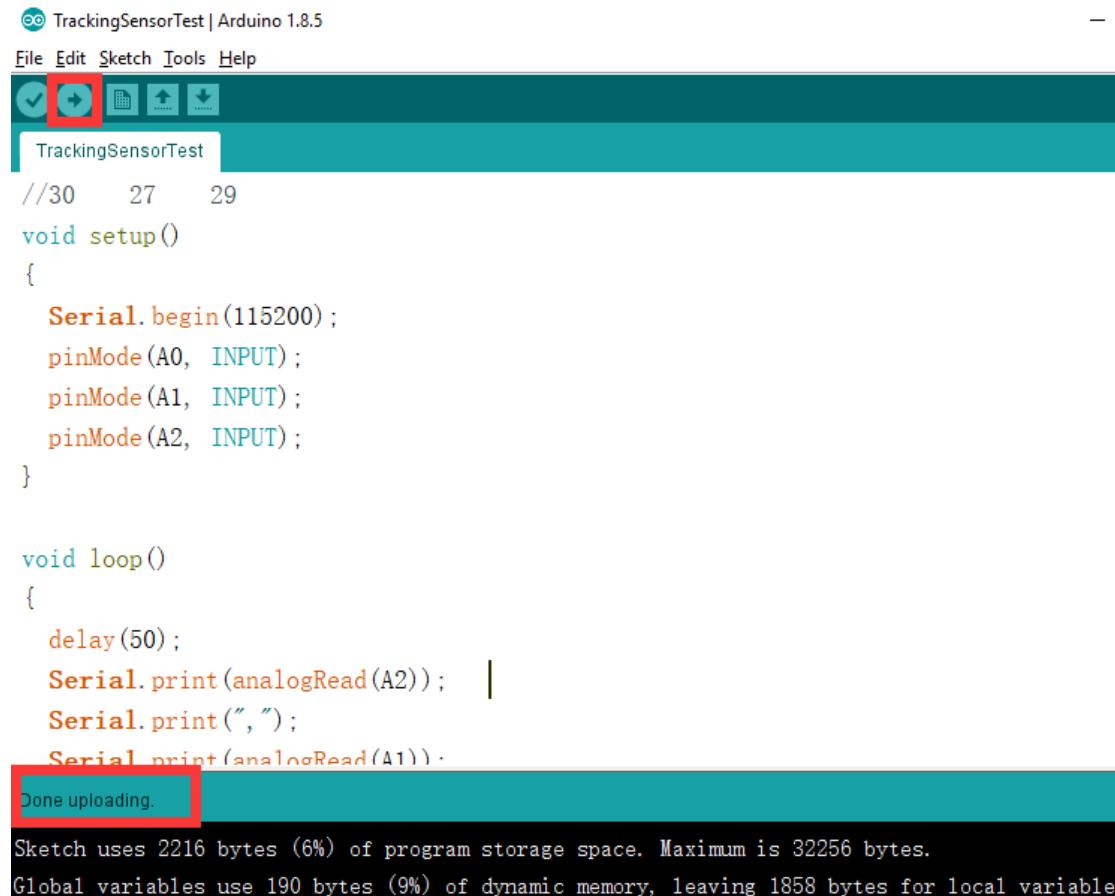
Done compiling.
```

4.2 In the menu bar of Arduino IDE, we need to select 【Tools】---【Port】--- selecting the port that the serial number displayed by the device manager just now, as shown in the figure below.





4.3 After the selection is completed, you need to click "→" under the menu bar to upload the code to the UNO board. When the word "**Done uploading**" appears in the lower left corner, the code has been successfully uploaded to the UNO board, as shown in the figure below.



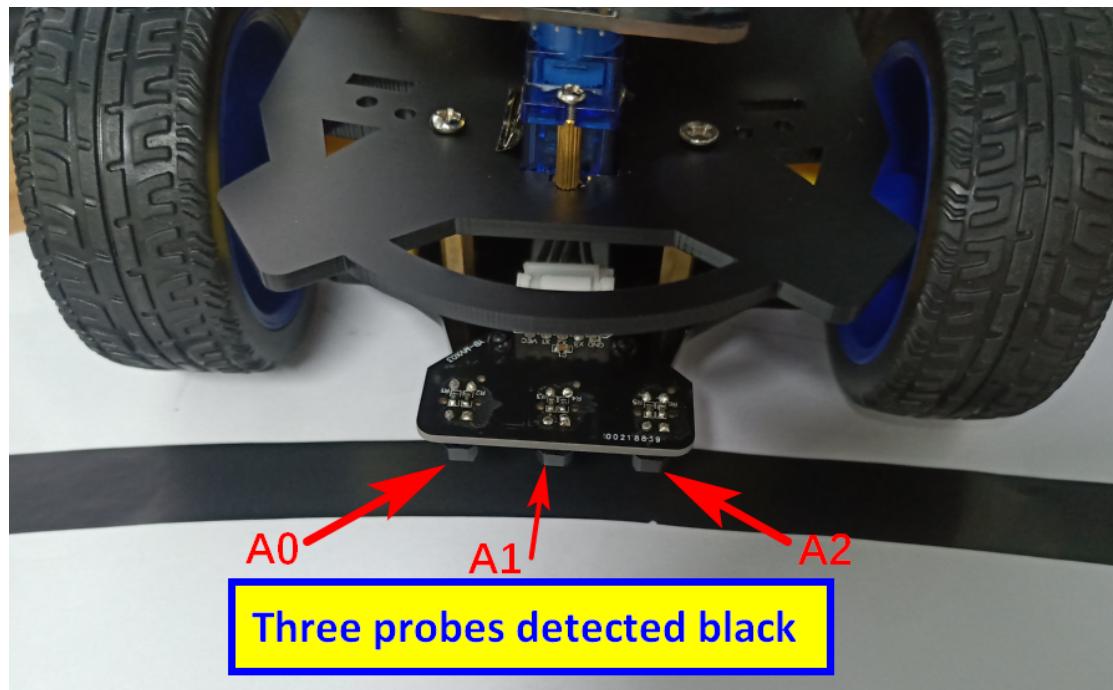
5. Experimental phenomena

For first code: Tracking_test.ino

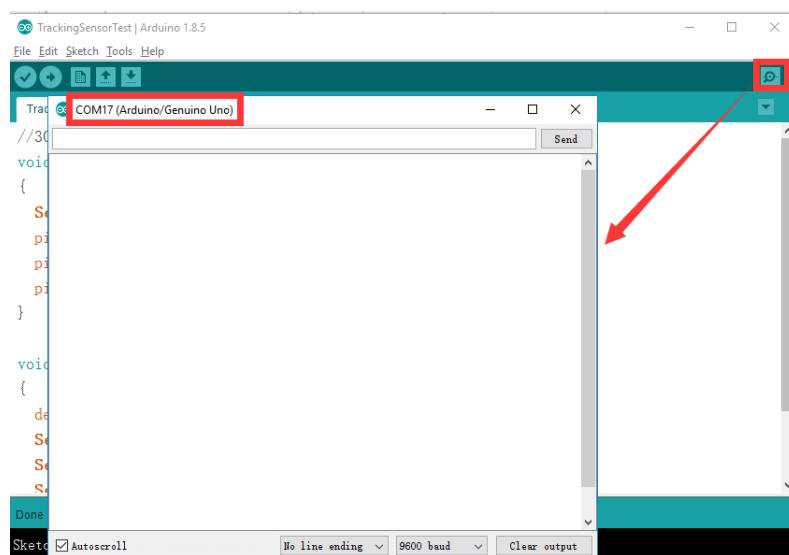
5.1.1 First, You need to open **TrackingSensorTest.ino** in the **TrackingSensorTest** folder. And connect the robot car with your computer by cable.

5.1.2 Then, you need to place three tracking probes on white (**must be the track where you will be conducting a tracking test**). As shown below.

5.1.3 Then, you need to place three tracking probes on black line (**must be the track where you will be conducting a tracking test**). As shown below.



5.1.4 Next, We need to open the **Serial Monitor** in the upper right corner of the Arduino IDE interface. And we need to select the same baud rate as set in the program. As shown below.



```

void setup()
{
    Serial.begin(115200);
    pinMode(A0, INPUT);
    pinMode(A1, INPUT);
    pinMode(A2, INPUT);
}

```

The screenshot shows the Arduino IDE interface. A red arrow points from the text "Serial.begin(115200);" in the code area to the "115200 baud" dropdown menu in the bottom toolbar. The toolbar also includes "No line ending" and "Clear output" buttons.

5.1.5 We can see that when the three probes of the tracking sensor detect white and detect black, the currently output analog value is printed out. As shown below.

(!!!Note: This data just for my experimental environment , you must record the value you printed, wait until the data is stable)

The screenshot shows the Arduino Serial Monitor window titled "TrackingSensorTest | Arduino 1.8.5". The data is printed in rows:

```

A0 A1 A2
1 45, 42, 43
2 46, 42, 43
3 46, 42, 44
4 59, 48, 49
5 169, 73, 63
6 185, 91, 69
7 216, 130, 98
8 266, 185, 149
9 336, 271, 228
10 593, 572, 523
11 873, 842, 851
12 889, 828, 881
13 863, 788, 864
14 897, 855, 886
15 895, 857, 883
16
17
18 }

```

Annotations with arrows and boxes:

- A blue box highlights row 3 with the text "Three probes detected white".
- An orange box highlights row 10 with the text "Excessive phase data".
- A green box highlights row 15 with the text "Three probes detected black".

If the data shows a little fluctuation, that is normal.

5.1.6 We need to open the **Tracking_test.ino** file in the **Tracking_test** folder, and according to the value printed in the previous step, take an optimal threshold and modify the data in the program.

```

File Edit Sketch Tools Help
Tracking_test Adafruit_PWMservoDriver.cpp Adafruit_PWMservoDriver.h
70 * 450, 350, 400 are the critical values between the black
71 * 450 is middle tracking probe
72 * 350 is left tracking probe
73 * 400 is right tracking probe
74 * Please be sure to print and observe these three data acc
75 */
76 void read_sensor_values()
77 {
78     if(M_Value>450)
79     {
80         run(50);
81     }
82     else if(L_Value > 350)
83     {
84         sleft(65);
85         while(L_Value>350);
86     }
87     else if(R_Value > 400)
88     {
89         sright(65);
90         while(R_Value > 400);
91     }
92 }

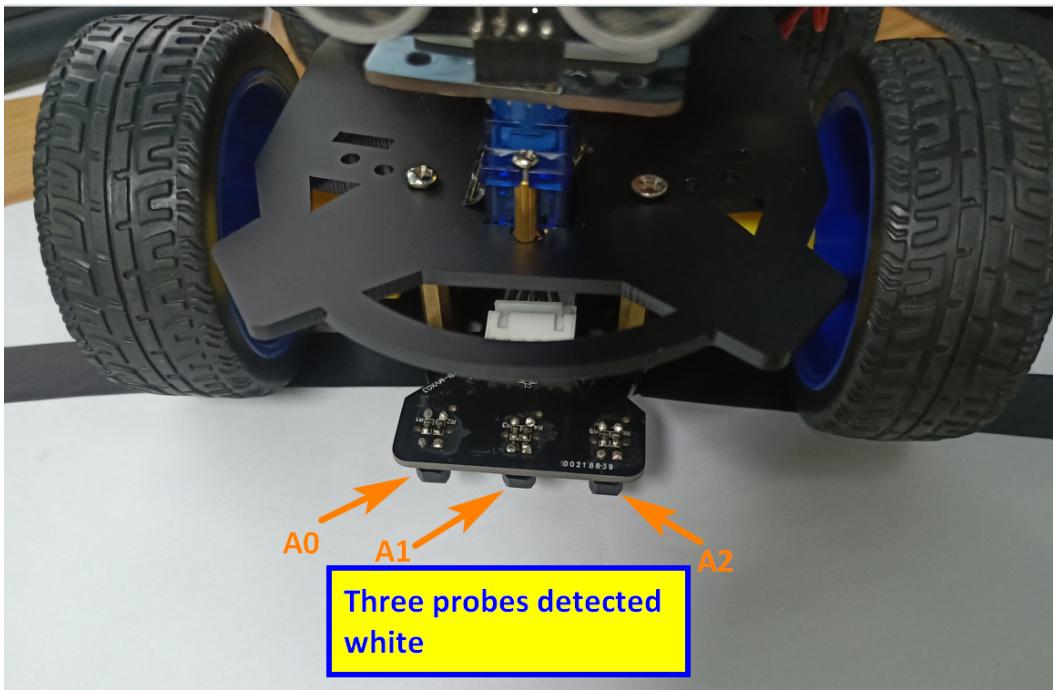
```

5.1.7 After the modification is complete, save the program and download the program to the robot car.

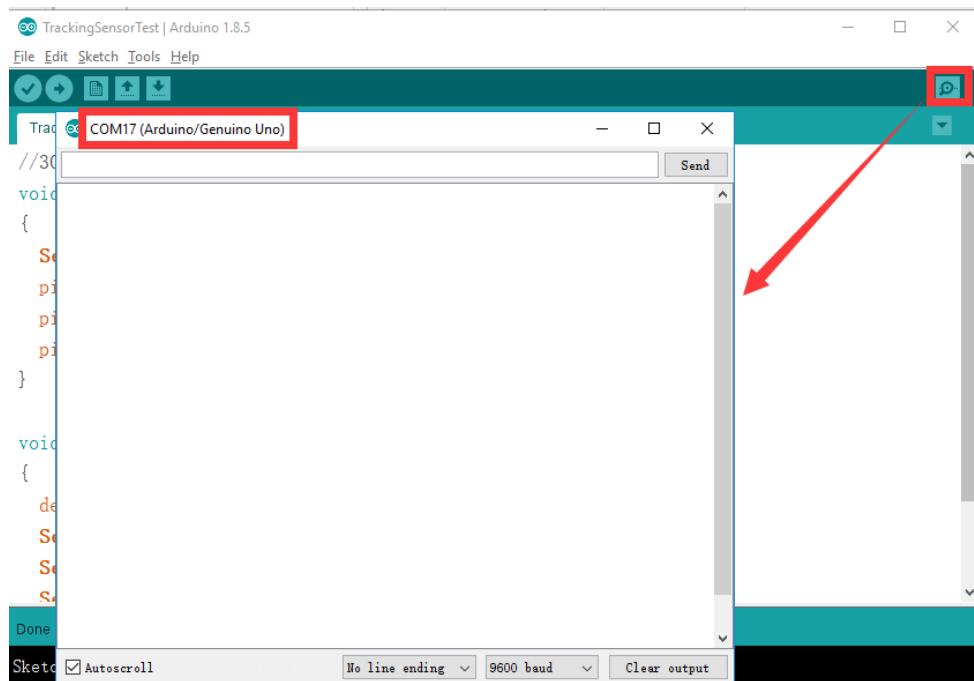
For second code: Tracking_PID.ino

5.2.1 First, You need to open **TrackingSensorTest.ino** in the **TrackingSensorTest** folder. And connect the robot car with your computer by cable.

5.2.2 Then, you need to place three tracking probes on white (**must be the track where you will be conducting a tracking test**). As shown below.



5.2.3 Next, We need to open the **Serial Monitor** in the upper right corner of the Arduino IDE interface. And we need to select the same baud rate as set in the program. As shown below.



```

void setup()
{
    Serial.begin(115200);
    pinMode(A0, INPUT);
    pinMode(A1, INPUT);
    pinMode(A2, INPUT);
}

```

The screenshot shows the Arduino IDE. At the top, there's a logo for YAHBOOM. Below it is the code for the `setup()` function. A red arrow points from the text "Serial.begin(115200);" down to the serial monitor window. The serial monitor window has three buttons at the bottom: "No line ending", "115200 baud" (which is highlighted with a red box), and "Clear output".

5.2.4 We can see that when the three probes of the tracking sensor detect white, the currently output analog value is printed out. As shown below.

(!!!Note: This data just for my experimental environment , you must record the value you printed, wait until the data is stable)

The screenshot shows the Arduino Serial Monitor window titled "COM58". The header includes "A0 A1 A2" and "Send" buttons. The main area displays a list of analog values for pins A0, A1, and A2. The first few lines of data are:

```

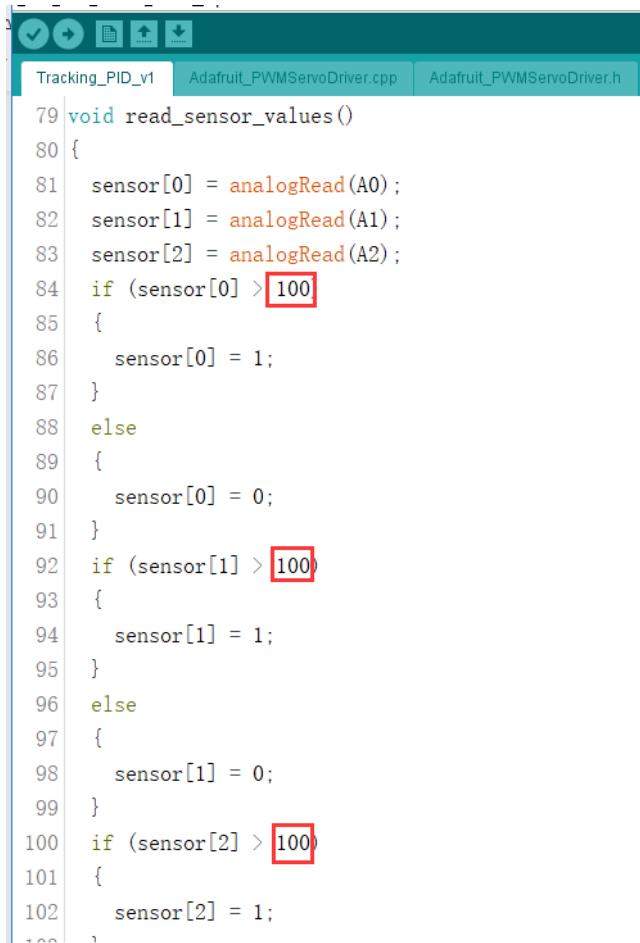
A0 A1 A2
41, 37, 37
42, 38, 37
41, 37, 36
41, 37, 37
41, 37, 38
41, 37, 37
41, 37, 37
41, 37, 37
42, 38, 37
41, 37, 37
42, 38, 37
41, 37, 37
42, 38, 37
41, 37, 37
42, 38, 37
41, 37, 37

```

A vertical red box highlights the first three lines of data. At the bottom of the monitor, there is an "Autoscroll" checkbox and three buttons: "No line ending", "115200 baud" (highlighted with a red box), and "Clear output".

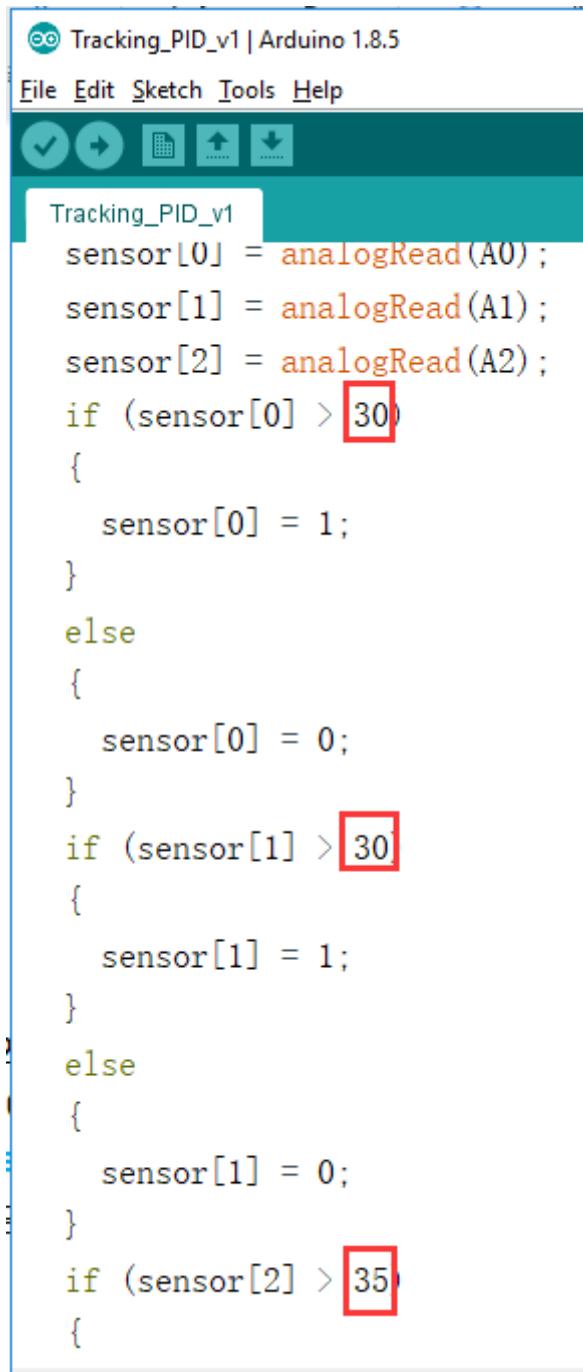
If the data shows a little fluctuation, that is normal, you can take the average of the five data.

5.2.5 You need to open **Tracking_PID.ino** in the **Tracking_PID** folder. And modify the three parameters in the program.



```
Tracking_PID_v1 Adafruit_PWMServoDriver.cpp Adafruit_PWMServoDriver.h
79 void read_sensor_values()
80 {
81     sensor[0] = analogRead(A0);
82     sensor[1] = analogRead(A1);
83     sensor[2] = analogRead(A2);
84     if (sensor[0] > 100)
85     {
86         sensor[0] = 1;
87     }
88     else
89     {
90         sensor[0] = 0;
91     }
92     if (sensor[1] > 100)
93     {
94         sensor[1] = 1;
95     }
96     else
97     {
98         sensor[1] = 0;
99     }
100    if (sensor[2] > 100)
101    {
102        sensor[2] = 1;
103    }
104 }
```

According to 5.2.4, you can see the data I printed is 41,37, 37. So the three parameters in the red coil in my program need to be changed to 100, 100, 100.
(In other words, the parameters you modify are larger than the values you print.)



The screenshot shows the Arduino IDE interface with the sketch titled "Tracking_PID_v1". The code reads analog values from three pins (A0, A1, A2) and sets sensor[0], sensor[1], and sensor[2] to 1 if the respective pin value is greater than 30, or 0 otherwise. Three specific values (30, 30, and 35) are highlighted with red boxes.

```
Tracking_PID_v1 | Arduino 1.8.5
File Edit Sketch Tools Help
Tracking_PID_v1
sensor[0] = analogRead(A0);
sensor[1] = analogRead(A1);
sensor[2] = analogRead(A2);
if (sensor[0] > 30)
{
    sensor[0] = 1;
}
else
{
    sensor[0] = 0;
}
if (sensor[1] > 30)
{
    sensor[1] = 1;
}
else
{
    sensor[1] = 0;
}
if (sensor[2] > 35)
{
```

5.2.6 For this program, you need to modify Kp, Ki, Kd according to actual condition.

```
#include <Adafruit_PWMServoDriver.h>
Adafruit_PWMServoDriver pwm = Adafruit_PWMServoDriver(0x40);

float max = 3.85;
float s = 100;
float Kp = 37, Ki = 4, Kd = 60; |
float error = 0, P = 0, I = 0, D = 0, PID_value = 0;
```

5.2.7 After the modification is complete, save the program and download the program to the robot car.