



Thanks for your support on our products, we will continue to provide you better quality and service!

Content

*About keyestudio.....	7
*References and After-sales Service.....	8
*Warning.....	8
*Copyright.....	8
1. Introduction.....	9
2. Features.....	10
3. Specification.....	11
4.Product List.....	11
5. Assembly Guide.....	18
Step 1: Install Bottom Motor.....	18
Step 2: Install Driver Wheel.....	20
Step 3: Install the Battery Holder.....	22
Step 4: Mount Acrylic Board and Sensors.....	25
Step 5: Install the Servo Platform.....	28
Step 6: Install Sensors and Boards.....	29
Step 7: Hook-up Guide.....	32
Step 8: Wire Up LED Panel.....	35



Step 10: Tank Robot.....	43
6. Install Arduino IDE and Driver.....	44
(1) Installing Arduino IDE.....	44
(2) Keyestudio V4.0 Development Board.....	46
(3) Installing V4.0 board Driver.....	49
(4) Install other visions of driver.....	55
(5) Arduino IDE Setting.....	58
(6) Start First Program.....	61
7. How to Add Libraries?.....	64
8.Projects.....	68
Project 1: LED Blink.....	69
(1) Description.....	70
(2) Specification.....	70
(3) Equipment.....	71
(4) V5 Sensor Shield.....	71
(5) Test Code.....	73
(6) Test Result.....	74
(7) Code Explanation.....	74
(8) Extension Practice.....	75
Project 2: Adjust LED Brightness.....	76
(1) Description.....	76
(2) Specification.....	78
(3) Equipment.....	78



(4) Connection Diagram.....	78
(5) Test Code.....	79
(6) Test Result.....	80
(7) Code Explanation.....	80
Project 3: Photoresistor Sensor.....	85
(1) Description.....	85
(2) Specification.....	86
(3) Equipment.....	86
(4) Test Code.....	87
(5) Test Result.....	88
(6) Code Explanation.....	88
(7) Extension Practice.....	89
Project 4: Servo Control.....	91
(1) Description.....	91
(2) Specification.....	93
(3) Equipment.....	94
(4) Connection Diagram:	94
(5) Test Code1.....	95
(6) Test Code2.....	97
(7) Test Result.....	98
(8) Code Explanation.....	98
Project 5: Ultrasonic Sensor.....	99
(1) Description.....	99



(2) Specification.....	100
(3) Equipment.....	100
(4) The principle of ultrasonic sensor.....	101
(5) Connection Diagram.....	103
(6) Test Code.....	104
(7) Test Result.....	106
(8) Code Explanation.....	106
(9) Extension Practice:.....	107
Project 6: IR Reception.....	110
(1) Description.....	110
(2) Specification.....	112
(3) Equipment.....	112
(4) Connection Diagram.....	113
(5) Test Code.....	113
(6) Test Result.....	115
(7) Code Explanation.....	116
(8) Extension Practice.....	116
Project 7: Bluetooth Remote Control.....	119
(1) Description.....	119
(2) Specification.....	120
(3) Equipment.....	120
(4) Connection Diagram.....	121
(5) Test Code.....	121



(6) Download APP.....	123
(7) Code Explanation.....	128
(8) Extension Practice.....	128
Project 8: Motor Driving and Speed Control.....	130
(1) Description.....	130
(2) Specification.....	131
(3) Drive Robot to Move.....	133
(4) Equipment.....	134
(5) Connection Diagram.....	134
(6) Test Code.....	135
(7) Test Result.....	139
(8) Code Explanation.....	139
(9) Extension Practice.....	139
Project 9: 8*16 LED Board.....	143
(1) Description.....	143
(2) Specification.....	144
(3) Equipment.....	144
(4) 8*16 Dot Matrix Display.....	144
(5) Connection Diagram.....	149
(6) Test Code.....	150
(7) Test Result.....	154
(8) Extension Practice.....	154
Project 10: Light Follow Robot.....	161



(1) Description.....	161
(2) Connection Diagram.....	163
(3) Test Code.....	165
(4) Test Result.....	168
Project 11: Ultrasonic Avoid Tank.....	169
(1) Description.....	169
(2) Flow chart.....	172
(3) Connection Diagram:	172
(4) Test Code:.....	173
(5) Test Result.....	180
Project 12: Ultrasonic Follow Tank.....	180
(1) Description.....	181
(2) Flow chart.....	182
(3) Connection Diagram.....	182
(4) Test Code.....	183
(5) Test Result.....	192
Project 13: IR Remote Robot Tank.....	193
(1) Description.....	193
(2) Flow Chart.....	194
(3) Connection Diagram.....	195
(4) Test Code.....	196
(5) Test Result.....	206
Project 14: Bluetooth Control Robot.....	207



(1) Description.....	207
(2) Test Code.....	208
(3) Connection Diagram.....	210
(4) Test Code.....	212
(5) Test Result.....	220
Project 15: Multi-purpose Robot Car.....	221
(1) Description.....	222
(2) Connection Diagram.....	222
(3) Test Code.....	228
(4) Test Result.....	246
9. Resources.....	247

*About keyestudio

Keyestudio is a best-selling brand owned by KEYES Corporation, our product lines range from controller boards, shields and sensor modules to smart car and complete starter kits for Arduino, Raspberry Pi and BBC micro:bit, which designed for customers of any level to learn electronics and programming knowledge. All of our products comply with international quality standards and are greatly appreciated in a variety of different markets throughout the world.

You can obtain the details and the latest information through visiting the following web



*References and After-sales Service

1. Download Profile: <https://fs.keyestudio.com/KS0428>
2. Feel free to contact us please, if there is missing part or you encounter some troubles.

Welcome to send email to us: service@keyestudio.com. We will update projects and products continuously based on your sincere advice.

*Warning

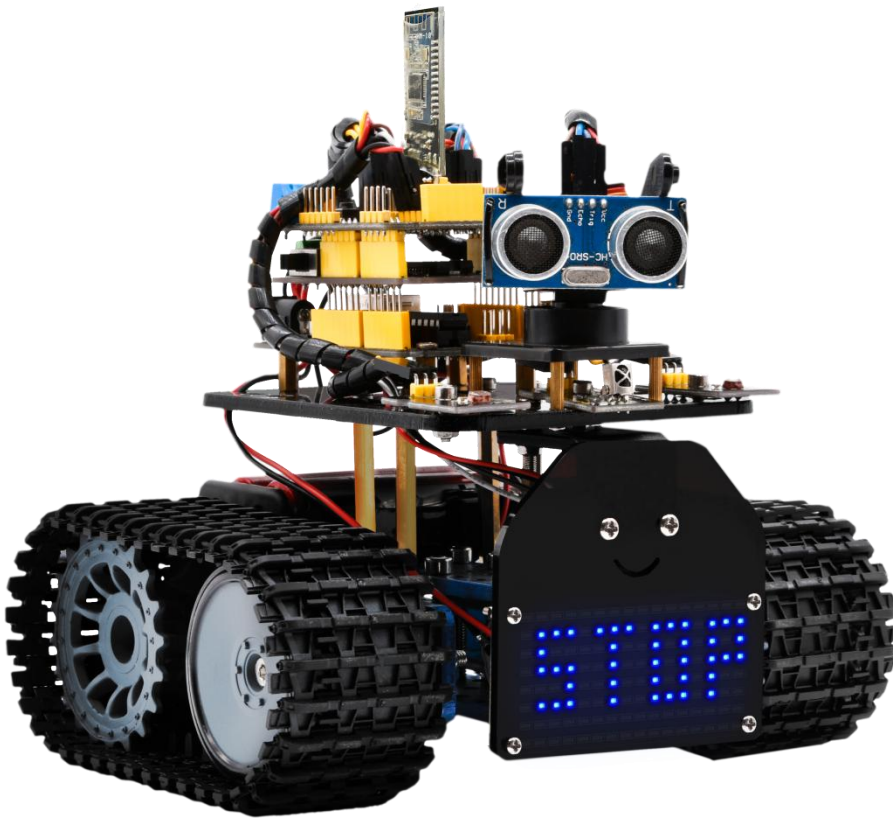
1. This product contains tiny parts(screws, copper pillars), keep it out of reach of children under 7 years old please.
2. This product contains conductive parts (control board and electronic module). Please operate according to the requirements of this tutorial. Improper operation may cause overheating and damage parts. Do not touch and immediately disconnect the circuit power.

*Copyright

The keyestudio trademark and logo are the copyright of KEYES DIY ROBOT co.,LTD. All products under keyestudio brand can't be copied, sold and resold without authorization by anyone or company. If you're interested in our items, please contact to our sales representatives: fennie@keyestudio.com

Mini Tank Robot V2

(Arduino tutorial)



1. Introduction

Nowadays, technological education such as VR, kids programming, and artificial intelligence, has become mainstream in educational industry. Thereby, people attach importance to STEM education. Arduino is pretty notable in Maker education.

So what is Arduino? Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online. Based on this,



Keyestudio team has designed a mini tank robot. The tank robot has a processor which is programmable using the Arduino IDE, to mapped its pins to sensors and actuators by a shield that plug in the processor, it reads sensors and controls the actuators and decides how to operate.

15 learning projects, from simple to complex, will guide you how to make a smart tank robot on you own and introduce the detailed knowledge about sensors and modules. Simultaneously, it is the best choice if you intend to obtain a DIY robot for learning programming, entertainment and competition requirement.

2. Features

1. Multi-purpose: Obstacle avoidance, follow, IR remote control, Bluetooth control, light following, ultrasonic follow and displaying face emoticons.
2. Simple assembly: No soldering circuit required, complete assembly easily.
3. High Tenacity : Aluminum alloy bracket, metal motors, high quality wheels and tracks
4. High extension: expand other sensors and modules through motor driver shield and sensor shield



5. Multiple controls: IR remote control, App control(IOS and Android system)

6. Basic programming: C language code of Arduino IDE.

3. Specification

Working voltage: 5v

Input voltage: 7-12V

Maximum output current: 2A

Maximum power dissipation: 25W (T=75°C)

Motor speed: 5V 200 rpm/min

Motor drive mode: dual H bridge drive (L298P)

Ultrasonic induction angle: <15 degrees

Ultrasonic detection distance: 2cm-400cm

Infrared remote control distance: 10 meters (measured)

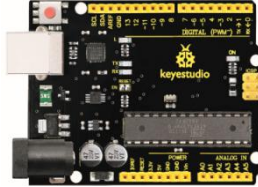

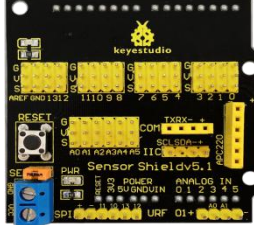



Bluetooth remote control distance: 50 meters (measured)

4. Product List





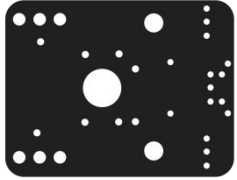
Make sure no any parts missing please when you get this robot kit.

And if it is, please feel free to contact us.



Electronic Parts			
#	Name	QTY	Picture
1	KEYESTUDIO V4.0 Development Board	1	
2	L298P Shield	1	
3	V5 Sensor Shield	1	
4	HC-SR04 Ultrasonic Sensor	1	
5	HM-10 Bluetooth-4.0 Module	1	
6	Remote Control	1	
7	8X16 LED Panel	1	





	HX-2.54 4P Female Dupont Line	1	
8	9G Servo Motor	1	
9	IR Receiver Module	1	
10	Photocell Sensor	2	
11	Red LED	1	
Components			
1	Acrylic Board	1	
2	Tank Robot Acrylic Board	1	






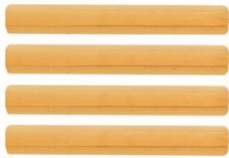


3	Metal Holder	4	
4	L-type Bracket	1	
5	Tank Driver Wheel	2	
6	Tank Load-bearing Wheel	2	
7	Caterpillar Band	2	
8	Metal Motor	2	
9	Plastic Platform (PC)	1	
10	USB Cable (1m)	1	
11	2.54 3pin F-F Dupont Wire 20cm	5	












12	F-F Dupont Wire (15CM)	10	
13	Supportive Parts (27*27*16MM, Blue)	2	
14	18650 2-Slot Battery Holder	1	
15	(Not included) 18650 Battery	2	

Tip : We recommend you to purchase it on Ebay or wish









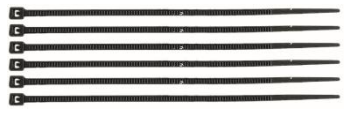

Nuts/Screws

1	Copper Bush	2	
2	Flange Bearing	4	
3	Hexagon Copper Bush(M3*10MM)	10	
4	Hexagon Copper Bush (M3*45MM)	4	
5	Copper Coupler	2	
6	M3*10MM Flat Head Screws	3	




7	Inner Hexagon Screws (M3*6MM)	20	
8	Inner Hexagon Screws (M3*8MM)	10	
9	Inner Hexagon Screws (M3*25MM)	4	
10	Inner Hexagon Screws (M4*12MM)	4	
11	Inner Hexagon Screws (M4*40MM)	4	
12	Inner Hexagon Screws (M4*50MM)	2	
13	M3 Nuts	14	
14	M4 Self-locking Nuts	2	
15	M2 Nuts	8	



16	M4 Nuts	10	
17	M2*10MM Round Head Screws	6	
18	M3*12MM Round Head Screws	8	
Tools			
1	2.0*40MM Blue and Black Slotted Screwdriver	1	
2	2.0*40MM Purple and Black Phillips Screwdriver	1	
3	M1.5 Hex Key Nickel Plated Allen Wrench	1	
4	M2.5 Hex Key Nickel Plated Allen Wrench	1	
5	M3 Hex Key Nickel Plated Allen Wrench	1	
6	Nylon Cable Ties	6	
7	8MM Winding Pipe	12CM	



8	Decorative Cardboard	1	
---	----------------------	---	---

5. Assembly Guide

After making an inventory all the parts in this kit, then we need to mount the tank robot. Let's install smart car in compliance with the following instructions.

Note: Peel the plastic film off the board first when installing smart car.

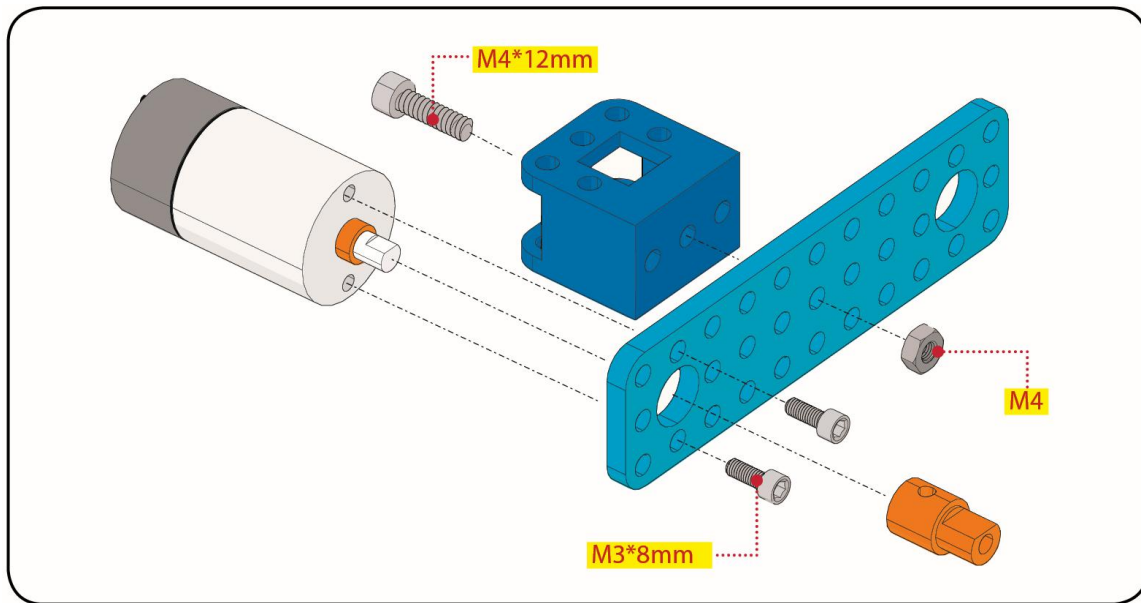
Step 1: Install Bottom Motor

Prepare the parts as follows:

- M4 Nut * 2
- Metal Motor *2
- Metal Holder *2
- Copper Coupler *2

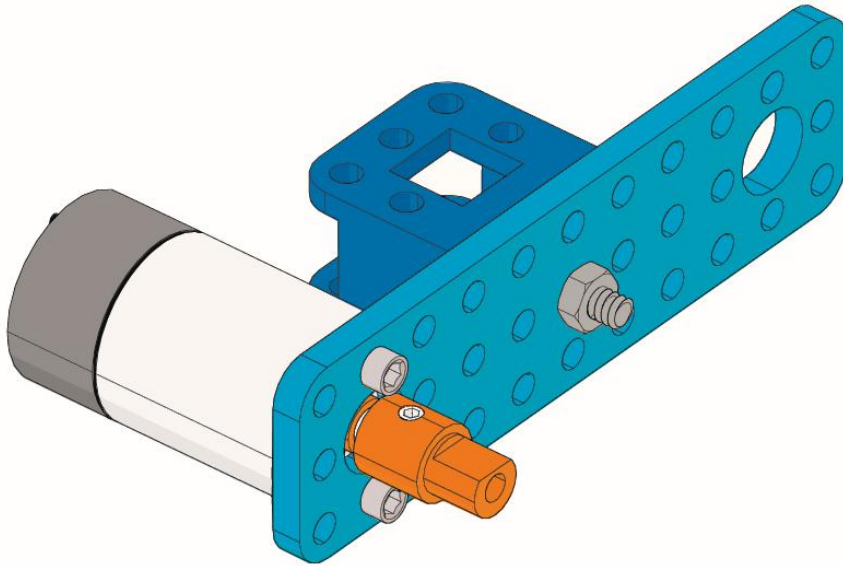


- Blue Supportive Parts *2
- M4*12MM Inner Hex Screw * 2
- M1.5 Hex Key Nickel Plated Allen Wrench *1
- M3 Hex Key Nickel Plated Allen Wrench *1
- M2.5 Hex Key Nickel Plated Allen Wrench *1
- M3*8MM Inner Hex Screw * 4





➤ Complete renderings

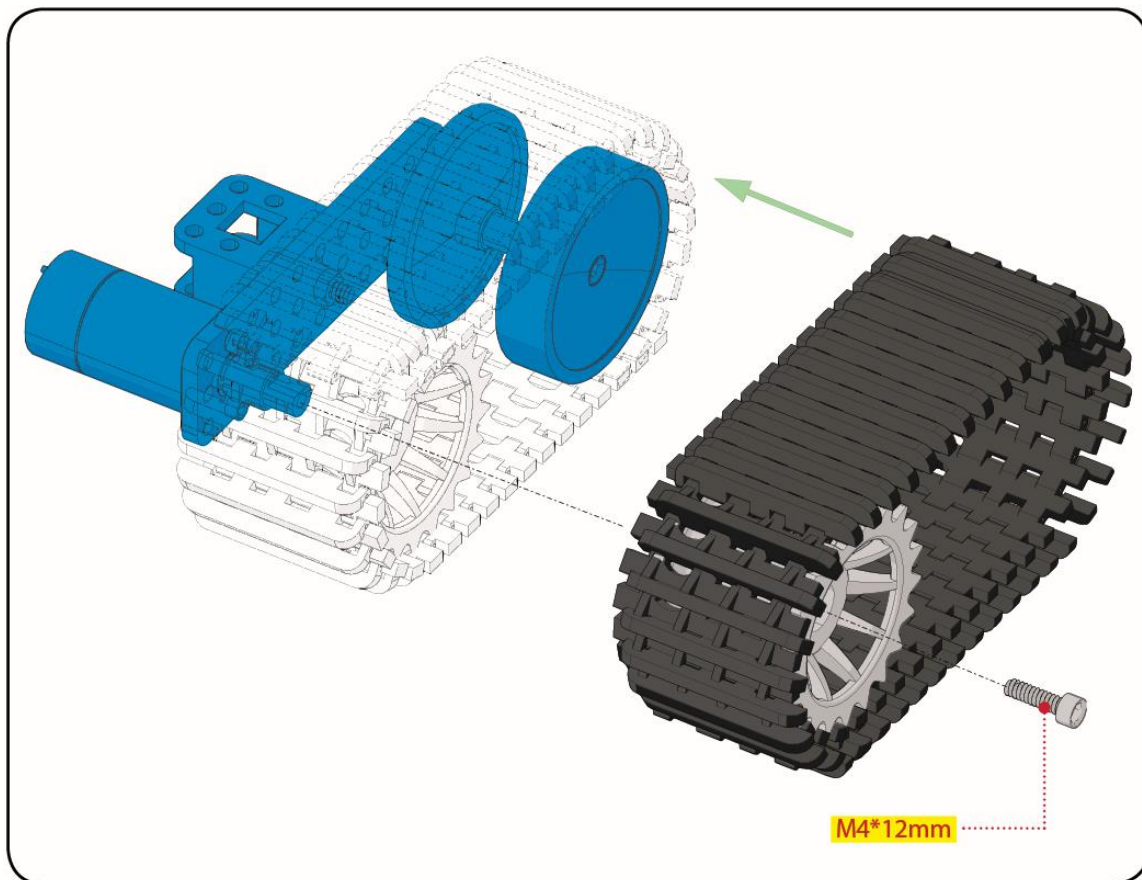
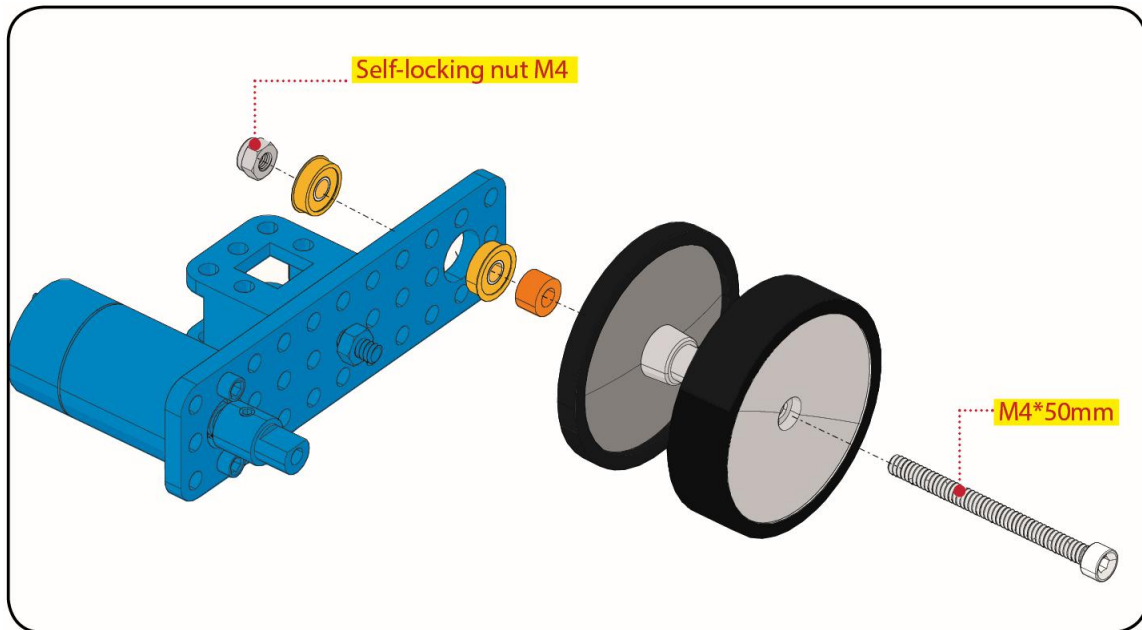


Prompt: assemble another side motor in same way

Step 2: Install Driver Wheel

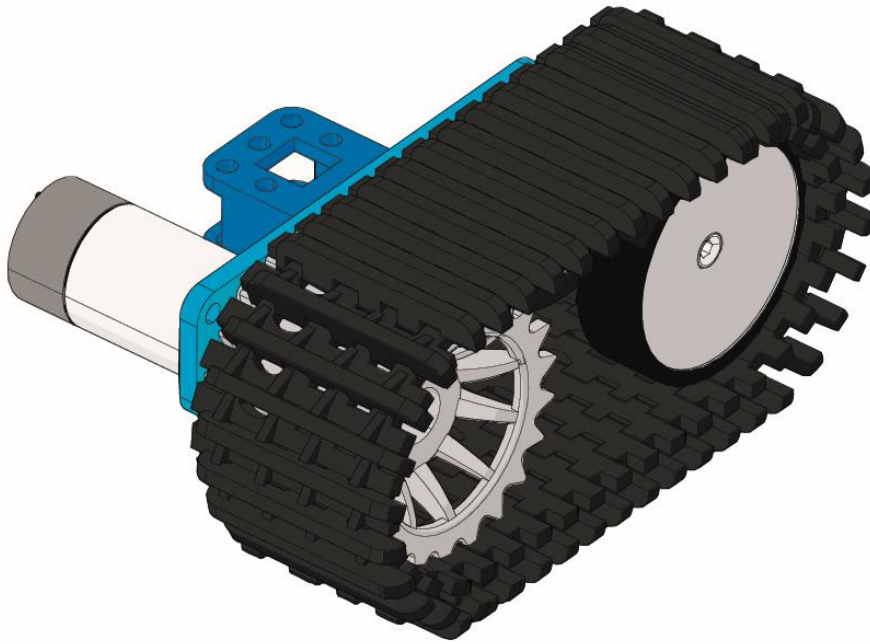
Prepare the parts as follows:

- M4*12MM Inner Hex Screw * 2
- M4*50MM Inner Hex Screw * 2
- Tank Load-bearing Wheel * 2
- Flange Bearing * 4
- Copper Bush *2
- Caterpillar Band *2
- M4 Self-locking Nut * 2
- M3 Hex Key Nickel Plated Allen Wrench *1





➤ Complete renderings

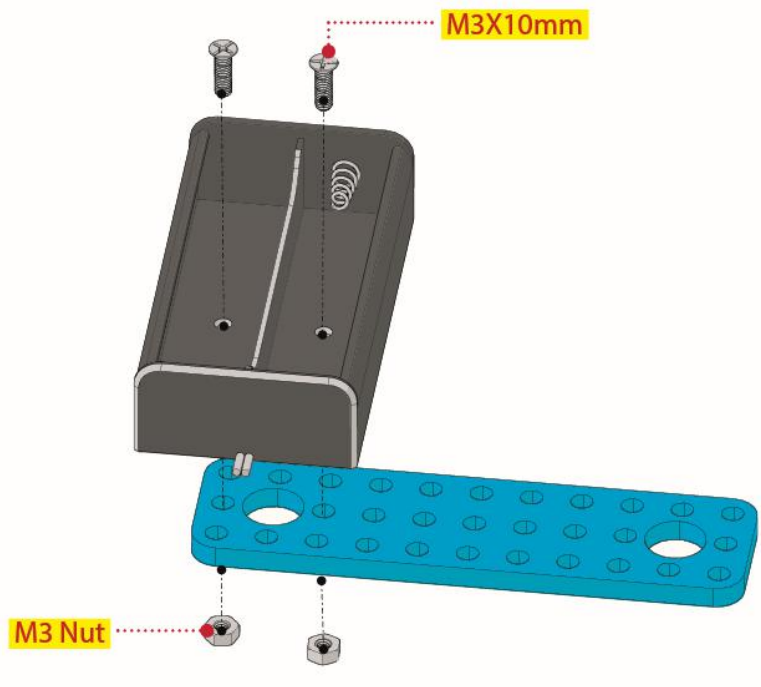


Prompt: complete assembly on the other side.

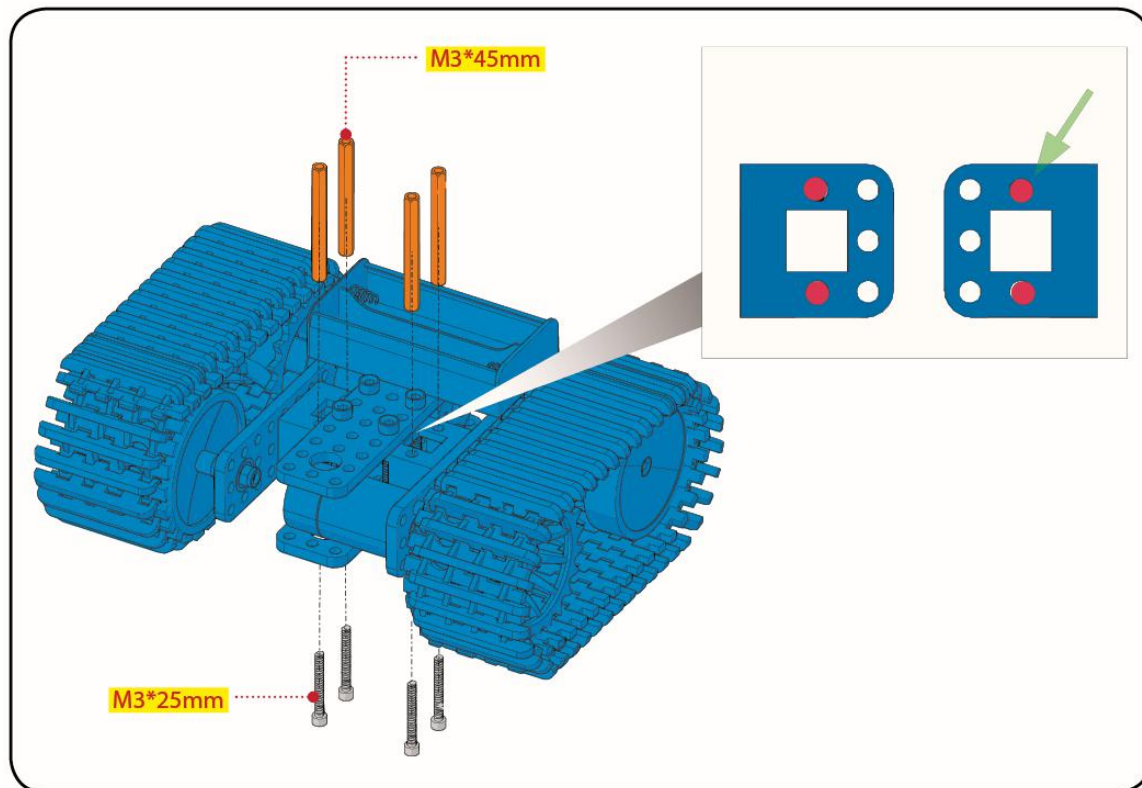
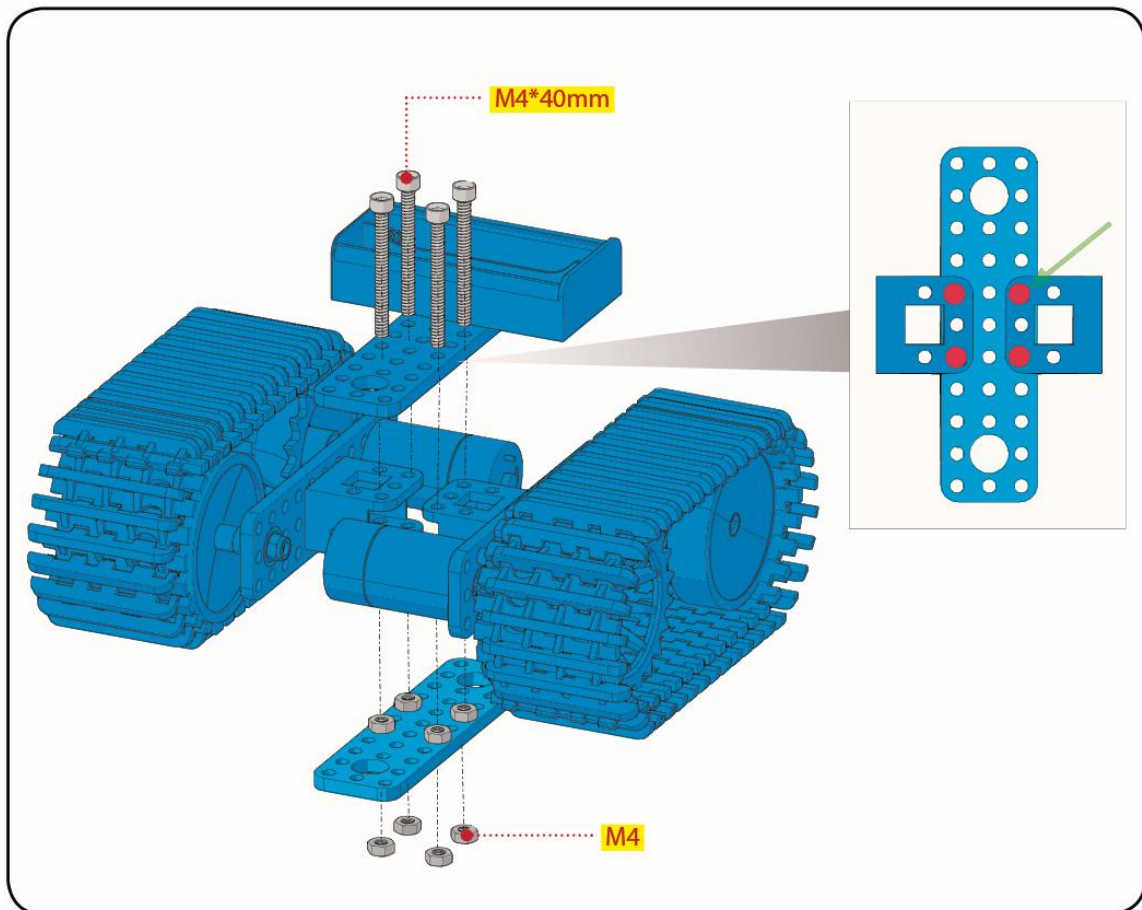
Step 3: Install the Battery Holder

Prepare the parts as follows:

- Battery Holder *1
- M3 Nut * 2
- Blue Metal holder *2
- M4 Nut *8
- M3*10MM Flat Head Screw * 2
- M4*40MM Inner Hex Screw *4
- M2.5 Hex Key Nickel Plated Allen Wrench*1
- M3 Hex Key Nickel Plated Allen Wrench *1
- M3*25MM Inner Hex Screw *4

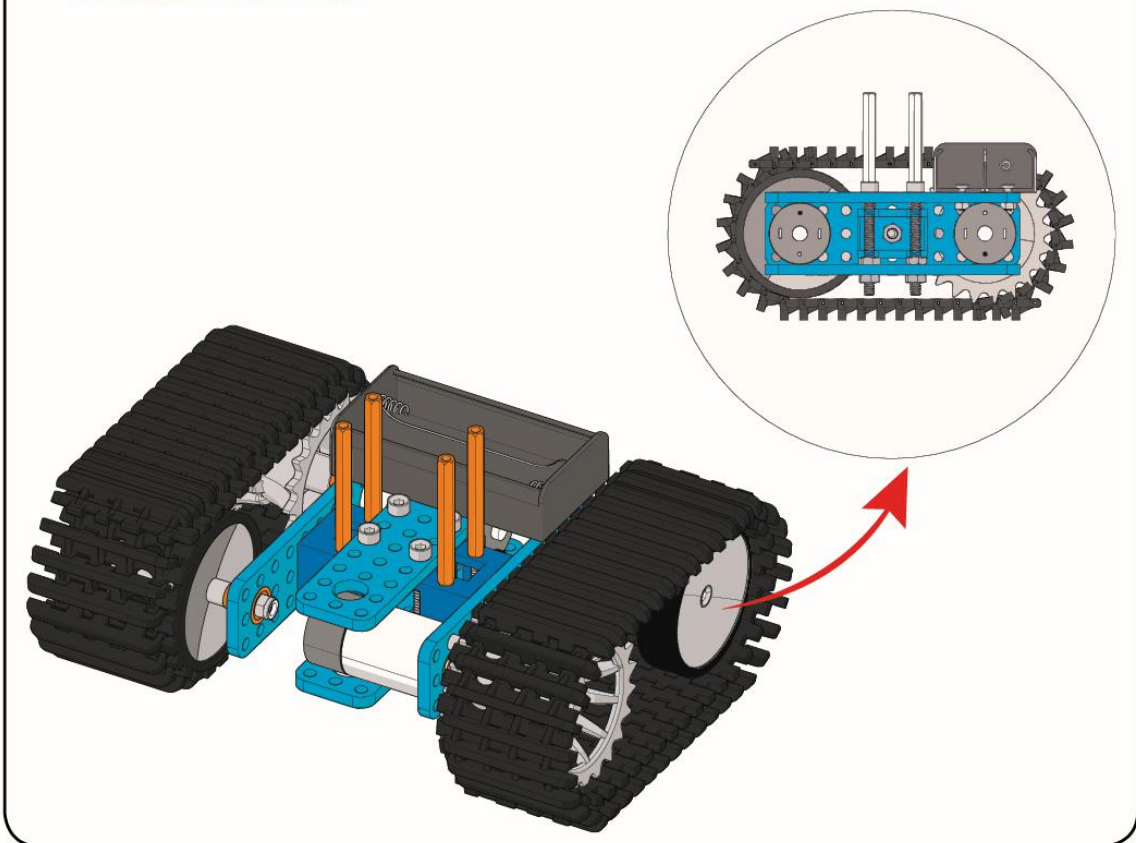


Finish the mount process. Go to fix the metal holder on the motor wheel with four M4*40MM inner hex screws and four M4 nuts.





➤ Complete renderings

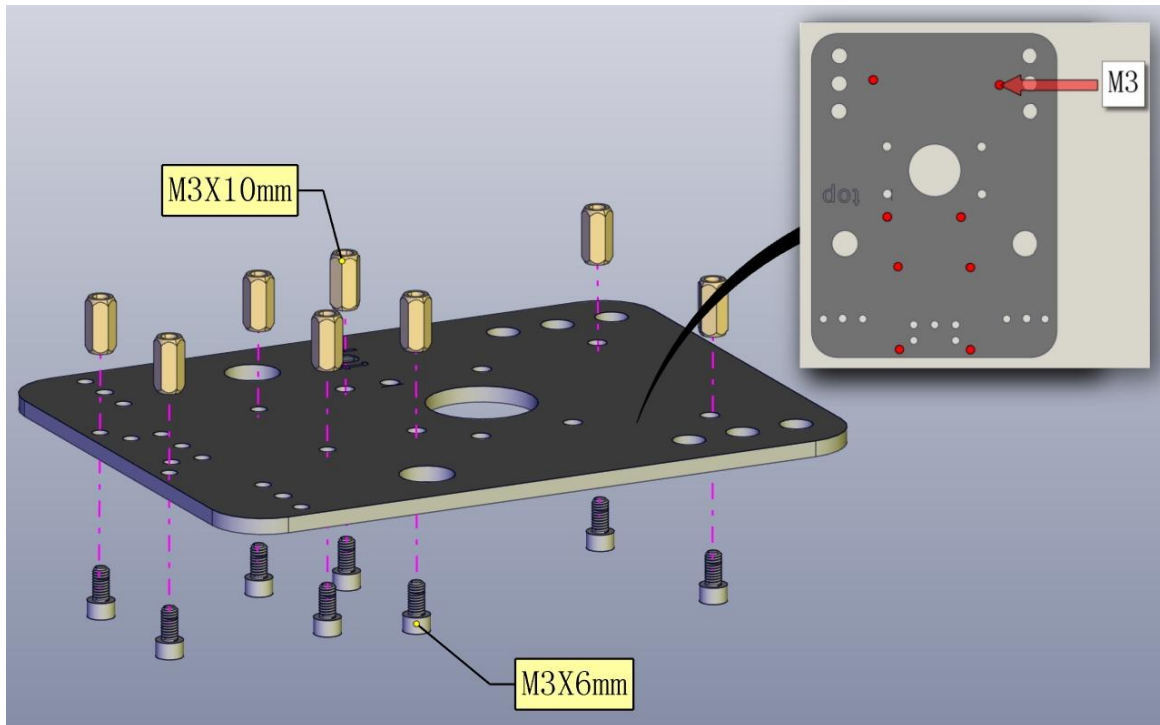


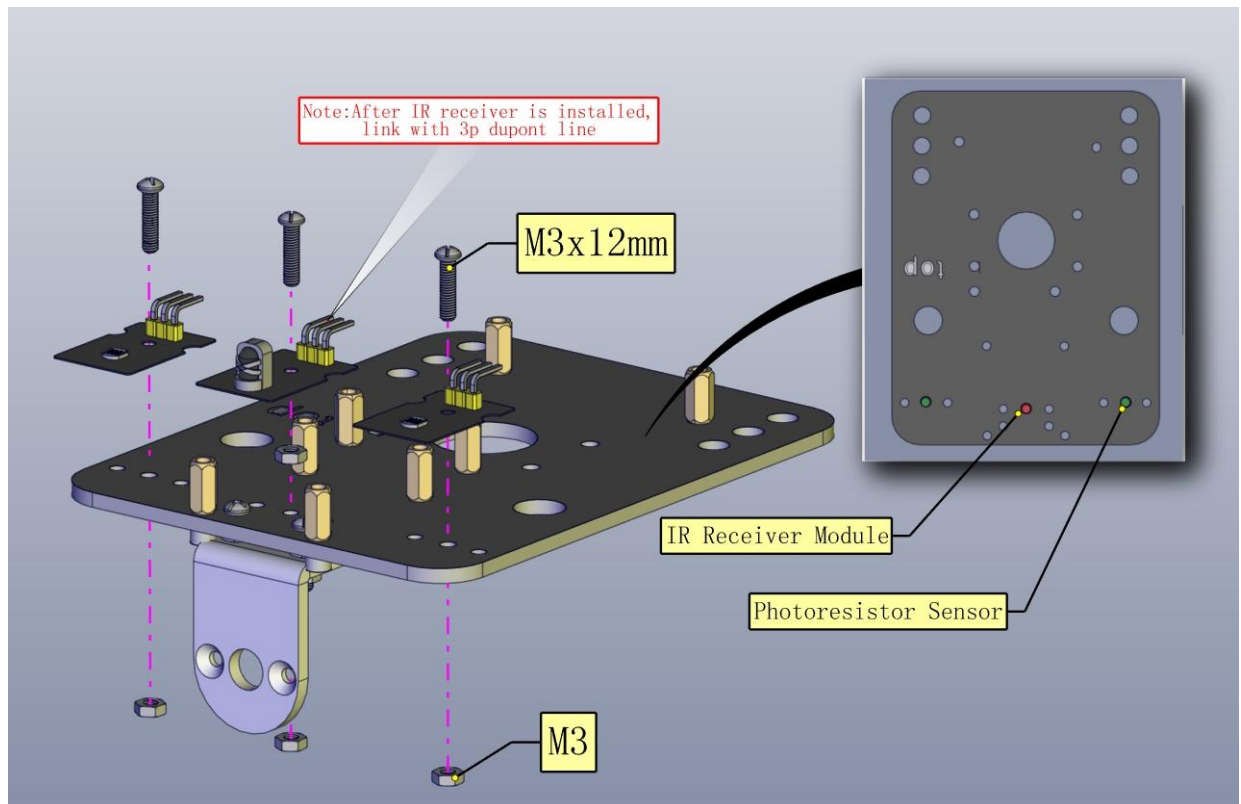
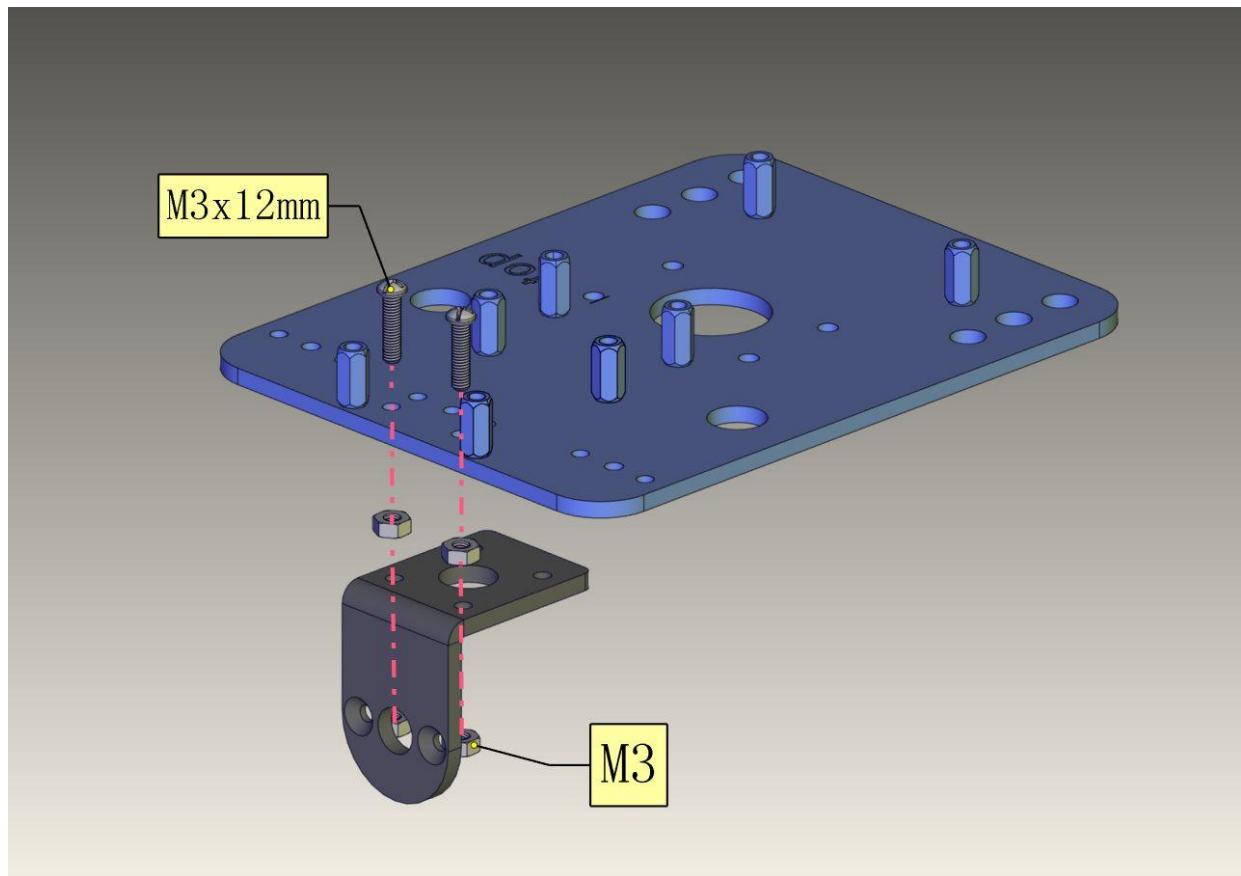
Step 4: Mount Acrylic Board and Sensors

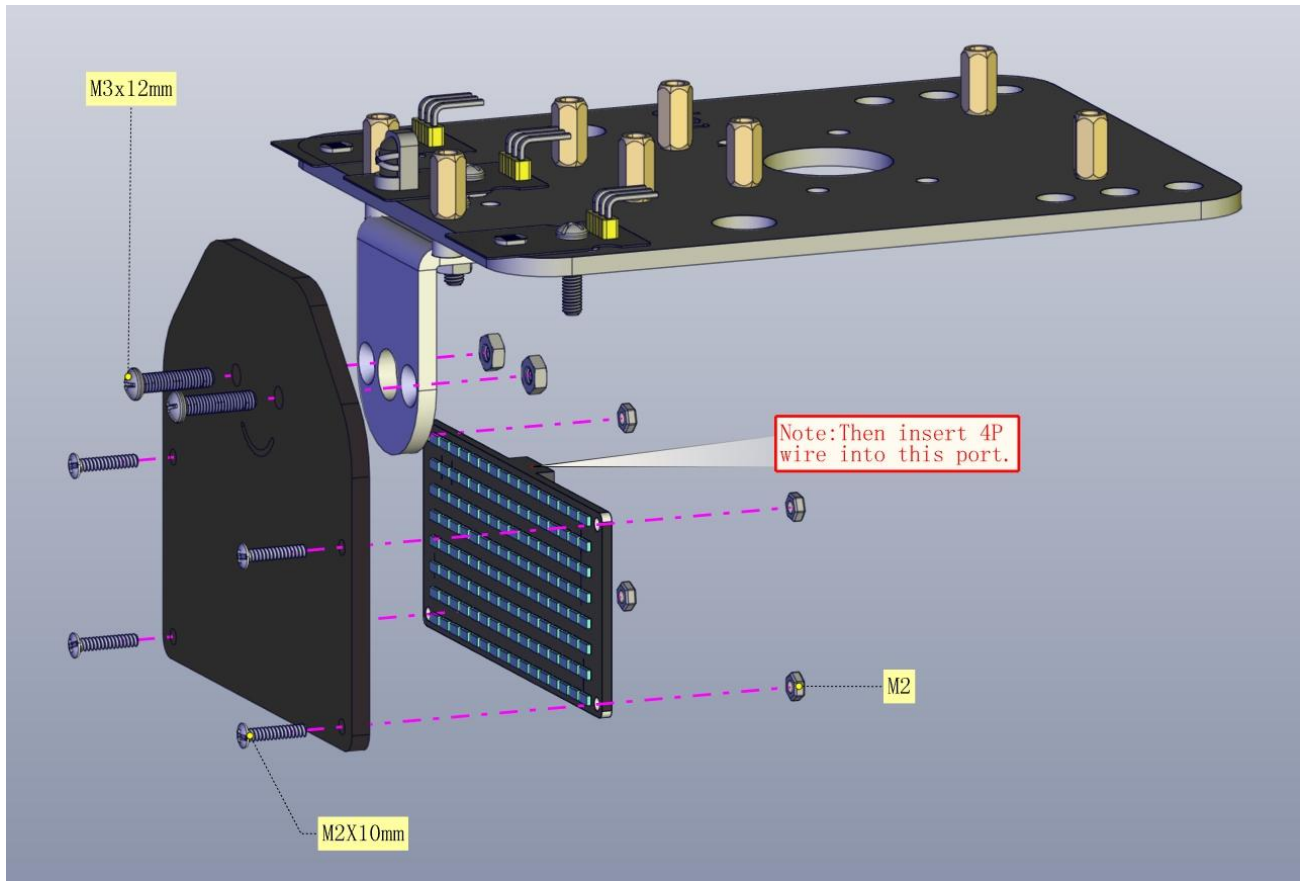
- Acrylic Board * 2
- L- type Black Bracket *1
- Photocell Sensor *2
- IR Receiver Module *1
- 8X16 LED Panel *1
- M2 Nut *4
- M3 Nut *10
- M3*6MM Inner Hex Screw * 8



- M2.5 Hex Key Allen Wrench *1
- M3*12MM Round Head Screw *7
- M3*10MM Hexagon Copper Bush *8
- M2*10MM Round Head Screw * 4





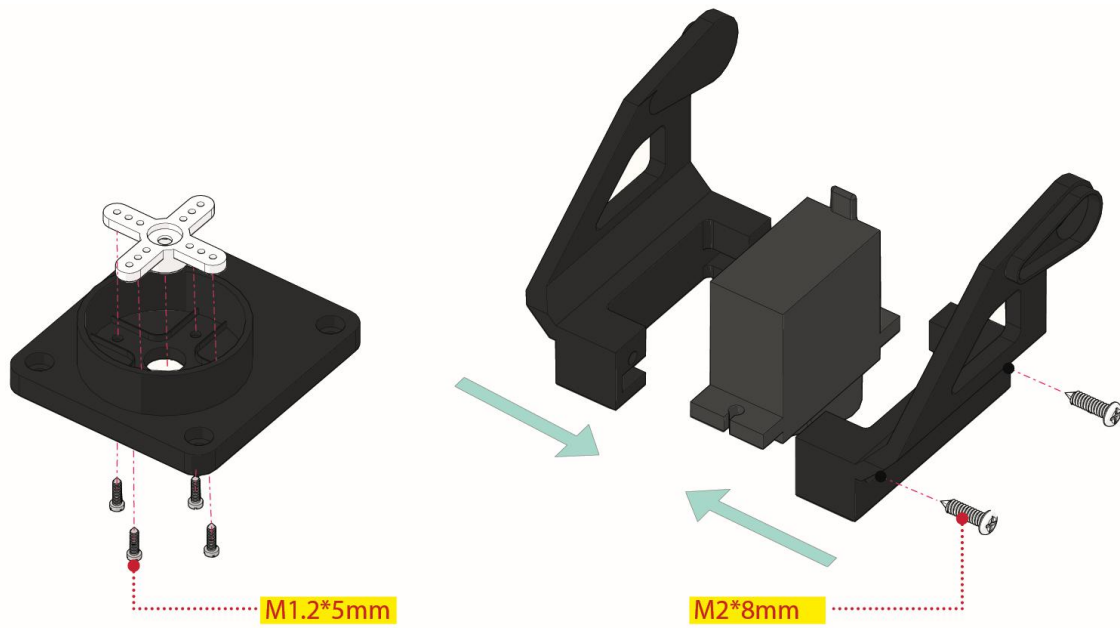


Step 5: Install the Servo Platform

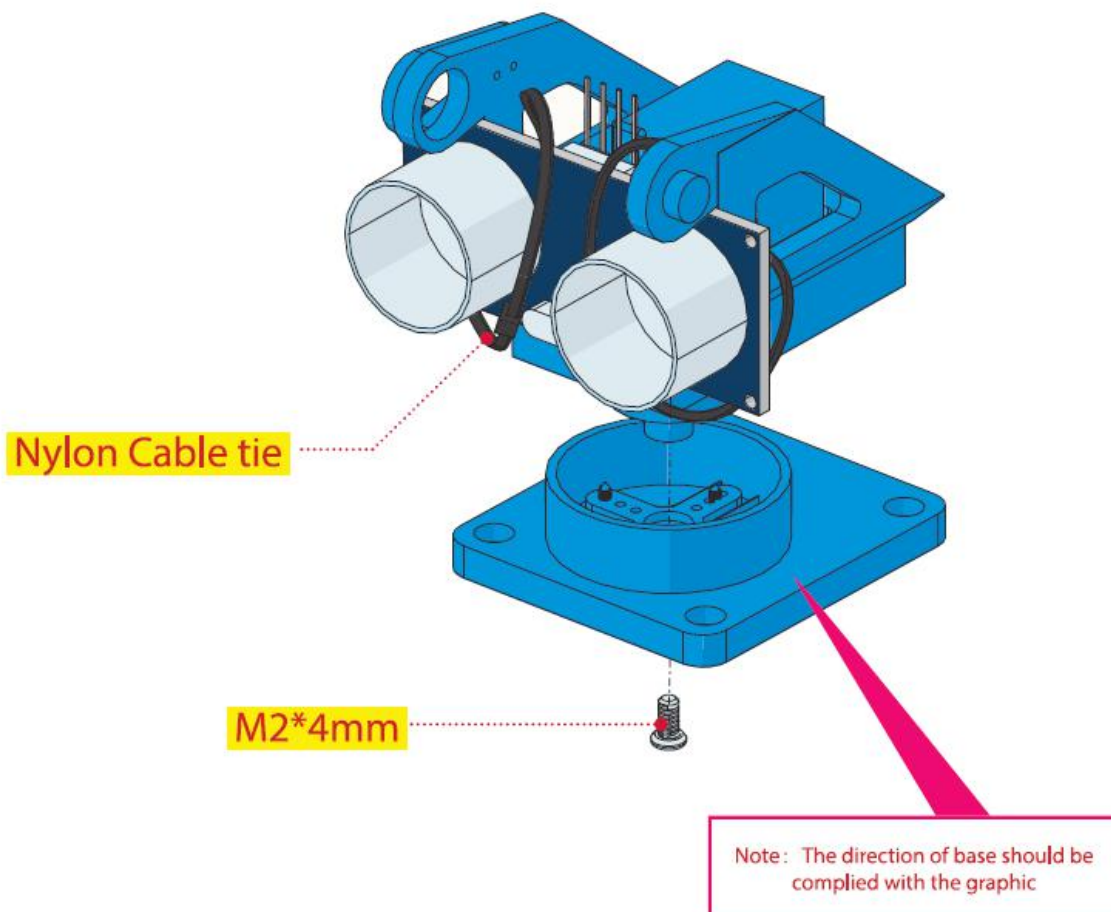
Prepare the parts as follows:

- Servo *1
- Black Gimbal *1
- Cable Tie *2
- M2x8 Round Head Cross Tapping Screw *2
- Ultrasonic Sensor *1
- M2*4 Screw *1
- M1.2*5 Screw *4

Note: for convenient debugging, keep the ultrasonic module straight ahead and the angle of servo motor 90°. Therefore, we need to set servo to 90° before installing the servo platform.



➤ Complete renderings

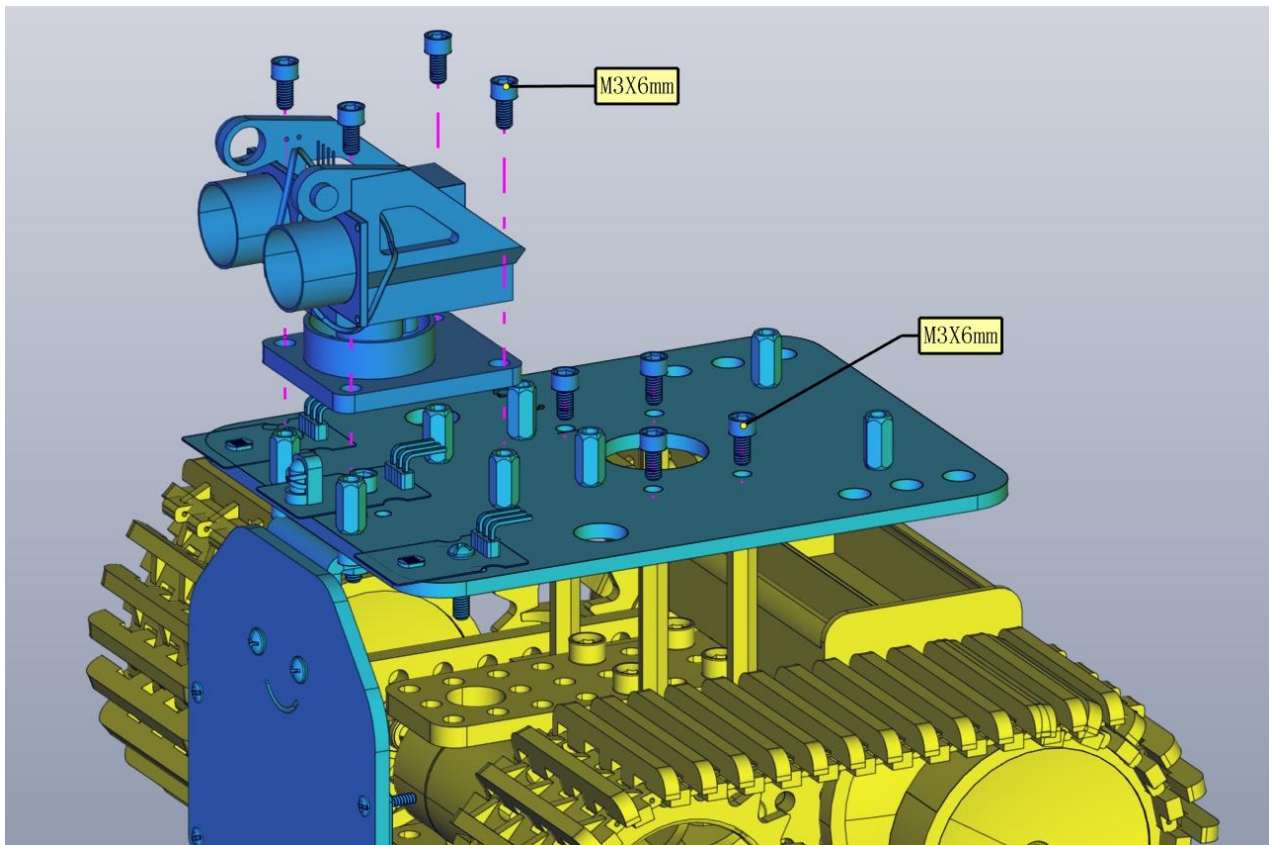


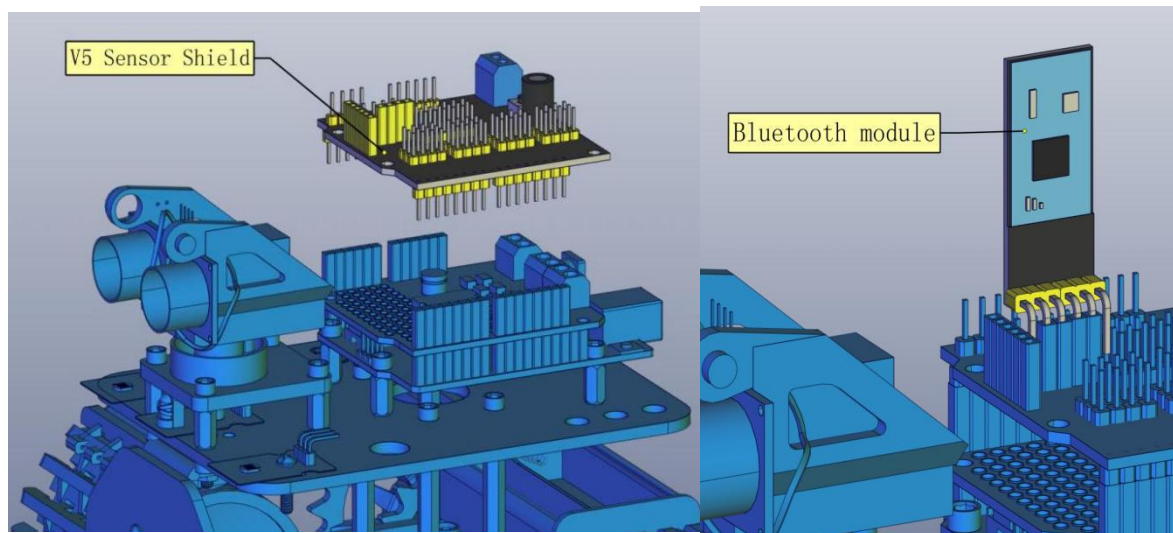
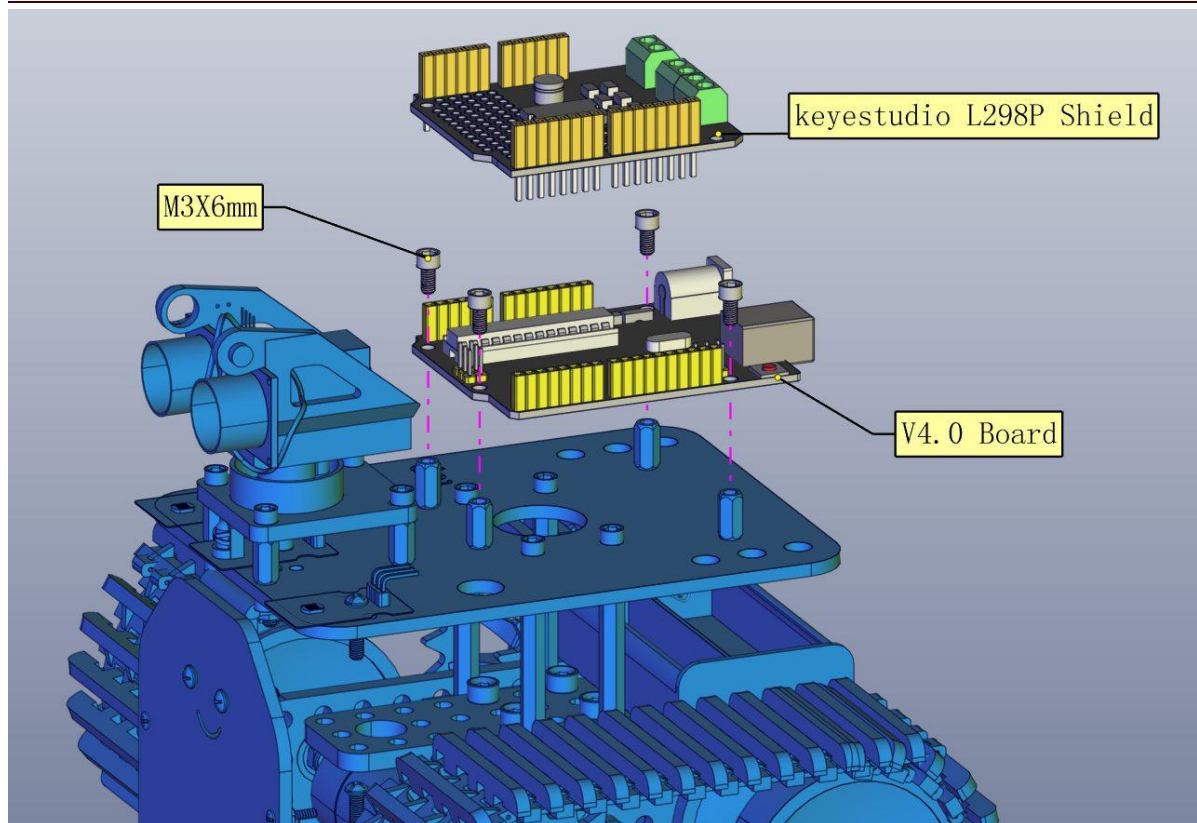
Step 6: Install Sensors and Boards

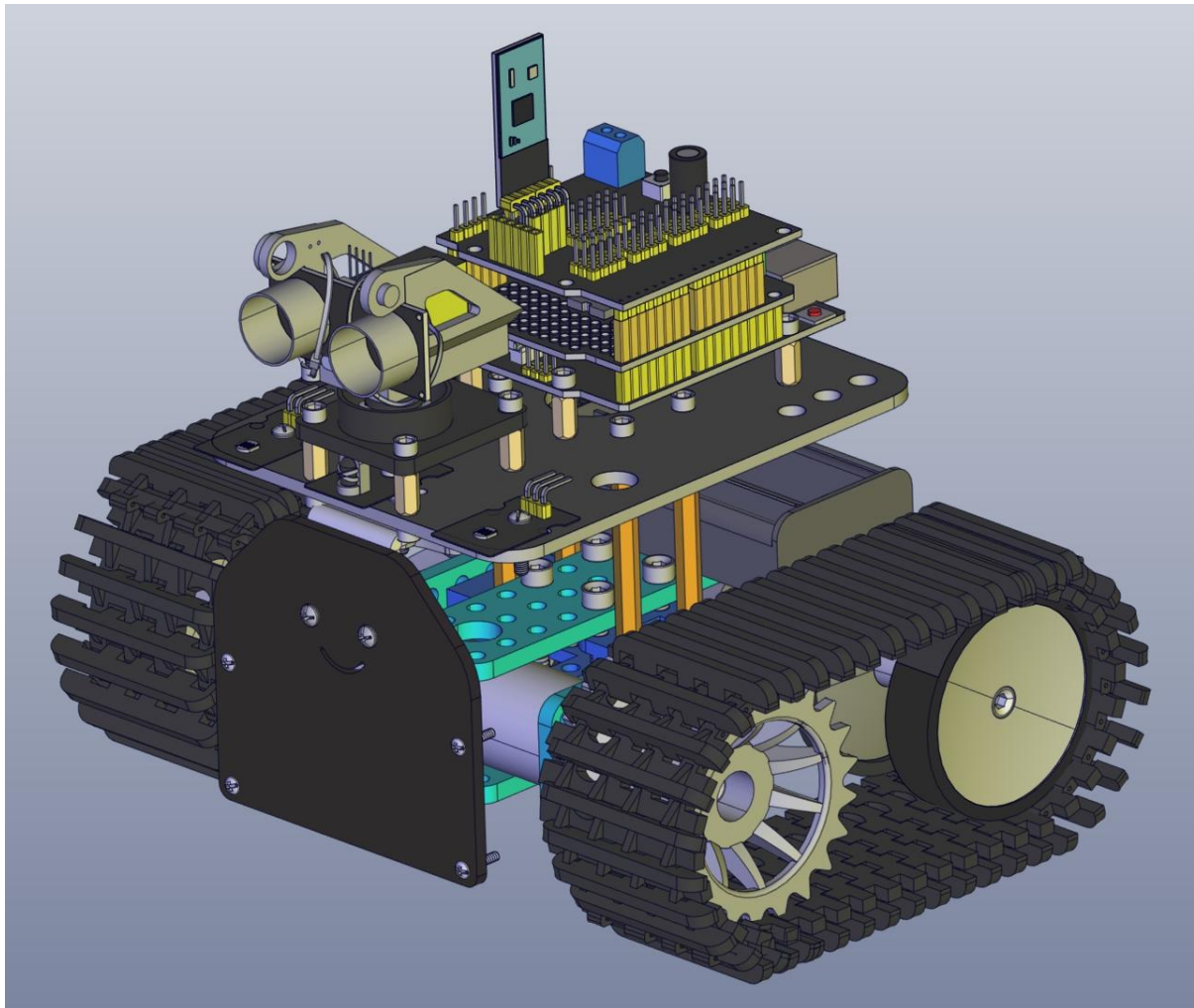


Prepare the parts as follows:

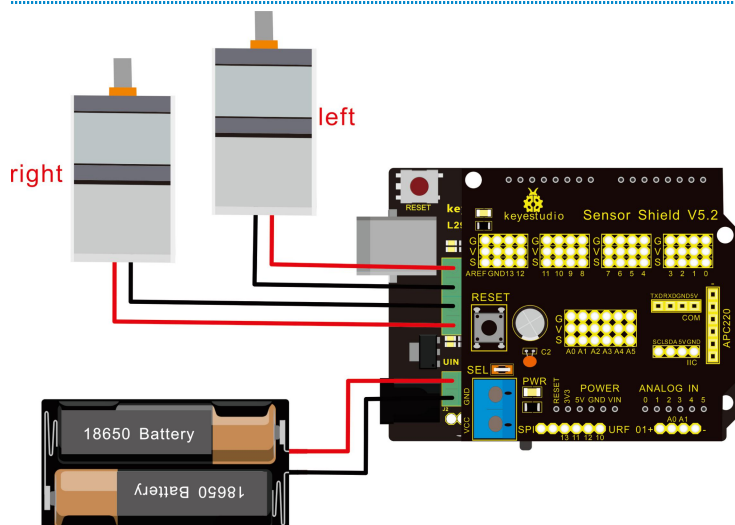
- M3*6MM Round Head Screw *12
- L298P Shield *1
- V4.0 Board *1
- V5 Sensor Shield *1
- Screwdriver *1
- Bluetooth Module *1

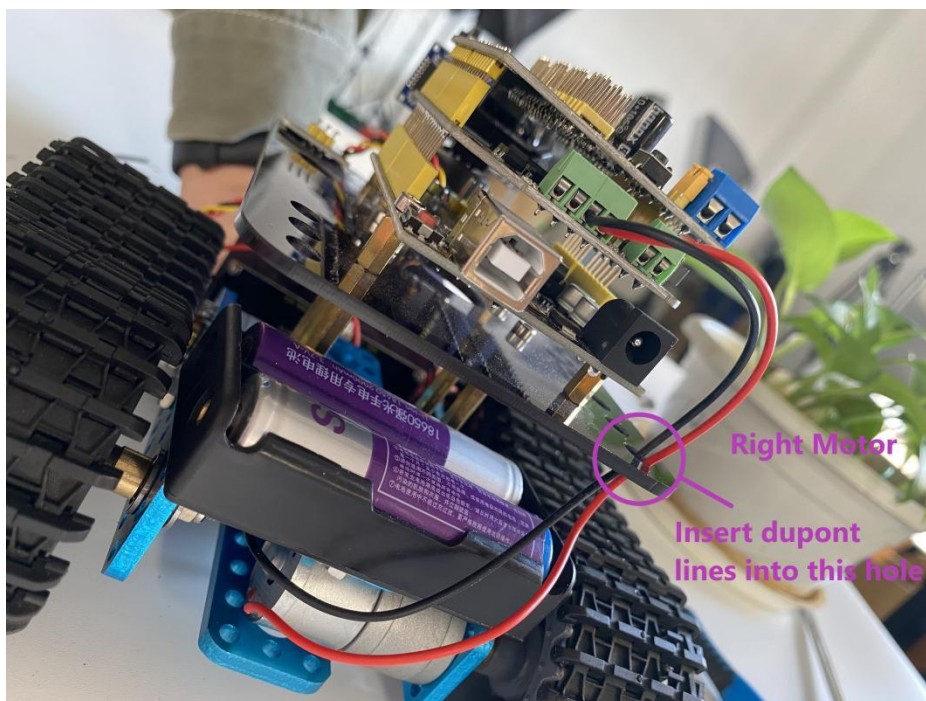
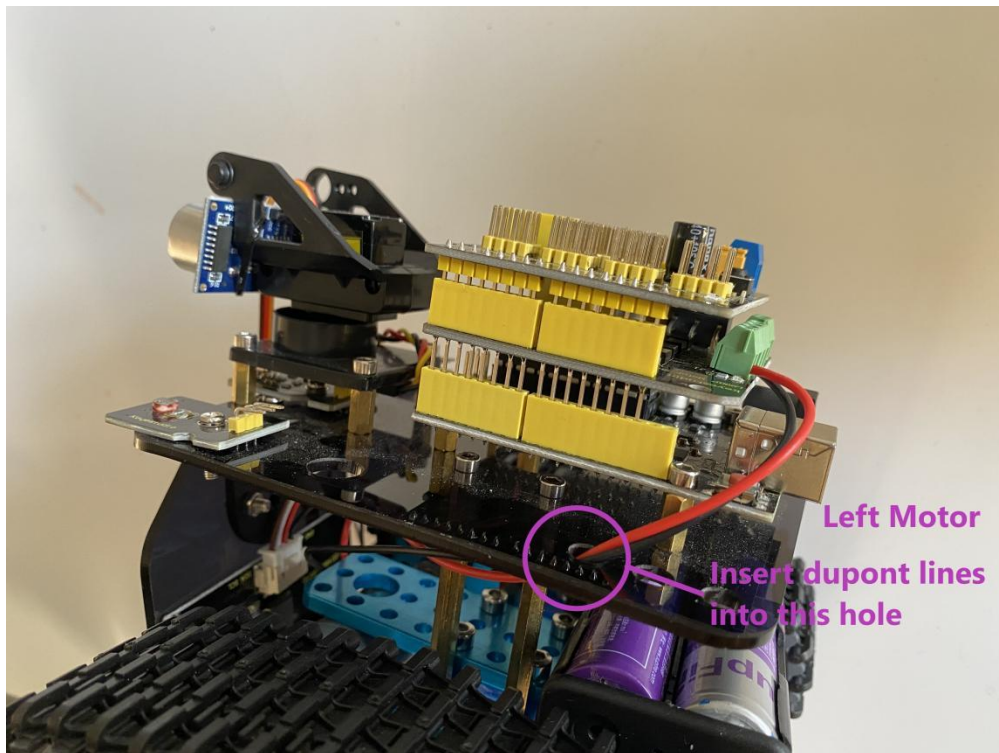


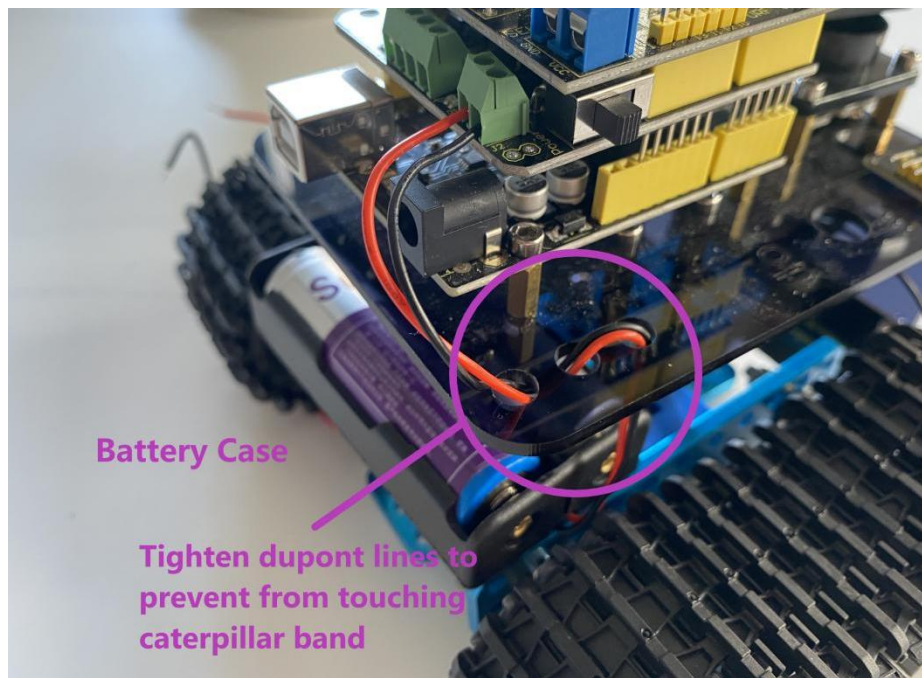


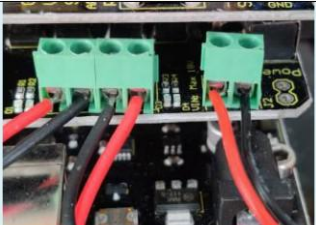


Step 7: Hook-up Guide



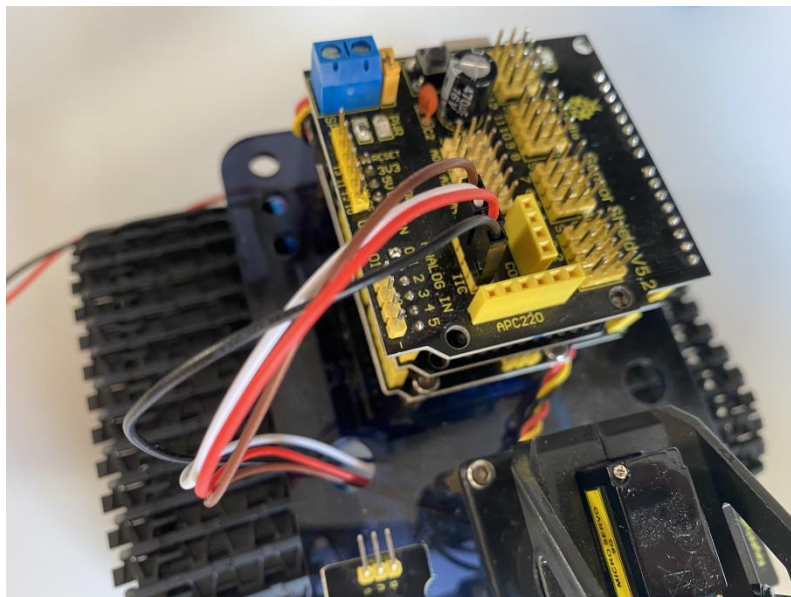
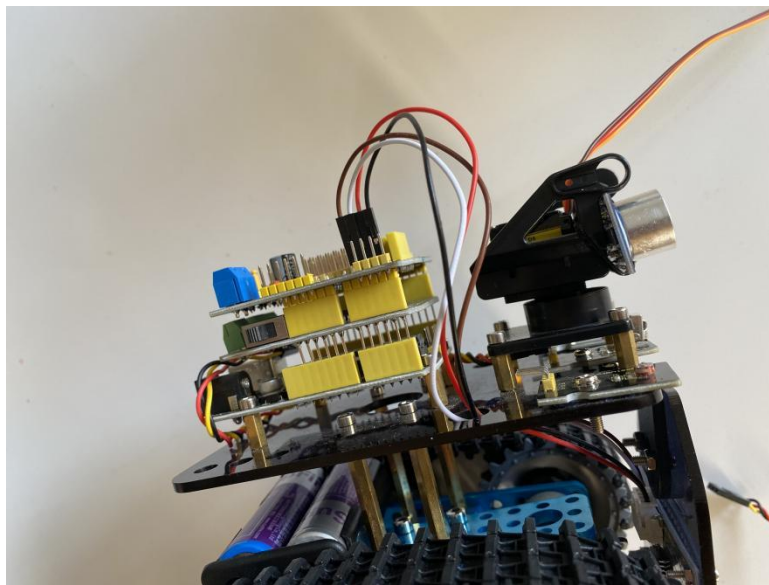
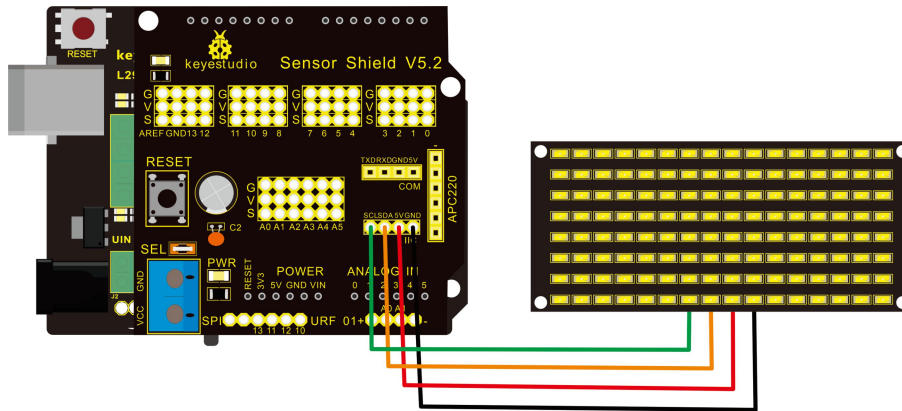




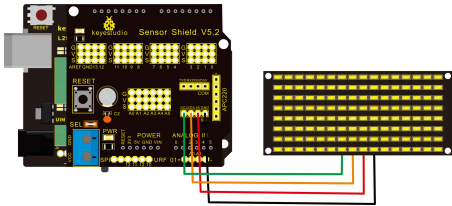
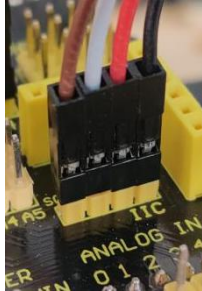
Motor	L298P Shield	
Right	Red wire→1 Black wire→2	
Left	Black wire→3 Red wire→4	



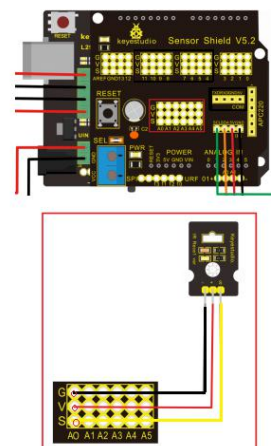
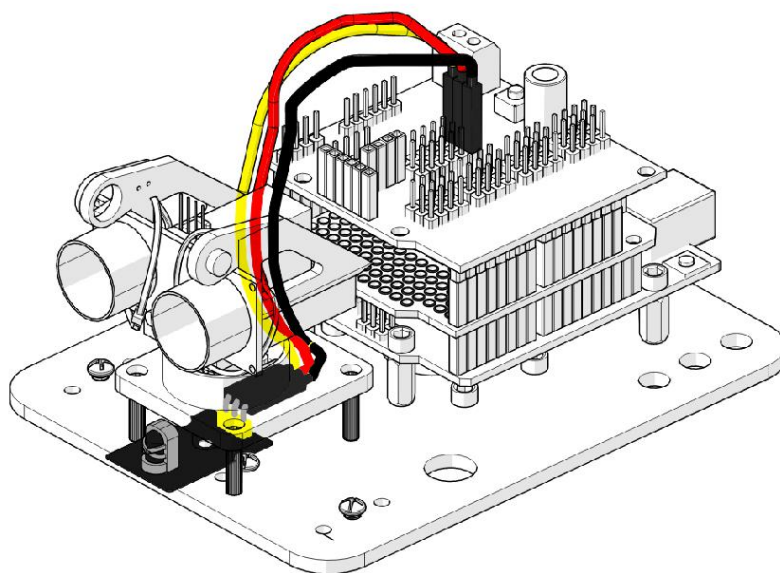
Step 8: Wire Up LED Panel

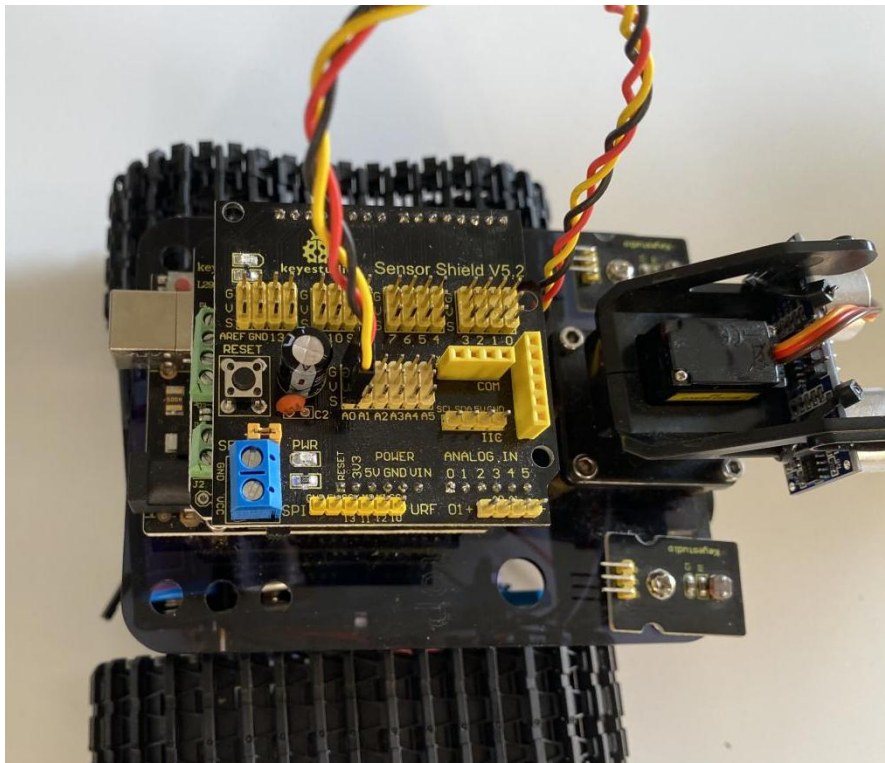




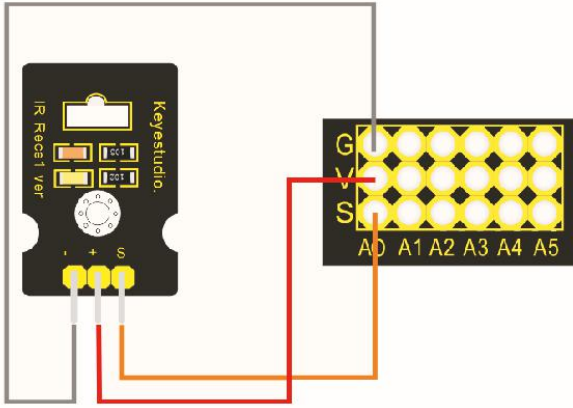
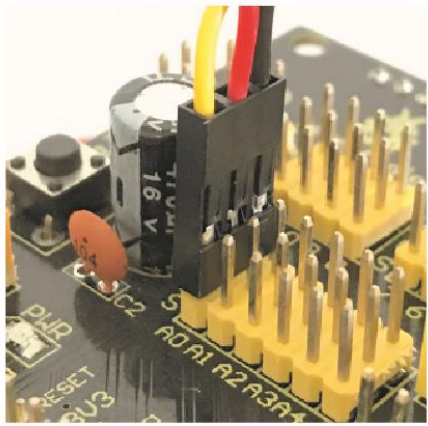
LED Panel	V5 Sensor Shield
GND	– (GND)
VCC	+ (VCC)
SDA	SDA
SCL	SCL
	

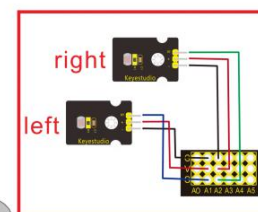
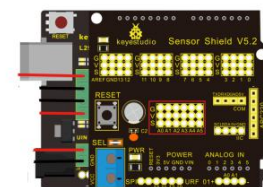
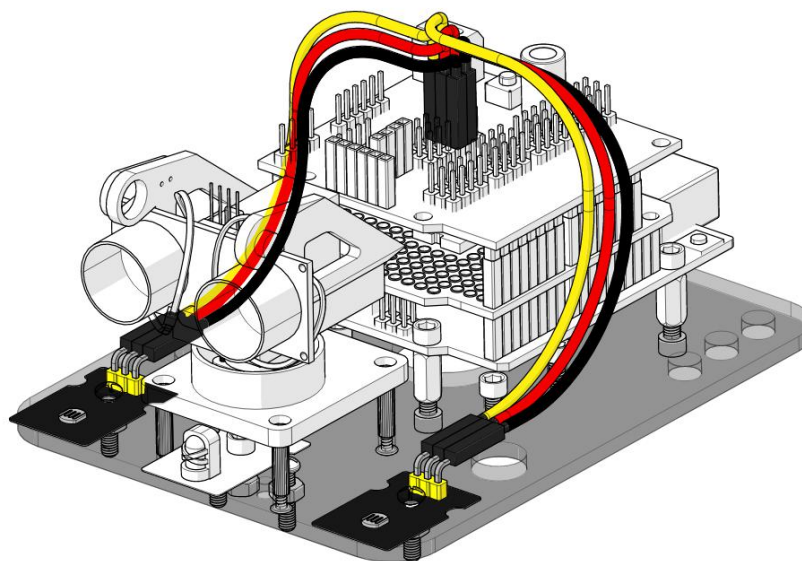
Step 9: install all parts of Acrylic plate

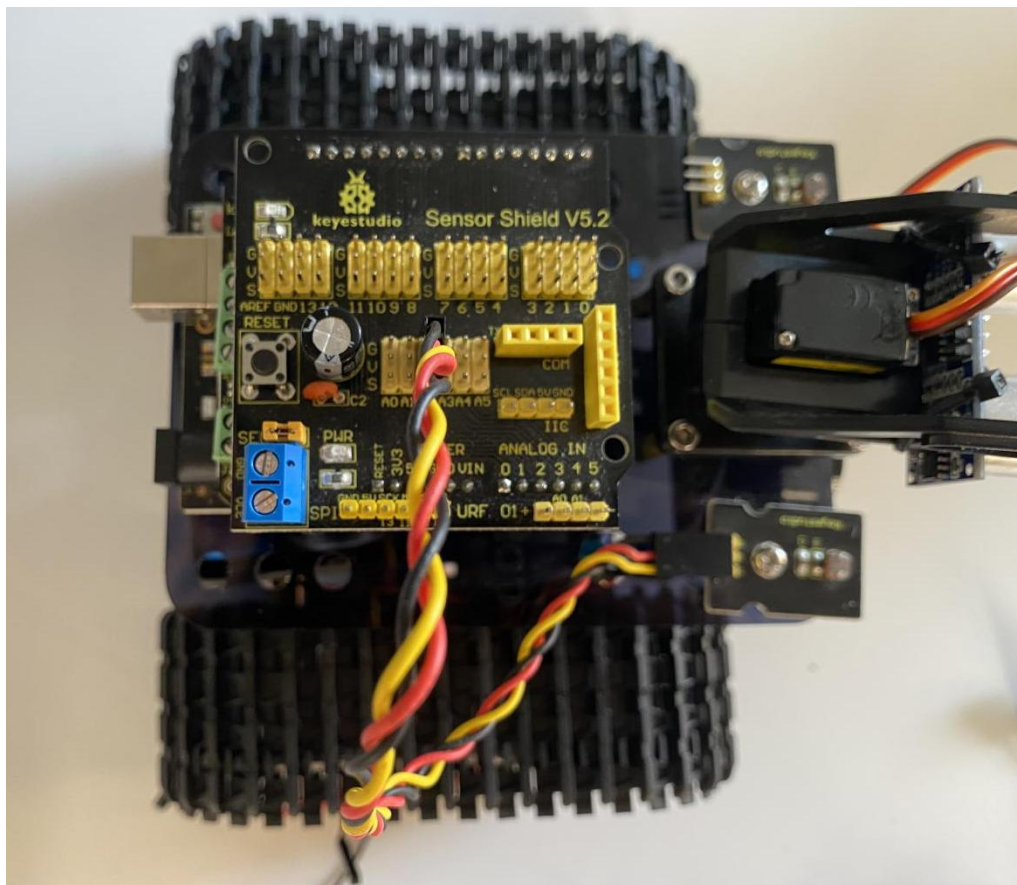
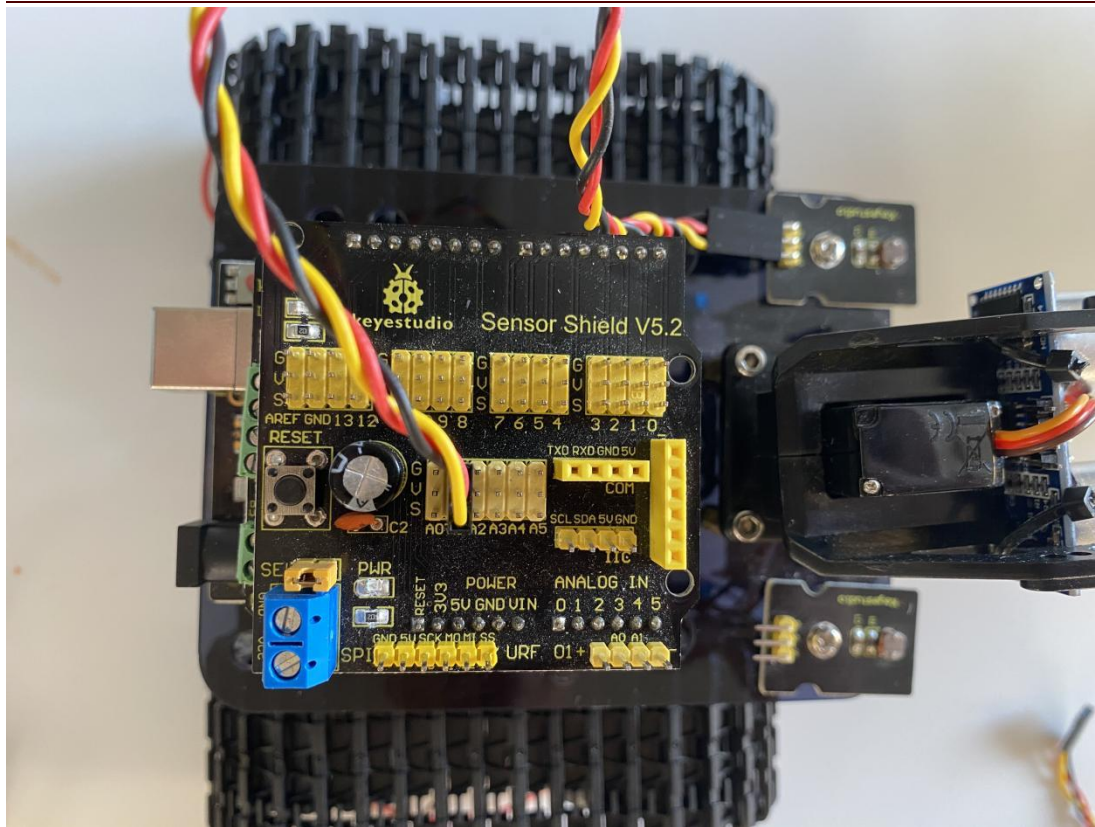






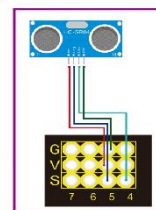
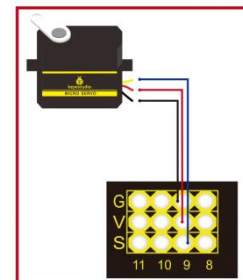
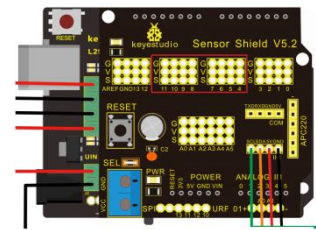
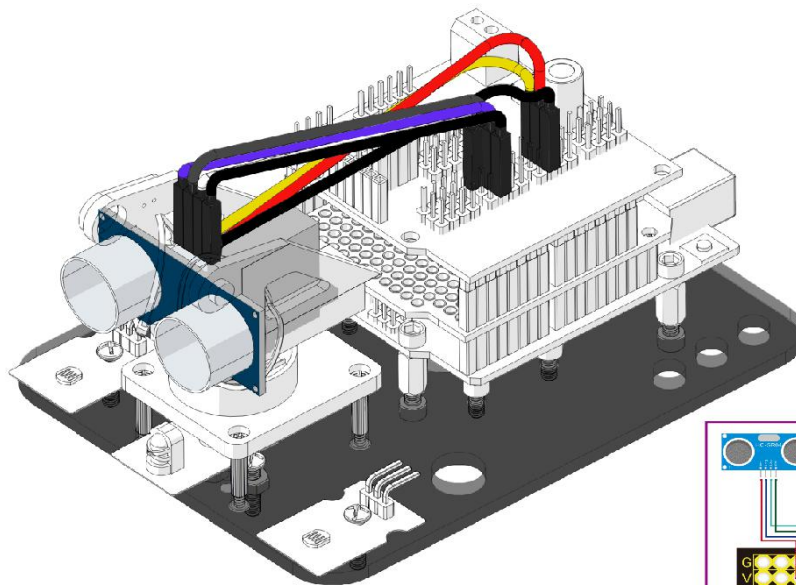
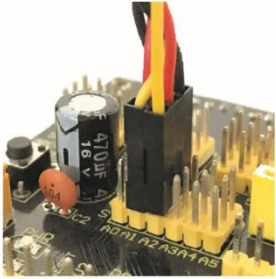
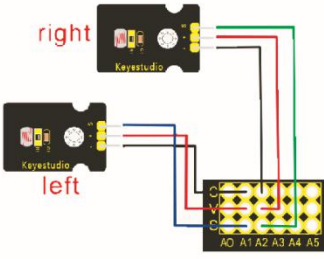
IR Receiver Sensor	V5 Sensor Shield
-	G (GND)
+	V (VCC)
S	A0
	

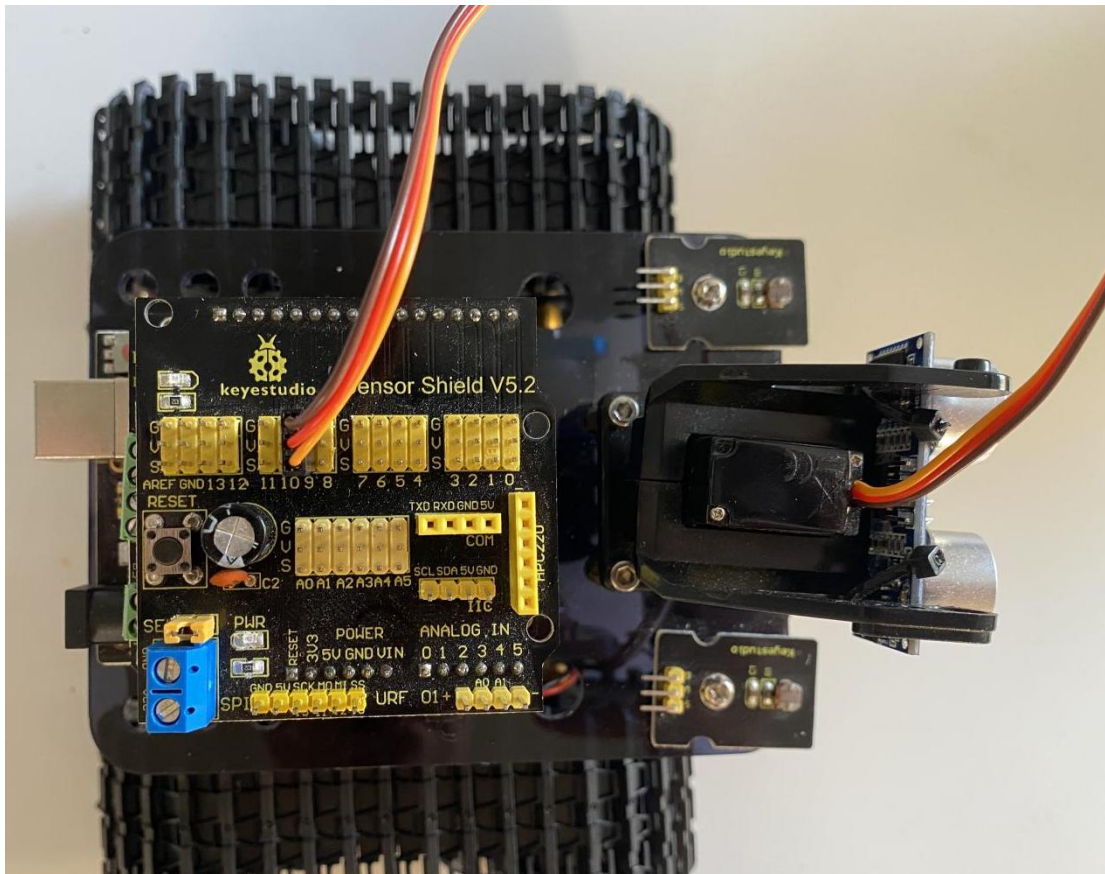
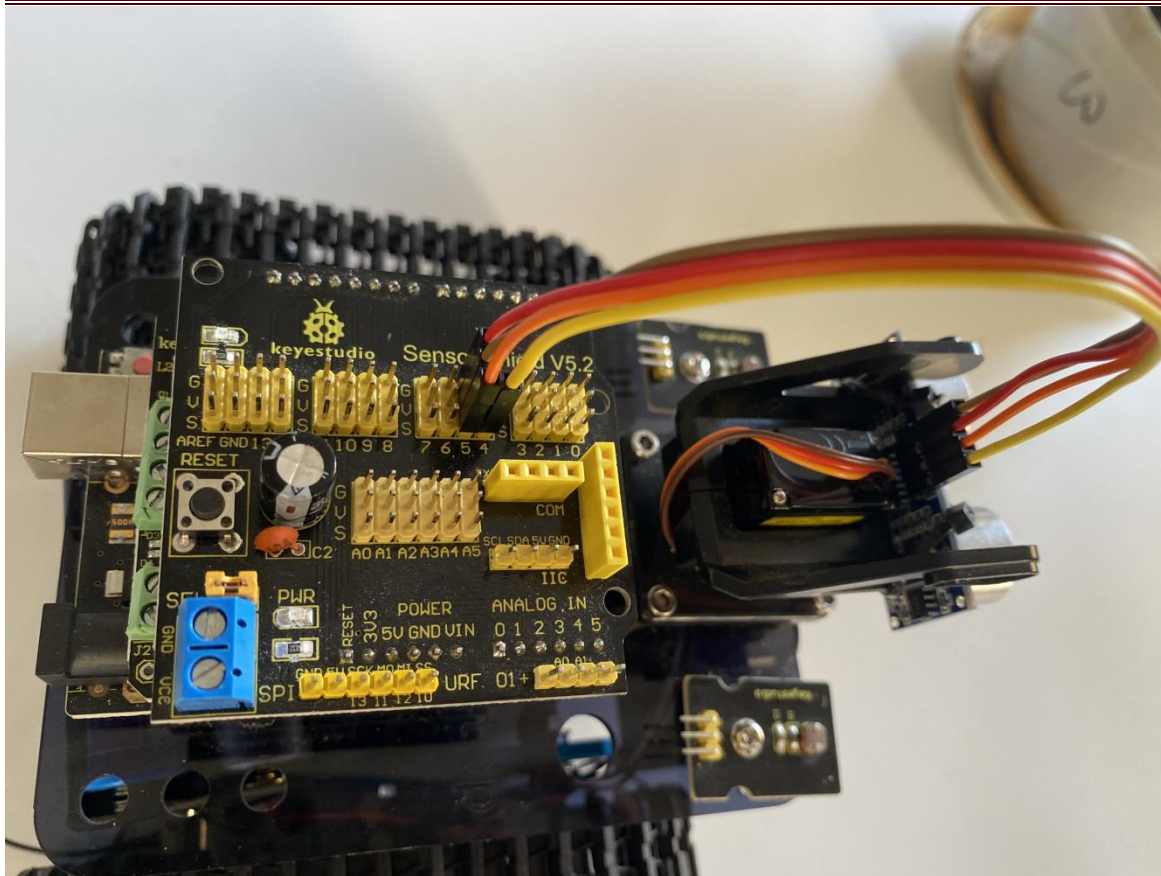




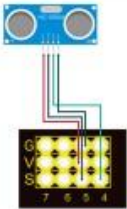
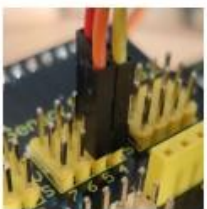
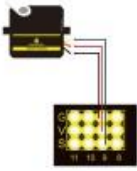



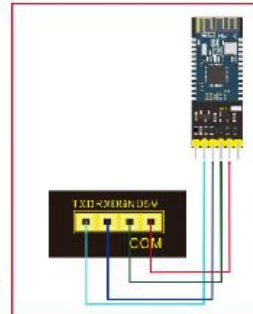
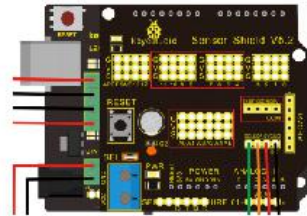
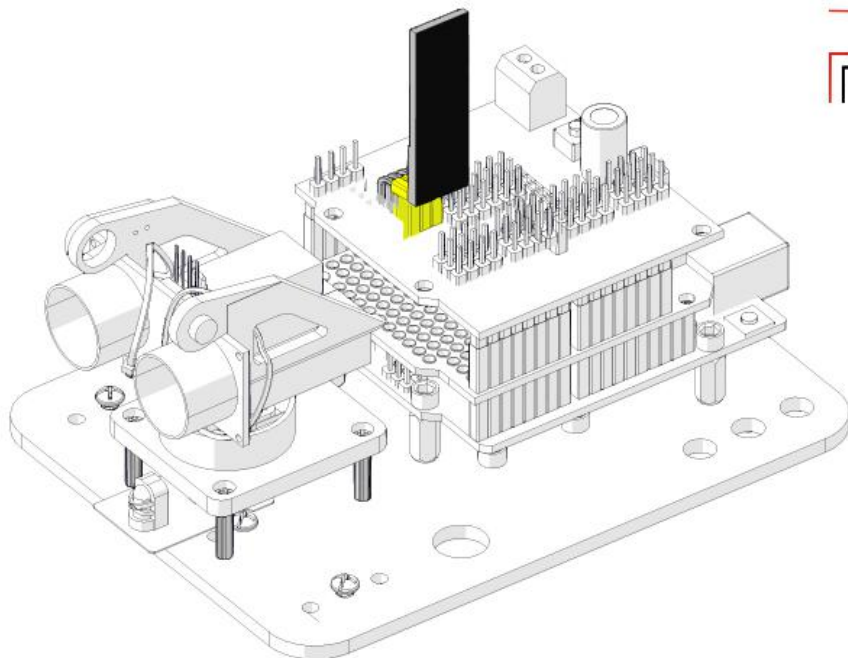
Photoresistor		V5 Sensor Shield
Left	-	G (GND)
	+	V (VCC)
	S	A1
Right	-	G (GND)
	+	V (VCC)
	S	A2



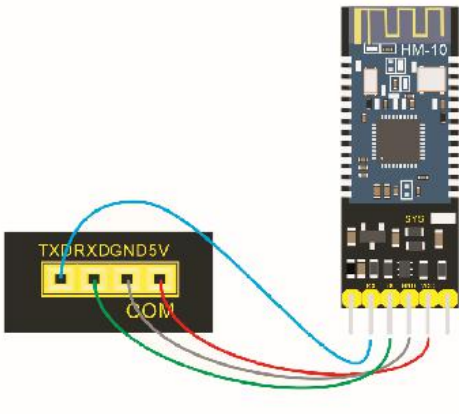





Ultrasonic	V5 Sensor Shield		
VCC	5v (V)		
Trig	5 (S)		
Echo	4 (S)		
Motor	V5 Sensor Shield		
S	9 (S)		
V	5v (V)		
G	Gnd (G)		

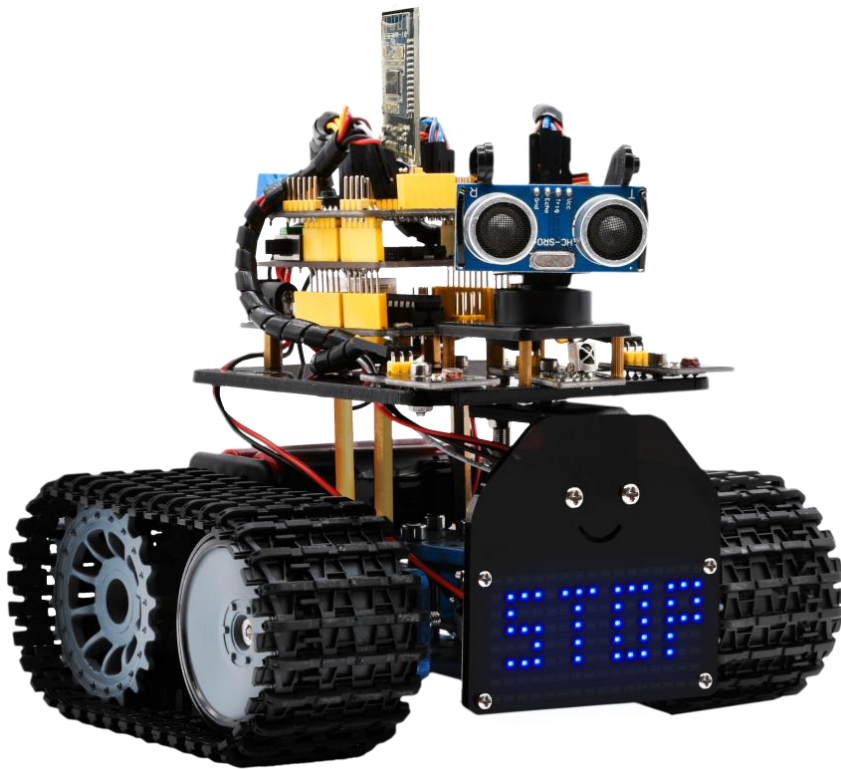




Bluetooth	V5 Sensor Shield
RXD	TX
TXD	RX
GND	- (GND)
VCC	+ (VCC)
	

Step 10: Tank Robot

Note: Remove the Bluetooth module before uploading test code, otherwise, you will fail to upload test code.



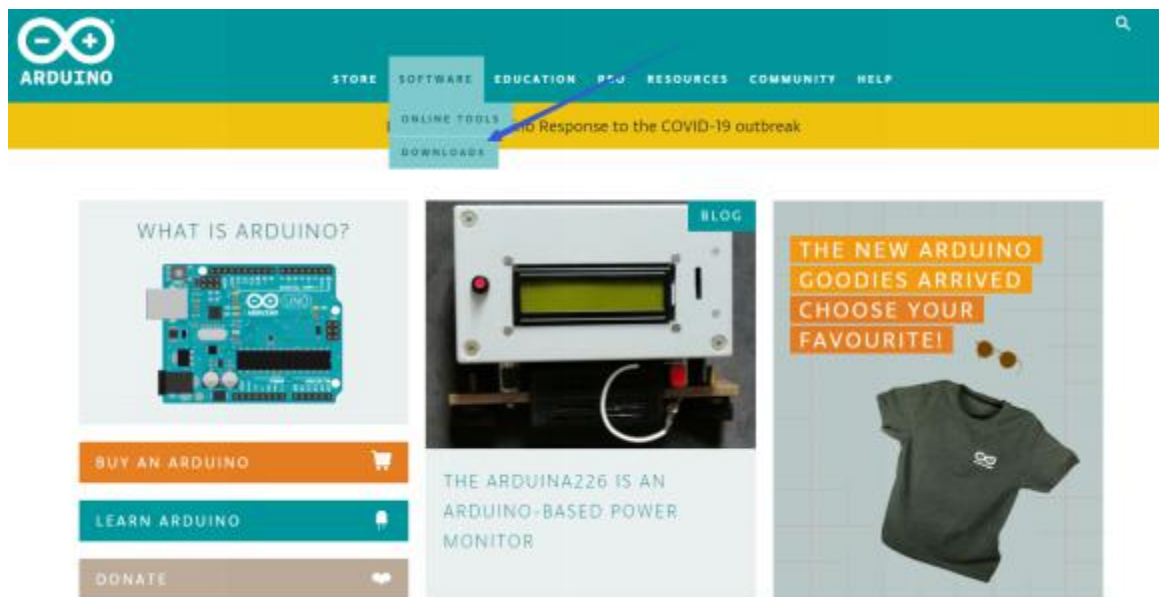
6. Install Arduino IDE and Driver

(1) Installing Arduino IDE

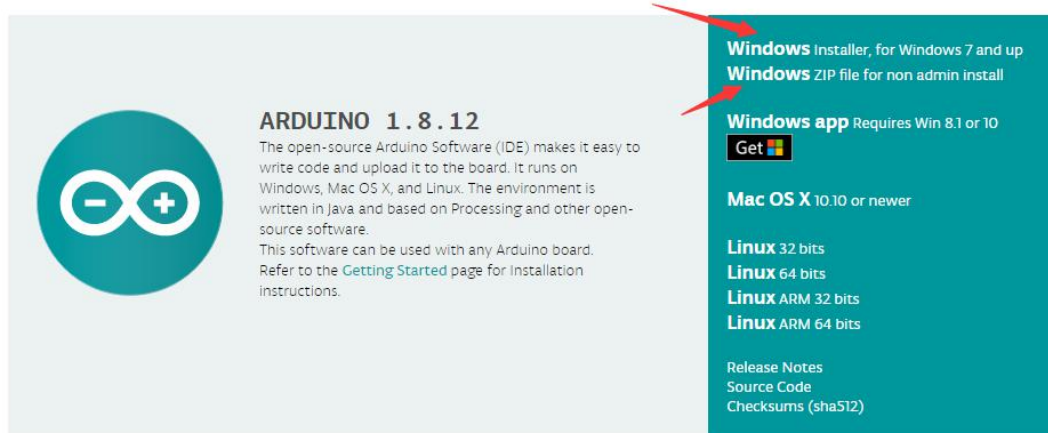
When we get control board, we need to download Arduino IDE and driver firstly.

You could download Arduino IDE from the official website:

<https://www.arduino.cc/>, click the **SOFTWARE** on the browse bar, click "DOWNLOADS" to enter download page, as shown below:



There are various versions Of IDE for Arduino, just download a version that compatible with your system, here we will show you how to download and install the windows version Arduino IDE.



There are two versions of IDE for WINDOWS system, you can choose between the installer (.exe) and the Zip packages. For installer, it can be directly downloaded, without the need of installing manually. For Zip package, you need to install the drivers manually.



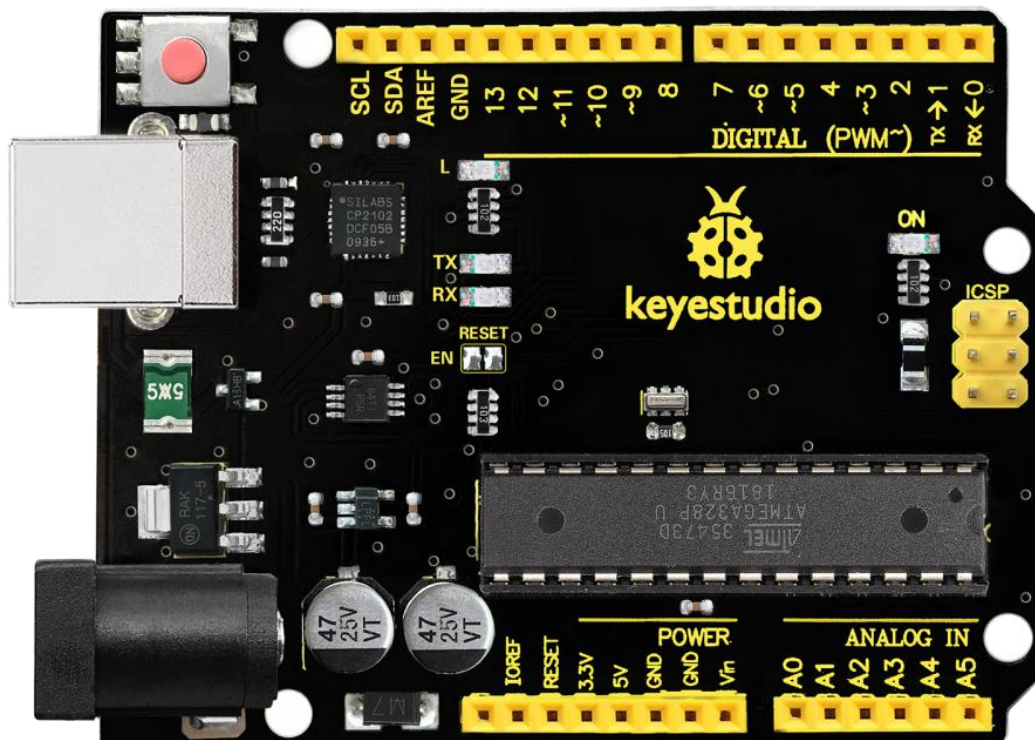
Consider supporting the Arduino Software by contributing to its development. (US tax payers, please note this contribution is not tax deductible). [Learn more on how your contribution will be used.](#)



You just need to click JUST DOWNLOAD.

(2) Keyestudio V4.0 Development Board

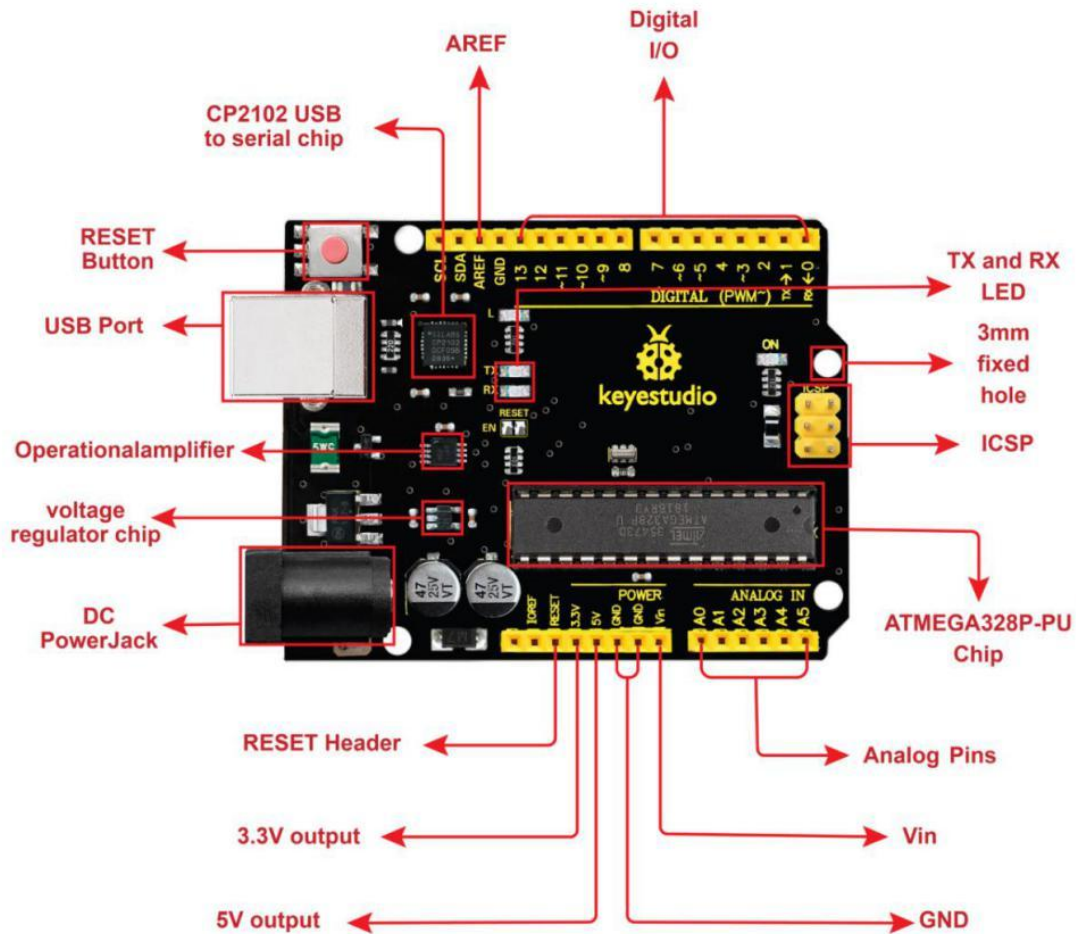
We need to know keyestudio V4.0 development board, as a core of this smart car.



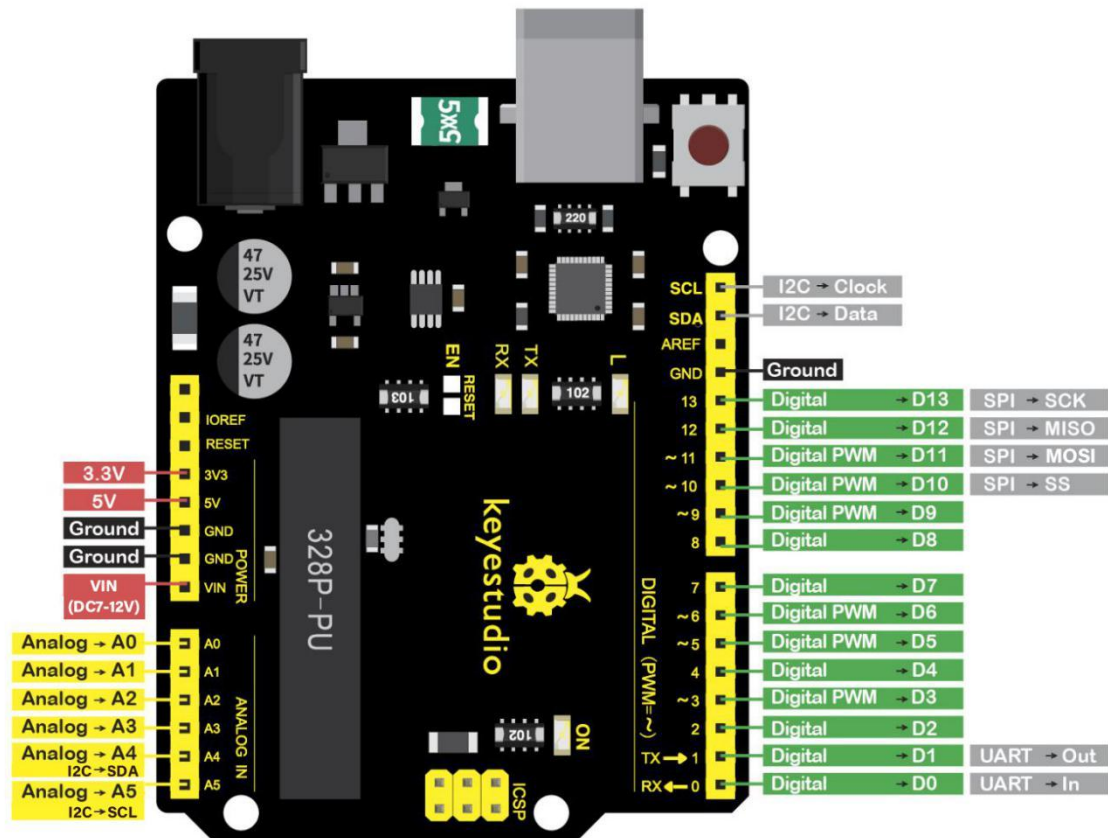
keyestudio V4.0 development board is an Arduino uno-compatible



board, which is based on ATmega328P MCU, and with a cp2102 chip as a UART-to-USB converter.



It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, 2 ICSP headers and a reset button.



It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it via an external DC power jack (DC 7-12V) or via female headers Vin/ GND(DC 7-12V) to get started.



Microcontroller	ATmega328P-PU
Operating Voltage	5V
Input Voltage (recommended)	DC7-12V
Digital I/O Pins	14 (D0-D13) (of which 6 provide PWM output)
PWM Digital I/O Pins	6 (D3, D5, D6, D9, D10, D11)
Analog Input Pins	6 (A0-A5)
DC Current per I/O Pin	20 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB (ATmega328P-PU) of which 0.5 KB used by bootloader
SRAM	2 KB (ATmega328P-PU)
EEPROM	1 KB (ATmega328P-PU)
Clock Speed	16 MHz
LED_BUILTIN	D13

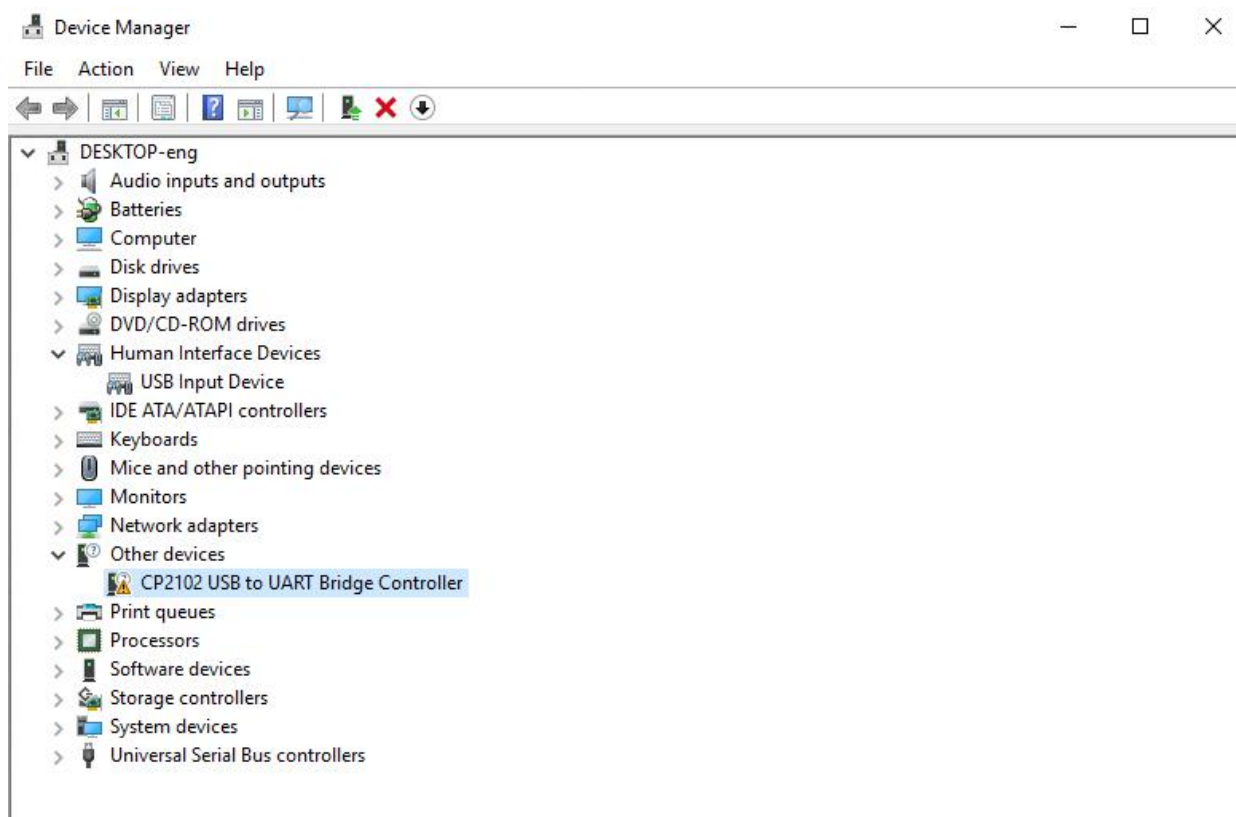
(3) Installing V4.0 board Driver

Let's install the driver of keyestudio V4.0 board. The USB-TTL chip

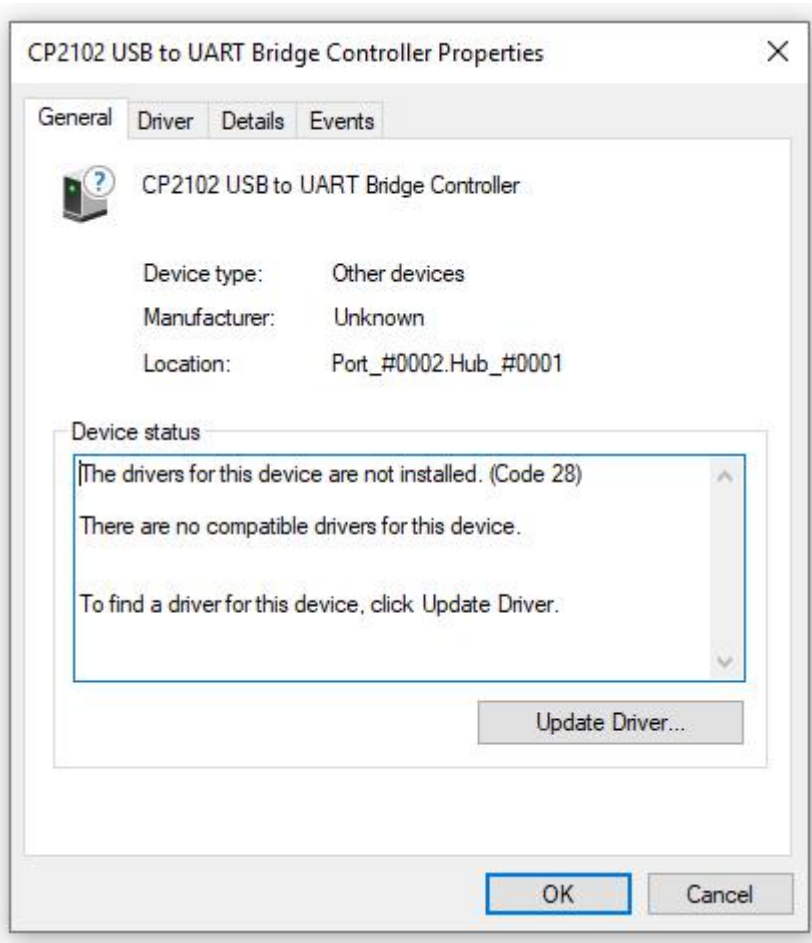


on V4.0 board adopts CP2102 serial chip. The driver program of this chip is included in Arduino 1.8 version and above, which is convenient. Plug on USB port of board, the computer can recognize the hardware and automatically install the driver of CP2102.

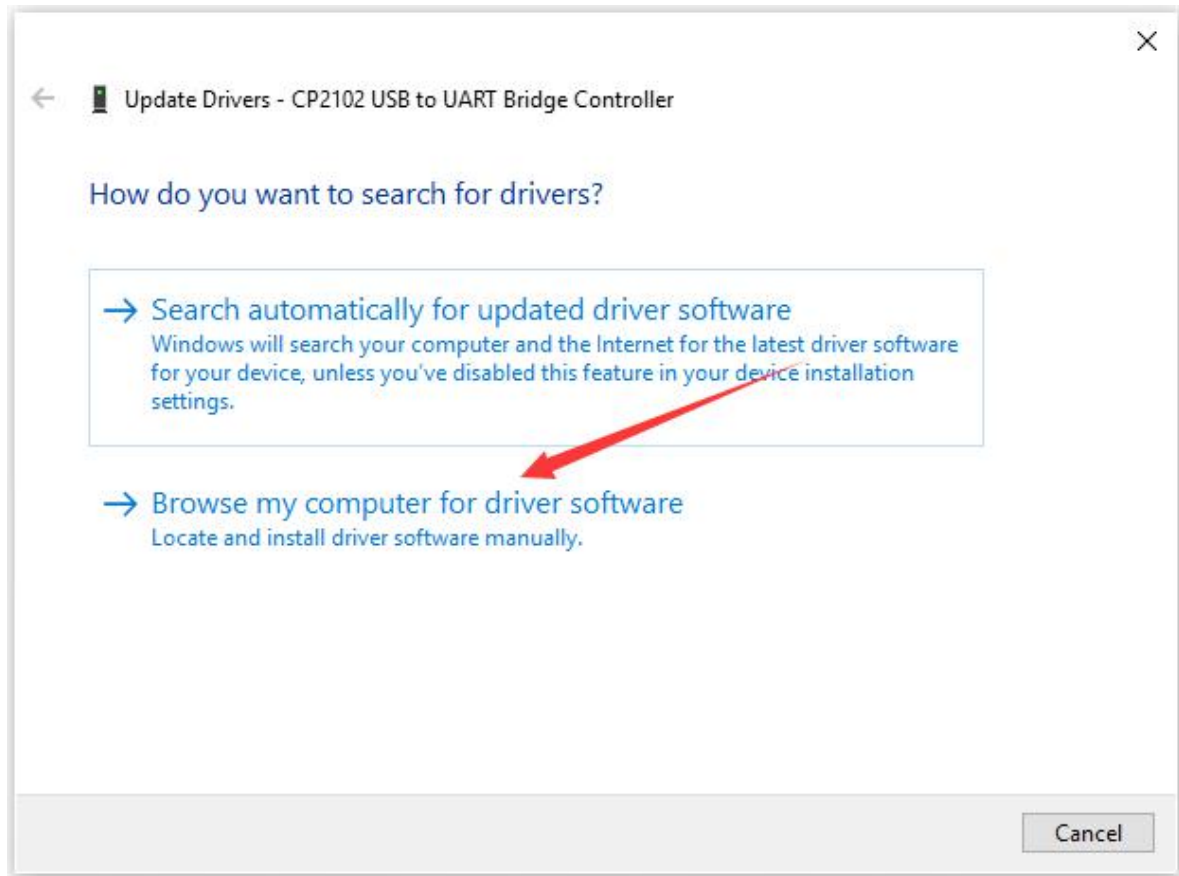
If install unsuccessfully, or you intend to install manually, open the device manager of computer. Right click Computer----- Properties----- Device Manager



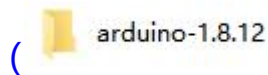
There is a yellow exclamation mark on the page, which implies installing unsuccessfully. Then we double click the hardware and update the driver.




Click "OK" to enter the following page, click "browse my computer for updated driver software" , find out the installed or downloaded ARDUINO software. As shown below:

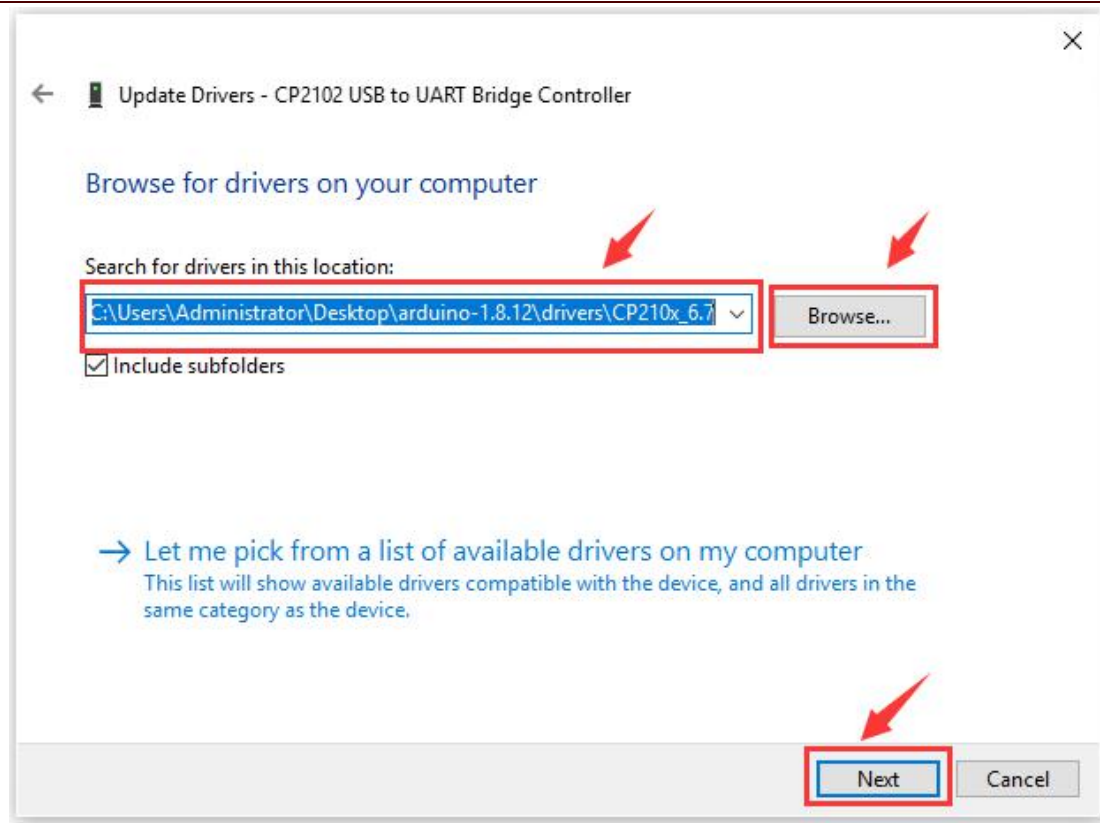


There is a **DRIVERS** folder in **Arduino software installed package**

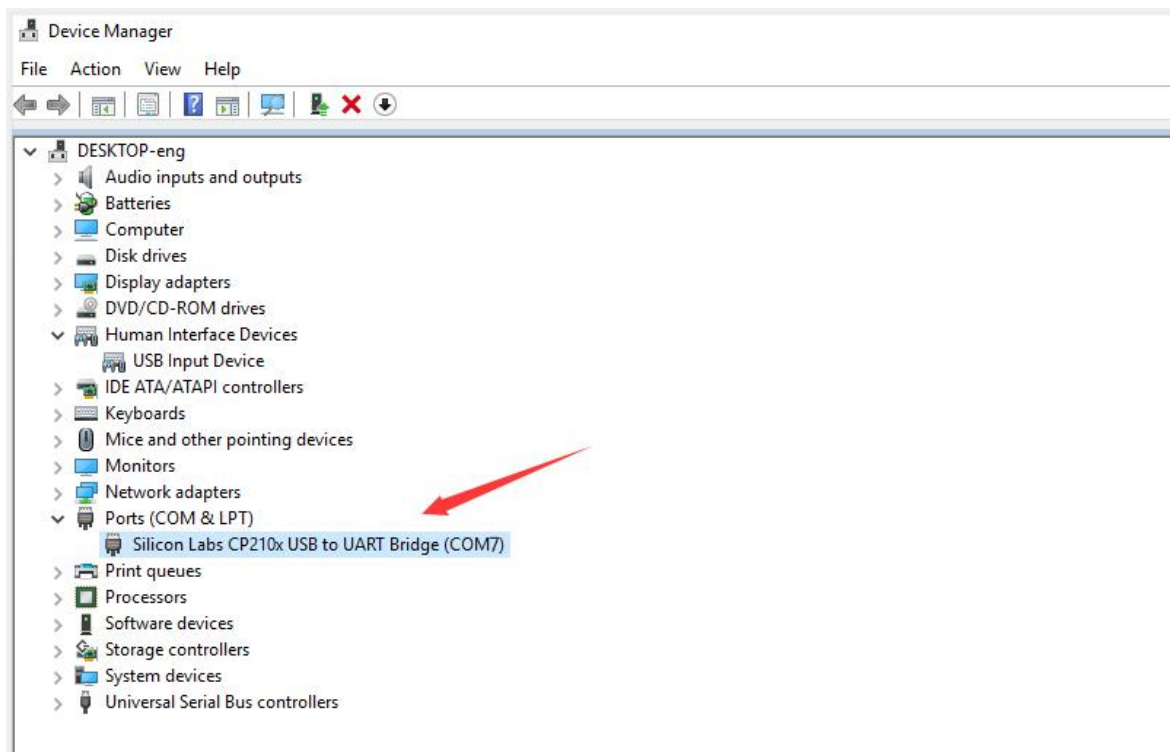
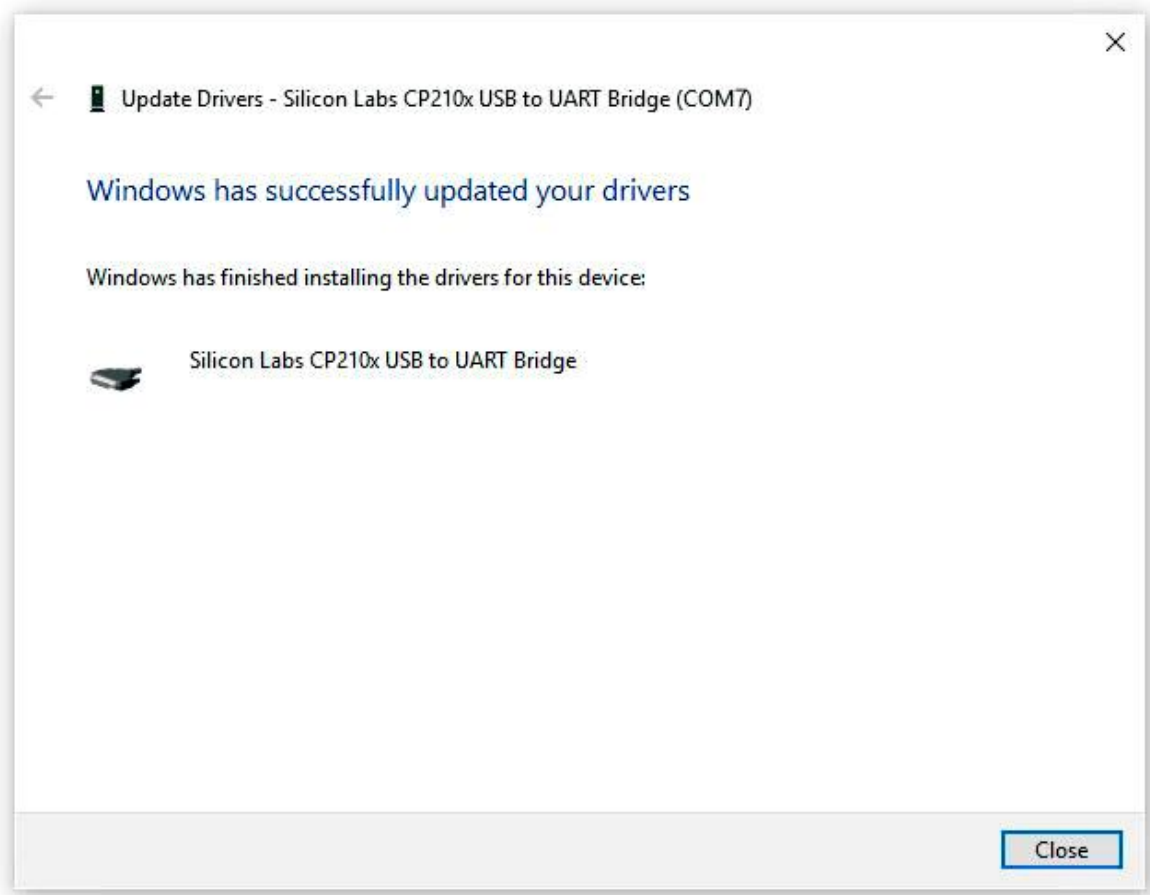


( arduino-1.8.12) , open driver folder and you can see the driver of **CP210X series chips**.

We click "Browse" , then find out the **driver** folder, or you could enter "driver" to search in rectangular box, then click "next", the driver will be installed successfully. (I place Arduino software folder on the desktop, you could follow my way)



Open device manager, we will find the yellow exclamation mark disappear. The driver of CP2102 is installed successfully.

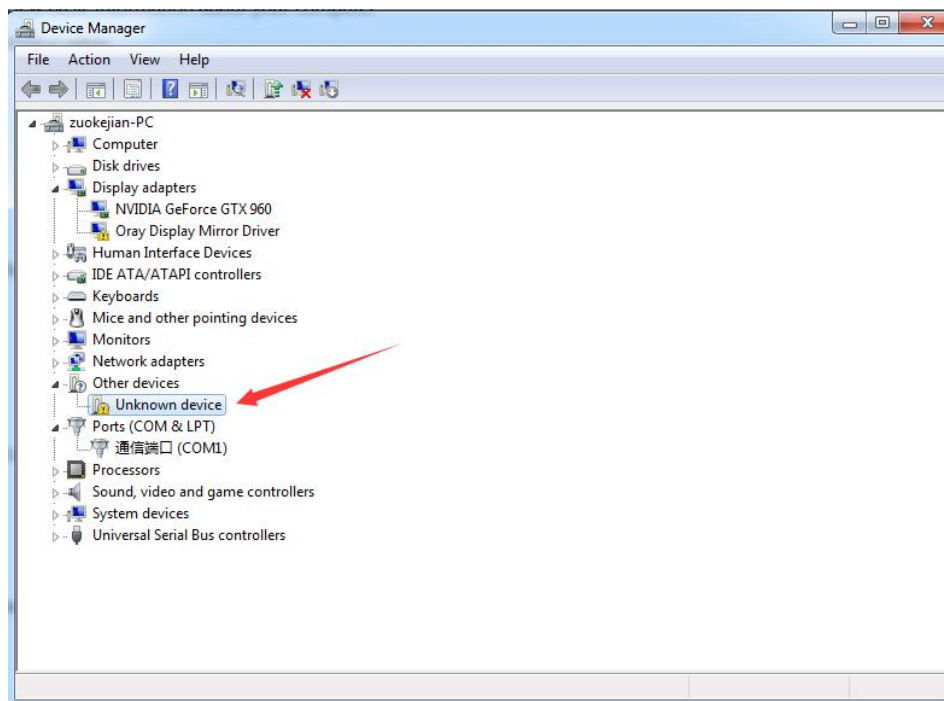




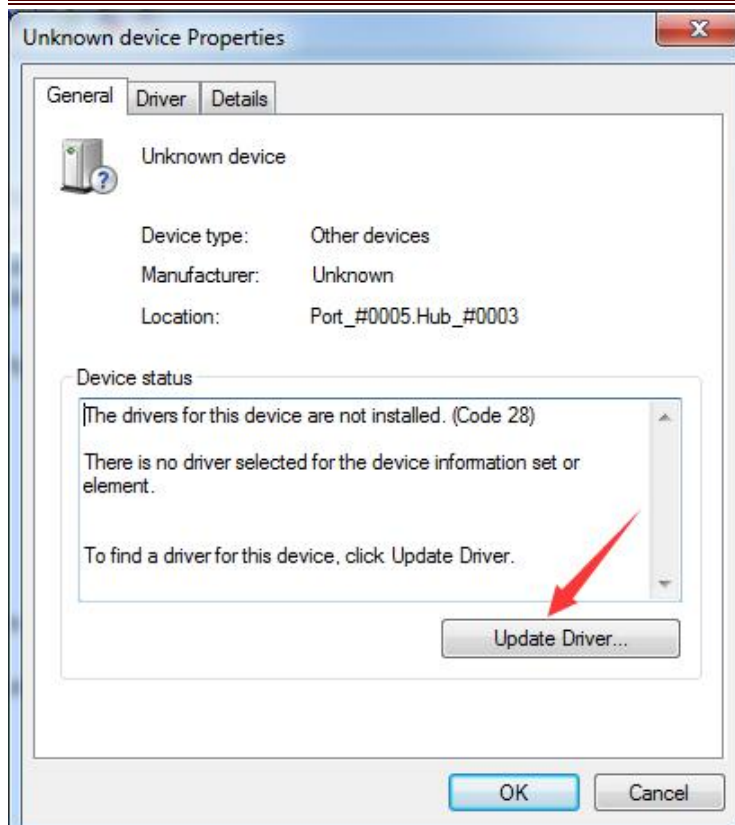
(4) Install other versions of driver

If your development board is Arduino UNO board, install the driver as follows:

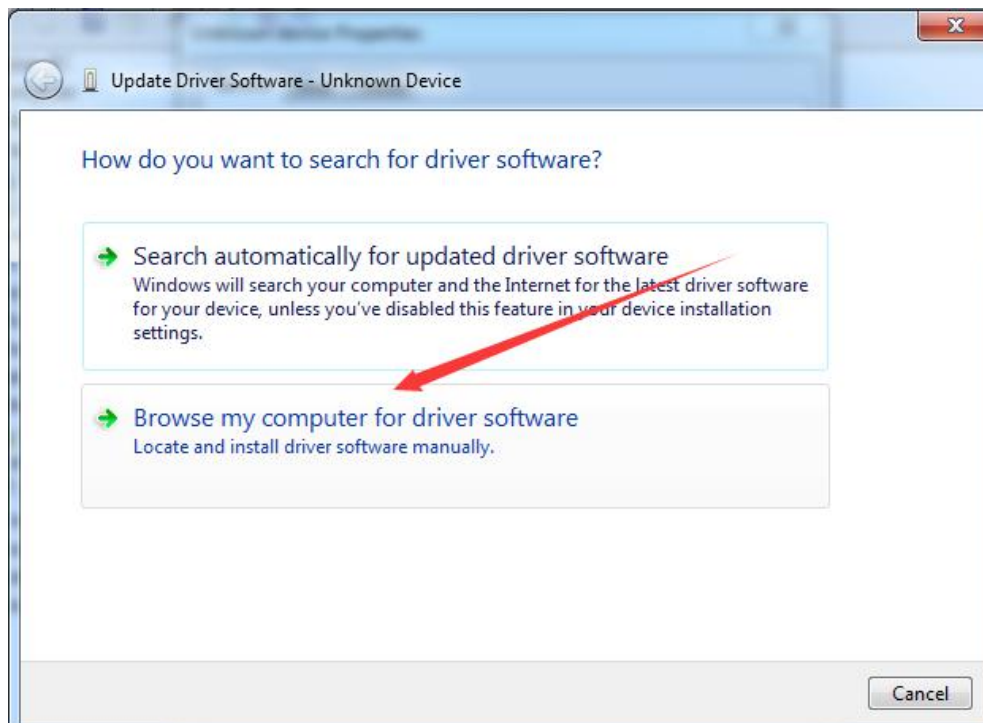
Step 1: Plug in the development board, click Computer----- Properties----- Device Manager, you could see the unknown device is shown.



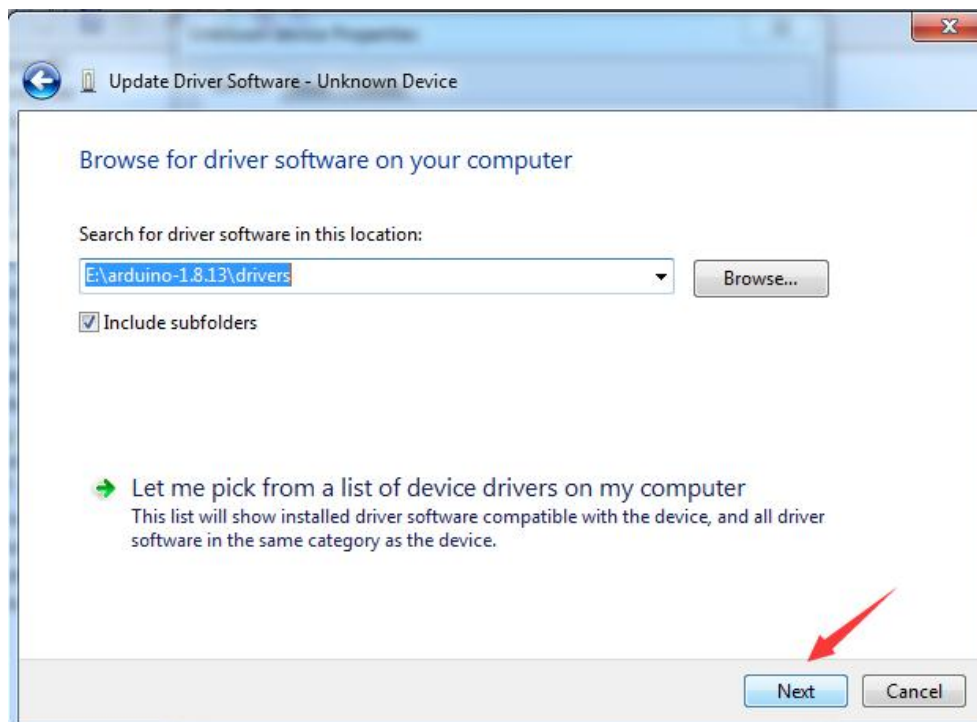
Step 2: Update the driver



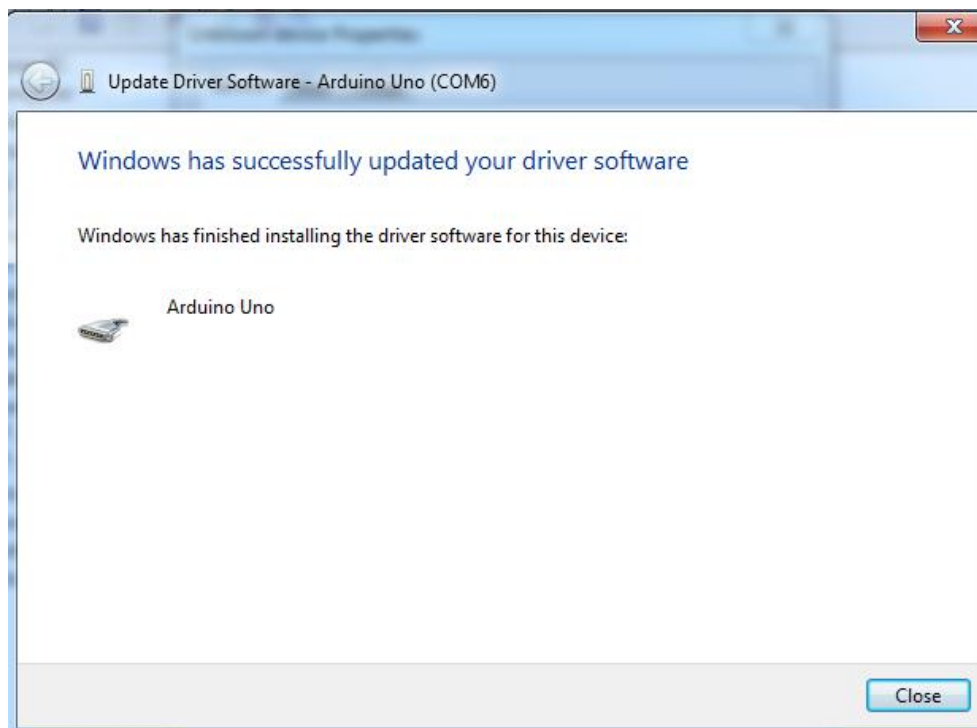
Step 3: click "browse my computer for updated driver software"



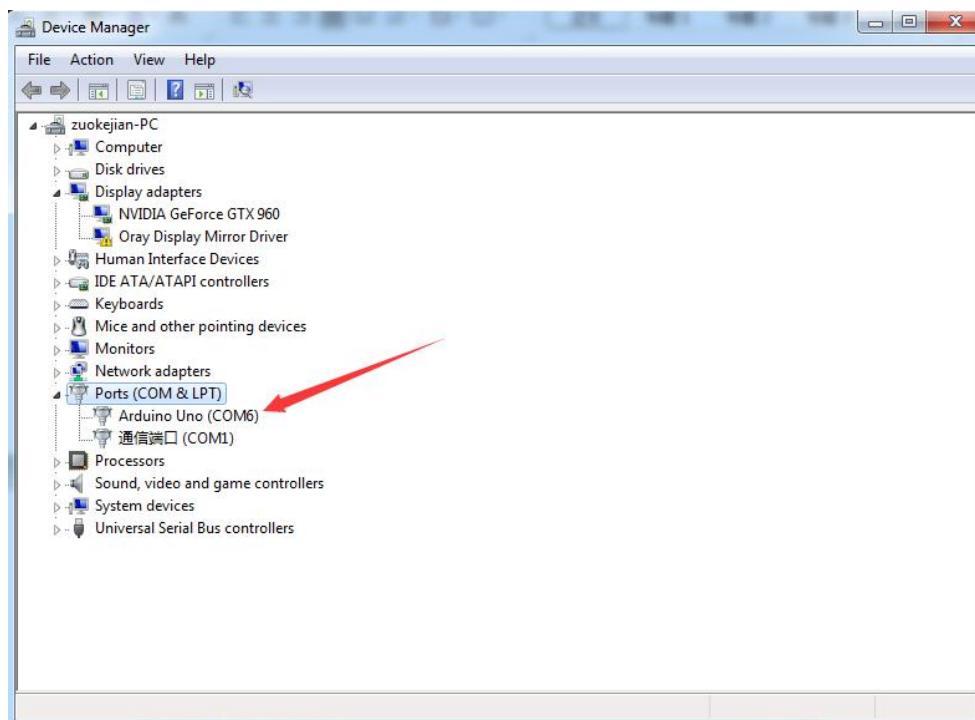
Step 4: find out the folder where the ARDUINO software is installed, click **drivers** folder and tap "Next"



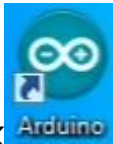
Step 5: the driver is installed successfully.



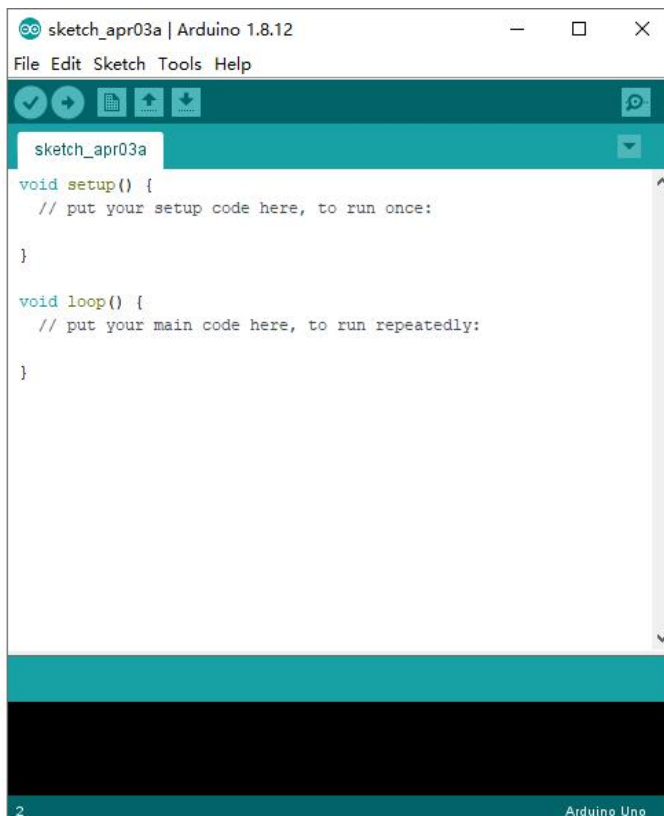
The device manager shows the serial port of Arduino.



(5) Arduino IDE Setting



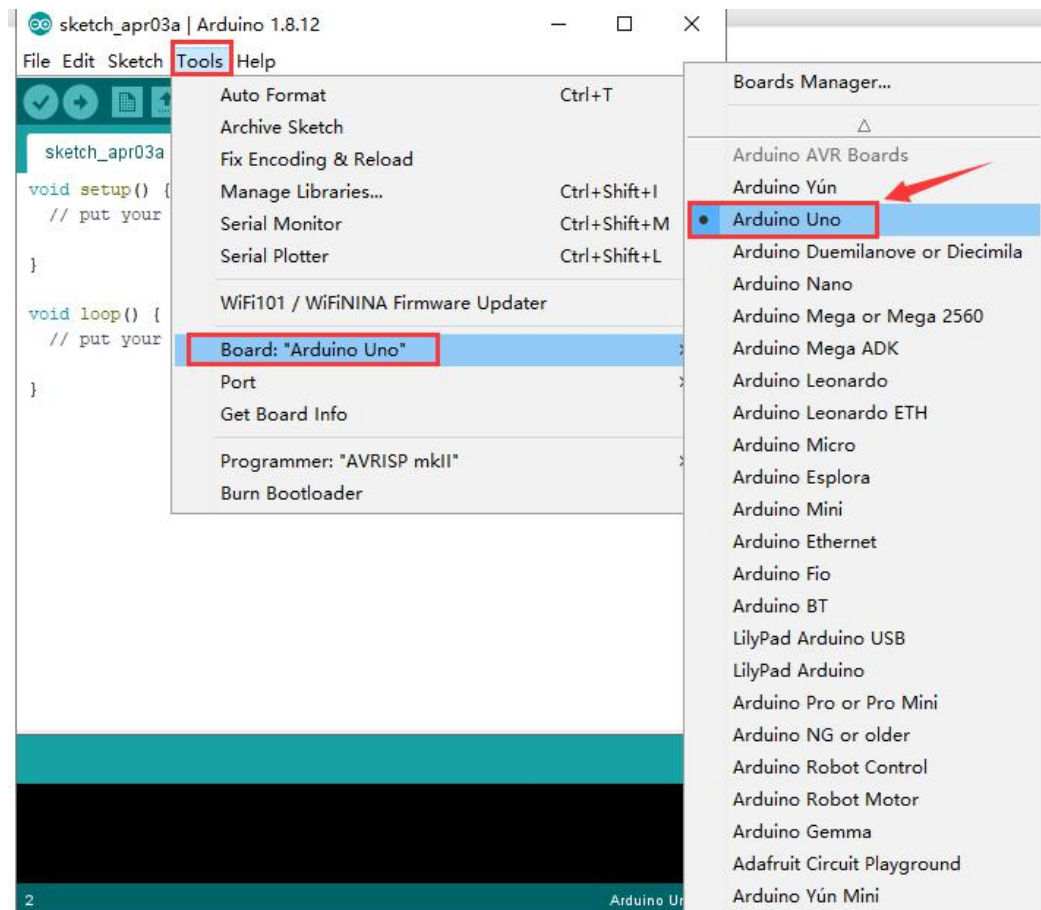
Click  icon, open Arduino IDE.



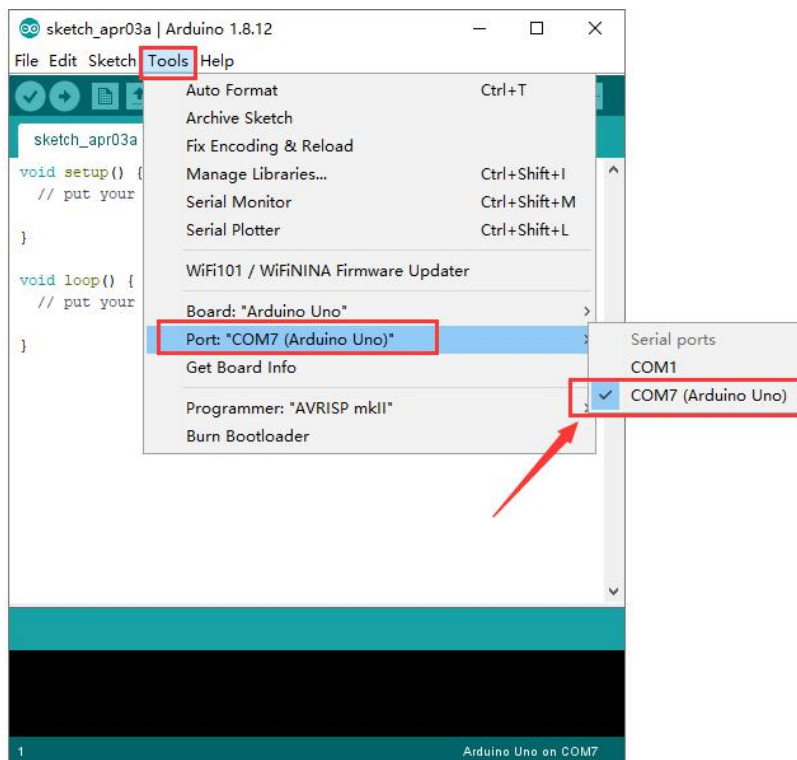


To avoid the errors when uploading the program to the board, you need to select the correct Arduino board that matches the board connected to your computer.

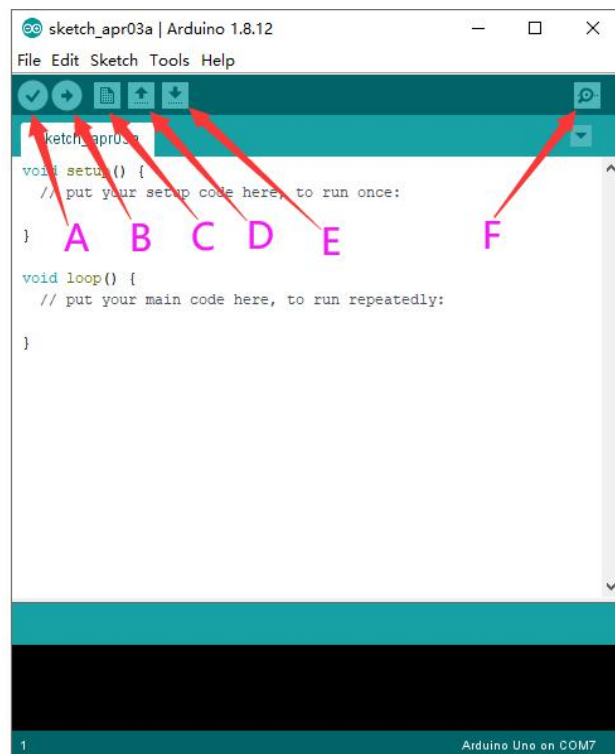
Then come back to the Arduino software, you should click Tools→Board, select the board. (as shown below)



Then select the correct COM port (you can see the corresponding COM port after the driver is successfully installed)



Before uploading the program to the board, let's demonstrate the function of each symbol in the Arduino IDE toolbar.



A- Used to verify whether there is any compiling mistakes or not.

B- Used to upload the sketch to your Arduino board.

C- Used to create shortcut window of a new sketch.

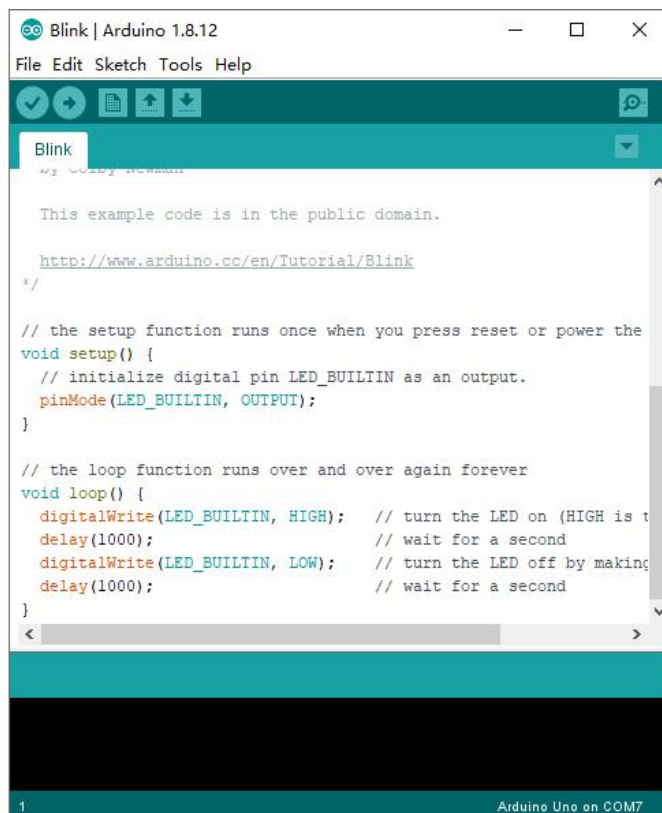
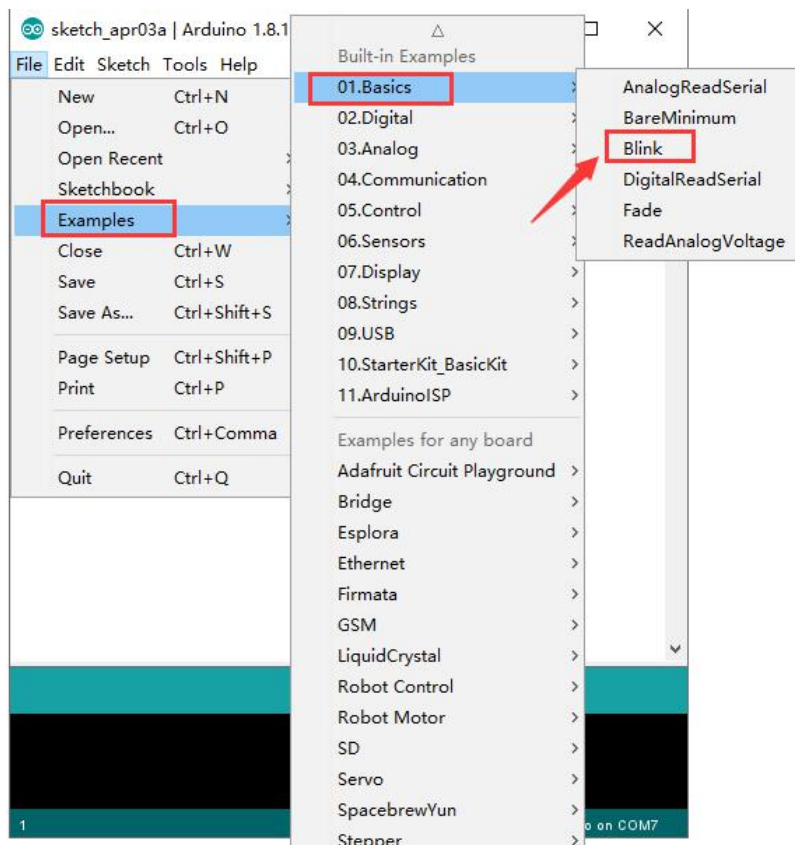
D- Used to directly open an example sketch.

E- Used to save the sketch.

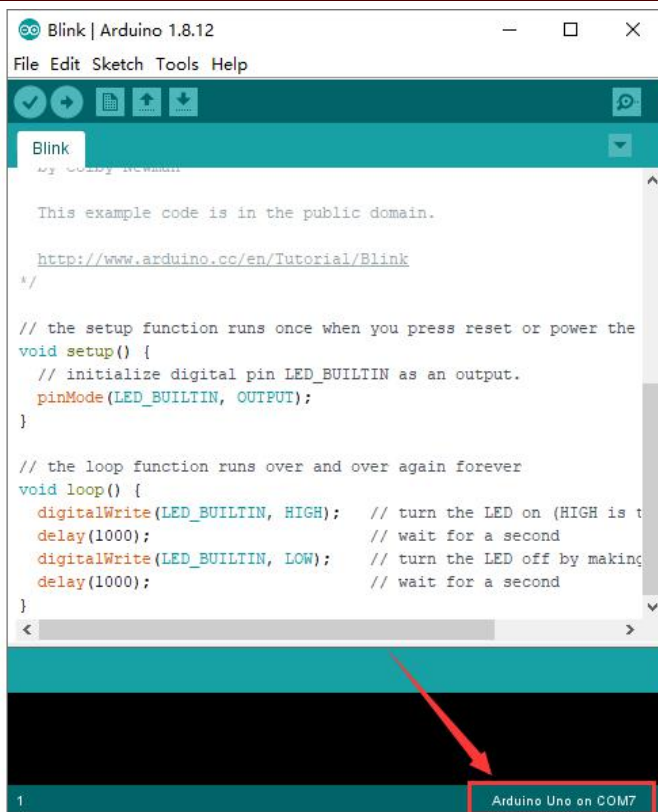
F- Used to send the serial data received from board to the serial monitor.

(6) Start First Program

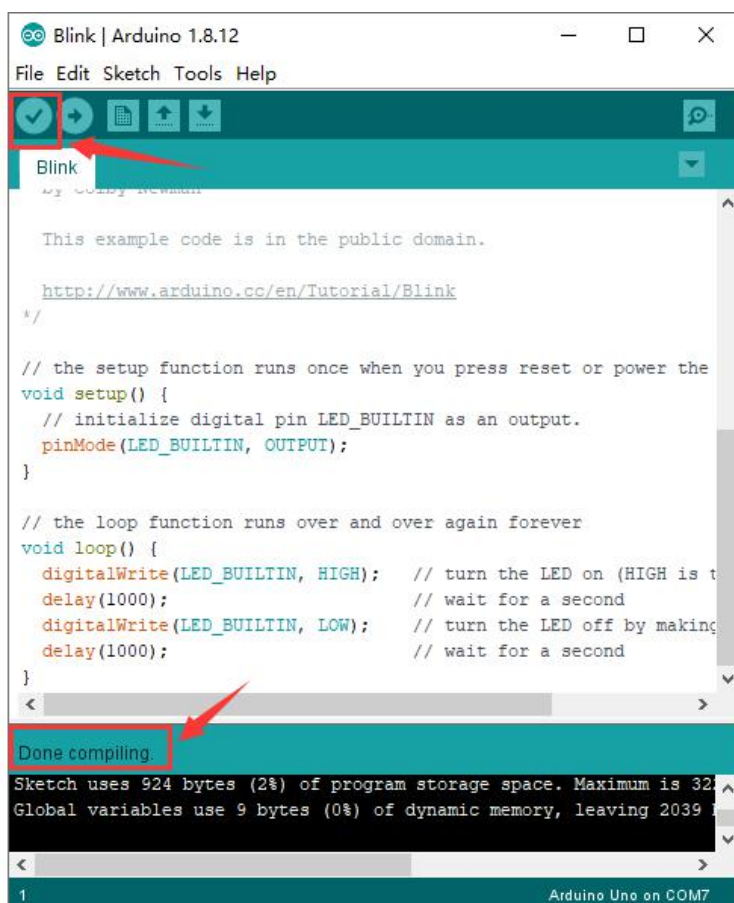
Open the file to select **Example**, choose **BLINK** from **BASIC**, as shown below:



Set board and COM port, the corresponding board and COM port are shown on the lower right of IDE.

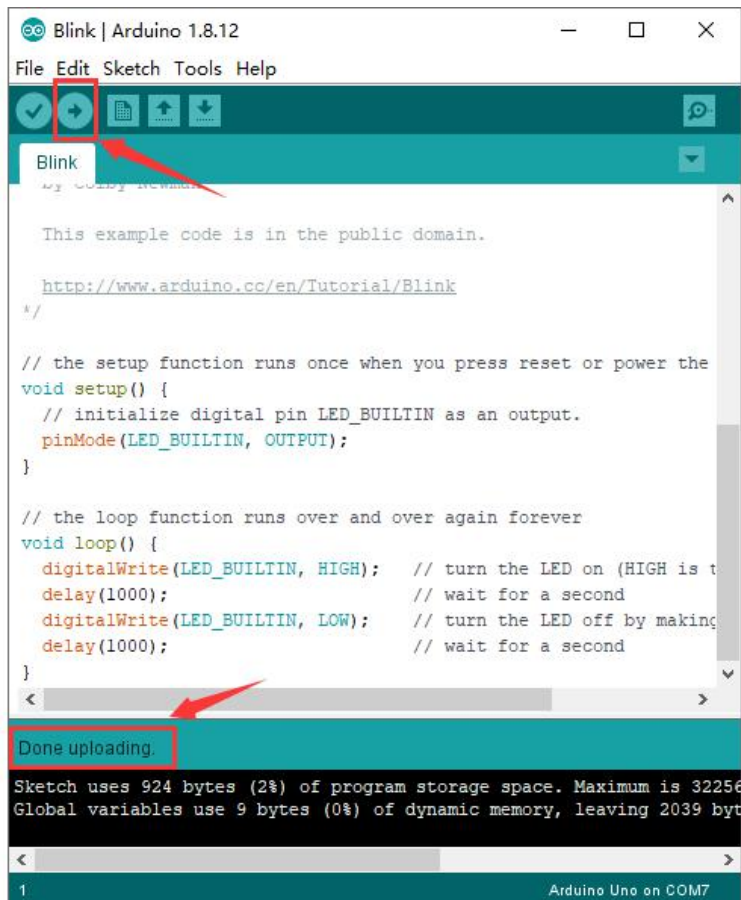


Click  to start compiling the program, check errors.





Click  to upload the program, upload successfully.



Upload the program successfully, the onboard LED lights on for 1s, lights off for 1s. Congratulation, you finish the first program.

7. How to Add Libraries?

What are Libraries ?

Libraries are a collection of code that makes it easy for you to connect to a sensor, display, module, etc.

For example, the built-in LiquidCrystal library helps talk to LCD



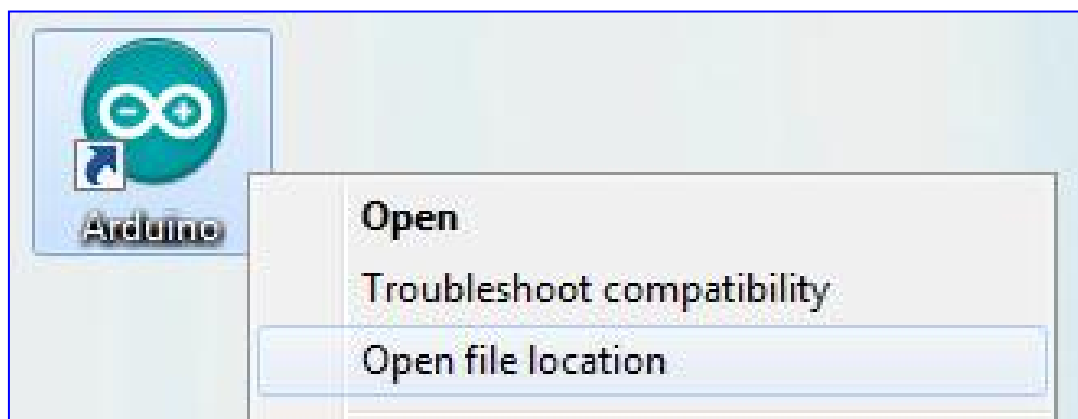
displays. There are hundreds of additional libraries available on the Internet for download.

The built-in libraries and some of these additional libraries are listed in the reference.

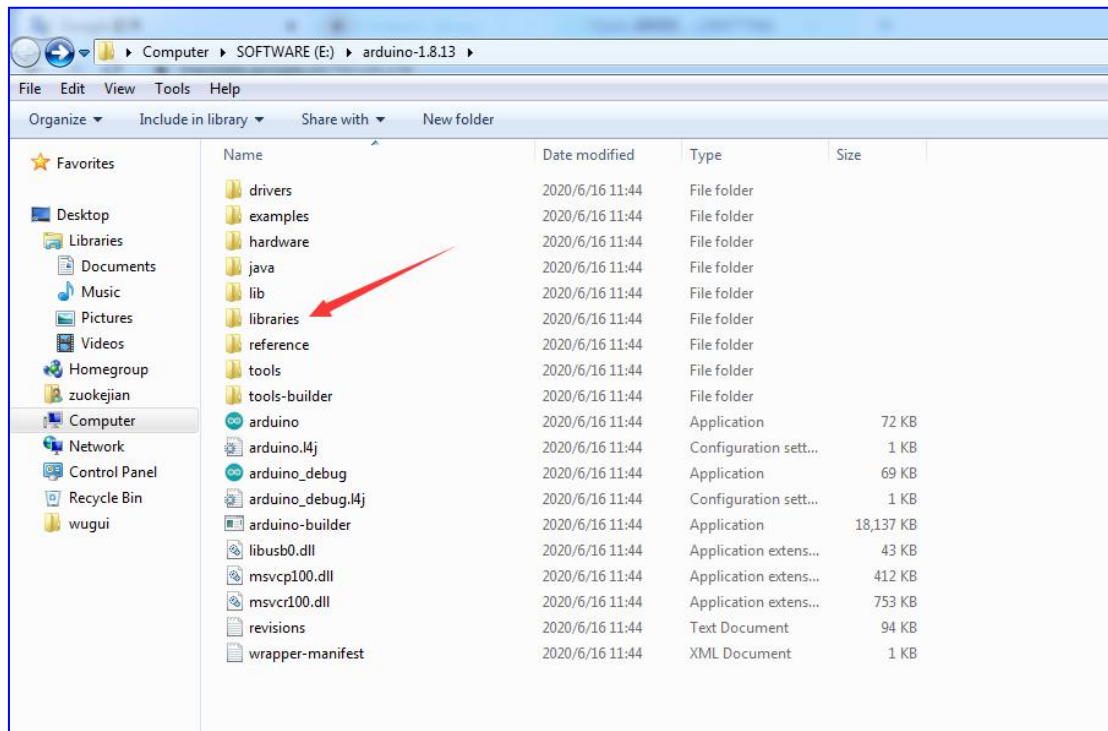
Here we will introduce the most simple way for you to add libraries .

Step 1: After downloading well the Arduino IDE, you can right-click the icon of Arduino IDE.

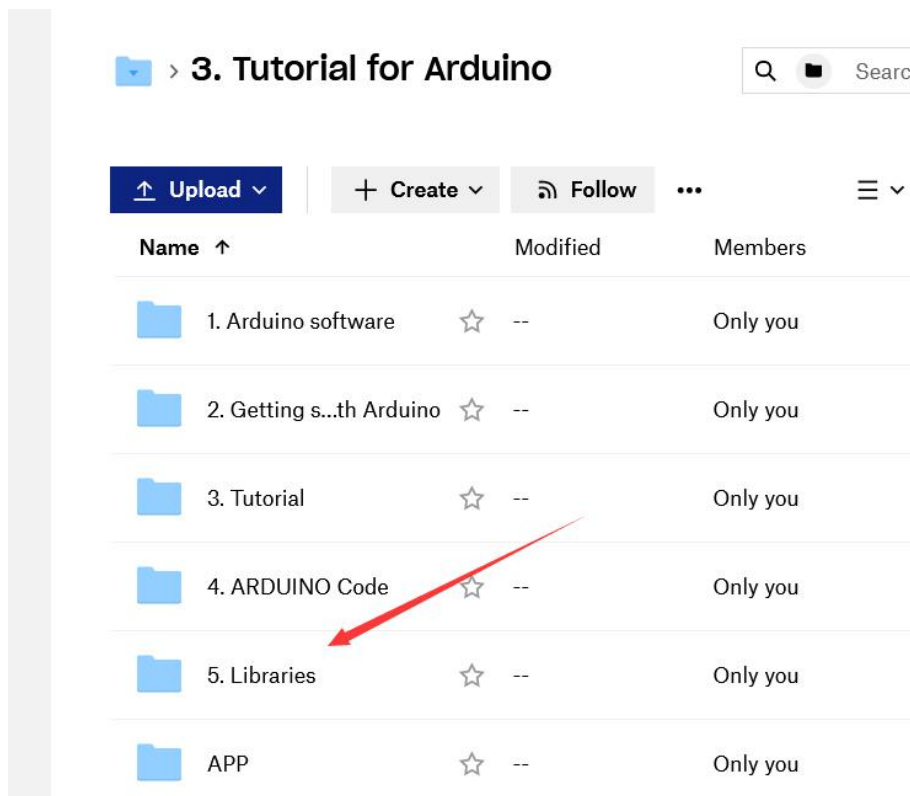
Find the option "Open file location" shown as below:




Step 2: Enter it to find out **libraries** folder which is the library file of Arduino.



Step 3: Next to find out the **"libraries" of tank robot**(seen in the link: <https://fs.keyestudio.com/KS0428>), you just need to replicate and paste into the **libraries folder of Arduino IDE**.








 > **5. libraries**


Overview [Hide](#)


Click here to describe this folder and turn it into a Space [Show examples](#)





 Upload

 Create

 Follow

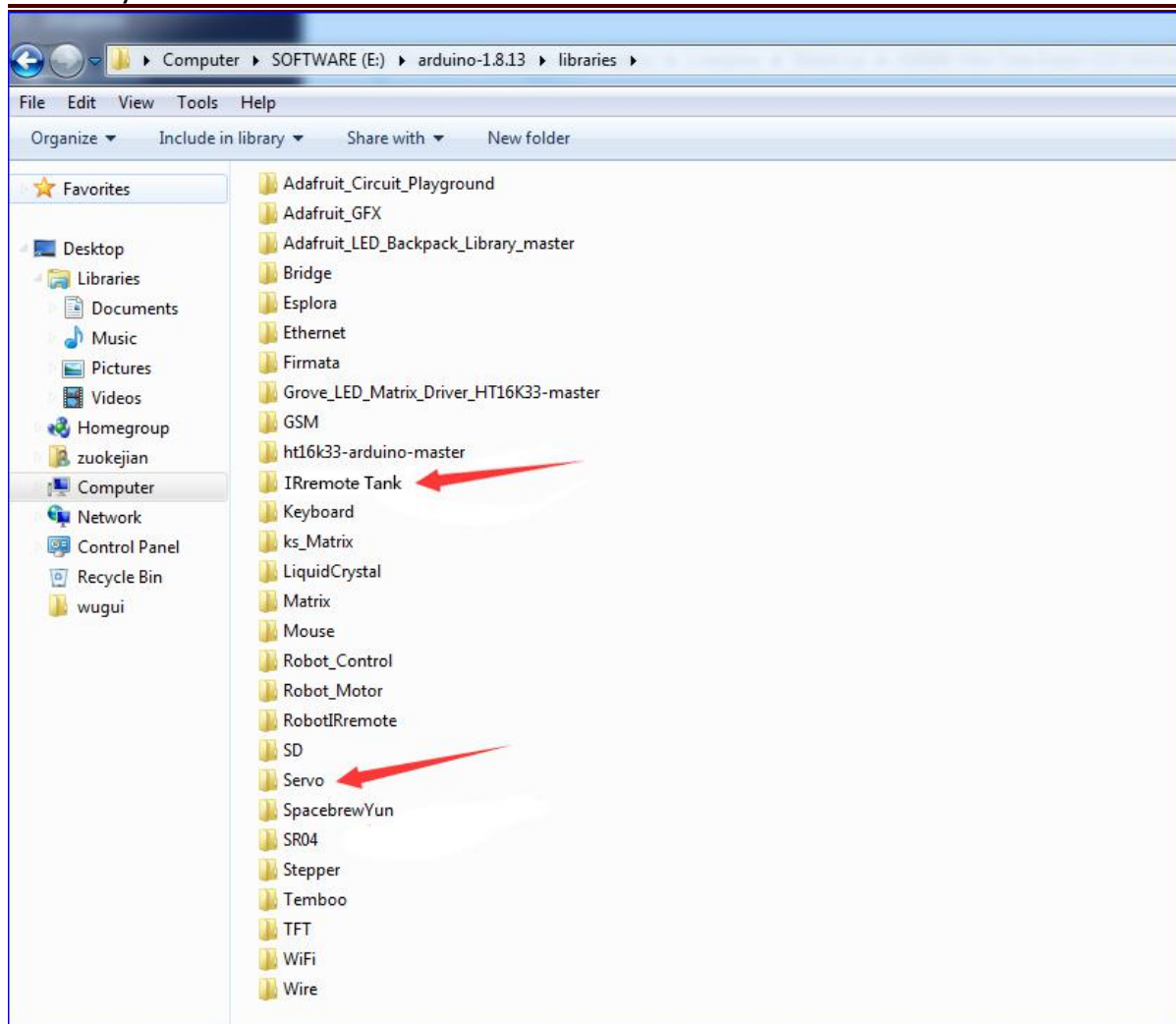




Name ↑		Modified	Members
 IRremoteTank.zip		Today, 10:47 AM by you	Only you
 Servo.zip		Today, 11:23 AM by you	Only you

Download them from the link and unzip them.

Then add them into libraries of Arduino 1.8.13, as shown below:



Now, you import libraries successfully.

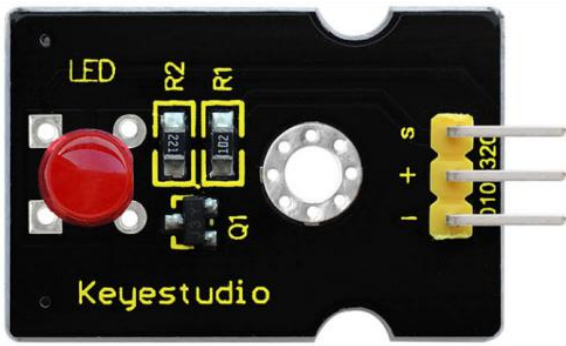
8. Projects

The whole project begins with basic program. Starting from simple to complex, the lessons will guide you to assemble robot car and absorb the knowledge of electronic and machinery step by step. I reckon that you could hardly sit still and itch to have a go, let's get started.



Note: (G), marked on each sensor and module, is negative pole and connected to "G" , " -" or "GND" on the sensor shield and control board ; (V) is positive pole and linked with V , VCC, + or 5V on the sensor shield or control board.

Project 1: LED Blink

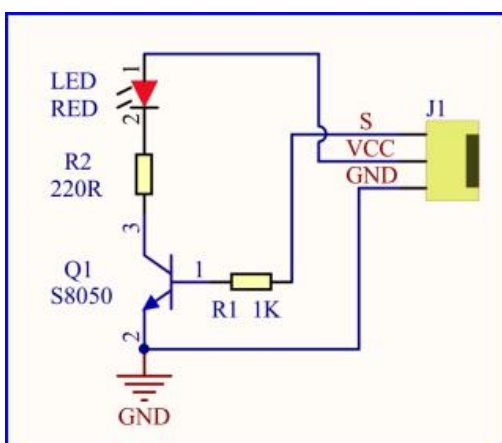


(1) Description

For the starter and enthusiast, this is a fundamental program---LED Blink.

LED, the abbreviation of light emitting diodes, consist of Ga, As, P, N chemical compound and so on. The LED can flash diverse color by altering the delay time in the test code. When in control, power on GND and VCC, the LED will be on if S end is high level; nevertheless, it will go off.

(2) Specification



Control interface: digital port

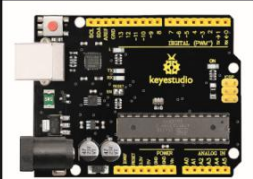
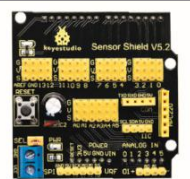


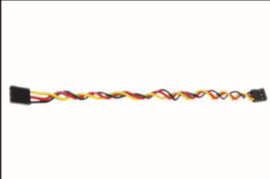
Working voltage: DC 3.3-5V

Pin spacing: 2.54mm



LED display color: red

(3) Equipment

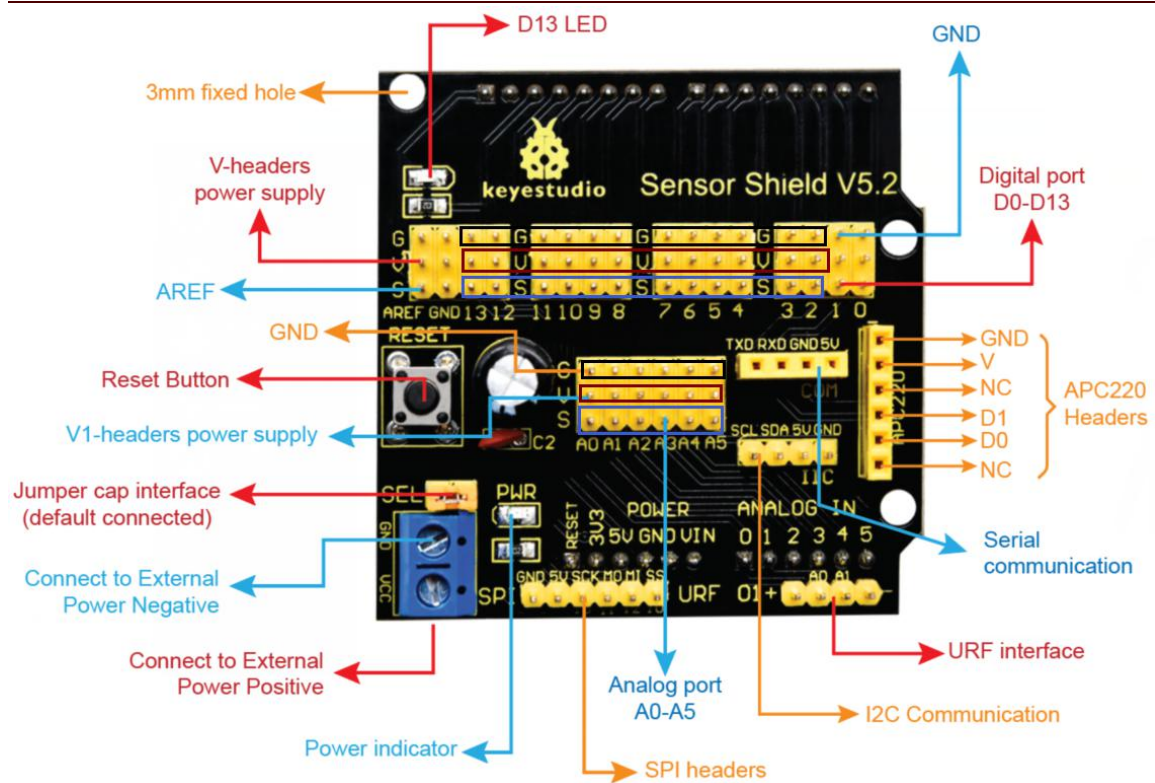
V4.0 Control board *1	Sensor shield *1	LED module *1	USB cable *1	3pin Dupont line *1
				

(4) V5 Sensor Shield

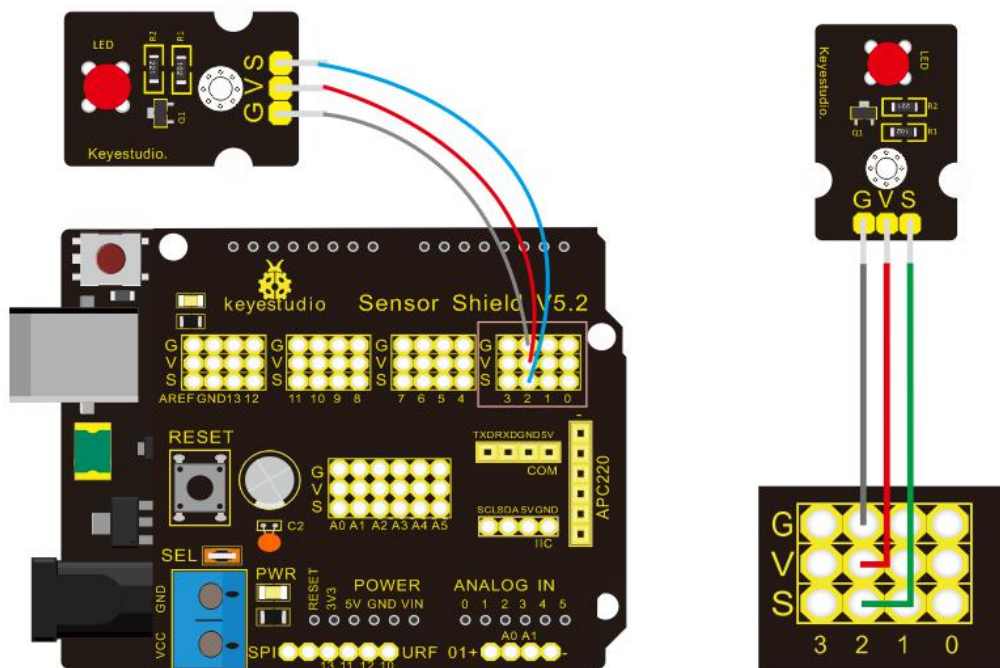
There will be troublesome when we combine Arduino development boards with numerous sensors. However, the V5 sensor shield, compatible with Arduino development board, address this problem perfectly. Just stack V5 board on it.

This sensor shield can be inserted into 3pin sensor modules and breaks out some some communication pins, like serial, IIC, and SPI communication as well.

Pins Description



Connection Diagram



Seen from the above diagram, LED is linked with D2



(5) Test Code

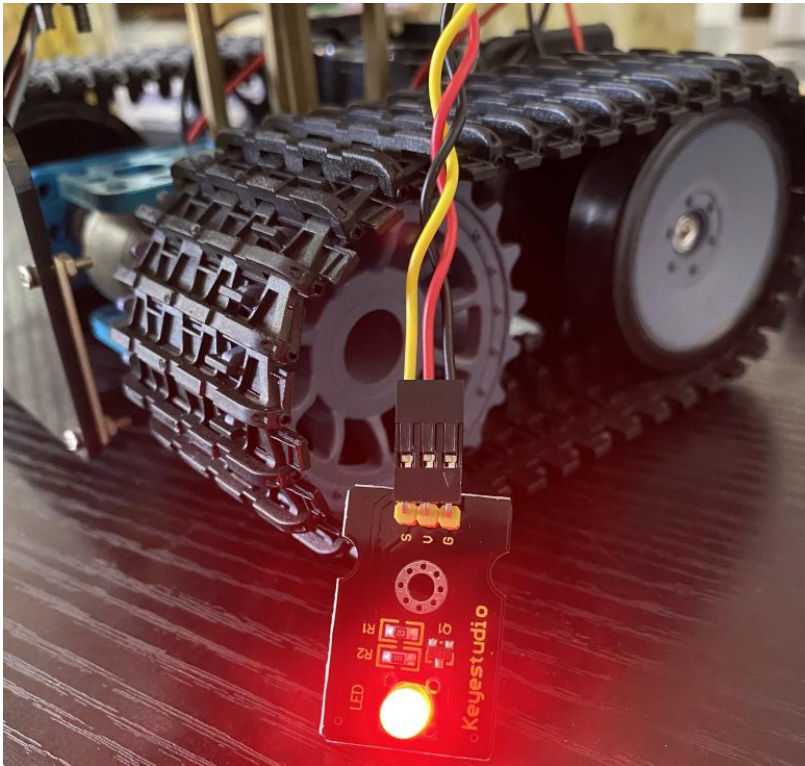
```
/*  
  
keyestudio Mini Tank Robot V2  
  
lesson 1.1  
  
Blink  
  
http://www.keyestudio.com  
  
*/  
  
void setup()  
{  
    pinMode(2, OUTPUT); // initialize digital pin 2 as an output.  
}  
  
void loop() // the loop function runs over and over again forever  
  
{  
    digitalWrite(2, HIGH); // turn the LED on (HIGH is the voltage  
level)  
    delay(1000); // wait for a second  
    digitalWrite(2, LOW); // turn the LED off by making the voltage  
LOW  
    delay(1000); // wait for a second  
}  
  
//*****
```



(6) Test Result

(There will be contradict about serial communication between code and Bluetooth when uploading code, therefore, don't link with Bluetooth module before uploading code.)

Upload the program on the development board, LED flickers with the interval of 1s.



(7) Code Explanation

pinMode(2, OUTPUT) - Set pin2 to OUTPUT

digitalWrite(2, HIGH) - When set pin2 to HIGH level(output 5V) or to LOW level(output 0V)



We succeed to blink LED. Next, let's observe what LED will change if we modify pins and delay time.

Test Code:

 $\ast/$



```
void setup() { // initialize digital pin 10 as an output.
    pinMode(10, OUTPUT);
}

// the loop function runs over and over again forever
void loop() {
    digitalWrite(10, HIGH); // turn the LED on (HIGH is the voltage
level)
    delay(100); // wait for 0.1 second
    digitalWrite(10, LOW); // turn the LED off by making the voltage
LOW
    delay(100); // wait for 0.1 second
}

//*****
```

The LED flickers faster through the test result, therefore, pins and delay time affect flash frequency.

Project 2: Adjust LED Brightness

(1) Description

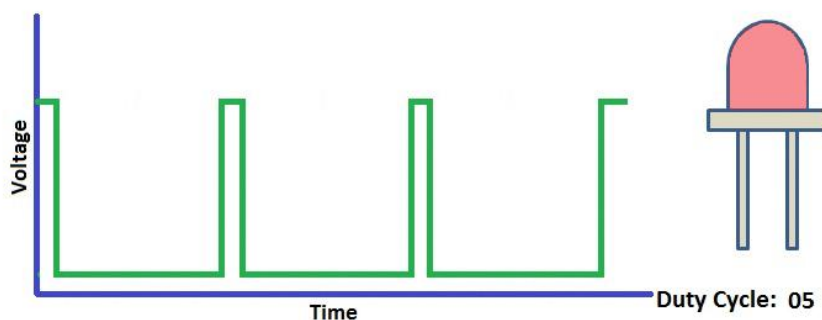
In previous lesson, we control LED on and off and make it blink.

In this project, we will control LED brightness through PWM to simulate breathing effect. Similarly, you can change the step length and delay time in the code so as to demonstrate different breathing



effect.

PWM is a means of controlling the analog output via digital means. Digital control is used to generate square waves with different duty cycles (a signal that constantly switches between high and low levels) to control the analog output. In general, the input voltage of port are 0V and 5V. What if the 3V is required? Or what if switch among 1V, 3V and 3.5V? We can't change resistor constantly. For this situation, we need to control by PWM.



For the Arduino digital port voltage output, there are only LOW and HIGH, which correspond to the voltage output of 0V and 5V. You can define LOW as 0 and HIGH as 1, and let the Arduino output five hundred 0 or 1 signals within 1 second.

If output five hundred 1, that is 5V; if all of which is 1, that is 0V. If output 0101010101 in this way then the output port is 2.5V, which is like showing movie. The movie we watch are not



completely continuous. It actually outputs 25 pictures per second. In this case, the human can't tell it, neither does PWM. If want different voltage, need to control the ratio of 0 and 1. The more 0,1 signals output per unit time, the more accurately control.

(2) Specification


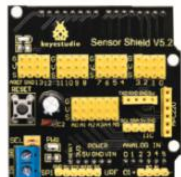



Control interface: digital port

Working voltage: DC 3.3-5V

Pin spacing: 2.54mm

Display color: red

(3) Equipment

V4.0 Control board *1	Sensor shield *1	LED module *1	USB cable *1	3pin Dupont line *1
				

(4) Connection Diagram



keyestudio Mini Tank Robot V2

lesson 2.1

pwm

<http://www.keyestudio.com>

```
int ledPin = 10; // Define the LED pin at D10
```

```
int value;
```

```
void setup ()
```

```
pinMode (ledPin, OUTPUT); // initialize ledpin as an output.
```

```
void loop ()
```

79



```
for (value = 0; value < 255; value = value + 1)
{
    analogWrite (ledPin, value); // LED lights gradually light up
    delay (5); // delay 5MS
}

for (value = 255; value > 0; value = value - 1)
{
    analogWrite (ledPin, value); // LED gradually goes out
    delay (5); // delay 5MS
}

//*****
```

(6) Test Result

Upload test code successfully, LED gradually becomes brighter then darker, like human breath, rather than light on and off immediately.

(7) Code Explanation

When we need to repeat some statements, we could use FOR statement.

FOR statement format is shown below:

① ② condition is true ④

```
for (cycle initialization; cycle condition; cycle adjustment statement) {
    ③ loop body statement;
}
```

FOR cyclic sequence:

Round 1: 1 → 2 → 3 → 4



Round 2: 2 → 3 → 4

...

Until number 2 is not established, “for” loop is over,

After knowing this order, go back to code:

```
for (int value = 0; value < 255; value=value+1){
```

```
    ...
```

```
}
```

```
for (int value = 255; value >0; value=value-1){
```

```
    ...
```

```
}
```

The two “for” statements make value increase from 0 to 255, then reduce from 255 to 0, then increase to 255,...infinitely loop

There is a new function in the following ----- analogWrite()

We know that digital port only has two state of 0 and 1. So how to send an analog value to a digital value? Here, this function is needed. Let's observe the Arduino board and find 6 pins marked “~” which can output PWM signals.

Function format as follows:

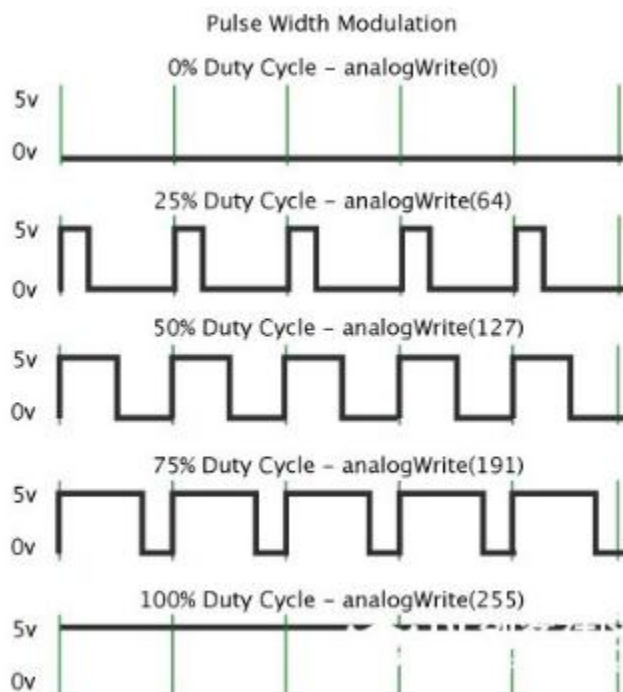
```
analogWrite(pin,value)
```

analogWrite() is used to write an analog value from 0~255 for PWM port, so the value is in the range of 0~255. Attention that you only write the digital pins with PWM function, such as pin 3, 5, 6, 9, 10, 11.



PWM is a technology to obtain analog quantity through digital method. Digital control forms a square wave, and the square wave signal only has two states of turning on and off (that is, high or low levels). By controlling the ratio of the duration of turning on and off, a voltage varying from 0 to 5V can be simulated. The time turning on (academically referred to as high level) is called pulse width, so PWM is also called pulse width modulation.

Through the following five square waves, let's acknowledge more about PWM.



In the above figure, the green line represents a period, and value of `analogWrite()` corresponds to a percentage which is called Duty Cycle as well. Duty cycle implies that high-level duration is divided by low-level duration in a cycle. From top to bottom, the duty cycle



of first square wave is 0% and its corresponding value is 0. The LED brightness is lowest, that is, turn off. The more time high level lasts, the brighter the LED. Therefore, the last duty cycle is 100%, which correspond to 255, LED is brightest. 25% means darker.

PWM mostly is used for adjusting the LED brightness or rotation speed of motor.

It plays vital role in controlling smart robot car. I believe that you can' t wait to enter next project.

(8) Extension Practice:

Let' s modify the value of delay and remain the pin unchanged, then observe how LED changes.

```
/*
```

```
keyestudio Mini Tank Robot V2
```

```
lesson 2.2
```

```
pwm-slow
```

```
http://www.keyestudio.com
```

```
*/
```

```
int ledPin = 10; // Define the LED pin at D10
```

```
int value;
```

```
void setup ()
```

```
{
```

```
pinMode (ledPin, OUTPUT); // initialize ledpin as an output.
```

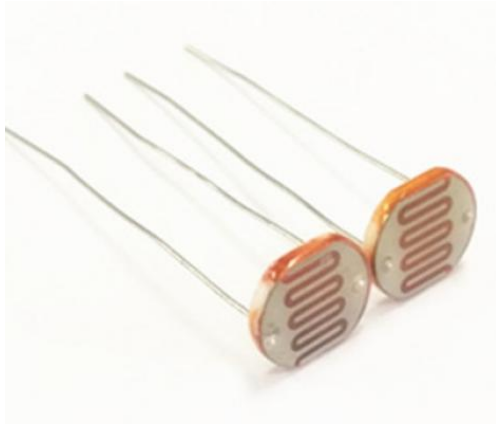


```
}  
  
void loop ()  
{  
  for (value = 0; value <255; value = value + 1)  
  {  
    analogWrite (ledPin, value); // LED lights gradually light up  
    delay (30); // delay 30MS  
  }  
  for (value = 255; value> 0; value = value-1)  
  {  
    analogWrite (ledPin, value); // LED gradually goes out  
    delay (30); // delay 30MS  
  }  
} //*****
```

Upload code on the development board and the time interval of LED getting dark is longer.



Project 3: Photoresistor Sensor



(1) Description

The photoresistor is a special resistor made of semiconductor materials such as CdS or Selenide septum. The surface is also coated with moisture-proof resin, which has a photoconductive effect. It is sensitive to ambient light. Its resistance varies from different light intensities.

We use the characteristics of the photo-resistor to design the circuit and generate the photo-resistor module.

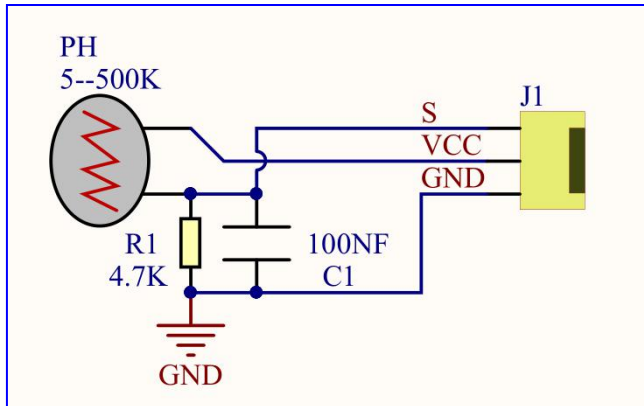
Connecting the signal pin of photocell module to Analog port, when the stronger the light intensity, the greater the voltage of analog port, the greater the analog value is.

On the contrary, the weaker the light intensity, the smaller the voltage of analog port, the smaller the analog value is.

Based on that, we can use the photocell module to read the analog value, so get the ambient light intensity.



(2) Specification



Resistance: 5K ohm-0.5Mohm

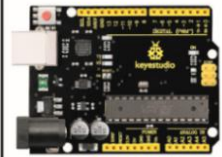
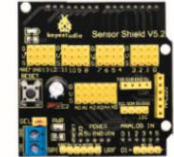

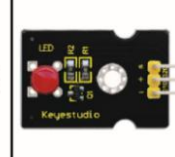

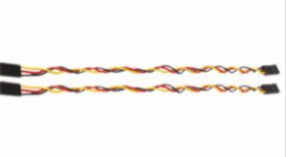
Interface Type: analog

Working Voltage: 3.3V-5V

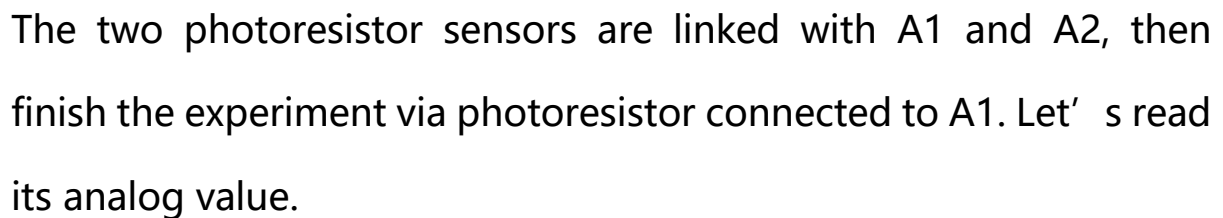
Easy installation: with screw fixing holes

Pin spacing: 2.54mm

(3) Equipment

V4.0 Control board *1	Sensor shield *1	Photocell sensor *1	LED module *1	USB cable *1	3pin Dupont line *2
					

Connection Diagram:



/*

<http://www.keyestudio.com>

```
int sensorValue = 0; // variable to store the value coming from the
sensor
```

87



```
Serial.begin(9600);

}

void loop() {

  sensorValue = analogRead(sensorPin);  // read the value from the
  sensor:

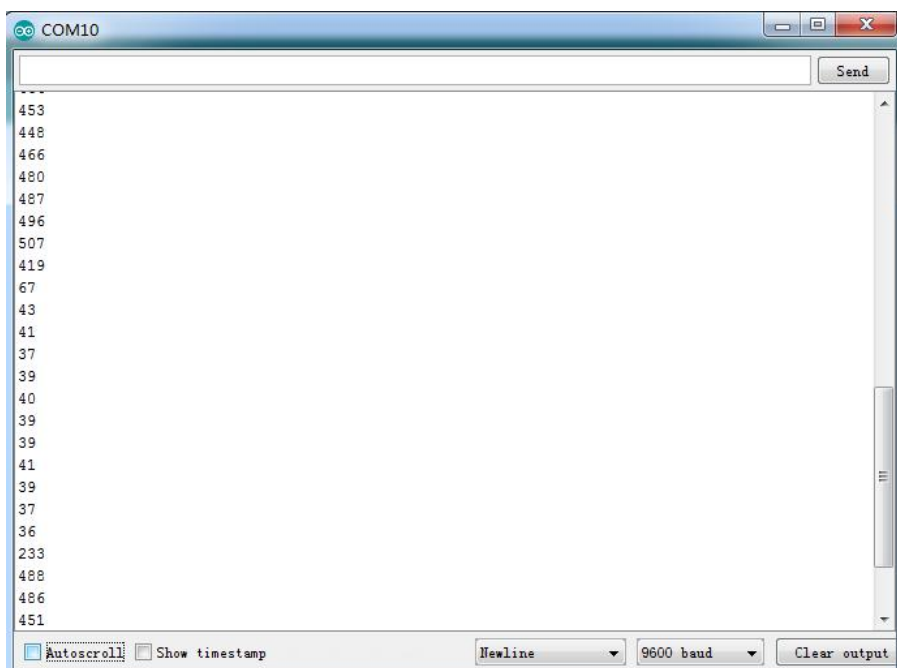
  Serial.println(sensorValue);  //Serial port prints the resistance value

  delay(500);

}

//*****
```

(5) Test Result



Upload code on development board, open serial monitor, check if its value diminishes when covering photoresistor. However, the value increases when uncovered.

(6) Code Explanation



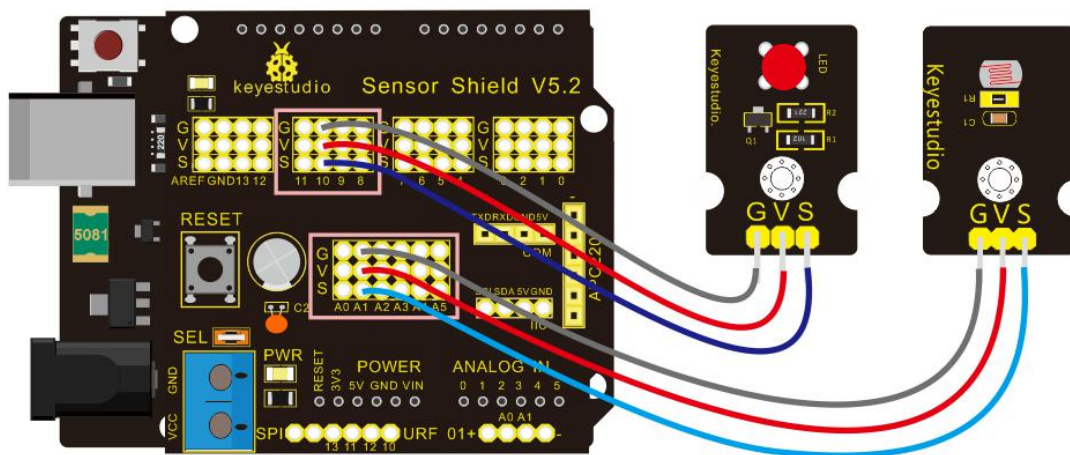
analogRead(sensorPin): read the analog value of photoresistor via analog ports.

Serial.begin(9600): Initialize the serial port, baud rate of serial communication is 9600

Serial.println : Serial port prints and word wrap.

(7) Extension Practice

We've known how to read the value of photoresistor. Let's combine photoresistor with LED and view the status of LED.



PWM restrains the brightness, so LED is linked with PWM pins, connect LED to pin 10, keep pin of photoresistor unchanged, then design the code:

```
/*keyestudio Mini Tank Robot V2
```

```
lesson 3.2
```

```
photocell-analog output
```

```
http://www.keyestudio.com
```



*/

int analogInPin = A1; // Analog input pin that the photocell is attached to

int analogOutPin = 10; // Analog output pin that the LED is attached to

int sensorValue = 0; // value read from the pot

int outputValue = 0; // value output to the PWM (analog out)

void setup() {

Serial.begin(9600);

}

void loop() {

 // read the analog in value:

 sensorValue = analogRead(analogInPin);

 // map it to the range of the analog out:

 outputValue = map(sensorValue, 0, 1023, 0, 255);

 // change the analog out value:

 analogWrite(analogOutPin, outputValue);

 // wait 2 milliseconds before the next loop for the analog-to-digital

 // converter to settle after the last reading:

 Serial.println(sensorValue); //serial port prints the value of photoresistor



```
delay(2);
```

```
}
```

```
//*****
```

Upload code, press it by hand to observe the the LED brightness.

Project 4: Servo Control



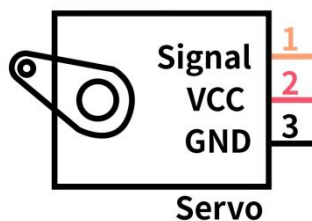
(1) Description

Servo motor is a position control rotary actuator. It mainly consists of housing, circuit board, core-less motor, gear and position sensor. Its working principle is that the servo receives the signal sent by MCU or receiver and produces a reference signal with a period of 20ms and width of 1.5ms, then compares the acquired DC bias voltage to the voltage of the potentiometer and obtain the voltage difference output.

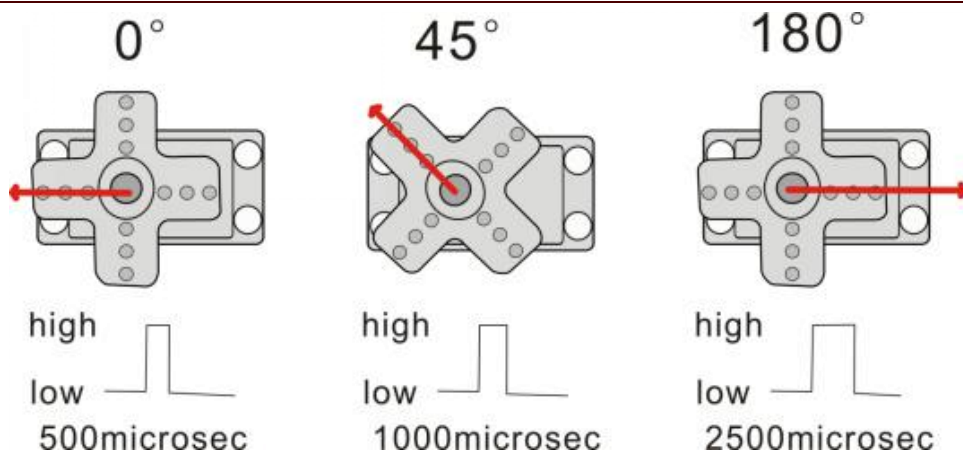


When the motor speed is constant, the potentiometer is driven to rotate through the cascade reduction gear, which leads that the voltage difference is 0, and the motor stops rotating. Generally, the angle range of servo rotation is 0° -- 180°

The rotation angle of servo motor is controlled by regulating the duty cycle of PWM (Pulse-Width Modulation) signal. The standard cycle of PWM signal is 20ms (50Hz). Theoretically, the width is distributed between 1ms-2ms, but in fact, it's between 0.5ms-2.5ms. The width corresponds the rotation angle from 0° to 180° . But note that for different brand motor, the same signal may have different rotation angle.



In general, servo has three line in brown, red and orange. Brown wire is grounded, red one is positive pole line and orange one is signal line.



The corresponding servo angles are shown below:

High level time	Servo angle
0.5ms	0 degree
1ms	45 degree
1.5ms	90 degree
2ms	135 degree
2.5ms	180 degree

(2) Specification

Working voltage: DC 4.8V ~ 6V

Operating angle range: about 180 ° (at 500 → 2500 µsec)

Pulse width range: 500 → 2500 µsec

No-load speed: 0.12 ± 0.01 sec / 60 (DC 4.8V) 0.1 ± 0.01 sec / 60 (DC 6V)

No-load current: 200 ± 20mA (DC 4.8V) 220 ± 20mA (DC 6V)

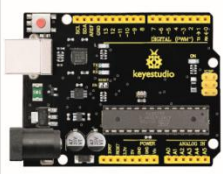
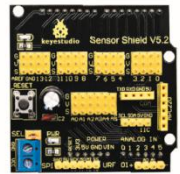



Stopping torque: 1.3 ± 0.01kg · cm (DC 4.8V) 1.5 ± 0.1kg · cm (DC 6V)



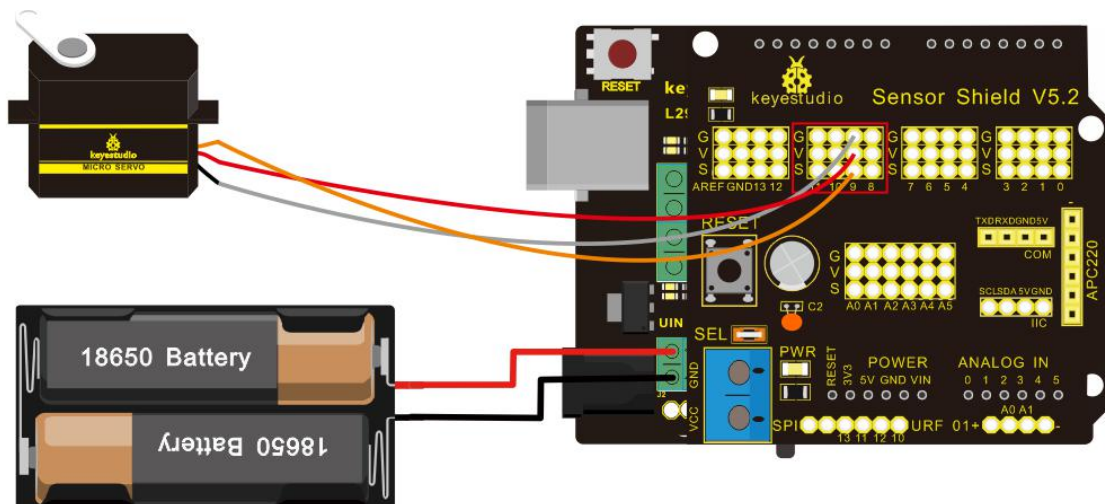
Stop current: $\leq 850\text{mA}$ (DC 4.8V) $\leq 1000\text{mA}$ (DC 6V)

Standby current: $3 \pm 1\text{mA}$ (DC 4.8V) $4 \pm 1\text{mA}$ (DC 6V)

(3) Equipment

V4.0 Control board *1	Sensor shield *1	Servo motor *1	USB cable *1	2*18650 Battery Holder *1
				

(4) Connection Diagram:



Wiring note: the brown line of servo is linked with Gnd(G), the red line is connected to 5v(V) and orange line is attached to digital 9.

The servo has to be connected to external power due to its high demand for driving servo current. Generally, the current of development board is not enough. If without connected power, the development board could be burnt.



(5) Test Code1

```
/*  
keyestudio Mini Tank Robot V2  
lesson 4.1  
Servo  
http://www.keyestudio.com  
*/  
  
#define servoPin 9 //servo Pin  
  
int pos; //angle variable of servo  
  
int pulsewidth; // pulse width variable of servo  
  
void setup() {  
    pinMode(servoPin, OUTPUT); //set servo pin to OUTPUT  
    procedure(0); //set the angle of servo to 0°  
}  
  
void loop() {  
    for (pos = 0; pos <= 180; pos += 1) { // goes from 0 degrees to  
180 degrees  
        // in steps of 1 degree  
        procedure(pos); // tell servo to go to position in  
variable 'pos'  
        delay(15); //control the rotation speed of
```



servo

```
}  
  
for (pos = 180; pos >= 0; pos -= 1) { // goes from 180 degrees to  
0 degrees  
    procedure(pos);                // tell servo to go to position in  
variable 'pos'  
    delay(15);  
}  
}  
  
// function to control servo  
void procedure(int myangle) {  
    pulsewidth = myangle * 11 + 500; //calculate the value of pulse  
width  
    digitalWrite(servoPin,HIGH);  
    delayMicroseconds(pulsewidth); //The duration of high level is  
pulse width  
    digitalWrite(servoPin,LOW);  
    delay((20 - pulsewidth / 1000)); // the cycle is 20ms, the low  
level last for the rest of time  
}  
  
//*****  
*****
```

Upload code successfully, servo swings back in the range of 0° to



180°

There is another guide for restraining servo----- servo library file, the following link of official website is for your reference.

<https://www.arduino.cc/en/Reference/Servo>

The library file of servo is used in the following code

(6) Test Code2

```
/*  
keyestudio Mini Tank Robot V2  
lesson 4.2  
servo  
http://www.keyestudio.com  
*/  
#include <Servo.h>  
  
Servo myservo; // create servo object to control a servo  
// twelve servo objects can be created on most boards  
int pos = 0;    // variable to store the servo position  
  
void setup() {  
    myservo.attach(9); // attaches the servo on pin 9 to the servo  
    object  
}
```



```
void loop() {  
    for (pos = 0; pos <= 180; pos += 1) { // goes from 0 degrees to  
180 degrees  
        // in steps of 1 degree  
        myservo.write(pos);           // tell servo to go to position  
in variable 'pos'  
        delay(15);                    // waits 15ms for the servo to  
reach the position  
    }  
    for (pos = 180; pos >= 0; pos -= 1) { // goes from 180 degrees to  
0 degrees  
        myservo.write(pos);           // tell servo to go to position  
in variable 'pos'  
        delay(15);                    // waits 15ms for the servo to  
reach the position  
    }  
}  
  
//*****
```

(7) Test Result

Upload code successfully and power on, servo swings in the range of 0° to 180°. The result is same. We usually control it by library file.

(8) Code Explanation



Arduino comes with **#include <Servo.h>** (servo function and statement)

The following are some common statements of the servo function:

1. attach (interface) ——Set servo interface, port 9 and 10 are available

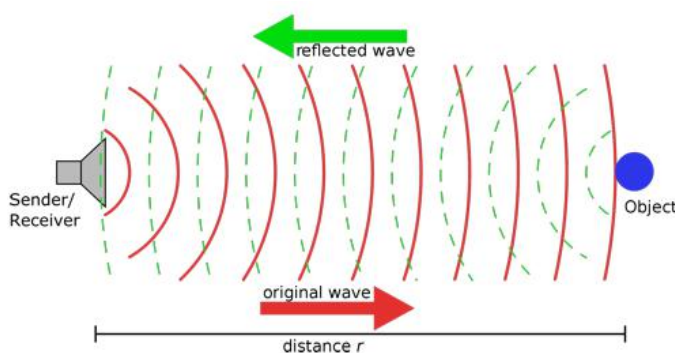
3. write (angle) ——The statement to set rotation angle of servo, the angle range is from 0° to 180°

3. read () ——The statement to read angle of servo, read the command value of "write()"

4. Note: The above written format is "servo variable name, specific statement () " , for instance: myservo.attach(9)

Project 5: Ultrasonic Sensor

(1) Description



The HC-SR04 ultrasonic sensor uses sonar to determine distance to an object like bats do. It offers excellent non-contact

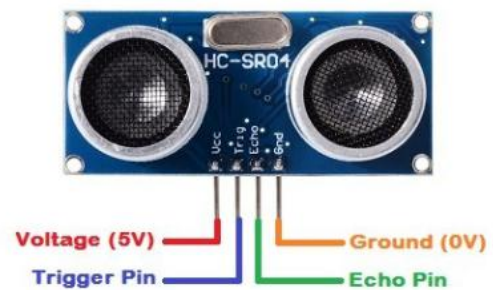
range detection with high accuracy and stable readings in an easy-to-use package. It comes complete with ultrasonic transmitter



and receiver modules.

The HC-SR04 or the ultrasonic sensor is being used in a wide range of electronics projects for creating obstacle detection and distance measuring application as well as

Ultrasonic Sensor Pinout



various other applications. Here we have brought the simple method to measure the distance with arduino and ultrasonic sensor and how to use ultrasonic sensor with arduino.

(2) Specification

Power Supply :+5V DC

Quiescent Current : <2mA

Working Current: 15mA

Effectual Angle: <15°


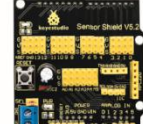




Ranging Distance : 2cm – 400 cm

Resolution : 0.3 cm

Measuring Angle: 30 degree

Trigger Input Pulse width: 10uS

(3) Equipment

V4.0 Control board *1	Sensor shield *1	Ultrasonic module *1	LED module *1	USB cable *1	4pin Dupont line *1
					



(4) The principle of ultrasonic sensor

As the above picture shown, it is like two eyes. One is transmitting end, the other is receiving end.

The ultrasonic module will emit the ultrasonic waves after trigger signal. When the ultrasonic waves encounter the object and are reflected back, the module outputs an echo signal, so it can determine the distance of object from the time difference between trigger signal and echo signal.

The t is the time that emitting signal meets obstacle and returns.
and the propagation speed of sound in the air is about 343m/s,
therefore, $\text{distance} = \text{speed} * \text{time}$, because the ultrasonic wave emits and comes back, which is 2 times of distance, so it needs to be divided by 2, the distance measured by ultrasonic wave = $(\text{speed} * \text{time})/2$

1. Use method and timing chart of ultrasonic module:

Setting the delay time of Trig pin of SR04 to 10 μ s at least, which can trigger it to detect distance.

2. After triggering, the module will automatically send eight 40KHz ultrasonic pulses and detect whether there is a signal return. This step will be completed automatically by the module.

3. If the signal returns, the Echo pin will output a high level, and the



The diagram illustrates the timing sequence for the ultrasonic module. It consists of three horizontal signal lines:

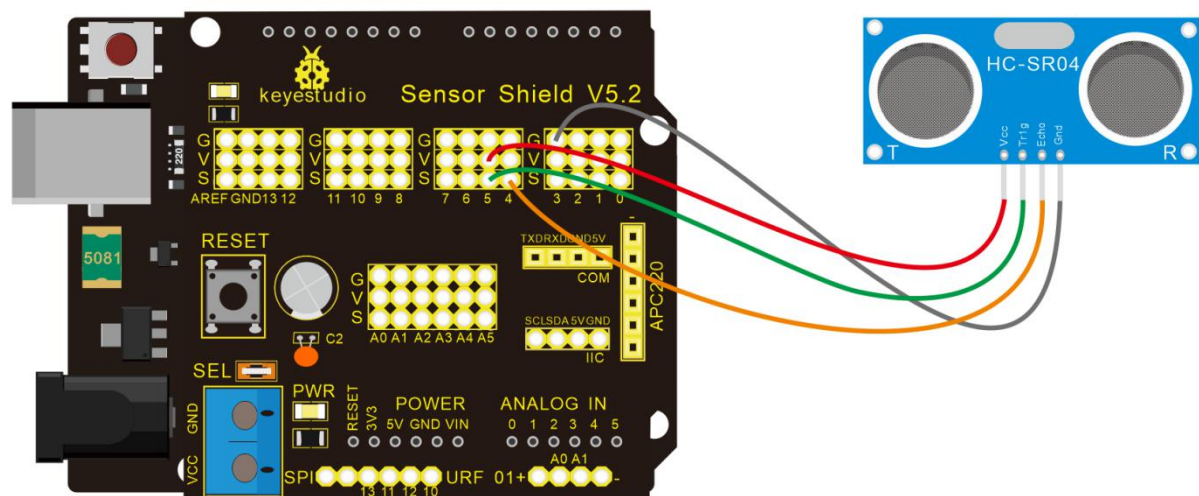
- Trigger signals:** A single high pulse labeled "10us high level".
- Send ultrasonic waves:** A series of 8 pulses labeled "Send 8t 40KHz ultrasonic pulses".
- Module gets the time gap of transmission and reception:** A high pulse labeled "Test result".

The sequence shows that the trigger signal occurs first, followed by the transmission of 8 ultrasonic pulses, and finally the module returns the test result.

The diagram illustrates a remote control system. The transmitter (left) consists of a 5V supply, a 10K resistor (R2), a 10K resistor (R3), a 22pF capacitor (C1), a 4MHz crystal (Y1), a 22pF capacitor (C6), and an NPN transistor (Q2). The microcontroller (STC11) is connected to the 5V supply and ground. The receiver (right) consists of a 5V supply, a 10K resistor (R5), a 10K resistor (R6), a 100nF capacitor (C4), a 100nF capacitor (C3), a 100nF capacitor (C8), a 100nF capacitor (C11), a PNP transistor (PNP), and a speaker (T40). The microcontroller (STC11) is connected to the 5V supply and ground. The MAX232 is connected to the microcontroller and the PNP transistor. The TL074 op-amp is connected to the 5V supply and ground. The op-amp is configured as a buffer and is connected to the speaker (T40).



(5) Connection Diagram





Wiring guide:

Ultrasonic sensor		keyestudio V5 sensor shield
VCC	→	5v(V)
Trig	→	5(S)
Echo	→	4(S)
Gnd	→	Gnd(G)

(6) Test Code

```
/*  
keyestudio Mini Tank Robot V2  
lesson 5  
Ultrasonic sensor  
http://www.keyestudio.com  
*/  
  
int trigPin = 5;    // Trigger  
int echoPin = 4;    // Echo  
  
long duration, cm, inches;  
  
void setup() {  
    //Serial Port begin  
    Serial.begin (9600);  
  
    //Define inputs and outputs
```



```
pinMode(trigPin, OUTPUT);

pinMode(echoPin, INPUT);

}

void loop() {

    // The sensor is triggered by a HIGH pulse of 10 or more
    microseconds.

    // Give a short LOW pulse beforehand to ensure a clean HIGH
    pulse:

    digitalWrite(trigPin, LOW);
    delayMicroseconds(2);
    digitalWrite(trigPin, HIGH);
    delayMicroseconds(10);
    digitalWrite(trigPin, LOW);

    // Read the signal from the sensor: a HIGH pulse whose
    // duration is the time (in microseconds) from the sending
    // of the ping to the reception of its echo off of an object.
    duration = pulseIn(echoPin, HIGH);

    // Convert the time into a distance

    cm = (duration/2) / 29.1;      // Divide by 29.1 or multiply by
0.0343

    inches = (duration/2) / 74;    // Divide by 74 or multiply by
0.0135

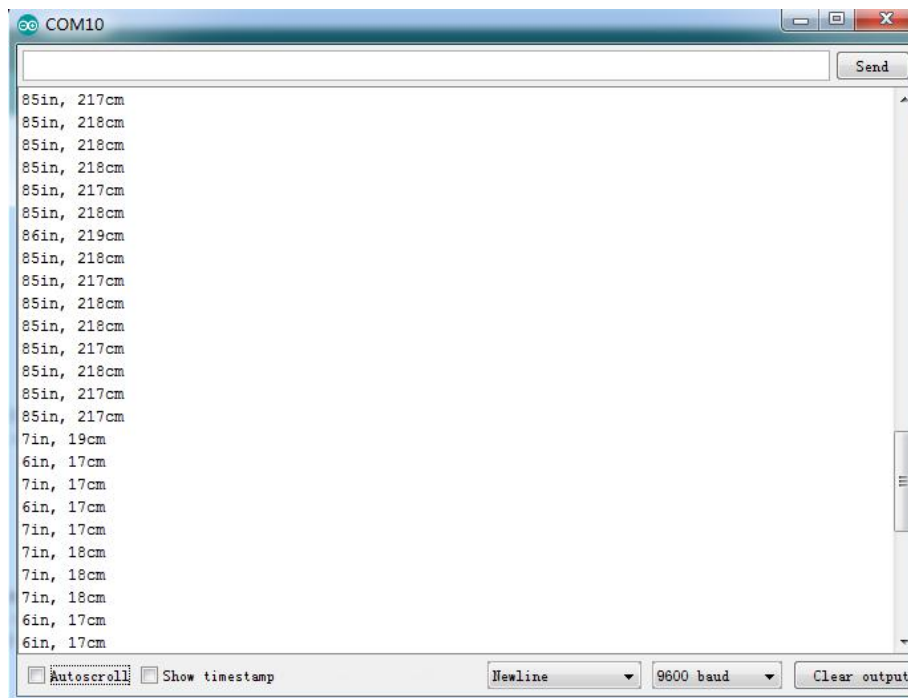
    Serial.print(inches);
```



```
Serial.print("in, ");  
  
Serial.print(cm);  
  
Serial.print("cm");  
  
Serial.println();  
  
delay(250);  
  
}  
  
//*****
```

(7) Test Result

Upload test code on the development board, open serial monitor and set baud rate to 9600. The detected distance will be displayed, unit is cm and inch. Hinder the ultrasonic sensor by hand, the displayed distance value gets smaller.



(8) Code Explanation

int trigPin = 5; this pin is defined to transmit ultrasonic waves,



generally output.

int echoPin = 4; this is defined as the pin of reception, generally input

cm = (duration/2) / 29.1; inches = (duration/2) / 74; by 0.0135

We can calculate the distance by using the following formula:

distance = (traveltime/2) x speed of sound

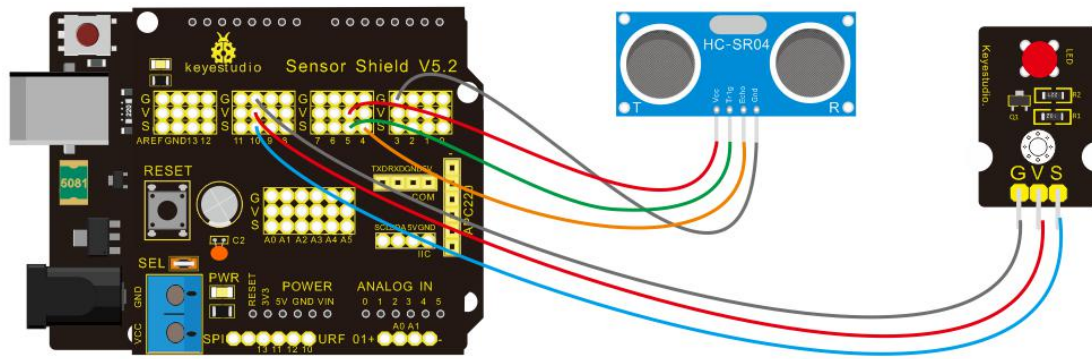
The speed of sound is: 343m/s = 0.0343 cm/uS = 1/29.1 cm/uS

Or in inches: 13503.9in/s = 0.0135in/uS = 1/74in/uS

We need to divide the travel time by 2 because we have to take into account that the wave was sent, hit the object, and then returned back to the sensor.

(9) Extension Practice:

We have measured the distance displayed by the ultrasonic. How about controlling the LED with the measured distance? Let's try it, connect an LED light module to the D10 pin.



/*

keyestudio Mini Tank Robot V2

lesson 5

Ultrasonic LED

<http://www.keyestudio.com>

*/

```
int trigPin = 5;    // Trigger
int echoPin = 4;    // Echo
long duration, cm, inches;

void setup() {
    //Serial Port begin
    Serial.begin (9600);

    //Define inputs and outputs
    pinMode(trigPin, OUTPUT);
    pinMode(echoPin, INPUT);
}
```




```
void loop()
{
    // The sensor is triggered by a HIGH pulse of 10 or more
microseconds.

    // Give a short LOW pulse beforehand to ensure a clean HIGH
pulse:

    digitalWrite(trigPin, LOW);
    delayMicroseconds(2);
    digitalWrite(trigPin, HIGH);
    delayMicroseconds(10);
    digitalWrite(trigPin, LOW);

    // Read the signal from the sensor: a HIGH pulse whose
    // duration is the time (in microseconds) from the sending
    // of the ping to the reception of its echo off of an object.
    duration = pulseIn(echoPin, HIGH);

    // Convert the time into a distance
    cm = (duration/2) / 29.1;    // Divide by 29.1 or multiply by
0.0343

    inches = (duration/2) / 74;  // Divide by 74 or multiply by
0.0135

    Serial.print(inches);
    Serial.print("in, ");
    Serial.print(cm);
```



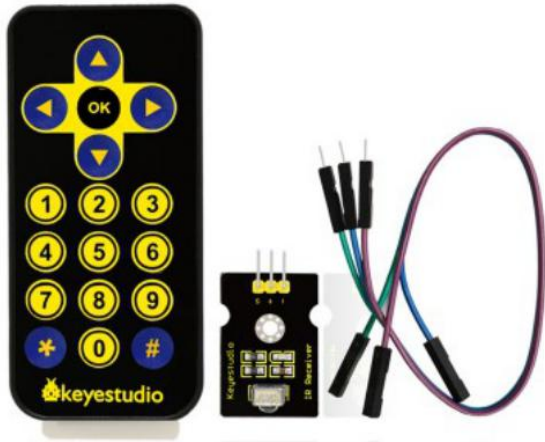
```
Serial.print("cm");  
  
Serial.println();  
  
delay(250);  
  
if (cm >= 2 && cm <= 10)  
digitalWrite(10, HIGH);  
delay(1000);  
digitalWrite(10, LOW);  
delay(1000);  
}  
  
//*****
```

Upload test code to development board and block ultrasonic sensor by hand, then check if LED is on

Project 6: IR Reception

(1) Description

There is no doubt that infrared remote control is ubiquitous in daily life. It is used to control various household appliances, such as TVs, stereos, video recorders and satellite signal receivers. Infrared remote control is composed of infrared transmitting and infrared receiving systems, that is, an infrared remote control and infrared receiving module and a single-chip microcomputer capable of decoding.



The 38K infrared carrier signal emitted by remote controller is encoded by the encoding chip in the remote controller. It is composed of a section of pilot code, user code, user inverse

code, data code, and data inverse code. The time interval of the pulse is used to distinguish whether it is a 0 or 1 signal and the encoding is made up of these 0, 1 signals.

The user code of the same remote control is unchanged. The data code can distinguish the key.

When the remote control button is pressed, the remote control sends out an infrared carrier signal. When the IR receiver receives the signal, the program will decode the carrier signal and determines which key is pressed. The MCU decodes the received 01 signal, thereby judging what key is pressed by the remote control.

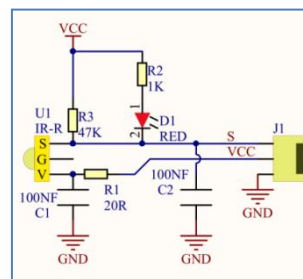
Infrared receiver we use is an infrared receiver module. Mainly composed of an infrared receiver head, it is a device that integrates reception, amplification, and demodulation. Its internal IC has completed demodulation, and can achieve from infrared reception to output and be compatible with TTL signals. Additionally, it is suitable for infrared remote control and infrared data transmission.

The infrared receiving module made by the receiver has only three



pins, signal line, VCC and GND. It is very convenient to communicate with arduino and other microcontrollers.

(2) Specification



Operating Voltage: 3.3-5V (DC)

Interface: 3PIN







Output Signal: Digital signal

Receiving Angle: 90 degrees

Frequency: 38khz

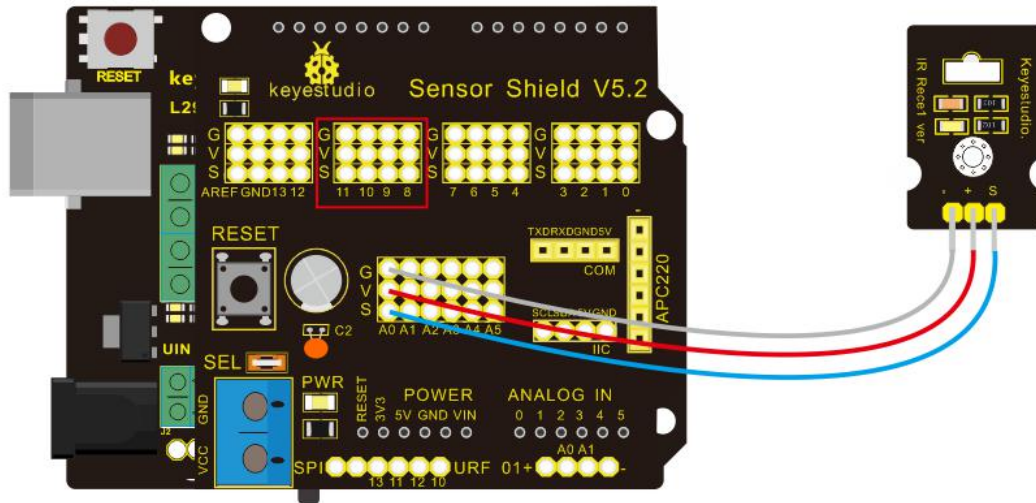
Receiving Distance: 10m

(3) Equipment

V4.0 Control board *1	Sensor shield *1	IR receiver module *1	LED module *1	USB cable *1	3pin Dupont line *1
					



(4) Connection Diagram



Respectively link "-", "+" and S of IR receiver module with G(GND), V (VCC) and A0 of keyestudio development board.

Attention: On the condition that digital ports are not available, analog ports can be regarded as digital ports. A0 equals to D14, A1 is equivalent to digital 15.

(5) Test Code

Firstly import library file of IR receiver module(refer to how to import Arduino library file) before designing code.

/*

keyestudio Mini Tank Robot V2



lesson 6

IRremote

<http://www.keyestudio.com>

```
*/
```

```
#include <RremoteTank.h>      // IRremote library statement
```

```
int RECV_PIN = A0;           //define the pins of IR receiver as A0
```

```
IRrecv irrecv(RECV_PIN);
```

```
decode_results results;      // decode results exist in the "result" of  
                             "decode results"
```

```
void setup()
```

```
{
```

```
    Serial.begin(9600);
```

```
    irrecv.enableIRIn(); //Enable receiver
```

```
}
```

```
void loop() {
```

```
    if (irrecv.decode(&results))//decode successfully, receive a set  
    of infrared signals
```

```
{
```

```
    Serial.println(results.value, HEX);//Wrap word in 16 HEX to  
output and receive code
```

```
    irrecv.resume(); // Receive the next value
```

```
}
```

```
    delay(100);
```

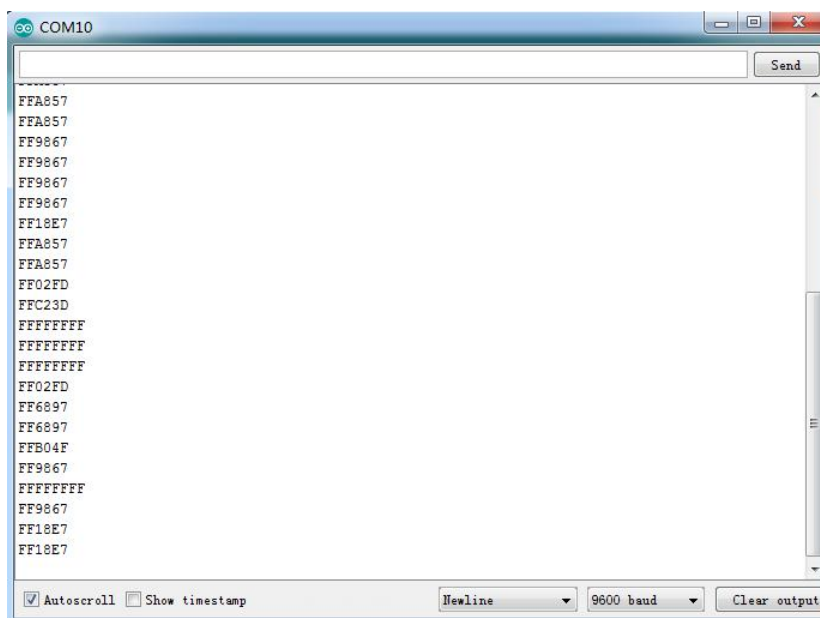



}

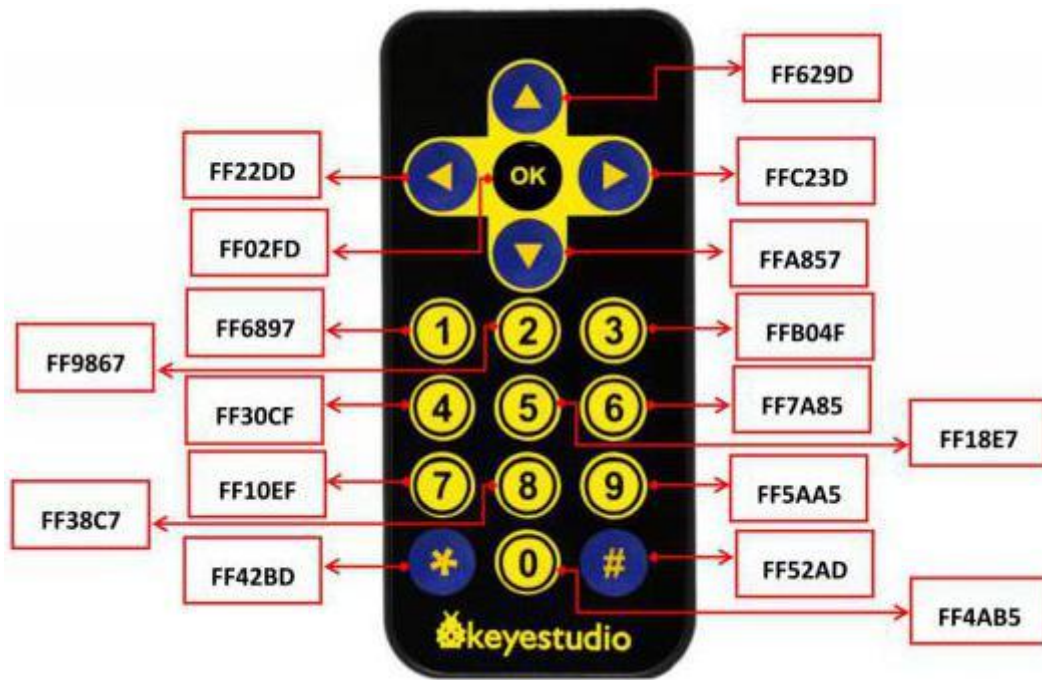
//*****

(6) Test Result

Upload test code, open serial monitor and set baud rate to 9600, point remote control to IR receiver and the corresponding value will be shown, if pressing so long, the error codes will appear



Below we have listed out each button value of keyestudio remote control. So you can keep it for reference.



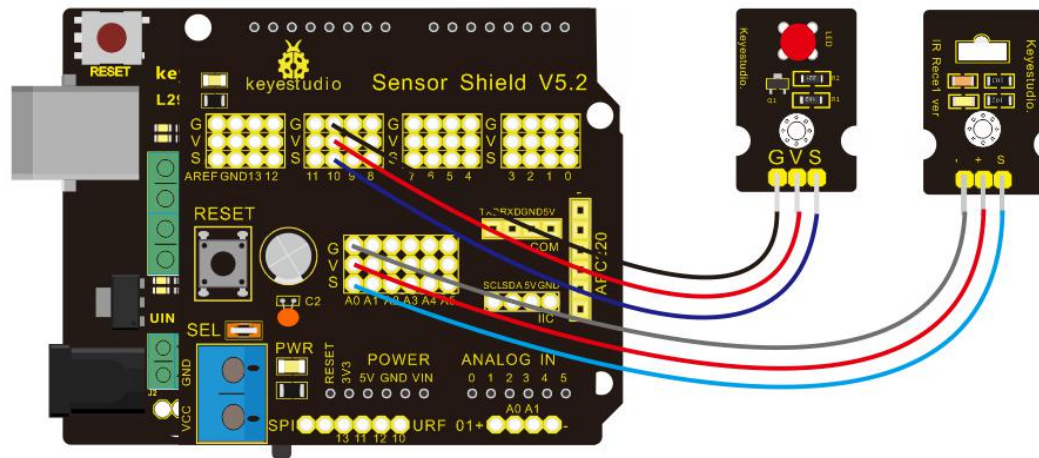
(7) Code Explanation

irrecv.enableIRIn(): after enabling IR decoding, the IR signals will be received, then function "decode()" will check continuously if decode successfully.

irrecv.decode(&results): after decoding successfully, this function will come back to "true" , and keep result in "results" . After decoding a IR signals, run the resume()function and receive the next signal

(8) Extension Practice

We decoded the key value of IR remote control. How about controlling LED by the measured value? We could operate an experiment to affirm. Attach an LED to D10, then press the keys of remote control to make LED light up and off



/* keyestudio Mini Tank Robot V2

lesson 6.2

IRremote

<http://www.keyestudio.com>

*/

```
#include <RremoteTank.h>
```

```
int RECV_PIN = A0;//define the pin of IR receiver as A0
```

```
int LED_PIN=10;//define the pin of LED
```

```
int a=0;
```

```
IRrecv irrecv(RECV_PIN);
```

```
decode_results results;
```

```
void setup()
```

```
{
```

```
  Serial.begin(9600);
```



```
    irrecv.enableIRIn(); // Initialize the IR receiver

    pinMode(LED_PIN,OUTPUT);//set LED_pin to OUTPUT
}

void loop() {
    if (irrecv.decode(&results)) {
        if(results.value==0xFF02FD &a==0) // according to the above key
        value, press "OK" on remote control , LED will be controlled
        {
            digitalWrite(LED_PIN,HIGH);//LED will be on
a=1;
        }
        else if(results.value==0xFF02FD &a==1) //press again
        {
            digitalWrite(LED_PIN,LOW);//LED will go off
a=0;
        }

        irrecv.resume(); //receive the next value

    }

}

//*****
```

Upload code to development board, press "OK" key on remote control to make LED on and off.



Project 7: Bluetooth Remote Control

(1) Description

Bluetooth, a simple wireless communication module most popular since the



last few decades and easy to use are being used in most of the battery-powered devices.

Over the years, there have been many upgrades of Bluetooth standard to keep fulfil the demand of customers and technology according to the need of time and situation.

Over the few years, there are many things changed including data transmission rate, power consumption with wearable and IoT Devices and Security System.

Here we are going to learn about HM-10 BLE 4.0 with Arduino Board. The HM-10 is a readily available Bluetooth 4.0 module. This module is used for establishing wireless data communication. The module is designed by using the Texas Instruments CC2540 or CC2541 Bluetooth low energy (BLE) System on Chip (SoC).



(2) Specification

Bluetooth protocol: Bluetooth Specification V4.0 BLE

No byte limit in serial port Transceiving

In open environment, realize 100m ultra-distance communication with iphone4s

Working frequency: 2.4GHz ISM band

Modulation method: GFSK(Gaussian Frequency Shift Keying)

Transmission power: -23dbm, -6dbm, 0dbm, 6dbm, can be modified by AT command.

Sensitivity: $\leq -84\text{dBm}$ at 0.1% BER

Transmission rate: Asynchronous: 6K bytes ; Synchronous: 6k Bytes

Security feature: Authentication and encryption







Supporting service: Central & Peripheral UUID FFE0, FFE1

Power consumption: Auto sleep mode, stand by current 400uA~800uA, 8.5mA during transmission.

Power supply: 5V DC

Working temperature: -5 to $+65$ Centigrade

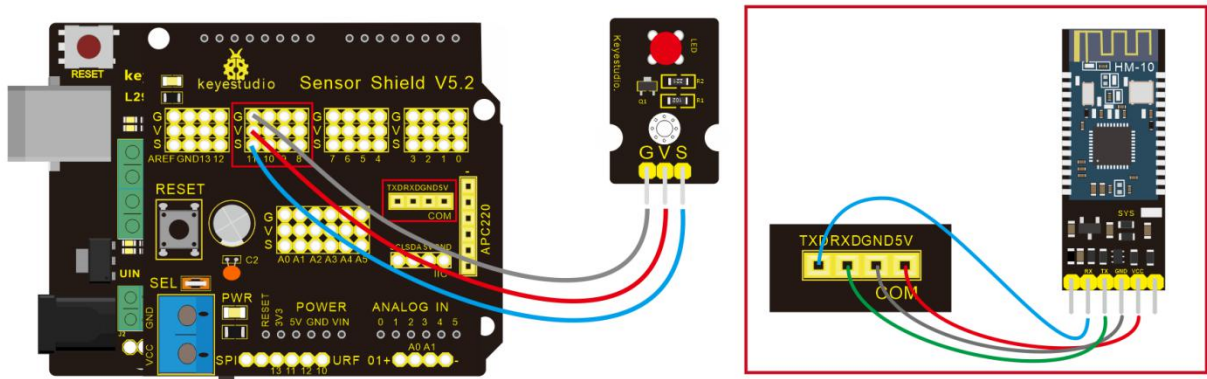
(3) Equipment

V4.0 Control board *1	Sensor shield *1	4.0 Bluetooth module *1	LED module *1	USB cable *1	3pin Dupont line *1
					



(4) Connection Diagram

1. STATE: state test pins, connected to internal LED, generally keep it unconnected.
2. RXD: serial interface, receiving terminal.
3. TXD: serial interface, transmitting terminal.
4. GND: Ground.
5. VCC: positive pole of the power source.
6. EN/BRK: break connect, it means breaking the Bluetooth connection, generally, keep it unconnected.



(5) Test Code

```
/*
```

```
keyestudio Mini Tank Robot v2.0
```

```
lesson 7.1
```

```
bluetooth
```

```
http://www.keyestudio.com
```

```
*/
```




char ble_val; //character variable: save the value of Bluetooth reception

```
void setup() {  
    Serial.begin(9600);  
}  
  
void loop() {  
    if(Serial.available() > 0) //make sure if there is data in serial  
buffer  
    {  
        ble_val = Serial.read(); //Read data from serial buffer  
        Serial.println(ble_val); //Print  
    }  
  
    //*****
```

(There will be contradiction between serial communication of code and communication of Bluetooth when uploading code, therefore, don't link with Bluetooth module before uploading code.)

After uploading code on development board, then insert Bluetooth module, wait for the command from cellphone.



(6) Download APP

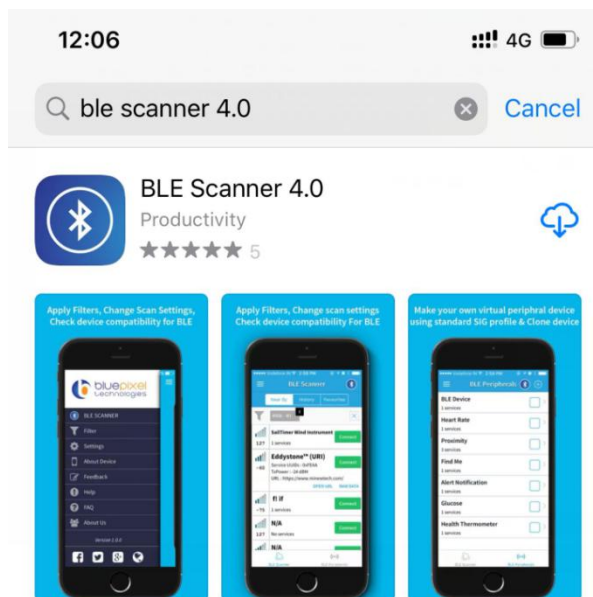
The code is for reading the received signal, and we also need a stuff to send signal. In this project, we send signal to control robot car via cellphone.

Then we need to download the APP.

1. iOS system

Note: Allow APP to access “location” in settings of your cellphone when connecting to Bluetooth module, otherwise, Bluetooth may not be connected.

Enter **APP STORE** to search **BLE Scanner 4.0**, then download it.

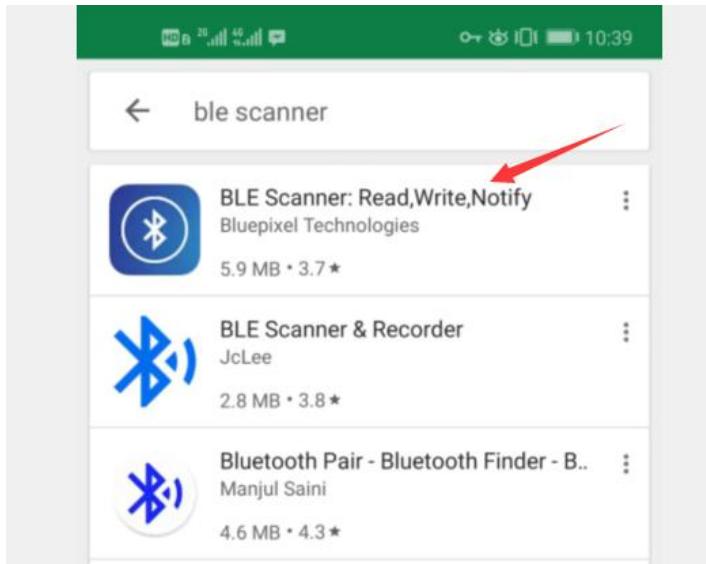


2. Android system



Enter [Google Play](#) to find out [BLE Scanner](#), then download.

And allow APP to access "location", you could enable "location" in settings of your cellphone.

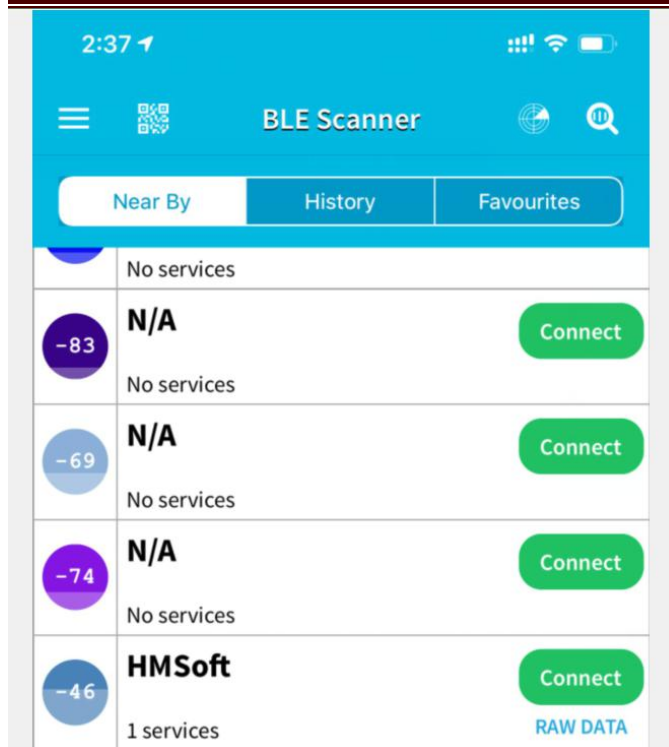


3. After installation, open App and enable "Location and Bluetooth" permission.

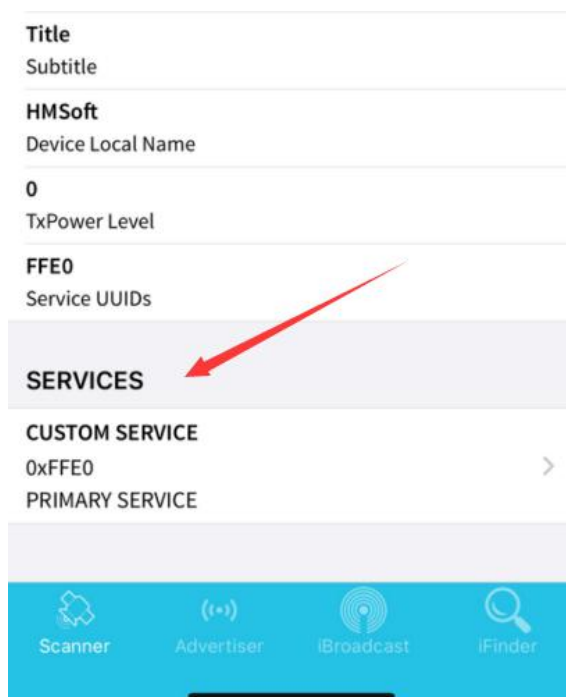
4. We take iOS version as example. The operation method of Android version is almost same as it.

5. Scan Bluetooth module to get Bluetooth BLE 4.0. Its name is HMSoft.

Then click "connect" to link with Bluetooth and use it.



6. After connecting to HMSoft, click it to get multiple options, such as device information, access permission, general and custom service. Choose "CUSTOM SERVICE"



7. Then pop up the following page



<

HMSoft

Status: Connected

CUSTOM SERVICE

FFE0

PRIMARY SERVICE

WWW.JNHUAMAO.CN

(FFE1)

Read,Notify,WriteWithoutResponse

Updating ? >

Read,Notify,WriteWithoutResponse

Properties

0x310d0a

Value - HEX at 02:53:58.121

1

Value - String at 02:53:58.121

0x1

02:53:31.239 - Client Characteristic Configuration (2902)

www.jnhuamao.cn

02:53:31.300 - Characteristic User Description (2901)

8. Click ([Read,Notify,WriteWithoutResponse](#))to enter the following page

<

HMSoft

Status: Connected

FFE0

Custom Characteristic

UUID: FFE1

Status: Connected

WRITE VALUE

Write Value

0x31

02:53:58.066

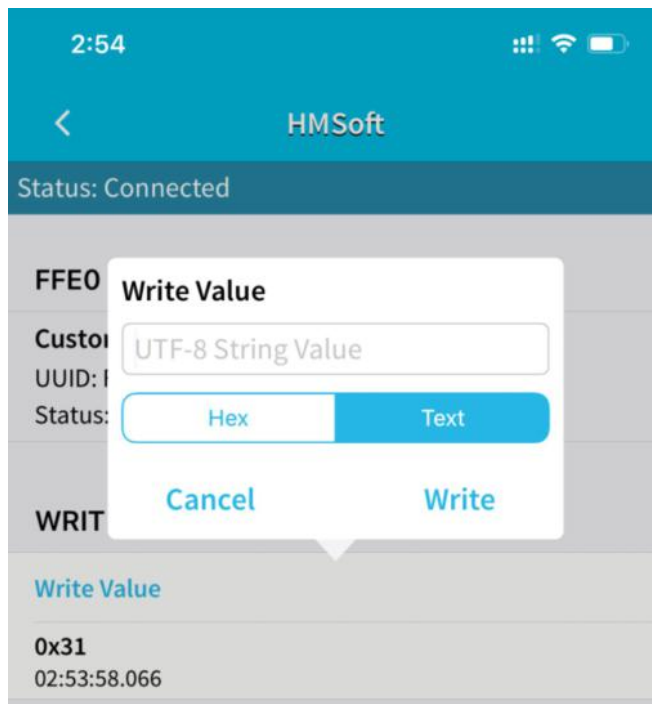
READ VALUE

Read Value

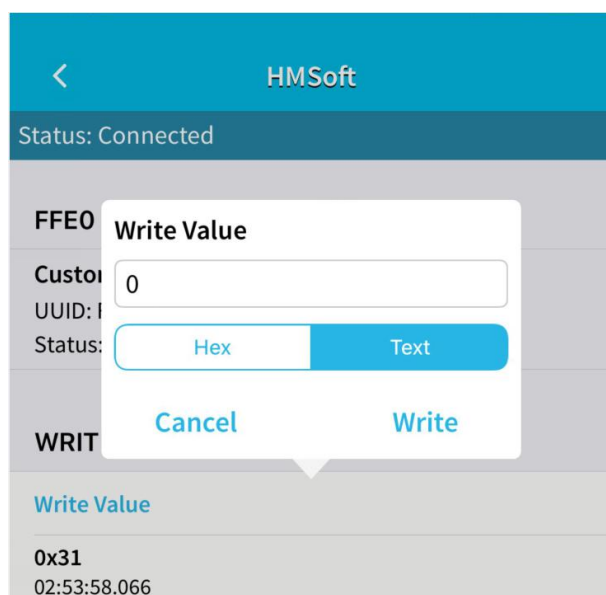
0x310d0a



9. Click **Write Value**, appear the interface to enter HEX or Text.

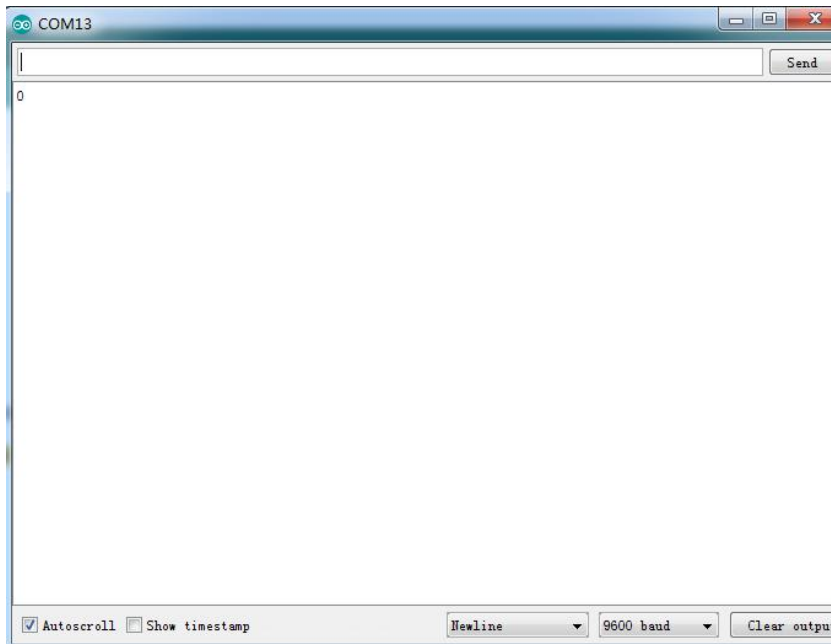


10. Open the serial monitor on Arduino, enter a 0 or other character at Text interface.





Then click "Write" , open serial monitor to view if there is a "0" signal



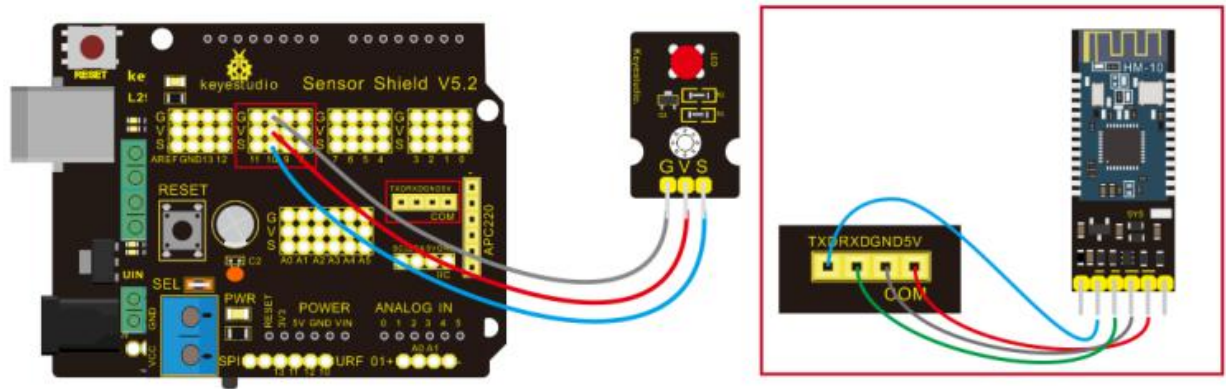
(7) Code Explanation

Serial.available() : The current rest characters when return to buffer area. Generally, this function is used to judge if there is data in buffer. When `Serial.available()>0`, it means that serial receives the data and can be read

Serial.read(): Read a data of a Byte in buffer of serial port, for instance, device sends data to Arduino via serial port, then we could read data by "Serial.read()"

(8) Extension Practice

We could send a command via cellphone to turn on and off a LED. D10 is connected to a LED, as shown below:



/*

keyestudio Mini Tank Robot v2.0

lesson 7.2

Bluetooth

<http://www.keyestudio.com>

*/

```
int ledpin=11;
```

```
void setup()
```

```
{Serial.begin(9600);
```

```
  pinMode(ledpin,OUTPUT);
```

```
}
```

```
void loop()
```

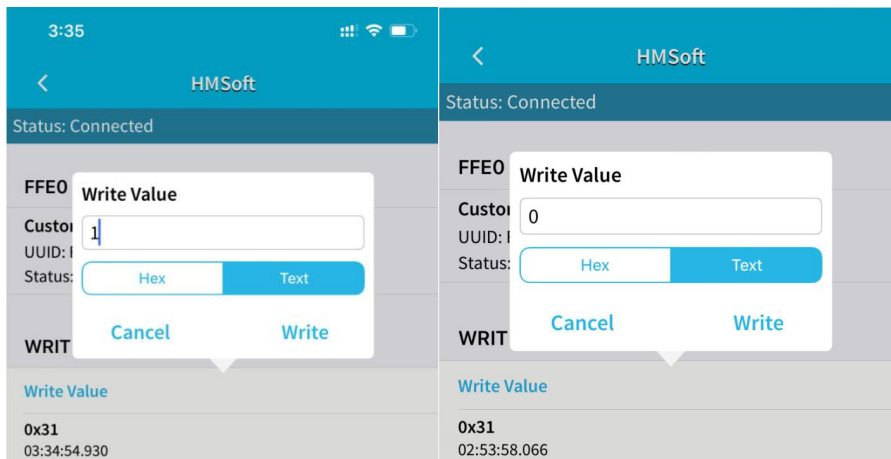
```
{ int i;
```

```
  if (Serial.available())
```

```
  {i=Serial.read();
```



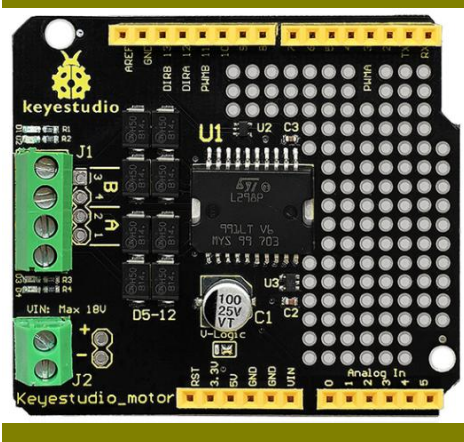
```
Serial.println("DATA RECEIVED:");  
  
if(i=='1')  
{ digitalWrite(ledpin,1);  
  Serial.println("led on");  
}  
  
if(i=='0')  
{ digitalWrite(ledpin,0);  
  Serial.println("led off");  
}  
}}//*****
```



Click “Write” on APP, when you enter 1, LED will be on, when you input 0, LED will be off. (Remember to remove the Bluetooth module after finishing experiment, otherwise, code-burning will be affected)

Project 8: Motor Driving and Speed Control

(1) Description



There are many ways to drive the motor.

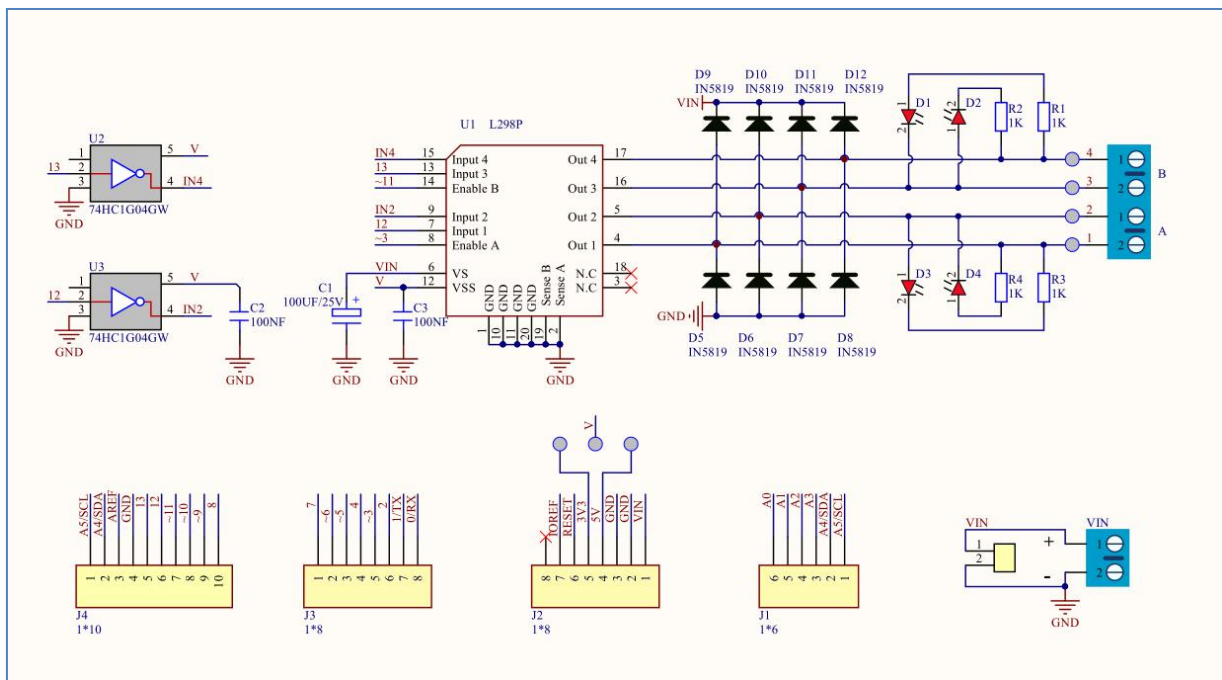
Our tank robot uses the most commonly used L298P solution. L298P is an excellent high-power motor driver IC produced by STMicroelectronics. It can directly drive DC motors, two-phase and four-phase stepping motors. The driving current up to 2A, and output terminal of motor adopts eight high-speed Schottky diodes as protection.

We designed a shield based on the circuit of L298p.

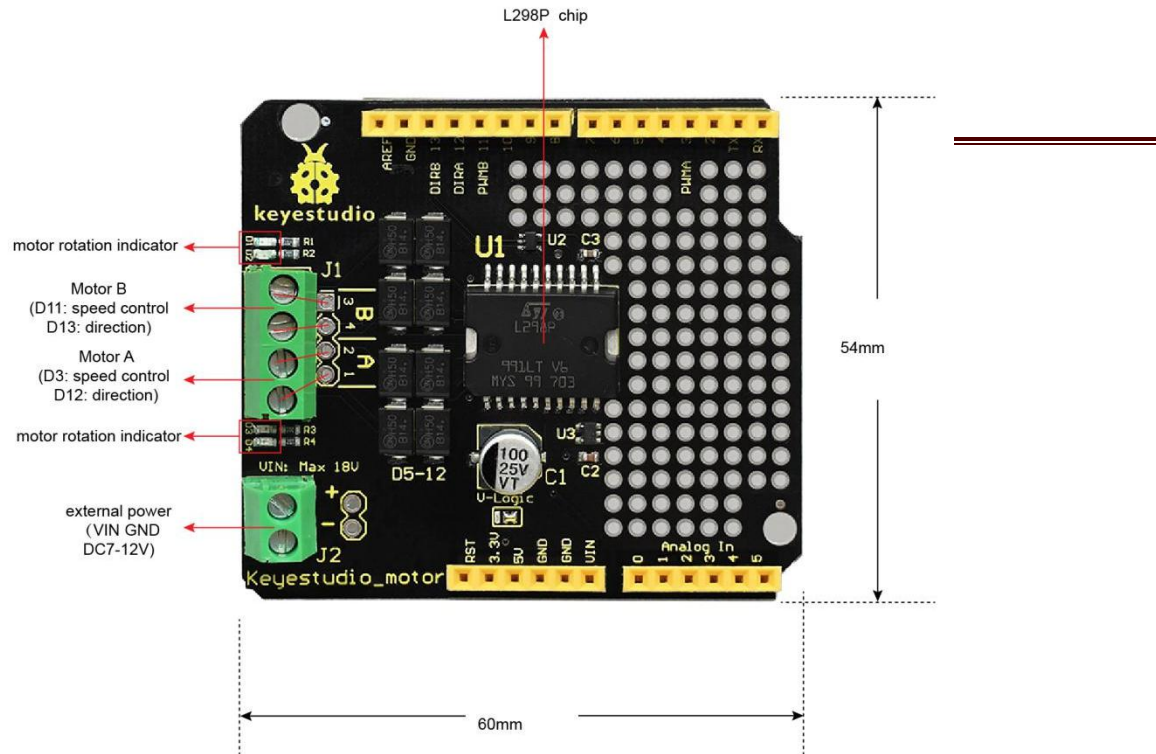
The stacked design reduces the technical difficulty of using and driving the motor.

(2) Specification

Circuit Diagram for L298P Board



- 1) Logic part input voltage: DC5V
- 2) Driving part input voltage: DC 7-12V
- 3) Logic part working current: <36mA
- 4) Driving part working current: <2A
- 5) Maximum power dissipation: 25W (T=75°C)
- 6) Working temperature: -25°C ~ +130°C
- 7) Control signal input level: high level $2.3V < V_{in} < 5V$, low level $-0.3V < V_{in} < 1.5V$



(3) Drive Robot to Move

Through the above circuit diagram, the direction pin of A motor is D12, and speed pin is D3; D13 is the direction pin of B motor, D11 is speed pin.



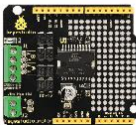



We know how to control digital ports according to the following chart.

PWM decides 2 motors to turn so as to drive robot car. The PWM value is in the range of 0-255, the larger the number, the faster the motor rotates

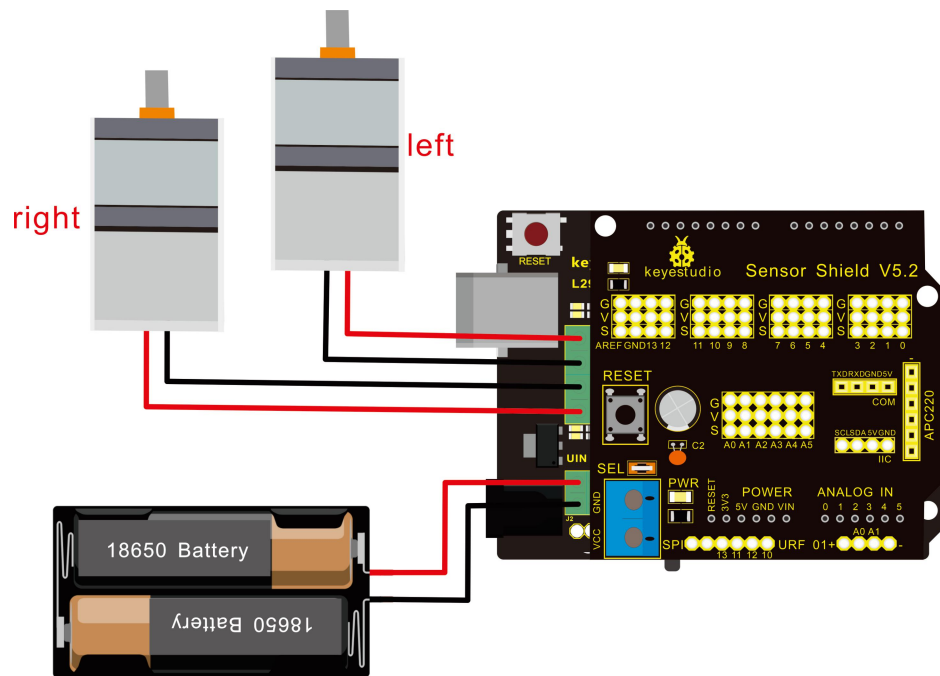


Tank Robot	Motor (A)	Motor (B)
Forward	Turn clockwise	
Backward	Turn anticlockwise	
Rotate to left	Turn anticlockwise	Turn clockwise
Rotate to right	Turn clockwise	Turn anticlockwise
Stop	Stop	Stop

(4) Equipment

V4.0 Control board *1	Sensor shield *1	L298P Motor Shield*1	Motor *2	USB cable *1	2*18650 Battery Holder *1
					

(5) Connection Diagram



Note: the 4Pin terminal block is marked with silkscreen 1234. The red line of right rear motor is connected to terminal 1, black line is linked with end 2. The red line of left front motor is attached to terminal 3, black line is linked with port 4.

(6) Test Code

/*

keyestudio Mini Tank Robot v2.0

lesson 8.1

motor driver

<http://www.keyestudio.com>

*/



```
#define ML_Ctrl 13 //define the direction control pin of left motor
#define ML_PWM 11 //define the PWM control pin of left motor
#define MR_Ctrl 12 //define direction control pin of right motor
#define MR_PWM 3 // define the PWM control pin of right
motor
```

```
void setup()
```

```
{
```

```
    pinMode(ML_Ctrl, OUTPUT); //define direction control pin of left
motor as output
```

```
    pinMode(ML_PWM, OUTPUT); //define PWM control pin of left
motor as output
```

```
    pinMode(MR_Ctrl, OUTPUT); //define direction control pin of
right motor as output.
```

```
    pinMode(MR_PWM, OUTPUT); //define the PWM control pin of
right motor as output
```

```
}
```

```
void loop()
```

```
{
```

```
    digitalWrite(ML_Ctrl, LOW); //set the direction control pin of left
motor to LOW
```

```
    analogWrite(ML_PWM, 200); //set the PWM control speed of left
```



motor to 200

digitalWrite(MR_Ctrl,LOW);//set the direction control pin of right motor to LOW

analogWrite(MR_PWM,200);//set the PWM control speed of right motor to 200

//front

delay(2000);//delay in 2s

digitalWrite(ML_Ctrl,HIGH);//set the direction control pin of left motor to HIGH

analogWrite(ML_PWM,200);//set the PWM control speed of left motor to 200

digitalWrite(MR_Ctrl,HIGH);//set the direction control pin of right motor to HIGH

analogWrite(MR_PWM,200);//set the PWM control speed of right motor to 200

//back

delay(2000);//delay in 2s

digitalWrite(ML_Ctrl,HIGH);//set the direction control pin of left motor to HIGH

analogWrite(ML_PWM,200);//set the PWM control speed of left motor to 200



```
digitalWrite(MR_Ctrl,LOW);//set the direction control pin of right  
motor to LOW
```

```
analogWrite(MR_PWM,200);//set the PWM control speed of right  
motor to 200
```

```
//left
```

```
delay(2000);//delay in 2s
```

```
digitalWrite(ML_Ctrl,LOW);//set the direction control pin of left  
motor to LOW
```

```
analogWrite(ML_PWM,200);//set the PWM control speed of left  
motor to 200
```

```
digitalWrite(MR_Ctrl,HIGH);//set the direction control pin of right  
motor to HIGH
```

```
analogWrite(MR_PWM,200);//set the PWM control speed of right  
motor to 200
```

```
//right
```

```
delay(2000);//delay in 2s
```

```
analogWrite(ML_PWM,0);//set the PWM control speed of left  
motor to 0
```

```
analogWrite(MR_PWM,0);//set the PWM control speed of right  
motor to 0
```



```
//stop
```

```
delay(2000); //delay in 2s
```

```
} //*****
```

(7) Test Result

Hook up by connection diagram, upload code and power on, smart car goes forward and back for 2s, turns left and right for 2s, stops for 2s and alternately.

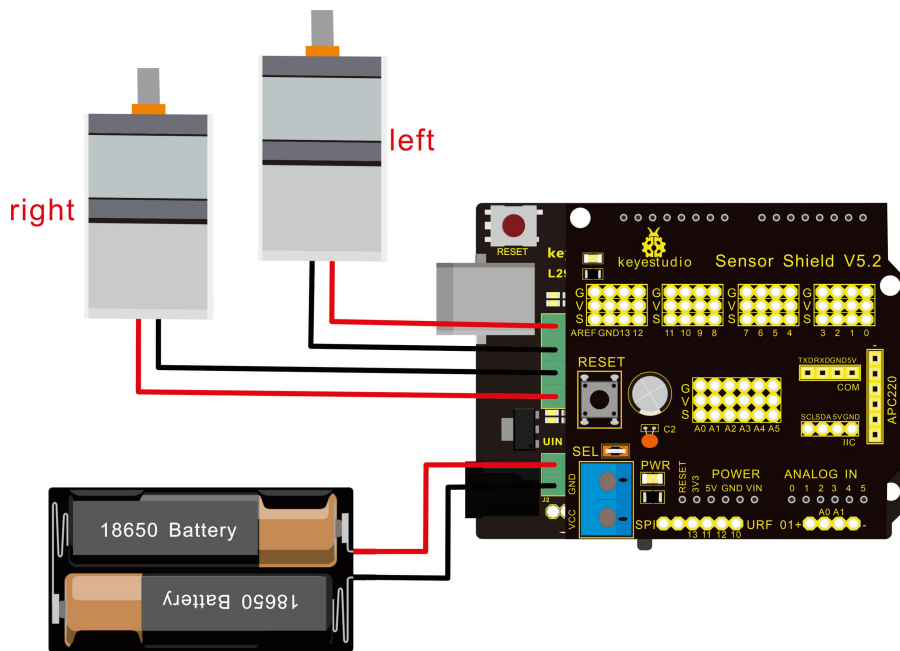
(8) Code Explanation

digitalWrite(ML_Ctrl,LOW): the rotation direction of motor is decided by the high/low level and the pins that decide rotation direction are digital pins.

analogWrite(ML_PWM,200): the speed of motor is regulated by PWM, and the pins that decide the speed of motor must be PWM pins.

(9) Extension Practice

Adjust the speed that PWM controls the motor, hook up in same way



/*

keyestudio Mini Tank Robot v2.0

lesson 8.2

motor driver pwm

<http://www.keyestudio.com>

*/

```
#define ML_Ctrl 13 //define the direction control pin of left motor
#define ML_PWM 11 //define the PWM control pin of left motor
#define MR_Ctrl 12 //define the direction control pin of right
motor
#define MR_PWM 3 //define the PWM control pin of right motor
void setup()
{ pinMode(ML_Ctrl, OUTPUT); //define the direction control pin of
left motor as OUTPUT
```



```
pinMode(ML_PWM, OUTPUT); //define the PWM control pin of
left motor as OUTPUT

pinMode(MR_Ctrl, OUTPUT); //define the direction control pin of
right motor as OUTPUT

pinMode(MR_PWM, OUTPUT); //define the PWM control pin of
right motor as OUTPUT

}

void loop()
{ digitalWrite(ML_Ctrl, LOW); //Set direction control pin of left motor
to LOW

  analogWrite(ML_PWM, 100); // Set the PWM control speed of left
motor to 100

  digitalWrite(MR_Ctrl, LOW); //Set the direction control pin of right
motor to LOW

  analogWrite(MR_PWM, 100); //Set the PWM control speed of
right motor to 100

  //front

  delay(2000); //define 2s

  digitalWrite(ML_Ctrl, HIGH); //Set direction control pin of left
motor to HIGH level

  analogWrite(ML_PWM, 250); //Set the PWM control speed of left
motor to 100
```



```
digitalWrite(MR_Ctrl,HIGH);//Set direction control pin of right  
motor to HIGH level
```

```
analogWrite(MR_PWM,250);//Set the PWM control speed of  
right motor to 100
```

```
//back
```

```
delay(2000);//define 2s
```

```
digitalWrite(ML_Ctrl,HIGH);//Set direction control pin of left  
motor to HIGH level
```

```
analogWrite(ML_PWM,250);//Set the PWM control speed of left  
motor to 100
```

```
digitalWrite(MR_Ctrl,LOW);//Set direction control pin of right  
motor to LOW level
```

```
analogWrite(MR_PWM,250);//Set the PWM control speed of  
right motor to 100
```

```
//left
```

```
delay(2000);//define 2s
```

```
digitalWrite(ML_Ctrl,LOW);//set the direction control pin of left  
motor to LOW
```

```
analogWrite(ML_PWM,250);//set the PWM control speed of left  
motor to 200
```

```
digitalWrite(MR_Ctrl,HIGH);//set the direction control pin of right  
motor to HIGH
```

```
analogWrite(MR_PWM,250);//set the PWM control speed of right
```




motor to 100

//right

delay(2000);//define 2s

analogWrite(ML_PWM,0);//set the PWM control speed of left
motor to 0

analogWrite(MR_PWM,0);// set the PWM control speed of right
motor to 0

//stop

delay(2000);//define 2s

}//*****

Upload code successfully, the motors rotate faster.

Project 9: 8*16 LED Board



(1) Description

If we add a 8*16 LED board to the robot, it will be amazing. Keyestudio's 8*16 dot matrix can meet your requirements. You can create facial emoticons, patterns or other interesting displays yourself. 8*16 LED light board comes with 128 LEDs. The data of the microprocessor (arduino) communicates with the AiP1640 through the two-wire bus interface, so as to control the 128 LEDs on the module, which produce the patterns you need on dot matrix. To



facilitate wiring, we also provide a HX-2.54 4Pin wiring.

(2) Specification

Working voltage: DC 3.3-5V

Power loss: 400mW


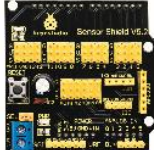



Oscillation frequency: 450KHz

Drive current: 200mA

Working temperature: -40~80°C

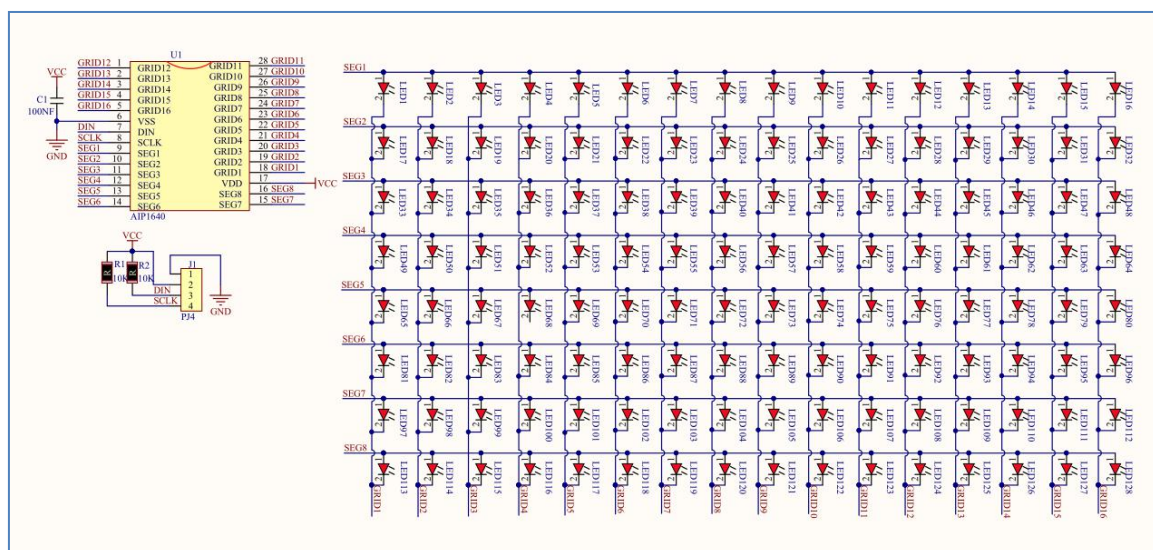
Communication method: two-wire bus

(3) Equipment

V4.0 Control board *1	Sensor shield *1	8x16 LED panel board *1		USB cable *1
				

(4) 8*16 Dot Matrix Display

Circuit Graph



The principle of 8*16 dot matrix:



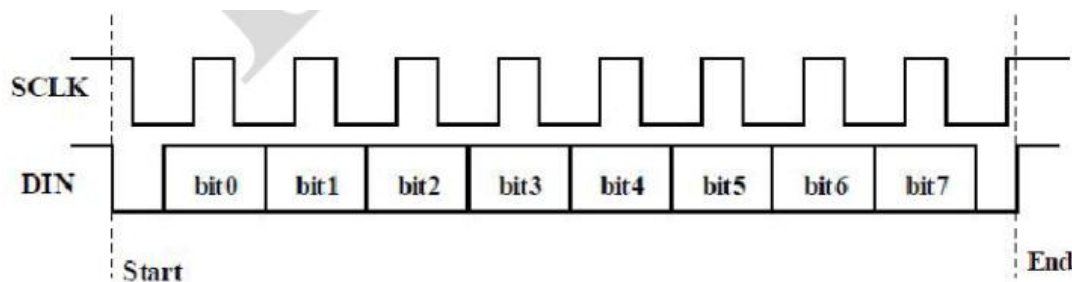
How to control each led light of 8*16 dot matrix? We know that a byte has 8 bits, each bit is 0 or 1. When a bit is 0, turn off LED and when a bit is 1, turn on LED. Thereby, one byte can control the LED in a row of dot matrix, so 16 bytes can control 16 columns of led lights, that is, 8*16 dot matrix.

Interface Description and Communication Protocol:

The data of the microprocessor (arduino) communicates with the AiP1640 through the two-wire bus interface.

The communication protocol diagram is shown below:

(SCLK) is SCL, (DIN) is SDA:



①The starting condition for data input: SCL is high level and SDA changes from high to low.

②For data command setting, there are methods as shown in the figure below

In our sample program, select the way to **add 1 to the address automatically**, the binary value is 0100 0000 and the corresponding hexadecimal value is 0x40



B7	B6	B5	B4	B3	B2	B1	B0	Description
0	1	Irrelevant choice, fill in 0			0	Irrelevant choice, fill in 0		add 1 to the address automatically Fixed address Universal mode Test mode
0	1				1			
0	1			0				
0	1			1				

③ For address command setting, the address can be selected as shown below.

The first 00H is selected in our sample program, and the binary number 1100 0000 corresponds to the hexadecimal 0xc0

B7	B6	B5	B4	B3	B2	B1	B0	Display address
1	1	Irrelevant choice, fill in 0		0	0	0	0	00H
1	1			0	0	0	1	01H
1	1			0	0	1	0	02H
1	1			0	0	1	1	03H
1	1			0	1	0	0	04H
1	1			0	1	0	1	05H
1	1			0	1	1	0	06H
1	1			0	1	1	1	07H
1	1			1	0	0	0	08H
1	1			1	0	0	1	09H
1	1			1	0	1	0	0AH
1	1			1	0	1	1	0BH
1	1			1	1	0	0	0CH
1	1			1	1	0	1	0DH
1	1			1	1	1	0	0EH
1	1			1	1	1	1	0FH

④ The requirement for data input is that SCL is high level when inputting data, the signal on SDA must remain unchanged. Only



when the clock signal on SCL is low level, the signal on SDA can be altered. The data input is low-order first, high-order is behind

⑤ The condition to end data transmission is that when SCL is low, SDA is low, and when SCL is high, the SDA level also becomes high.

⑥ Display control, set different pulse width, the pulse width can be selected as shown below

In the example, we choose pulse width 4/16, and the hexadecimal corresponds to 1000 1010 is 0x8A

B7	B6	B5	B4	B3	B2	B1	B0	Function	Description
1	0	Irrelevant choice, fill in 0		1	0	0	0	Clear quantity setting (Brightness setting)	Set pulse width to 1/16
1	0			1	0	0	1		Set pulse width to 2/16
1	0			1	0	1	0		Set pulse width to 4/16
1	0			1	0	1	1		Set pulse width to 10/16
1	0			1	1	0	0		Set pulse width to 11/16
1	0			1	1	0	1		Set pulse width to 12/16
1	0			1	1	1	0		Set pulse width to 13/16
1	0			1	1	1	1		Set pulse width to 14/16
1	0			0	X	X	X	Display switch setting	On off
1	0			1	X	X	X		

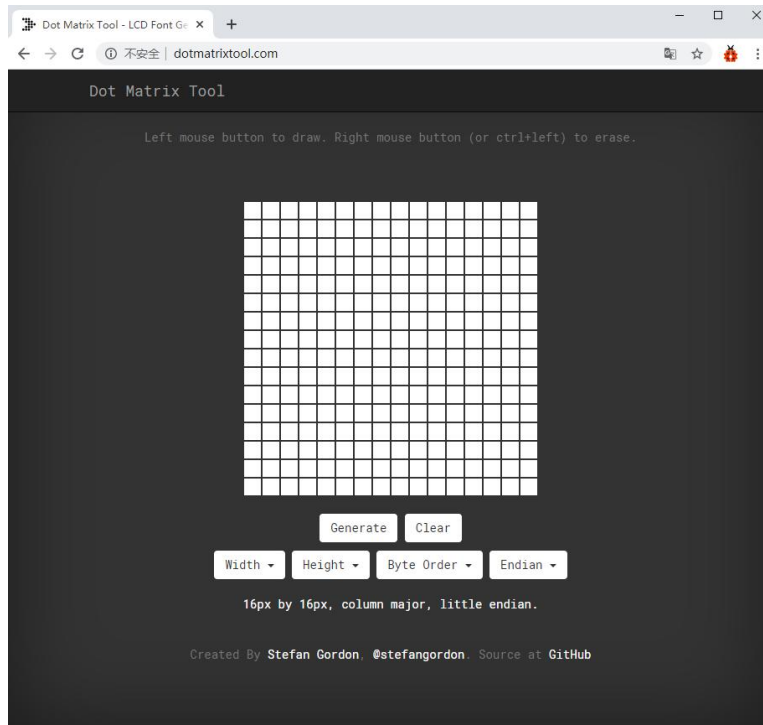
4. Introduction for Modulus Tool

The online version of dot matrix modulus tool:

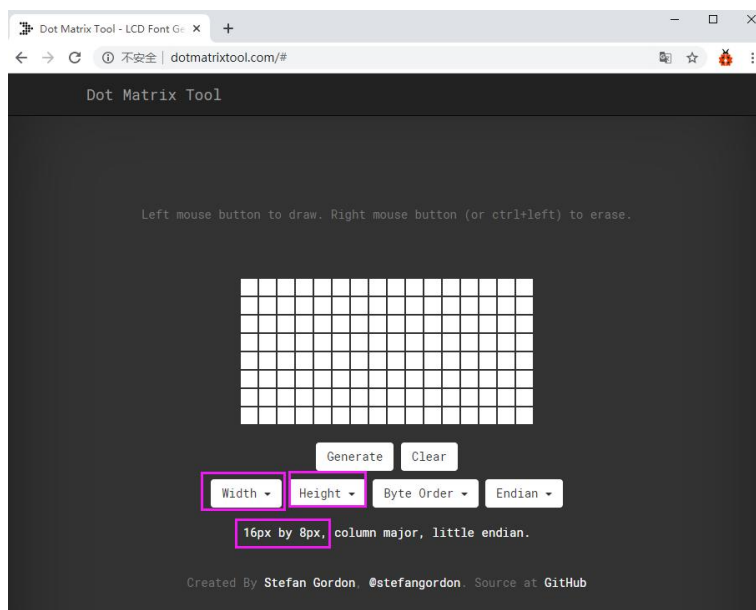
<http://dotmatrixtool.com/#>



①Open links to enter the following page.



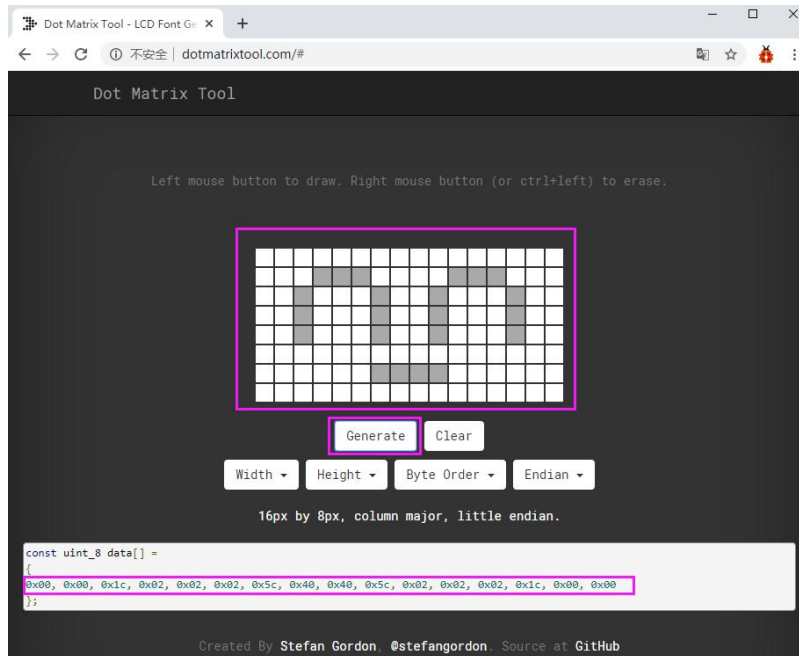
②The dot matrix is 8*16 in this project, so set the height to 8, width to 16, as shown below.



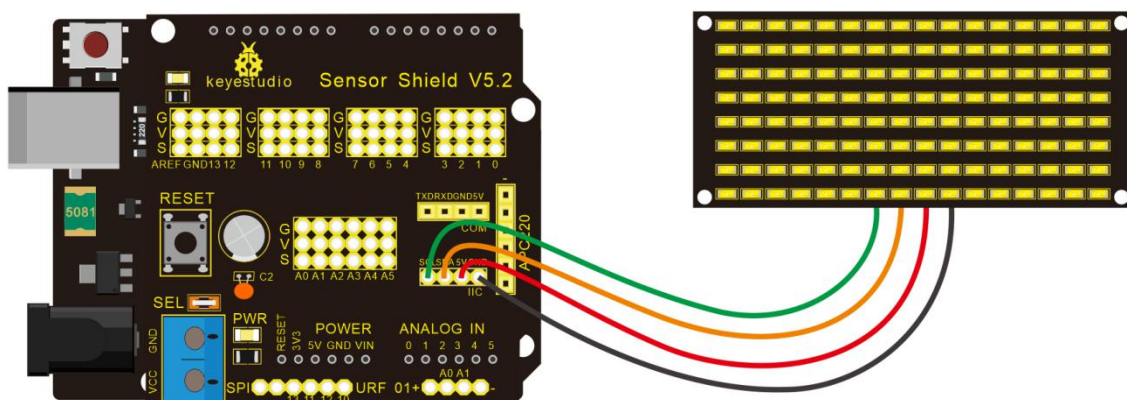


③ Generate hexadecimal data from the pattern

As shown below, press the left mouse button to select, the right button to cancel, draw the pattern you want, click **Generate**, and the hexadecimal data we need will be produced.



(5) Connection Diagram



Wiring note: The GND, VCC, SDA, and SCL of the 8x16 LED panel are



respectively connected to -(GND), + (VCC), A4 and A5 of the keyestudio sensor expansion board for two-wire serial communication. (Note: This pin is connected to arduino IIC, but this module is not IIC communication, it can be linked with any two pins.)

(6) Test Code

The code that shows smile face

```
/*  
keyestudio Mini Tank Robot v2.0  
lesson 9.1  
Matrix face  
http://www.keyestudio.com  
*/  
  
//the data of smiley from modulus tool  
unsigned char smile[] = {0x00, 0x00, 0x1c, 0x02, 0x02, 0x02, 0x5c,  
0x40, 0x40, 0x5c, 0x02, 0x02, 0x02, 0x1c, 0x00, 0x00};  
  
#define SCL_Pin  A5  //Set clock pin to A5  
#define SDA_Pin  A4  //Set data pin to A4  
  
void setup(){  
    //Set pin to output
```



```
pinMode(SCL_Pin,OUTPUT);

pinMode(SDA_Pin,OUTPUT);

//clear the display

//matrix_display(clear);

}

void loop(){

    matrix_display(smile); // display smile face

}

// the function for dot matrix display
void matrix_display(unsigned char matrix_value[])
{
    IIC_start(); // use the function of the data transmission start
condition
    IIC_send(0xc0); //select address

    for(int i = 0;i < 16;i++) //pattern data has 16 bits
    {
        IIC_send(matrix_value[i]); //convey the pattern data
    }

    IIC_end(); //end the transmission of pattern data
    IIC_start();
    IIC_send(0x8A); //display control, set pulse width to 4/16 s
```



```
IIC_end();

}

//the condition to start conveying data
void IIC_start()
{
    digitalWrite(SCL_Pin,HIGH);
    delayMicroseconds(3);
    digitalWrite(SDA_Pin,HIGH);
    delayMicroseconds(3);
    digitalWrite(SDA_Pin,LOW);
    delayMicroseconds(3);
}

//Convey data
void IIC_send(unsigned char send_data)
{
    for(char i = 0;i < 8;i++) //Each byte has 8 bits 8bit for every
character
    {
        digitalWrite(SCL_Pin,LOW); // pull down clock pin SCL_Pin
to change the signal of SDA
        delayMicroseconds(3);
        if(send_data & 0x01) //set high and low level of SDA_Pin
```



according to 1 or 0 of every bit

```
{  
    digitalWrite(SDA_Pin,HIGH);  
}  
else  
{  
    digitalWrite(SDA_Pin,LOW);  
}  
delayMicroseconds(3);  
digitalWrite(SCL_Pin,HIGH); //pull up the clock pin SCL_Pin to  
stop transmission  
delayMicroseconds(3);  
send_data = send_data >> 1;  // detect bit by bit, shift the  
data to the right by one  
}  
}
```

//The sign of ending data transmission

void IIC_end()

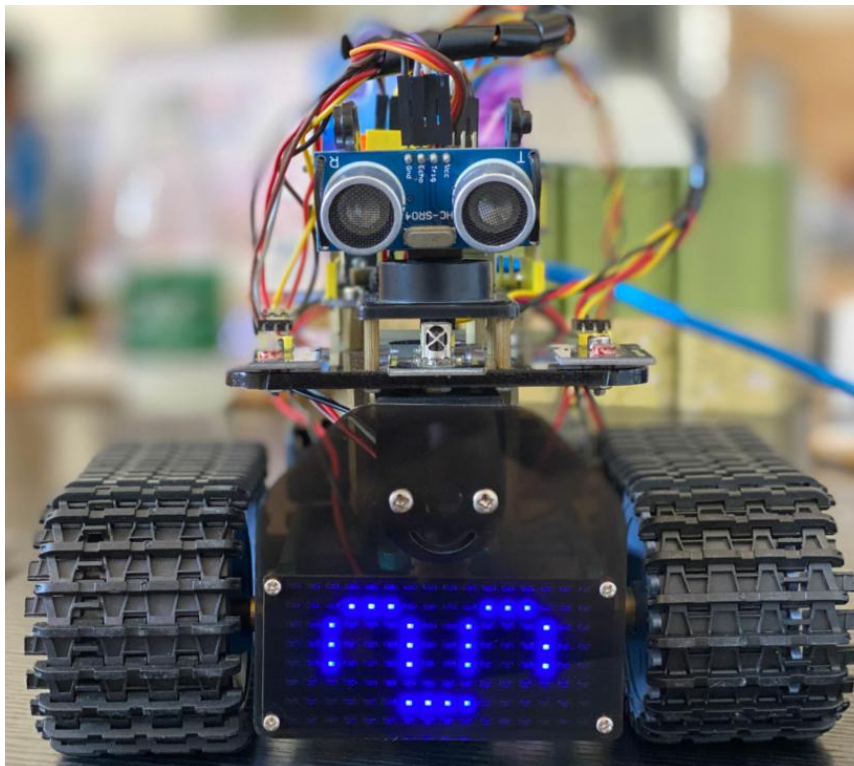
```
{  
    digitalWrite(SCL_Pin,LOW);  
    delayMicroseconds(3);  
    digitalWrite(SDA_Pin,LOW);
```



```
delayMicroseconds(3);  
  
digitalWrite(SCL_Pin,HIGH);  
  
delayMicroseconds(3);  
  
digitalWrite(SDA_Pin,HIGH);  
  
delayMicroseconds(3);  
  
}  
  
//*****
```

(7) Test Result

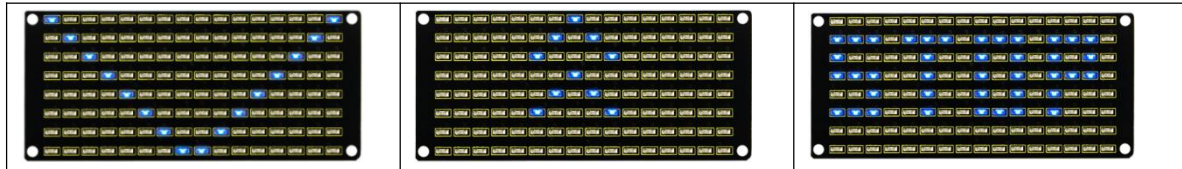
Wire according to connection diagram. The DIP switch is dialed to right end and power on, the smile face appears on dot matrix.



(8) Extension Practice



We use the modulo tool (<http://dotmatrixtool.com/#>) to make the dot matrix alternately display start, go front and stop patterns then clear the patterns, the time interval is 2000 milliseconds.



Get the graphical code to be displayed via modulus tool

Start:

0x01,0x02,0x04,0x08,0x10,0x20,0x40,0x80,0x80,0x40,0x20,0x10,0x08,0x04,0x02,0x01

Go front:

0x00,0x00,0x00,0x00,0x00,0x24,0x12,0x09,0x12,0x24,0x00,0x00,0x00,0x00,0x00,0x00

Go back:

0x00,0x00,0x00,0x00,0x00,0x24,0x48,0x90,0x48,0x24,0x00,0x00,0x00,0x00,0x00,0x00

Turn left:

0x00,0x00,0x00,0x00,0x00,0x00,0x44,0x28,0x10,0x44,0x28,0x10,0x44,0x28,0x10,0x00

Turn right:



0x00,0x10,0x28,0x44,0x10,0x28,0x44,0x10,0x28,0x44,0x00,0x00,0x0
0,0x00,0x00,0x00

Stop:

0x2E,0x2A,0x3A,0x00,0x02,0x3E,0x02,0x00,0x3E,0x22,0x3E,0x00,0x3
E,0x0A,0x0E,0x00

Clear the displayed code :

0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x0
0,0x00,0x00,0x00

The code that the multiple patterns shift:

/* keyestudio Mini Tank Robot v2.0

lesson 9.2

Matrix loop

<http://www.keyestudio.com>

*/

//Array, used to store the data of the pattern, can be calculated by
yourself or obtained from the modulus tool

unsigned char start01[] =

{0x01,0x02,0x04,0x08,0x10,0x20,0x40,0x80,0x80,0x40,0x20,0x10,0x
08,0x04,0x02,0x01};

unsigned char front[] =

{0x00,0x00,0x00,0x00,0x00,0x24,0x12,0x09,0x12,0x24,0x00,0x00,0x



```
00,0x00,0x00,0x00};

unsigned char back[] =
{0x00,0x00,0x00,0x00,0x00,0x24,0x48,0x90,0x48,0x24,0x00,0x00,0x
00,0x00,0x00,0x00};

unsigned char left[] =
{0x00,0x00,0x00,0x00,0x00,0x00,0x44,0x28,0x10,0x44,0x28,0x10,0x
44,0x28,0x10,0x00};

unsigned char right[] =
{0x00,0x10,0x28,0x44,0x10,0x28,0x44,0x10,0x28,0x44,0x00,0x00,0x
00,0x00,0x00,0x00};

unsigned char STOP01[] =
{0x2E,0x2A,0x3A,0x00,0x02,0x3E,0x02,0x00,0x3E,0x22,0x3E,0x00,0x
3E,0x0A,0x0E,0x00};

unsigned char clear[] =
{0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x
00,0x00,0x00,0x00};

#define SCL_Pin  A5  //Set clock pin to A5
#define SDA_Pin  A4  //Set data pin to A4

void setup(){
    //Set pins to output
    pinMode(SCL_Pin,OUTPUT);
    pinMode(SDA_Pin,OUTPUT);
    //Clear the display
```



```
matrix_display(clear);  
  
}  
  
void loop(){  
  
    matrix_display(start01); // Display start pattern  
    delay(2000);  
  
    matrix_display(front);    //Front pattern  
    delay(2000);  
  
    matrix_display(STOP01);   //Stop pattern  
    delay(2000);  
  
    matrix_display(clear);    //Clear the display Clear the screen  
    delay(2000);  
  
}  
  
// This function is used to display of dot matrix  
void matrix_display(unsigned char matrix_value[])  
{  
  
    IIC_start(); //call the function that data transmission start  
    IIC_send(0xc0); //Choose address  
  
  
    for(int i = 0;i < 16;i++) //pattern data has 16 bits  
    {  
  
        IIC_send(matrix_value[i]); //data to convey patterns  
    }  
  
    IIC_end(); //end the transmission of pattern dataEnd
```



```
IIC_start();

IIC_send(0x8A);  //display control, set pulse width to 4/16

IIC_end();

}

//The condition starting to transmit data

void IIC_start()

{

    digitalWrite(SCL_Pin,HIGH);

    delayMicroseconds(3);

    digitalWrite(SDA_Pin,HIGH);

    delayMicroseconds(3);

    digitalWrite(SDA_Pin,LOW);

    delayMicroseconds(3);

}

//Convey data

void IIC_send(unsigned char send_data)

{

    for(char i = 0;i < 8;i++)  //Each byte has 8 bits

    {

        digitalWrite(SCL_Pin,LOW);  //pull down clock pin SCL Pin to

change the signals of SDA

        delayMicroseconds(3);

        if(send_data & 0x01)  //set high and low level of SDA_Pin
```



according to 1 or 0 of every bit

```
{
    digitalWrite(SDA_Pin,HIGH);
}
else
{
    digitalWrite(SDA_Pin,LOW);
}

delayMicroseconds(3);

digitalWrite(SCL_Pin,HIGH); //pull up clock pin SCL_Pin to
stop transmitting data

delayMicroseconds(3);

send_data = send_data >> 1; //detect bit by bit, so shift the
data right by one
}}

//The sign that data transmission ends
void IIC_end()
{
    digitalWrite(SCL_Pin,LOW);
    delayMicroseconds(3);
    digitalWrite(SDA_Pin,LOW);
    delayMicroseconds(3);
    digitalWrite(SCL_Pin,HIGH);
```



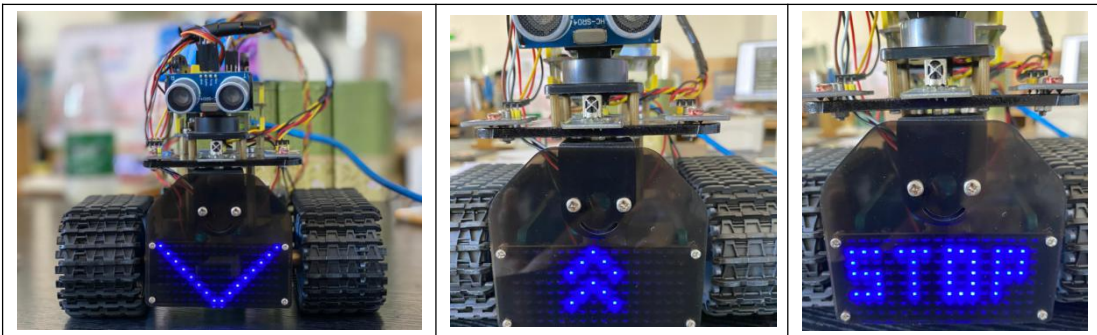
```
delayMicroseconds(3);
```

```
digitalWrite(SDA_Pin,HIGH);
```

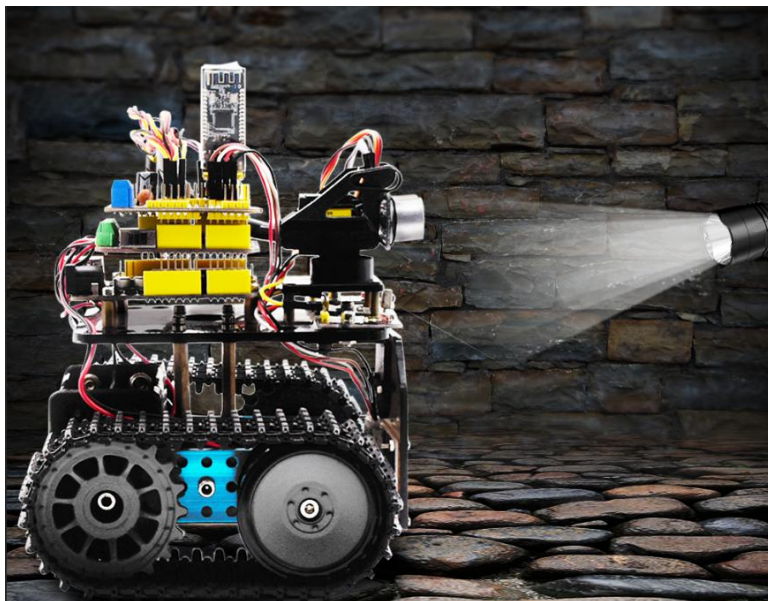
```
delayMicroseconds(3);}
```

```
//*****
```

Upload code on development board, 8*16 dot matrix displays front , back and stop patterns, alternately.



Project 10: Light Follow Robot



(1) Description

We' ve introduce how to use various sensors, modules.

In this lesson, we combine with hardware knowledge --

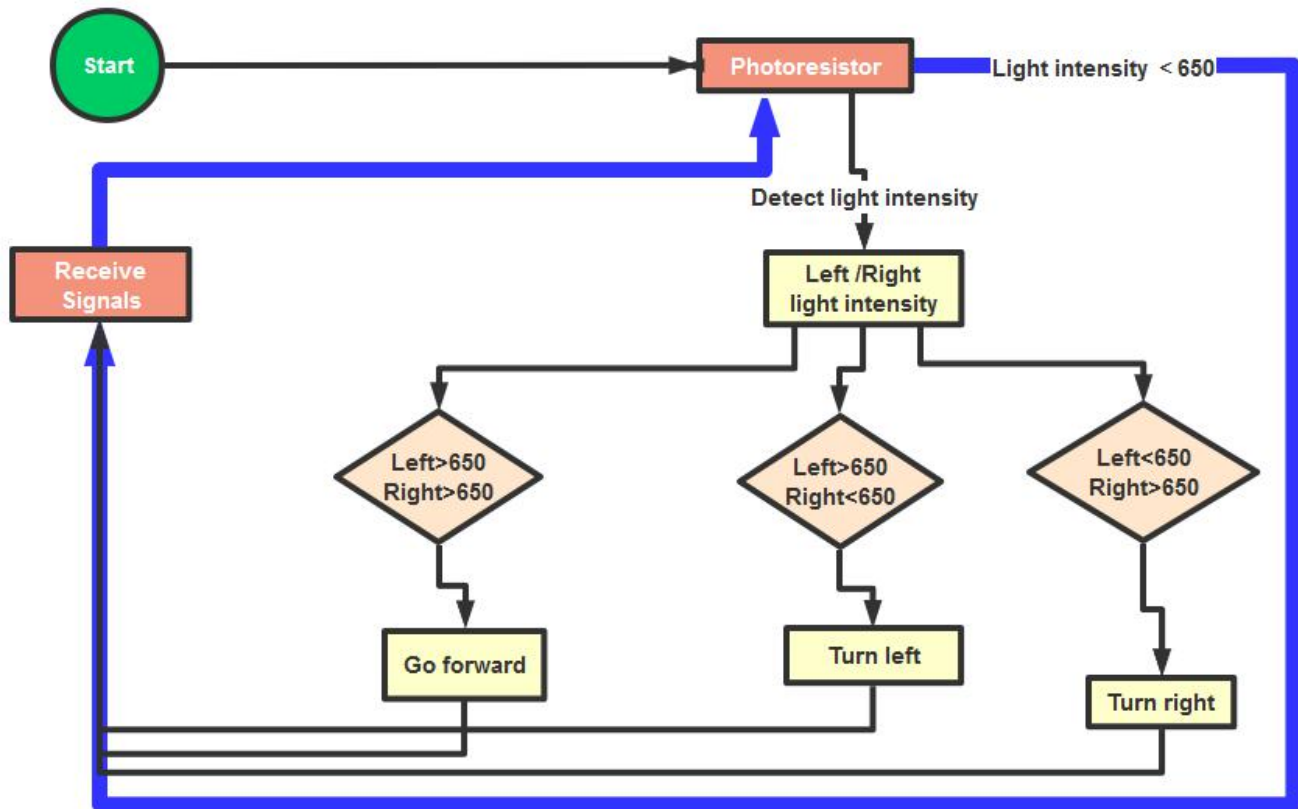


photoresistor module, motor driving, to build a light-following robot!

Just need to use 2 photoresistor modules to detect the light intensity at the both side of robot. Read the analog value to rotate the 2 motors, thus drive the tank robot run.

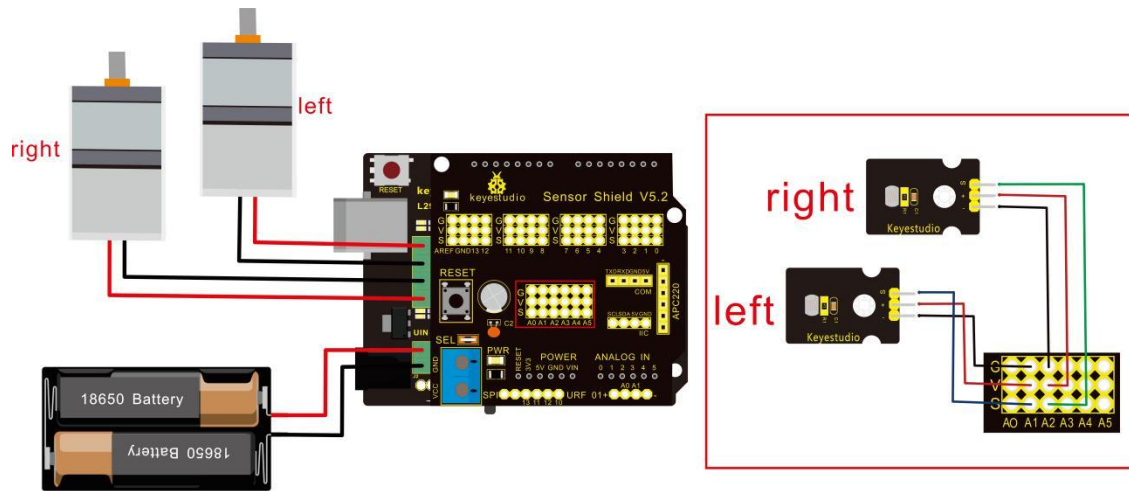
The specific logic of light following robot is shown as the table below:

Detection (the higher the brightness, the greater the value is)	Left photocell module	left_light
	Right photocell module	right_light
If	left_light > 650 and right_light > 650	
Status	Go forward (PWM set to 200)	
If	left_light > 650 and right_light ≤ 650	
Status	Rotate to left (PWM set to 200)	
If	left_light ≤ 650 and right_light > 650	
Status	Rotate to right (PWM set to 200)	
If	left_light ≤ 650 and right_light ≤ 650	
Status	stop	



We make a flow chart based on the above logic table, as shown below:

(2) Connection Diagram



Attention:

The 4Pin terminal block is marked with silkscreen 1234. The red line of right rear motor is connected to terminal 1, black line is linked with end 2. The red line of left front motor is attached to terminal 3, black line is linked with port 4.

Left photo resistor		Sensor Shield
-	→	G (GND)
+	→	V (VCC)
S	→	A1
Right	Photo	Sensor Shield



resistor		
-	→	G (GND)
+	→	V (VCC)
S	→	A2

(3) Test Code

```
/*
```

```
keyestudio Mini Tank Robot v2.0
```

```
lesson 10
```

```
Light-following tank
```

```
http://www.keyestudio.com
```

```
*/
```

```
#define light_L_Pin A1    //define the pin of left photo resistor
```

```
#define light_R_Pin A2    //define the pin of right photo resistor
```

```
#define ML_Ctrl 13    //define the direction control pin of left motor
```

```
#define ML_PWM 11    //define the PWM control pin of left motor
```

```
#define MR_Ctrl 12    //define the direction control pin of right  
motor
```

```
#define MR_PWM 3    //define the PWM control pin of right motor
```

```
int left_light;
```

```
int right_light;
```

```
void setup(){
```



```
Serial.begin(9600);

pinMode(light_L_Pin, INPUT);

pinMode(light_R_Pin, INPUT);

pinMode(ML_Ctrl, OUTPUT);

pinMode(ML_PWM, OUTPUT);

pinMode(MR_Ctrl, OUTPUT);

pinMode(MR_PWM, OUTPUT);

}

void loop(){

    left_light = analogRead(light_L_Pin);
    right_light = analogRead(light_R_Pin);
    Serial.print("left_light_value = ");
    Serial.println(left_light);
    Serial.print("right_light_value = ");
    Serial.println(right_light);
    if (left_light > 650 && right_light > 650) //the value detected
photo resistor, go front
    {
        Car_front();
    }
    else if (left_light > 650 && right_light <= 650) //the value
detected photo resistor, turn left
    {
```



```
    Car_left();

}

    else if (left_light <= 650 && right_light > 650) //the value
detected photo resistor, turn right

    {

        Car_right();

    }

    else //other situations, stop

    {

        Car_Stop();

    }

}

void Car_front()

{

    digitalWrite(MR_Ctrl,LOW);
    analogWrite(MR_PWM,200);
    digitalWrite(ML_Ctrl,LOW);
    analogWrite(ML_PWM,200);

}

void Car_left()

{

    digitalWrite(MR_Ctrl,LOW);
    analogWrite(MR_PWM,200);
```



```
    digitalWrite(ML_Ctrl,HIGH);  
    analogWrite(ML_PWM,200);  
}  
  
void Car_right()  
{  
    digitalWrite(MR_Ctrl,HIGH);  
    analogWrite(MR_PWM,200);  
    digitalWrite(ML_Ctrl,LOW);  
    analogWrite(ML_PWM,200);  
}  
  
void Car_Stop()  
{  
    digitalWrite(MR_Ctrl,LOW);  
    analogWrite(MR_PWM,0);  
    digitalWrite(ML_Ctrl,LOW);  
    analogWrite(ML_PWM,0);  
}  
  
//*****
```

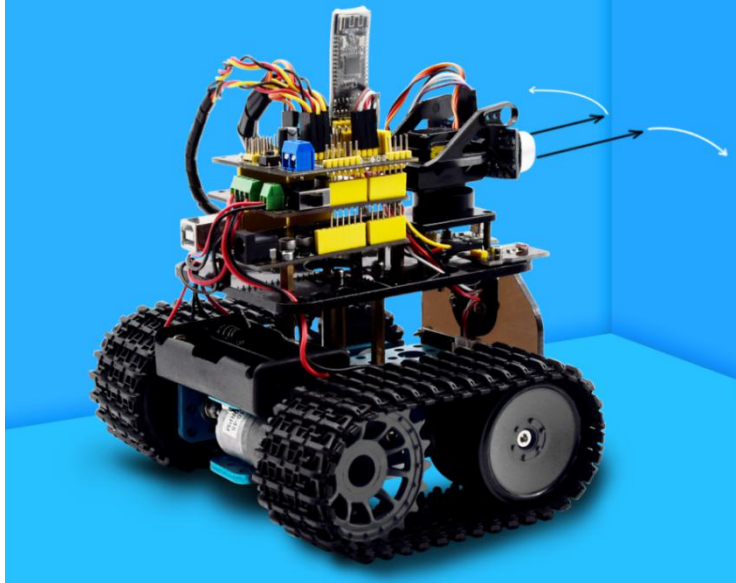
(4) Test Result

Upload code on keyestudio V4.0 development board, DIP switch is dialed to right end and power on, the smart robot follows light to



move.

Project 11: Ultrasonic Avoid Tank



(1) Description

In this program, the ultrasonic sensor detects the distance of obstacle to send signals that control the robot car. Next, let's show you how to make an obstacle avoidance car.

The specific logic of ultrasonic avoiding robot is as shown below:

Detection	measured distance of front obstacle (servo a (unit: cm) angle 90°)
-----------	--

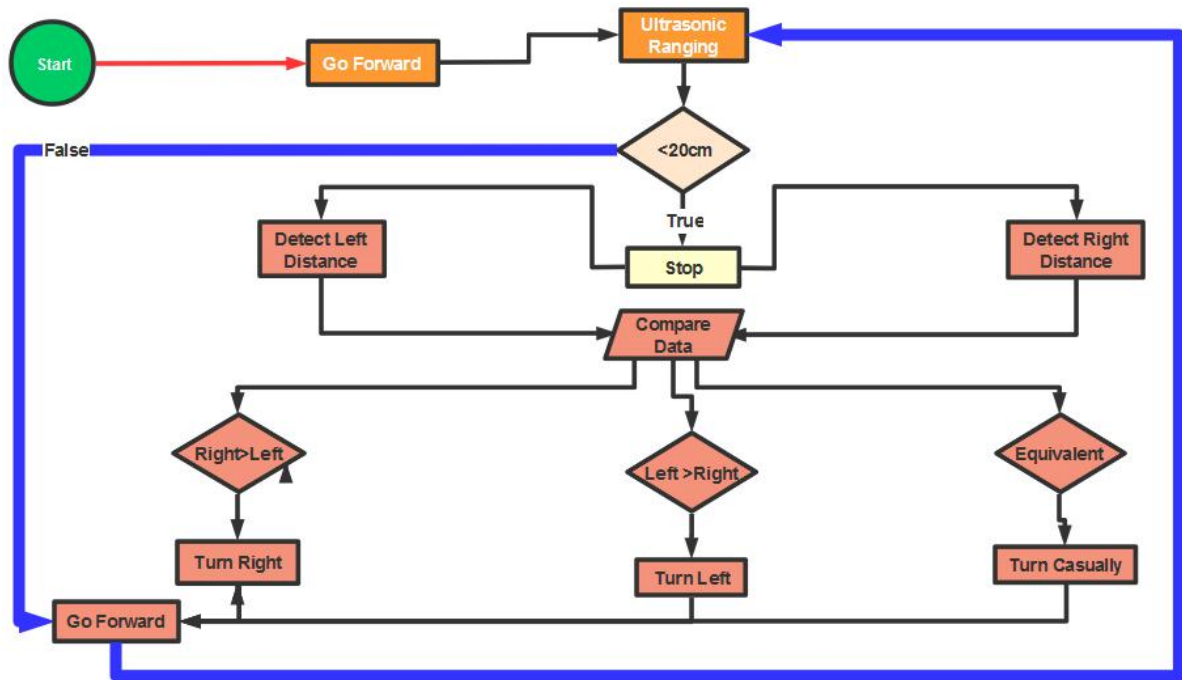


	measured distance of right obstacle (servo angle 20°)		a2 (unit: cm)
	measured distance of left obstacle (servo angle 160°)		a1 (unit: cm)
Settings	Servo initial angle 90°		
Condition 1	State		
a < 20	Stop 1 second; set the servo angle to 160°, reading a1, delay 500ms; set the servo angle to 20°, reading a2, delay 500ms;		
	Condition 2	State	
	a1 < 50 Or a2 < 50	Compare a1 and a2	
		Condition 3	State
		a1 > a2	Set the servo to 90°, rotate to left (PWM set to 255) for 0.5s, go front (PWM set to 200)

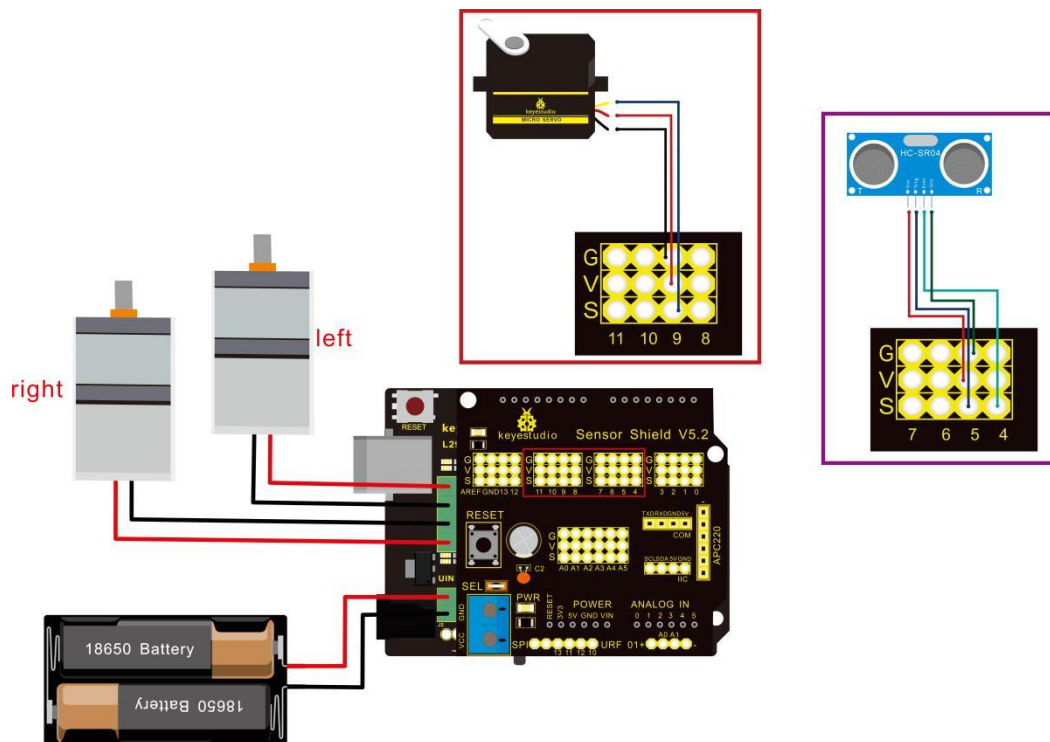


		$a1 < a2$	Set the servo to 90 ° , rotate to right (PWM set to 255) for 0.5s, go front (PWM set to 200)
	Condi on 2	State	
	$a1 \geq 50$ Or $a2 \geq 50$	Random	Set the servo to 90 ° , rotate to left (PWM set to 255) for 0.5s, go front (PWM set to 200)
			Set the servo to 90 ° , rotate to right (PWM set to 255) for 0.5s, go front (PWM set to 200)
Condition 1	State		
$a \geq 20$	go front (PWM set to 200)		

(2) Flow chart



(3) Connection Diagram:





Note: “-” 、 “+” and “S” pins of servo are respectively attached to G (GND) , V (VCC) and D9 of expansion board. The VCC, Trig, Echo and Gnd of ultrasonic sensor are linked with 5v(V), 5(S), Echo and Gnd(G) of expansion board.

(4) Test Code:

```
/*  
keyestudio Mini Tank Robot v2.0  
lesson 11  
ultrasonic_avoid_tank  
http://www.keyestudio.com  
*/  
  
int random2;  
  
int a;  
  
int a1;  
  
int a2;  
  
#define ML_Ctrl 13 //define the direction control pin of left motor  
#define ML_PWM 11 //define PWM control pin of left motor  
#define MR_Ctrl 12 //define the direction control pin of right  
motor  
#define MR_PWM 3 //define PWM control pin of right motor
```



```
#define Trig 5 //ultrasonic trig Pin

#define Echo 4 //ultrasonic echo Pin

int distance;

#define servoPin 9 //servo Pin

int pulsewidth;

/*****the function to run motor*****/

void Car_front()

{

    digitalWrite(MR_Ctrl,LOW);

    analogWrite(MR_PWM,200);

    digitalWrite(ML_Ctrl,LOW);

    analogWrite(ML_PWM,200);

}

void Car_back()

{

    digitalWrite(MR_Ctrl,HIGH);

    analogWrite(MR_PWM,200);

    digitalWrite(ML_Ctrl,HIGH);

    analogWrite(ML_PWM,200);

}

void Car_left()

{

    digitalWrite(MR_Ctrl,LOW);
```



```
    analogWrite(MR_PWM,255);  
    digitalWrite(ML_Ctrl,HIGH);  
    analogWrite(ML_PWM,255);  
}  
  
void Car_right()  
{  
    digitalWrite(MR_Ctrl,HIGH);  
    analogWrite(MR_PWM,255);  
    digitalWrite(ML_Ctrl,LOW);  
    analogWrite(ML_PWM,255);  
}  
  
void Car_Stop()  
{  
    digitalWrite(MR_Ctrl,LOW);  
    analogWrite(MR_PWM,0);  
    digitalWrite(ML_Ctrl,LOW);  
    analogWrite(ML_PWM,0);  
}  
  
//The function to control servo  
void procedure(int myangle) {  
    for (int i = 0; i <= 50; i = i + (1)) {  
        pulsewidth = myangle * 11 + 500;
```



```
    digitalWrite(servoPin,HIGH);

    delayMicroseconds(pulsewidth);

    digitalWrite(servoPin,LOW);

    delay((20 - pulsewidth / 1000));

}

}

//The function to control ultrasonic sensor
float checkdistance() {
    digitalWrite(Trig, LOW);
    delayMicroseconds(2);
    digitalWrite(Trig, HIGH);
    delayMicroseconds(10);
    digitalWrite(Trig, LOW);

    float distance = pulseIn(Echo, HIGH) / 58.00;    //58.20, that is,
2*29.1=58.2

    delay(10);

    return distance;
}

//*****

void setup(){
    pinMode(servoPin, OUTPUT);

    procedure(90); //set servo to 90°
```



```
pinMode(Trig, OUTPUT);

pinMode(Echo, INPUT);

pinMode(ML_Ctrl, OUTPUT);

pinMode(ML_PWM, OUTPUT);

pinMode(MR_Ctrl, OUTPUT);

pinMode(MR_PWM, OUTPUT);

}

void loop(){

    random2 = random(1, 100);

    a = checkdistance();    //assign the front distance detected by
ultrasonic sensor to variable a

    if (a < 20) //when the front distance detected is less than 20
    {

        Car_Stop(); //robot stops

        delay(500); //delay in 500ms

        procedure(160); //Ultrasonic platform turns left

        for (int j = 1; j <= 10; j = j + (1)) { //for statement, the data will
be more accurate if ultrasonic sensor detect a few times.

            a1 = checkdistance(); //assign the left distance detected
by ultrasonic sensor to variable a1

        }

        delay(300);
```



```
procedure(20); //Ultrasonic platform turns right
for (int k = 1; k <= 10; k = k + (1)) {
    a2 = checkdistance(); //assign the right distance detected
    by ultrasonic sensor to variable a2
}

if (a1 < 50 || a2 < 50) //robot will turn to the longer distance
side when left or right distance is less than 50cm.
{
    if (a1 > a2) //left distance is greater than right side
    {
        procedure(90); //Ultrasonic platform turns back to right
        ahead
        Car_left(); //robot turns left
        delay(500); //turn left for 500ms
        Car_front(); //go front
    }
    else
    {
        procedure(90);
        Car_right(); //robot turns right
        delay(500);
        Car_front(); //go front
    }
}
```




```
    }  
  }  
  else //If both side is greater than or equal to 50cm, turn left  
or right randomly  
  {  
    if ((long) (random2) % (long) (2) == 0) //When the  
random number is even  
    {  
      procedure(90);  
      Car_left(); //tank robot turns left  
      delay(500);  
      Car_front(); //go front  
    }  
    else  
    {  
      procedure(90);  
      Car_right(); //robot turns right  
      delay(500);  
      Car_front(); //go front  
    }  
  }  
}  
  
else //If the front distance is greater than or equal to 20cm,
```



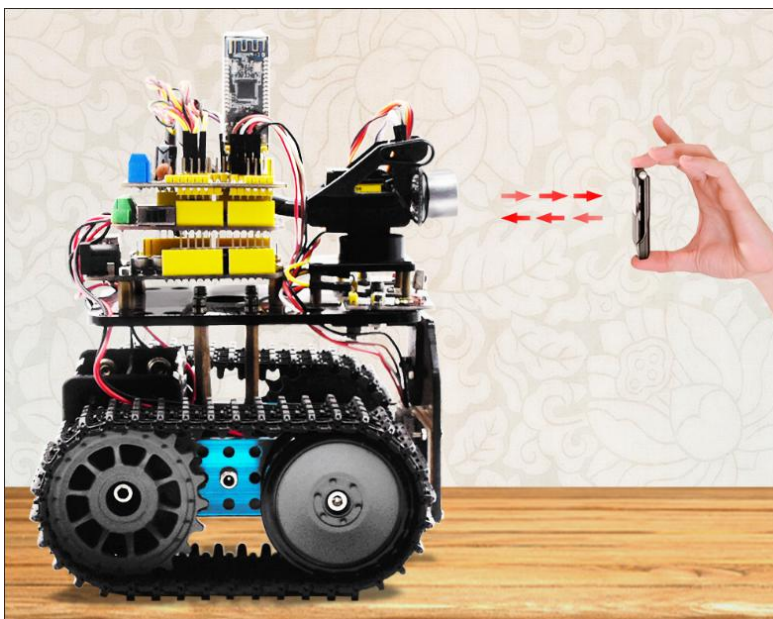
robot car will go front

```
{  
    Car_front(); //go front  
}  
}  
  
//*****
```

(5) Test Result

Upload code successfully, DIP switch is dialed to right end and power on, tank robot goes forward and automatically avoids the obstacle.

Project 12: Ultrasonic Follow Tank





(1) Description

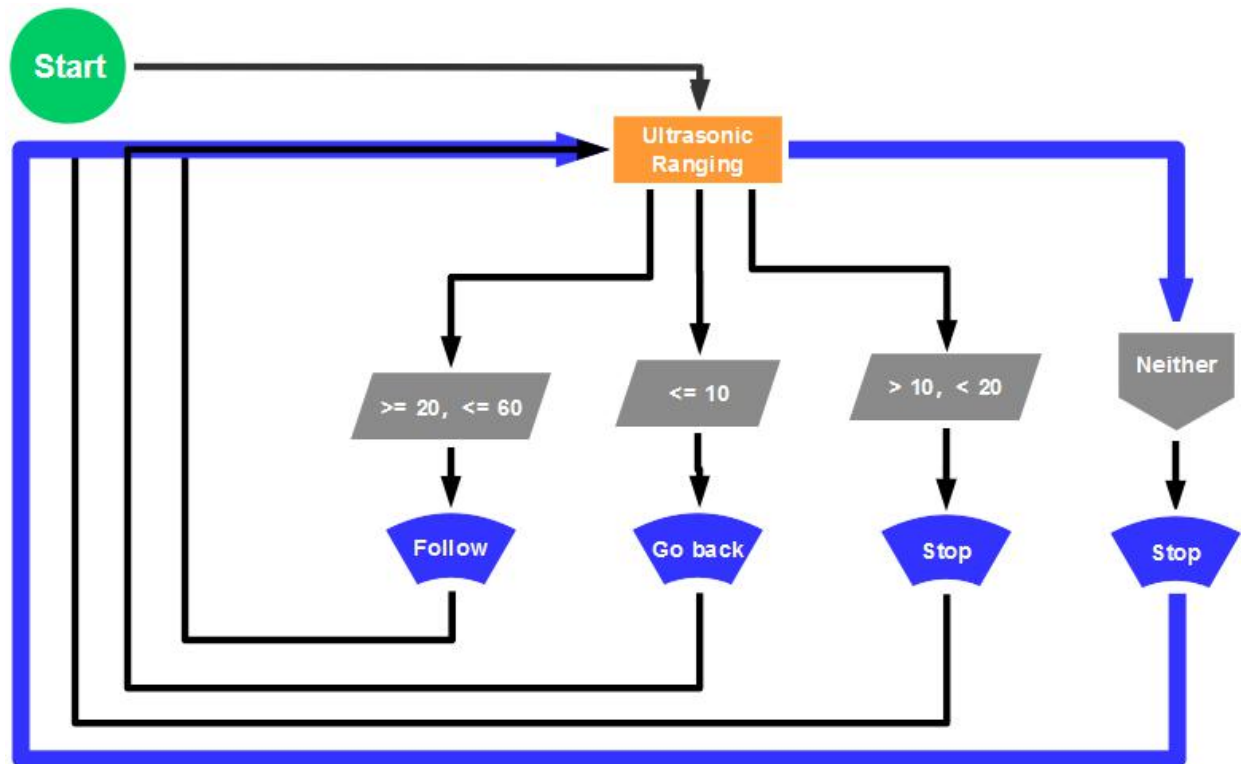
In project 11, we made an obstacle avoidance car. In fact, we only need to alter a test code to transform an obstacle avoidance car into following car. In this lesson, we will make an ultrasonic follow robot. The ultrasonic sensor detects the distance between smart car and the obstacle to drive tank car to move.

The specific logic of ultrasonic follow robot is as shown below:

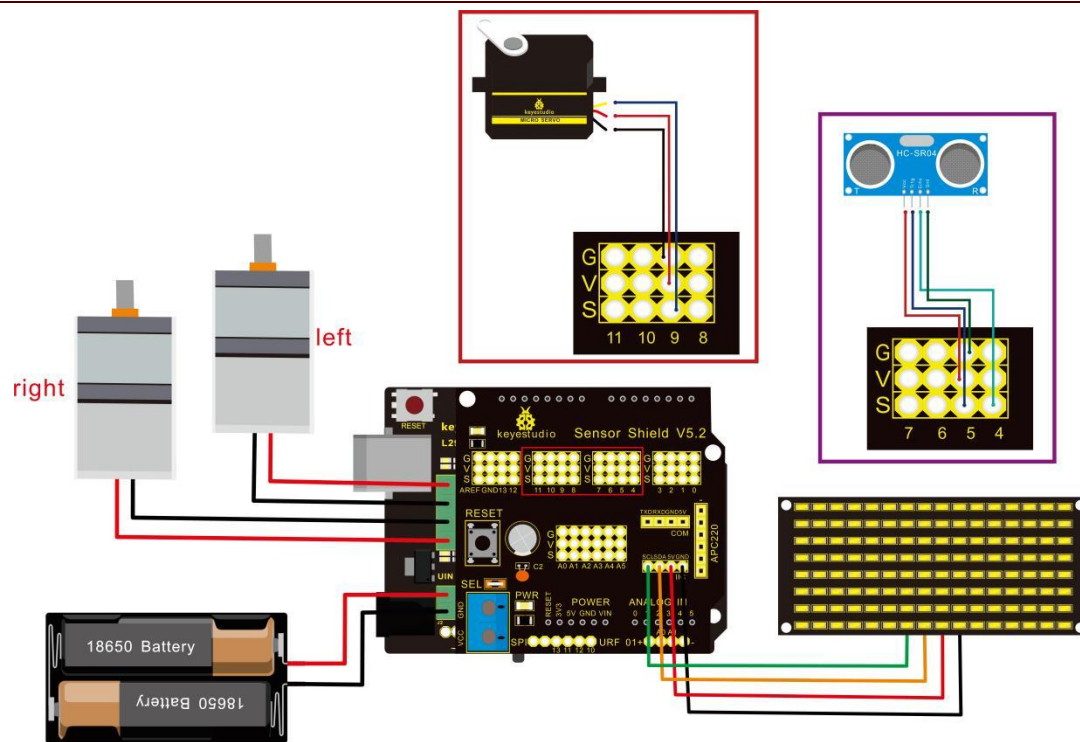
Detection	Measured distance of front obstacles	Distance (unit: cm)
Settings	Servo angle 90°	
	8X16 LED panel shows the icon "V"	
If	$20 \leq \text{distance} \leq 60$	
Status	Go front (set PWM to 200)	
If	$10 < \text{distance} < 20$	
	$\text{distance} > 60$	
Status	stop	
If	$\text{distance} \leq 10$	
Status	Stop (set PWM to 200)	



(2) Flow chart



(3) Connection Diagram



Wire-up note:

1.8x16 LED panel		V5 Sensor Shield
GND	→	- (GND)
VCC	→	+ (VCC)
SDA	→	SDA
SCL	→	SCL

(4) Test Code

/*

keyestudio Mini Tank Robot v2.0

lesson 12

ultrasonic follow tank



<http://www.keyestudio.com>

*/

//Array, used to store the data of the pattern, can be calculated by yourself or obtained from the modulus tool

```
unsigned          char          start01[]          =  
{0x01,0x02,0x04,0x08,0x10,0x20,0x40,0x80,0x80,0x40,0x20,0x10,0x  
08,0x04,0x02,0x01};
```

```
unsigned          char          front[]          =  
{0x00,0x00,0x00,0x00,0x00,0x24,0x12,0x09,0x12,0x24,0x00,0x00,0x  
00,0x00,0x00,0x00};
```

```
unsigned          char          back[]          =  
{0x00,0x00,0x00,0x00,0x00,0x24,0x48,0x90,0x48,0x24,0x00,0x00,0x  
00,0x00,0x00,0x00};
```

```
unsigned          char          left[]          =  
{0x00,0x00,0x00,0x00,0x00,0x00,0x44,0x28,0x10,0x44,0x28,0x10,0x  
44,0x28,0x10,0x00};
```

```
unsigned          char          right[]          =  
{0x00,0x10,0x28,0x44,0x10,0x28,0x44,0x10,0x28,0x44,0x00,0x00,0x  
00,0x00,0x00,0x00};
```

```
unsigned          char          STOP01[]          =  
{0x2E,0x2A,0x3A,0x00,0x02,0x3E,0x02,0x00,0x3E,0x22,0x3E,0x00,0x  
3E,0x0A,0x0E,0x00};
```

```
unsigned          char          clear[]          =
```



```
{0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00};
```

```
#define SCL_Pin  A5  //Set clock pin to A5
```

```
#define SDA_Pin  A4  //Set data pin to A4
```

```
#define ML_Ctrl 13  //define the direction control pin of left motor
```

```
#define ML_PWM 11  //define PWM control pin of left motor
```

```
#define MR_Ctrl 12  //define the direction control pin of right motor
```

```
#define MR_PWM 3  //define PWM control pin of right motor
```

```
#define Trig 5  //ultrasonic trig Pin
```

```
#define Echo 4  //ultrasonic echo Pin
```

```
int distance;
```

```
int pulsewidth;
```

```
#define servoPin 9  //servo Pin
```

```
void setup(){
```

```
    Serial.begin(9600);
```

```
    pinMode(SCL_Pin,OUTPUT);
```

```
    pinMode(SDA_Pin,OUTPUT);
```

```
    matrix_display(clear); //Clear the display
```

```
    matrix_display(start01); //display start pattern
```

```
    pinMode(servoPin, OUTPUT);
```



```
procedure(90); //set servo to 90°

pinMode(Trig, OUTPUT);

pinMode(Echo, INPUT);

pinMode(ML_Ctrl, OUTPUT);

pinMode(ML_PWM, OUTPUT);

pinMode(MR_Ctrl, OUTPUT);

pinMode(MR_PWM, OUTPUT);

}

void loop(){

    distance = checkdistance(); //assign the distance detected by
ultrasonic sensor to distance

    if (distance >= 20 && distance <= 60) //range to go front
    {

        Car_front();

    }

    else if (distance > 10 && distance < 20) //range to stop
    {

        Car_Stop();

    }

    else if (distance <= 10) //range to go back
    {

        Car_back();

    }
```




```
else //other situations, stop

{

    Car_Stop();

}

}

/*****the function for motor running*****/

void Car_front()

{

    digitalWrite(MR_Ctrl,LOW);
    analogWrite(MR_PWM,200);
    digitalWrite(ML_Ctrl,LOW);
    analogWrite(ML_PWM,200);

}

void Car_back()

{

    digitalWrite(MR_Ctrl,HIGH);
    analogWrite(MR_PWM,200);
    digitalWrite(ML_Ctrl,HIGH);
    analogWrite(ML_PWM,200);

}

void Car_left()

{

    digitalWrite(MR_Ctrl,LOW);
```



```
    analogWrite(MR_PWM,200);

    digitalWrite(ML_Ctrl,HIGH);

    analogWrite(ML_PWM,200);

}

void Car_right()

{

    digitalWrite(MR_Ctrl,HIGH);

    analogWrite(MR_PWM,200);

    digitalWrite(ML_Ctrl,LOW);

    analogWrite(ML_PWM,200);

}

void Car_Stop()

{

    digitalWrite(MR_Ctrl,LOW);

    analogWrite(MR_PWM,0);

    digitalWrite(ML_Ctrl,LOW);

    analogWrite(ML_PWM,0);

}

/*****dot matrix*****/

// the function for dot matrix display

void matrix_display(unsigned char matrix_value[])

{
```



```
IIC_start(); // call the function that data transmission start

IIC_send(0xc0); //Choose address

for(int i = 0;i < 16;i++) //pattern data has 16 bits
{
    IIC_send(matrix_value[i]); //data to convey patterns
}

IIC_end(); //end to convey data pattern

IIC_start();
IIC_send(0x8A); //select pulse width4/16, control display
IIC_end();
}

//The condition starting to transmit data
void IIC_start()
{
    digitalWrite(SCL_Pin,HIGH);
    delayMicroseconds(3);
    digitalWrite(SDA_Pin,HIGH);
    delayMicroseconds(3);
    digitalWrite(SDA_Pin,LOW);
```



```
    delayMicroseconds(3);  
}  
  
// transmit data  
void IIC_send(unsigned char send_data)  
{  
    for(char i = 0;i < 8;i++) //Each byte has 8 bits  
    {  
        digitalWrite(SCL_Pin,LOW); //pull down clock pin SCL Pin  
to change the signals of SDA  
        delayMicroseconds(3);  
        if(send_data & 0x01) //set high and low level of SDA_Pin  
according to 1 or 0 of every bit  
        {  
            digitalWrite(SDA_Pin,HIGH);  
        }  
        else  
        {  
            digitalWrite(SDA_Pin,LOW);  
        }  
        delayMicroseconds(3);  
        digitalWrite(SCL_Pin,HIGH); //pull up clock pin SCL_Pin to  
stop transmitting data
```



```
        delayMicroseconds(3);

        send_data = send_data >> 1;  // detect bit by bit, so move
the data right by one

    }

}

//The sign that data transmission ends
void IIC_end()
{
    digitalWrite(SCL_Pin,LOW);
    delayMicroseconds(3);
    digitalWrite(SDA_Pin,LOW);
    delayMicroseconds(3);
    digitalWrite(SCL_Pin,HIGH);
    delayMicroseconds(3);
    digitalWrite(SDA_Pin,HIGH);
    delayMicroseconds(3);
}

/*****end dot matrix display*****/

//The function to control servo
void procedure(int myangle) {
    for (int i = 0; i <= 50; i = i + (1)) {
        pulsewidth = myangle * 11 + 500;
        digitalWrite(servoPin,HIGH);
```



```
    delayMicroseconds(pulsewidth);

    digitalWrite(servoPin, LOW);

    delay((20 - pulsewidth / 1000));

  }}

//The function to control ultrasonic sensor function controlling
ultrasonic

float checkdistance() {
    digitalWrite(Trig, LOW);
    delayMicroseconds(2);
    digitalWrite(Trig, HIGH);
    delayMicroseconds(10);
    digitalWrite(Trig, LOW);

    float distance = pulseIn(Echo, HIGH) / 58.20; //58.20, that is ,
2*29.1=58.2

    delay(10);

    return distance;

}

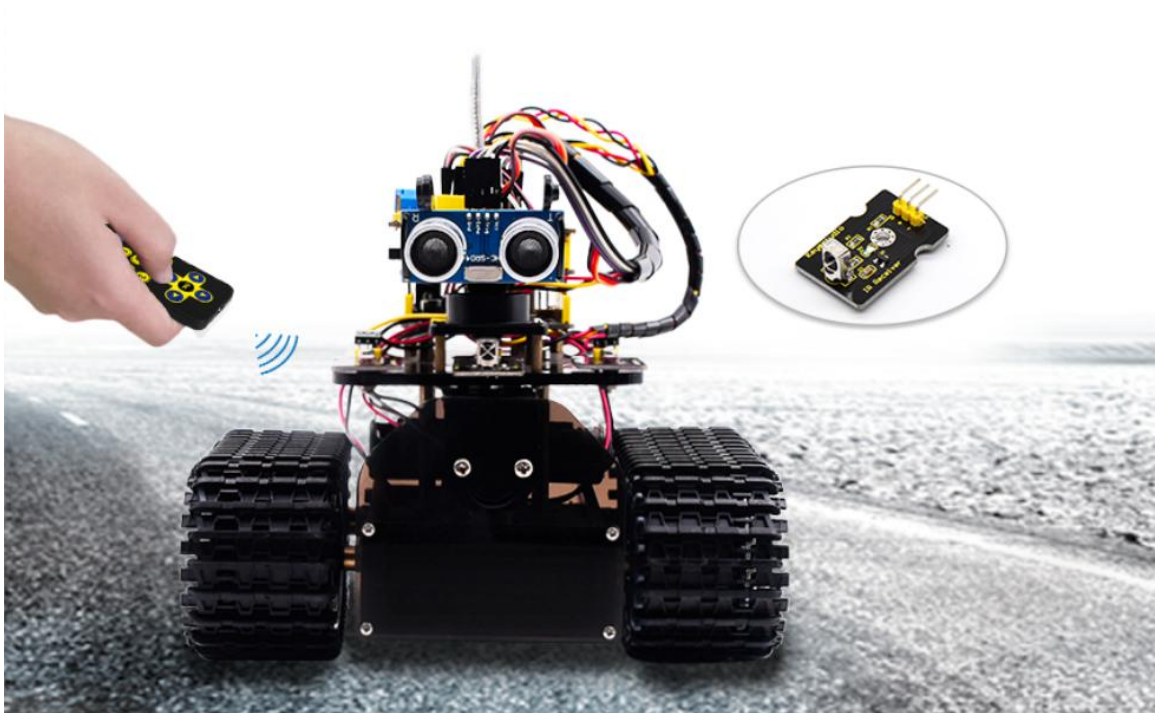
//*****
```

(5) Test Result

Upload code successfully, DIP switch is dialed to right end, the servo rotates to 90°, "V" is shown on 8X16 LED panel and smart car moves as the obstacle moves.



Project 13: IR Remote Robot Tank










(1) Description

IR remote control is one of most ubiquitous control, applied in TV, electric fan and some household appliances. In this project, we will make an IR remote smart car. And we' ve known every key value on IR remote control. Thus, we could control smart car via and display the patterns on dot matrix via corresponding key value

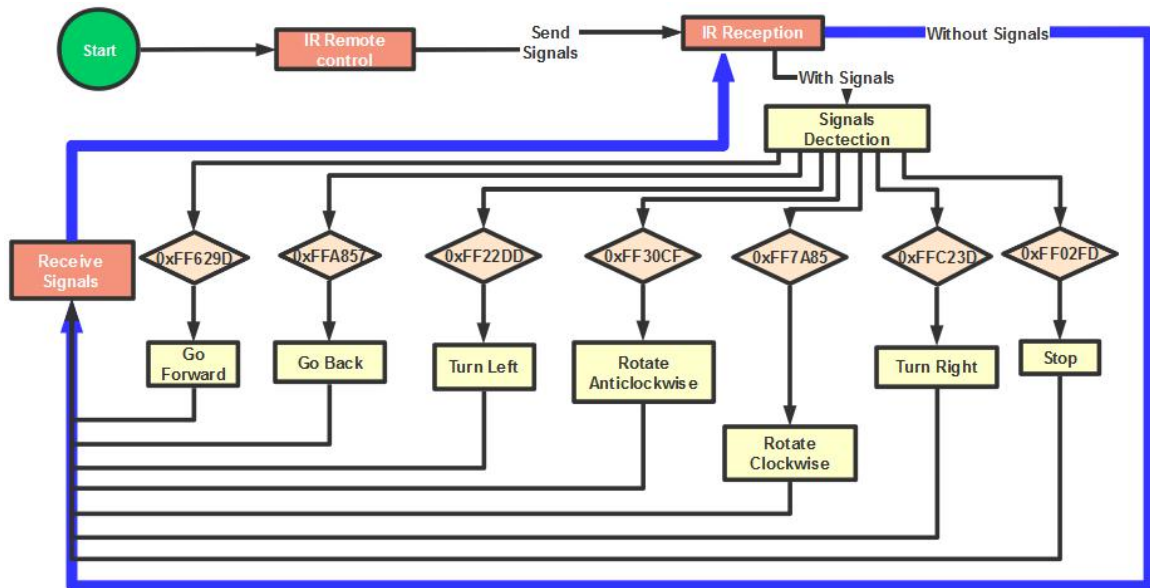
The specific logic of infrared remote control robot is shown below:

Initial setup	Servo angle 90°
---------------	-----------------

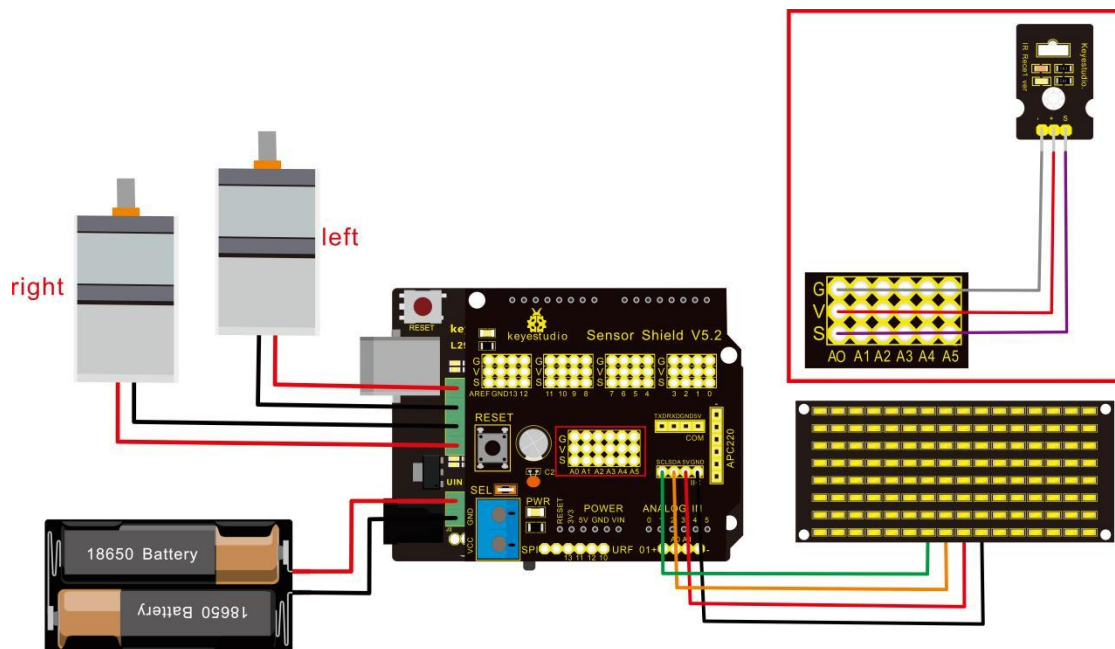


	8X16 LED matrix panel shows an icon "V"	
Remote control	Key value	Key state
	FF629D	Go front (PWM set to 200)
		8X16 LED panel shows front icon
	FFA857	Go back (PWM set to 200)
		8X16 LED panel shows back icon
	FF22DD	Turn left
		8X16 LED panel shows leftward icon
	FFC23D	Turn right
		8X16 LED panel shows rightward icon
	FF02FD	Stop
		8X16 LED panel shows "STOP"
	FF30CF	Rotate to left (PWM set to 200)
		8X16 LED panel shows leftward icon
	FF7A85	Rotate to right (PWM set to 200)
		8X16 LED panel shows rightward icon

(2) Flow Chart



(3) Connection Diagram



Attention: GND,VCC, SDA, SCL of 8x16 LED panel are respectively linked with - (GND), + (VCC), SDA ,SCL. And "-", "+" and S of IR receiver module are attached to G (GND), V (VCC) and A0 on sensor shield. On the condition of insufficient digital ports, the analog ports can be treat as digital ports. A0 equals to digital 14, A1



is like digital 15.

(4) Test Code

```
/*  
  
keyestudio Mini Tank Robot v2.0  
  
lesson 13  
  
IR remote tank  
  
http://www.keyestudio.com  
  
*/  
  
#include <IRremoteTank.h>  
  
IRrecv irrecv(A0); //set IRrecv irrecv to A0  
decode_results results;  
  
long ir_rec; //save the IR value received  
  
//Array, used to store the data of the pattern, can be calculated by  
yourself or obtained from the modulus tool  
  
unsigned char start01[] =  
{0x01,0x02,0x04,0x08,0x10,0x20,0x40,0x80,0x80,0x40,0x20,0x10,0x08,  
0x04,0x02,0x01};  
  
unsigned char front[] =  
{0x00,0x00,0x00,0x00,0x00,0x24,0x12,0x09,0x12,0x24,0x00,0x00,0x00,  
0x00,0x00,0x00};
```



```
unsigned          char          back[]          =
{0x00,0x00,0x00,0x00,0x00,0x24,0x48,0x90,0x48,0x24,0x00,0x00,0x00,
0x00,0x00,0x00};

unsigned          char          left[]           =
{0x00,0x00,0x00,0x00,0x00,0x00,0x44,0x28,0x10,0x44,0x28,0x10,0x44,
0x28,0x10,0x00};

unsigned          char          right[]          =
{0x00,0x10,0x28,0x44,0x10,0x28,0x44,0x10,0x28,0x44,0x00,0x00,0x00,
0x00,0x00,0x00};

unsigned          char          STOP01[]         =
{0x2E,0x2A,0x3A,0x00,0x02,0x3E,0x02,0x00,0x3E,0x22,0x3E,0x00,0x3E,
0x0A,0x0E,0x00};

unsigned          char          clear[]          =
{0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,
0x00,0x00,0x00};

#define SCL_Pin   A5   //Set clock pin to A5

#define SDA_Pin   A4   //Set data pin to A4


#define ML_Ctrl 13   //define the direction control pin of left motor
#define ML_PWM 11    //define PWM control pin of left motor
#define MR_Ctrl 12   //define the direction control pin of right motor
#define MR_PWM 3     //define PWM control pin of right motor
```



```
#define servoPin 9 //pin of servo

int pulsewidth; //save the pulse width value of servo

void setup(){
    Serial.begin(9600);

    irrecv.enableIRIn(); //Initialize the IR reception library

    pinMode(ML_Ctrl, OUTPUT);
    pinMode(ML_PWM, OUTPUT);
    pinMode(MR_Ctrl, OUTPUT);
    pinMode(MR_PWM, OUTPUT);

    pinMode(SCL_Pin,OUTPUT);
    pinMode(SDA_Pin,OUTPUT);
    matrix_display(clear); //Clear Screen
    matrix_display(start01); //show start picture

    pinMode(servoPin, OUTPUT);
    procedure(90); //Servo rotates to 90°
}

void loop(){
    if (irrecv.decode(&results)) //receive the IR remote value
```



```
{  
    ir_rec=results.value;  
  
    String type="UNKNOWN";  
  
    String typelist[14]={"UNKNOWN", "NEC", "SONY", "RC5", "RC6",  
"DISH", "SHARP", "PANASONIC", "JVC", "SANYO", "MITSUBISHI",  
"SAMSUNG", "LG", "WHYENTER"};  
  
    if(results.decode_type>=1&&results.decode_type<=13){  
        type=typelist[results.decode_type];  
    }  
  
    Serial.print("IR TYPE:"+type+" ");  
  
    Serial.println(ir_rec,HEX);  
  
    irrecv.resume();  
}  
  
  
if (ir_rec == 0xFF629D) //Go forward  
{  
    Car_front();  
    matrix_display(front); //Display front image  
}  
  
if (ir_rec == 0xFFA857) //Robot car goes back  
{  
    Car_back();  
    matrix_display(front); //Go back
```



```
}  
  
if (ir_rec == 0xFF22DD)    //Robot car turns left  
{  
    Car_T_left();  
    matrix_display(left); //Display left-turning image  
}  
  
if (ir_rec == 0xFFC23D)    //Robot car turns right  
{  
    Car_T_right();  
    matrix_display(right); //Display right-turning image  
}  
  
if (ir_rec == 0xFF02FD)    //Robot car stops  
{  
    Car_Stop();  
    matrix_display(STOP01); //show stop image  
}  
  
if (ir_rec == 0xFF30CF)    //robot car rotates anticlockwise  
{  
    Car_left();  
    matrix_display(left); //show anticlockwise rotation picture  
}  
  
if (ir_rec == 0xFF7A85)    //robot car rotates clockwise  
{
```



```
Car_right();

matrix_display(right); //show clockwise rotation picture

}

}

/*****Control Servo*****/

void procedure(int myangle) {

    for (int i = 0; i <= 50; i = i + (1)) {

        pulsewidth = myangle * 11 + 500;

        digitalWrite(servoPin,HIGH);

        delayMicroseconds(pulsewidth);

        digitalWrite(servoPin,LOW);

        delay((20 - pulsewidth / 1000));

    }

}

/*****Dot Matrix*****/

// this function is used for dot matrix display

void matrix_display(unsigned char matrix_value[])

{

    IIC_start();

    IIC_send(0xc0); //Choose address

    for(int i = 0;i < 16;i++) //The picture has 16 bits

    {
```



```
IIC_send(matrix_value[i]); //data to convey patterns

}

IIC_end();    //end to convey data pattern


IIC_start();

IIC_send(0x8A); //display control, set pulse width to 4/16

IIC_end();

}


//The condition starting to transmit data
void IIC_start()
{
    digitalWrite(SCL_Pin,HIGH);
    delayMicroseconds(3);
    digitalWrite(SDA_Pin,HIGH);
    delayMicroseconds(3);
    digitalWrite(SDA_Pin,LOW);
    delayMicroseconds(3);
}

//传输数据
void IIC_send(unsigned char send_data)
{
    for(char i = 0;i < 8;i++)    //Each byte has 8 bits 8bits for every
```




character

```
{  
    digitalWrite(SCL_Pin,LOW);    //pull down clock pin SCL Pin to  
change the signals of SDA  
    delayMicroseconds(3);  
    if(send_data & 0x01)    //set high and low level of SDA_Pin  
according to 1 or 0 of every bit  
    {  
        digitalWrite(SDA_Pin,HIGH);  
    }  
    else  
    {  
        digitalWrite(SDA_Pin,LOW);  
    }  
    delayMicroseconds(3);  
    digitalWrite(SCL_Pin,HIGH); //pull up clock pin SCL_Pin to stop  
transmitting data  
    delayMicroseconds(3);  
    send_data = send_data >> 1;    // detect bit by bit, so move the  
data right by one  
}  
}  
  
//The sign that data transmission ends
```



```
void IIC_end()
{
    digitalWrite(SCL_Pin,LOW);
    delayMicroseconds(3);
    digitalWrite(SDA_Pin,LOW);
    delayMicroseconds(3);
    digitalWrite(SCL_Pin,HIGH);
    delayMicroseconds(3);
    digitalWrite(SDA_Pin,HIGH);
    delayMicroseconds(3);
}

/*****the function to run motor*****/

void Car_front()
{
    digitalWrite(MR_Ctrl,LOW);
    analogWrite(MR_PWM,200);
    digitalWrite(ML_Ctrl,LOW);
    analogWrite(ML_PWM,200);
}

void Car_back()
{
    digitalWrite(MR_Ctrl,HIGH);
    analogWrite(MR_PWM,200);
```



```
    digitalWrite(ML_Ctrl,HIGH);

    analogWrite(ML_PWM,200);
}

void Car_left()
{
    digitalWrite(MR_Ctrl,LOW);
    analogWrite(MR_PWM,255);
    digitalWrite(ML_Ctrl,HIGH);
    analogWrite(ML_PWM,255);
}

void Car_right()
{
    digitalWrite(MR_Ctrl,HIGH);
    analogWrite(MR_PWM,255);
    digitalWrite(ML_Ctrl,LOW);
    analogWrite(ML_PWM,255);
}

void Car_Stop()
{
    digitalWrite(MR_Ctrl,LOW);
    analogWrite(MR_PWM,0);
    digitalWrite(ML_Ctrl,LOW);
    analogWrite(ML_PWM,0);
}
```



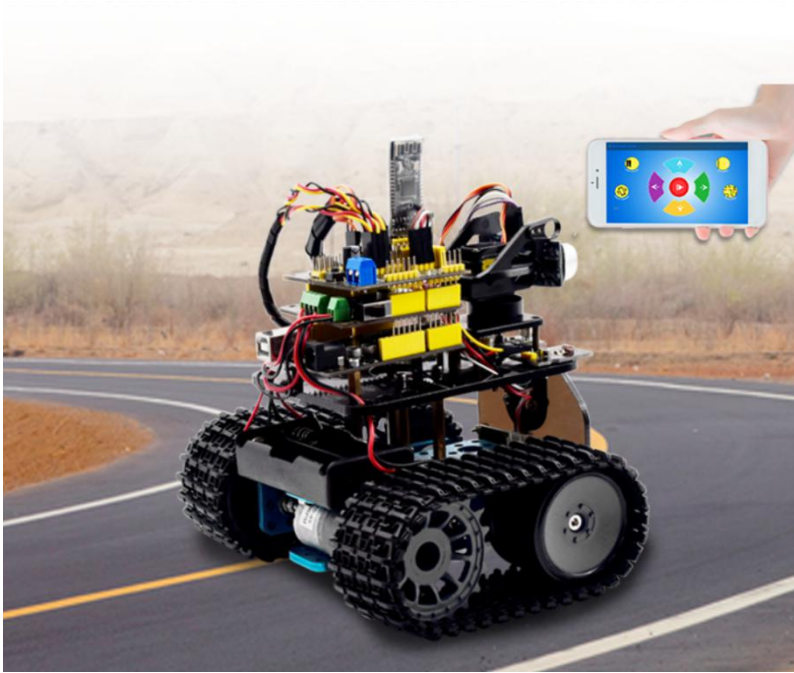
```
}  
  
void Car_T_left()  
{  
    digitalWrite(MR_Ctrl,LOW);  
    analogWrite(MR_PWM,255);  
    digitalWrite(ML_Ctrl,LOW);  
    analogWrite(ML_PWM,180);  
}  
  
void Car_T_right()  
{  
    digitalWrite(MR_Ctrl,LOW);  
    analogWrite(MR_PWM,180);  
    digitalWrite(ML_Ctrl,LOW);  
    analogWrite(ML_PWM,255);  
}  
  
//*****  
  
*****
```

(5) Test Result

Upload code successfully and power on, the smart robot can be controlled by IR remote, at same time, the corresponding pattern is shown on 8X16 LED panel.



Project 14: Bluetooth Control Robot

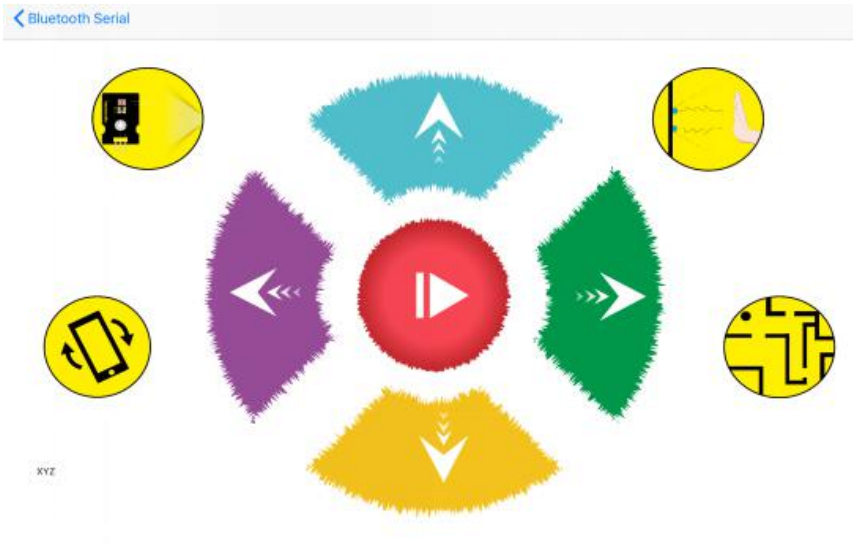


(1) Description

We' ve learned the basic knowledge of Bluetooth, in this lesson, we will make a Bluetooth remote smart car. In the experiment, we default the HM-10 Bluetooth module as a Slave and the cellphone as a Host.

keyes BT car is an APP rolled out by keyestudio team. You could control the robot car by it readily.

There is a guide to how to download and install APP in the document as for your reference. The interface is shown below.



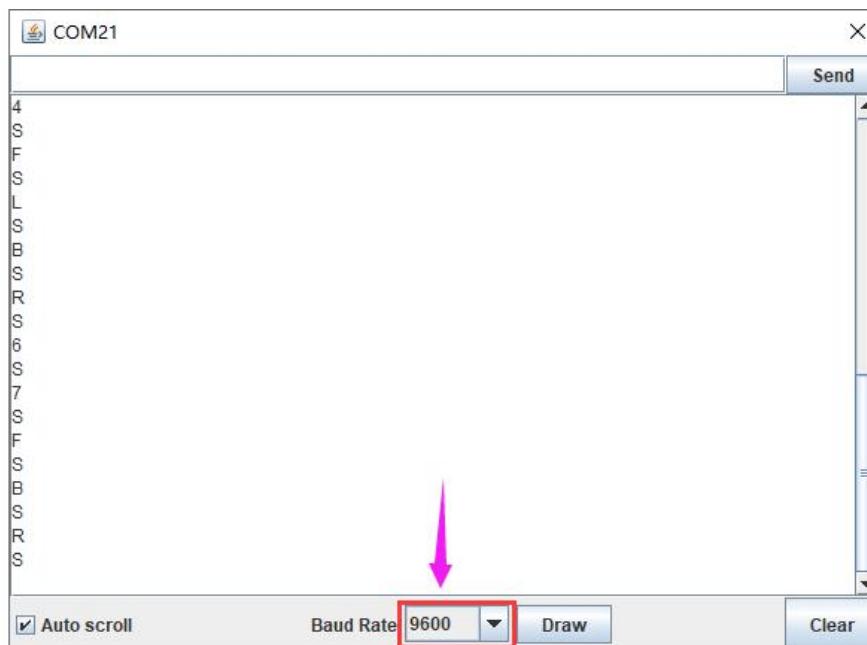
(2) Test Code

```
/*  
  keyestudio Mini Tank Robot v2.0  
  lesson 14.1  
  bluetooth test  
  http://www.keyestudio.com  
*/  
  
char ble_val; //character variables, used to save the value of  
Bluetooth reception  
  
void setup() {  
  Serial.begin(9600);  
}  
  
void loop() {  
  if(Serial.available() > 0) //judge if there is data in buffer area
```












```
{ ble_val = Serial.read(); //read the data from serial buffer  
  Serial.println(ble_val); //print out  
}  
//*****
```

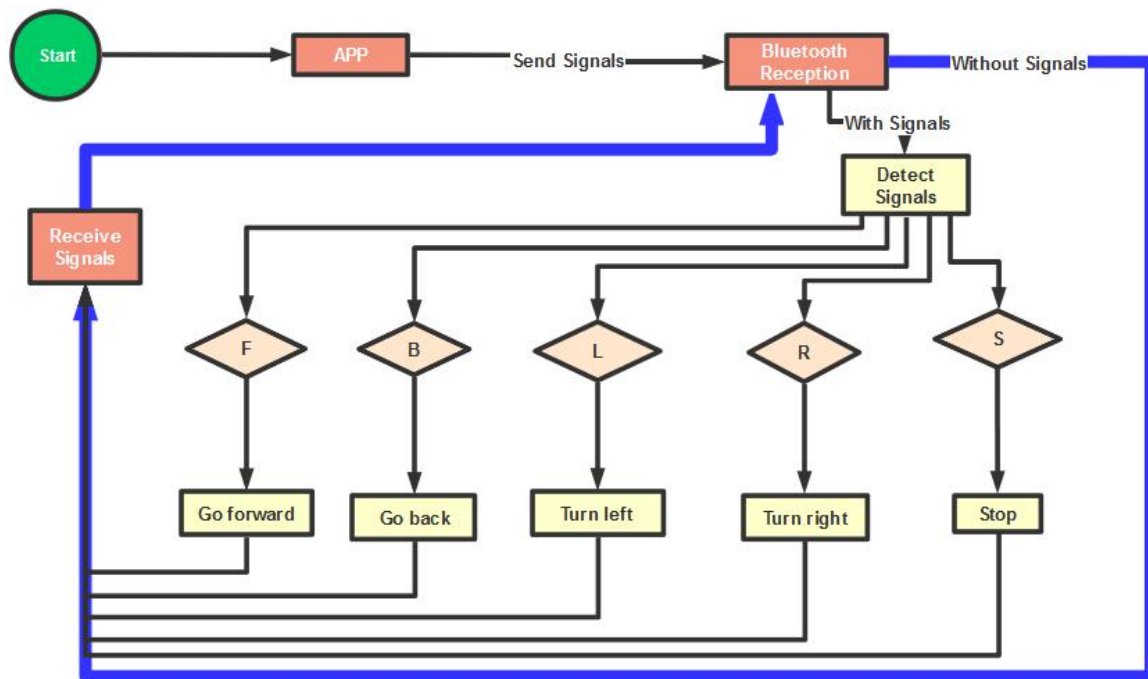
Pull off the Bluetooth module, upload test code, reconnect Bluetooth module, open serial monitor and set baud rate to 9600. Point at Bluetooth module and press keys on APP, the corresponding character is shown below.



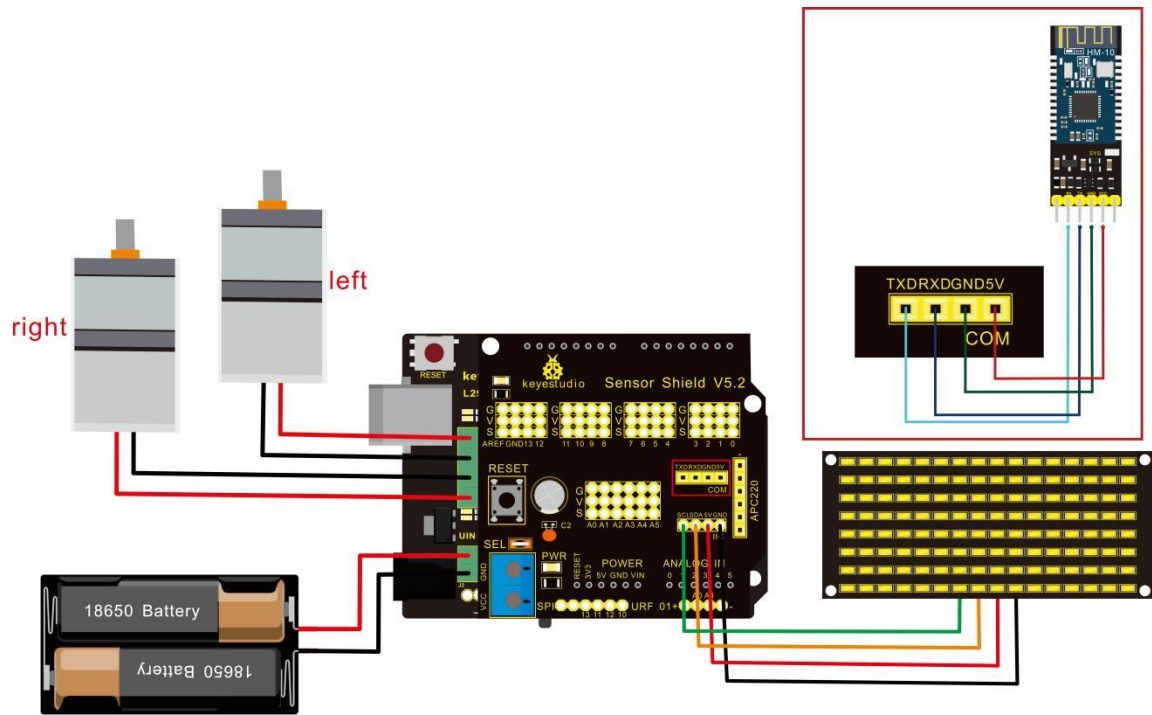
The detected character and corresponding function:



Icon	Control character	Function	Icon	Control character	Function	Icon	Control character	function
CONNECT	Pair and connect HM-10Bluetooth module		CONNECT	Pair and connect HM-10 Bluetooth module		DISCONNECT	Disconnect Bluetooth module	
	Press to send "F"; release to send "S"	Press and hold, car moves forward; release to stop		press to send "L"; release to send "S"	Car turns left; car stops		Click to send "S"	Car stops
	Press to send "B"; release to send "S"	Press and hold, car moves back; release to stop		click to send "R"; release to send "S"	Car turns right; car stops		Click to send "X"	Start light following function, click stop button to end
	Forward, back, left and right turning and more	Start gravitational induction function, click stop button to end		Click to send "Y"	Start ultrasonic following function, click stop button to end		Press to send "U"	Start obstacle avoidance function, click stop button to end



(3) Connection Diagram



Wiring Attention:

8x16 LED panel		Expansion Board
GND	→	- (GND)
VCC	→	+ (VCC)
SDA	→	SDA
SCL	→	SCL
Insert Bluetooth module vertically, you don' t need to attach to its STATE and BRK pins		



(4) Test Code

Note: Remove the Bluetooth module before uploading test code, otherwise, you will fail to upload test code.

```
/*  
keyestudio Robot Car v2.0  
lesson 14.2  
bluetooth car  
http://www.keyestudio.com  
*/  
  
//Array, used to store the data of pattern, can be calculated by  
yourself or obtained from the modulus tool  
unsigned          char          start01[]          =  
{0x01,0x02,0x04,0x08,0x10,0x20,0x40,0x80,0x80,0x40,0x20,0x10,0x  
08,0x04,0x02,0x01};  
unsigned          char          front[]            =  
{0x00,0x00,0x00,0x00,0x00,0x24,0x12,0x09,0x12,0x24,0x00,0x00,0x  
00,0x00,0x00,0x00};  
unsigned          char          back[]             =  
{0x00,0x00,0x00,0x00,0x00,0x24,0x48,0x90,0x48,0x24,0x00,0x00,0x  
00,0x00,0x00,0x00};
```



```
unsigned          char          left[]          =
{0x00,0x00,0x00,0x00,0x00,0x00,0x44,0x28,0x10,0x44,0x28,0x10,0x
44,0x28,0x10,0x00};

unsigned          char          right[]          =
{0x00,0x10,0x28,0x44,0x10,0x28,0x44,0x10,0x28,0x44,0x00,0x00,0x
00,0x00,0x00,0x00};

unsigned          char          STOP01[]          =
{0x2E,0x2A,0x3A,0x00,0x02,0x3E,0x02,0x00,0x3E,0x22,0x3E,0x00,0x
3E,0x0A,0x0E,0x00};

unsigned          char          clear[]          =
{0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x
00,0x00,0x00,0x00};

#define SCL_Pin   A5   //Set clock pin to A5
#define SDA_Pin   A4   //Set data pin to A4

#define ML_Ctrl 13   //define direction control pin of left motor
#define ML_PWM 11    //define PWM control pin of left motor
#define MR_Ctrl 12   //define direction control pin of right motor
#define MR_PWM 3     //define PWM control pin of right motor

char bluetooth_val; //save the value of Bluetooth reception

void setup(){
```



```
Serial.begin(9600);

pinMode(SCL_Pin,OUTPUT);
pinMode(SDA_Pin,OUTPUT);
matrix_display(clear);    //Clear the display
matrix_display(start01);  //display start pattern


pinMode(ML_Ctrl, OUTPUT);
pinMode(ML_PWM, OUTPUT);
pinMode(MR_Ctrl, OUTPUT);
pinMode(MR_PWM, OUTPUT);
}

void loop(){
  if (Serial.available())
  {
    bluetooth_val = Serial.read();
    Serial.println(bluetooth_val);
  }
  switch (bluetooth_val)
  {
    case 'F':  //forward command
      Car_front();
```



```
        matrix_display(front); // show forward design
        break;

    case 'B': //Back command

        Car_back();

        matrix_display(back); //show back pattern

        break;

    case 'L': // left-turning instruction

        Car_left();

        matrix_display(left); //show "left-turning" sign

        break;

    case 'R': //right-turning instruction

        Car_right();

        matrix_display(right); //display right-turning sign

        break;

    case 'S': //stop command

        Car_Stop();

        matrix_display(STOP01); //show stop picture

        break;

    }

}

/*****The function of dot matrix*****/

//this function is used for dot matrix display
```



```
void matrix_display(unsigned char matrix_value[])
{
    IIC_start();

    IIC_send(0xc0); //Choose address

    for(int i = 0;i < 16;i++) //pattern data has 16 bits
    {
        IIC_send(matrix_value[i]); //data to convey patterns
    }

    IIC_end(); //end to convey data pattern

    IIC_start();

    IIC_send(0x8A); //display control, set pulse width to 4/16
    IIC_end();
}

//The condition starting to transmit data
void IIC_start()
{
    digitalWrite(SCL_Pin,HIGH);
    delayMicroseconds(3);
    digitalWrite(SDA_Pin,HIGH);
    delayMicroseconds(3);
    digitalWrite(SDA_Pin,LOW);
```



```
    delayMicroseconds(3);  
}  
  
//transmit data  
void IIC_send(unsigned char send_data)  
{  
    for(char i = 0;i < 8;i++) //Each byte has 8 bits  
    {  
        digitalWrite(SCL_Pin,LOW); //pull down clock pin SCL Pin to  
change the signals of SDA  
        delayMicroseconds(3);  
        if(send_data & 0x01) //set high and low level of SDA_Pin  
according to 1 or 0 of every bit  
        {  
            digitalWrite(SDA_Pin,HIGH);  
        }  
        else  
        {  
            digitalWrite(SDA_Pin,LOW);  
        }  
        delayMicroseconds(3);  
        digitalWrite(SCL_Pin,HIGH); //pull up clock pin SCL_Pin to  
stop transmitting data  
        delayMicroseconds(3);  
    }  
}
```



```
        send_data = send_data >> 1;  // Detect bit by bit, so move  
the data right by one
```

```
    }  
}  
//The sign that data transmission ends
```

```
void IIC_end()
```

```
{  
    digitalWrite(SCL_Pin,LOW);  
    delayMicroseconds(3);  
    digitalWrite(SDA_Pin,LOW);  
    delayMicroseconds(3);  
    digitalWrite(SCL_Pin,HIGH);  
    delayMicroseconds(3);  
    digitalWrite(SDA_Pin,HIGH);  
    delayMicroseconds(3);  
}
```

```
/******the function to run motor******/
```

```
void Car_front()
```

```
{  
    digitalWrite(MR_Ctrl,LOW);  
    analogWrite(MR_PWM,200);  
    digitalWrite(ML_Ctrl,LOW);  
    analogWrite(ML_PWM,200);  
}
```




```
}  
  
void Car_back()  
{  
    digitalWrite(MR_Ctrl,HIGH);  
    analogWrite(MR_PWM,200);  
    digitalWrite(ML_Ctrl,HIGH);  
    analogWrite(ML_PWM,200);  
}  
  
void Car_left()  
{  
    digitalWrite(MR_Ctrl,LOW);  
    analogWrite(MR_PWM,255);  
    digitalWrite(ML_Ctrl,HIGH);  
    analogWrite(ML_PWM,255);  
}  
  
void Car_right()  
{  
    digitalWrite(MR_Ctrl,HIGH);  
    analogWrite(MR_PWM,255);  
    digitalWrite(ML_Ctrl,LOW);  
    analogWrite(ML_PWM,255);  
}  
  
void Car_Stop()
```



```
{
    digitalWrite(MR_Ctrl,LOW);
    analogWrite(MR_PWM,0);
    digitalWrite(ML_Ctrl,LOW);
    analogWrite(ML_PWM,0);
}

void Car_T_left()
{
    digitalWrite(MR_Ctrl,LOW);
    analogWrite(MR_PWM,255);
    digitalWrite(ML_Ctrl,LOW);
    analogWrite(ML_PWM,180);
}








void Car_T_right()
{
    digitalWrite(MR_Ctrl,LOW);
    analogWrite(MR_PWM,180);
    digitalWrite(ML_Ctrl,LOW);
    analogWrite(ML_PWM,255);
}

//*****
```

(5) Test Result



Upload code successfully, DIP switch is dialed to right end and power on. After connecting Bluetooth, we could drive smart car to move by Bluetooth App.

Press , tank robot goes forward; click , smart car goes back; press  button, tank robot turns left; click , robot turns right; hold , it stops. Click  to enable gravitational control, tap  again, end gravitational control. At same time, 8X16 LED panel on robot car displays the corresponding pattern.

Project 15: Multi-purpose Robot Car

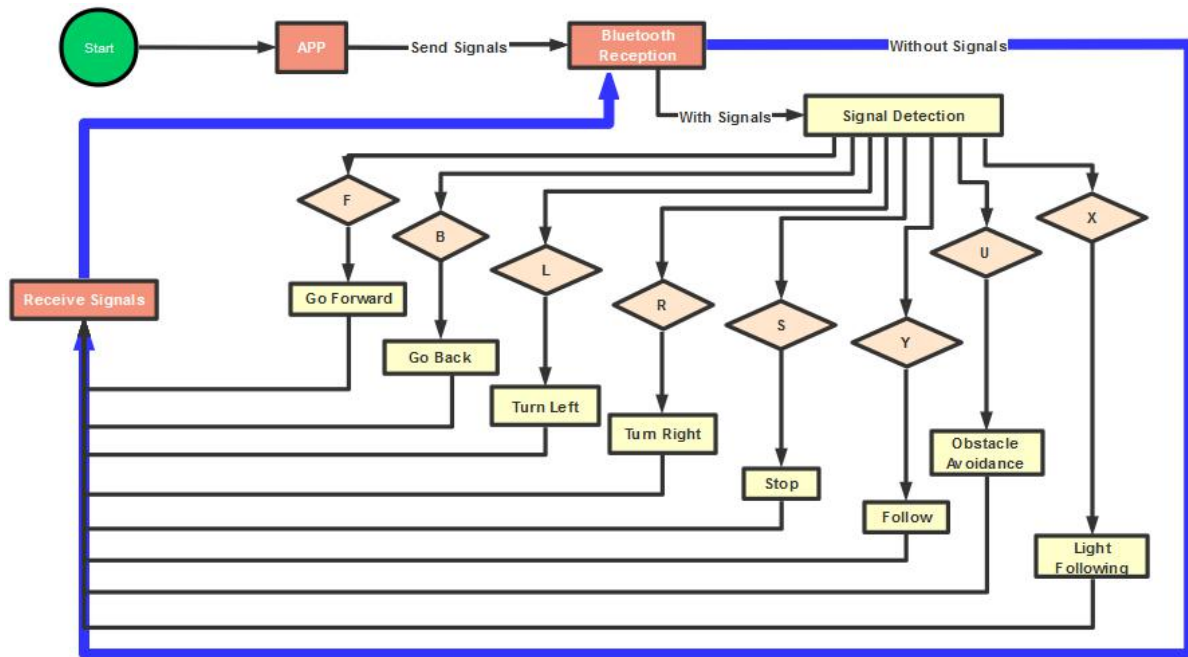




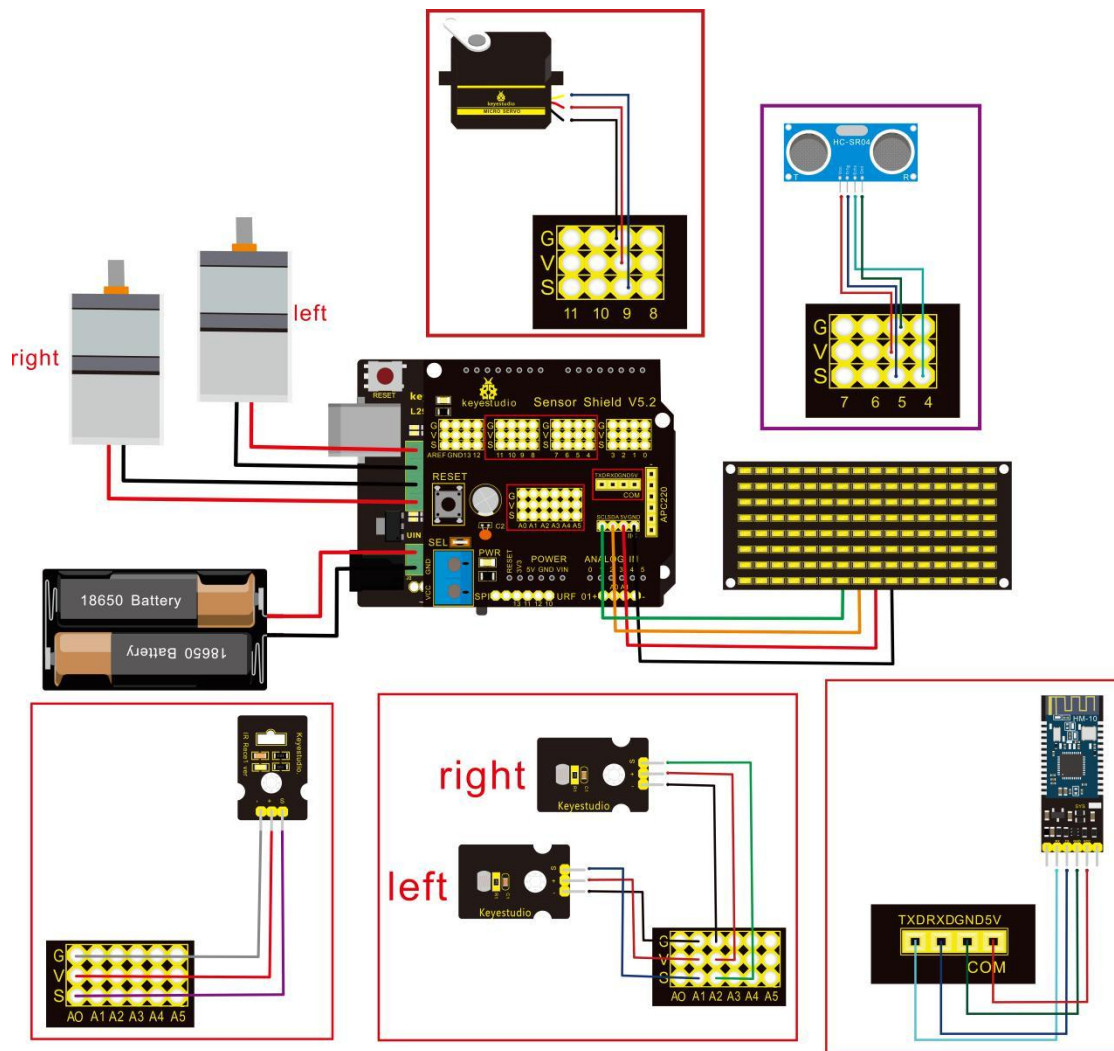
(1) Description

In previous projects, the tank car only performs single function, however, in this lesson, we integrate all of function to control smart car via Bluetooth control.

Here is a simple flow chart of multi-purpose robot car as for your reference.



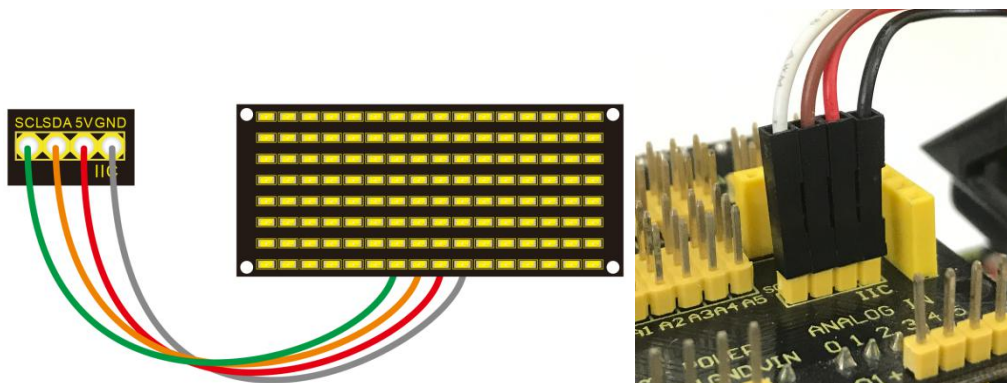
(2) Connection Diagram



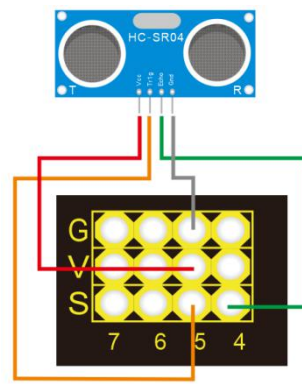
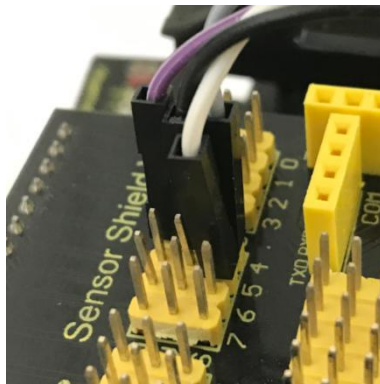
Attention: Confirm that every component is connected.

Wire-up Guide:

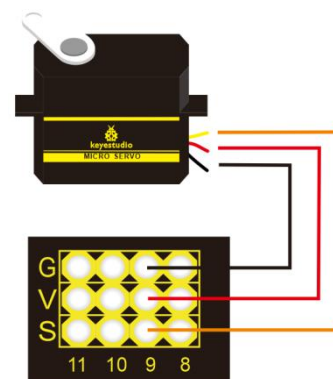
8x16 LED panel		Expansion Board
GND	→	- (GND)
VCC	→	+ (VCC)
SDA	→	SDA
SCL	→	SCL



Ultrasonic Module		
VCC	→	5v(V)
Trig	→	5(S)
Echo	→	4(S)
Gnd	→	Gnd(G)

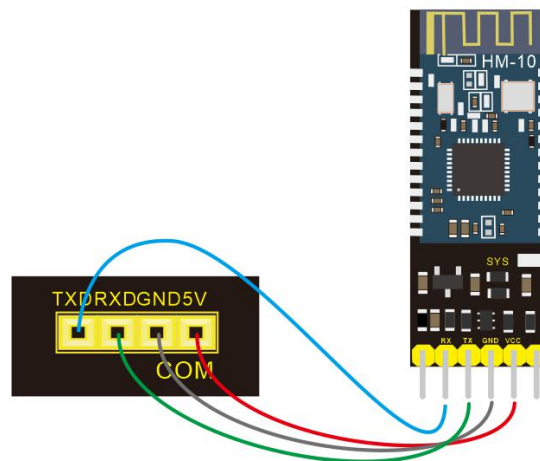


Servo Motor		
Brown Wire	→	Gnd(G)
Red Wire	→	5v(V)
Orange Wire	→	9



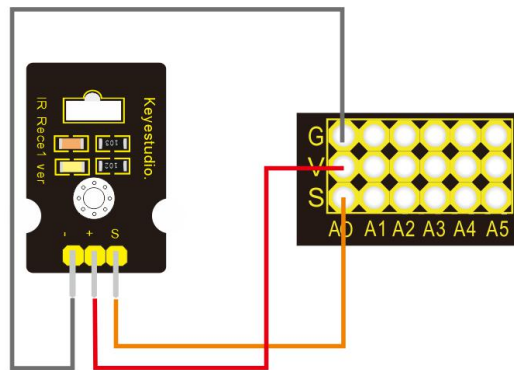
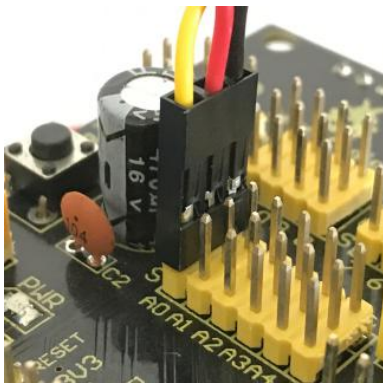


Bluetooth Module		
RXD	→	TX
TXD	→	RX
GND	→	- (GND)
VCC		+ (VCC)
No need to attach to STATE and BRK pins		



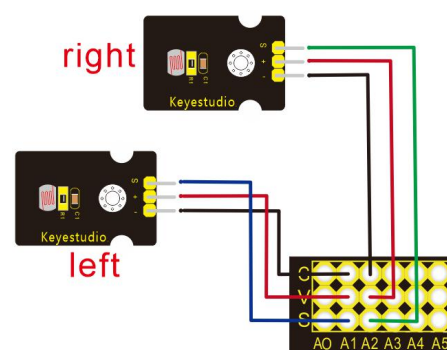
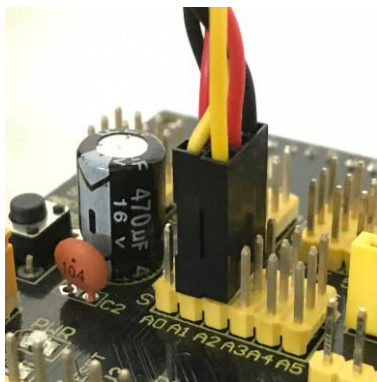


IR Receiver Module		Sensor Shield
-	→	G (GND)
+	→	V (VCC)
S	→	A0





Left photo resistor		Sensor Shield
-	→	G (GND)
+	→	V (VCC)
S	→	A1
Right Photo resistor		Sensor Shield
-	→	G (GND)
+	→	V (VCC)
S	→	A2



(3) Test Code

```
/*
```



keyestudio Mini Tank Robot v2.0

lesson 15

multiple functions

<http://www.keyestudio.com>

*/

//Array, used to store the data of the pattern, can be calculated by yourself or obtained from the modulus tool

unsigned char start01[] =

{0x01,0x02,0x04,0x08,0x10,0x20,0x40,0x80,0x80,0x40,0x20,0x10,0x08,0x04,0x02,0x01};

unsigned char front[] =

{0x00,0x00,0x00,0x00,0x00,0x24,0x12,0x09,0x12,0x24,0x00,0x00,0x00,0x00,0x00,0x00};

unsigned char back[] =

{0x00,0x00,0x00,0x00,0x00,0x24,0x48,0x90,0x48,0x24,0x00,0x00,0x00,0x00,0x00,0x00};

unsigned char left[] =

{0x00,0x00,0x00,0x00,0x00,0x00,0x44,0x28,0x10,0x44,0x28,0x10,0x44,0x28,0x10,0x00};

unsigned char right[] =

{0x00,0x10,0x28,0x44,0x10,0x28,0x44,0x10,0x28,0x44,0x00,0x00,0x00,0x00,0x00,0x00};



```
unsigned char STOP01[] =
{0x2E,0x2A,0x3A,0x00,0x02,0x3E,0x02,0x00,0x3E,0x22,0x3E,0x00,0x
3E,0x0A,0x0E,0x00};

unsigned char clear[] =
{0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x
00,0x00,0x00,0x00};

#define SCL_Pin  A5  //Set clock pin to A5
#define SDA_Pin  A4  //Set data pin to A4

#define ML_Ctrl 13  //define direction control pin of left motor
#define ML_PWM 11   //define PWM control pin of left motor
#define MR_Ctrl 12  //define direction control pin of right motor
#define MR_PWM 3    //define PWM control pin of right motor

#define Trig 5  //ultrasonic trig Pin
#define Echo 4  //ultrasonic echo Pin

int distance; //save the distance value detected by ultrasonic, follow
function

int random2; //save the variable of random numberssave the
variable of random numbers

//save the distance value detected by ultrasonic, obstacle
avoidance function

int a;
```



```
int a1;
```

```
int a2;
```

```
#define servoPin 9 //servo Pin
```

```
int pulsewidth;
```

```
#define light_L_Pin A1 //define the pin of left photo resistor  
sensor
```

```
#define light_R_Pin A2 //define the pin of right photo resistor  
sensor
```

```
int left_light;
```

```
int right_light;
```

```
char bluetooth_val; //save the value of Bluetooth reception
```

```
int flag; //flag variable, it is used to entry and exist function
```

```
void setup(){
```

```
    Serial.begin(9600);
```

```
    pinMode(Trig, OUTPUT);
```

```
    pinMode(Echo, INPUT);
```

```
    pinMode(ML_Ctrl, OUTPUT);
```

```
    pinMode(ML_PWM, OUTPUT);
```

```
    pinMode(MR_Ctrl, OUTPUT);
```

```
    pinMode(MR_PWM, OUTPUT);
```



```
pinMode(servoPin, OUTPUT);

procedure(90); //set servo to 90°

pinMode(SCL_Pin,OUTPUT);

pinMode(SDA_Pin,OUTPUT);

matrix_display(clear);    //Clear the display

matrix_display(start01);  //display start pattern

pinMode(light_L_Pin, INPUT);

pinMode(light_R_Pin, INPUT);

}

void loop(){

  if (Serial.available())

  {

    bluetooth_val = Serial.read();

    Serial.println(bluetooth_val);

  }

  switch (bluetooth_val)

  {

    case 'F': //Forward instruction

      Car_front();

      matrix_display(front); //display forward pattern

      break;
```



```
case 'B': //Back instruction
    Car_back();
    matrix_display(back); // display back pattern
    break;
case 'L': //left-turning instruction
    Car_left();
    matrix_display(left); //show left-turning pattern
    break;
case 'R': //right-turning instruction
    Car_right();
    matrix_display(right); //show right-turning pattern
    break;
case 'S': //stop instruction
    Car_Stop();
    matrix_display(STOP01); //display stop pattern
    break;
case 'Y':
    matrix_display(start01); //show start pattern
    follow();
    break;
case 'U':
    matrix_display(start01); //show start pattern
    avoid();
```



```
        break;

    case 'X':

        matrix_display(start01);  //show start pattern

        light_track();

        break;

    }}

/*****Obstacle Avoidance Function*****/
void avoid()
{
    flag = 0;  //the design that enter obstacle avoidance function
    while (flag == 0)
    {
        random2 = random(1, 100);

        a = checkdistance();  //assign the front distance detected by
ultrasonic sensor to variable a

        if (a < 20) //when the front distance detected is less than 20cm
        {
            Car_Stop();  //robot stops
            delay(200); //delay in 200ms

            procedure(160);  //Ultrasonic platform turns left
```




for (int j = 1; j <= 10; j = j + (1)) { ///for statement, the data will be more accurate if ultrasonic sensor detect a few times.

 a1 = checkdistance(); //assign the left distance detected by ultrasonic sensor to variable a1

 }

 delay(200);

 procedure(20); //Ultrasonic platform turns right

 for (int k = 1; k <= 10; k = k + (1)) {

 a2 = checkdistance(); //assign the right distance detected by ultrasonic sensor to variable a2

 }

 if (a1 < 50 || a2 < 50) //robot will turn to the longer distance side when left or right distance is less than 50cm.if the left or right distance is less than 50cm, the robot will turn to the greater distance

 {

 if (a1 > a2) //left distance is greater than right

 {

 procedure(90); //Ultrasonic platform turns back to right ahead ultrasonic platform turns front

 Car_left(); //robot turns left

 delay(500); //turn left 500ms

 Car_front(); //go forward



```
    }  
  
    else  
  
    {  
  
        procedure(90);  
        Car_right(); //robot turns right  
        delay(500);  
        Car_front(); //go forward  
    }  
}  
  
else //both distance on two side is greater than or equal to  
50cm, turn randomly  
  
{  
  
    if ((long) (random2) % (long) (2) == 0) //when the  
random number is even  
  
    {  
  
        procedure(90);  
        Car_left(); //robot turns left  
        delay(500);  
        Car_front(); //go forward  
    }  
  
    else  
  
    {  
  
        procedure(90);
```



```
        Car_right(); //robot turns right
        delay(500);
        Car_front(); ///go forward
    } } }

    else //If the front distance is greater than or equal to 20cm,
robot car will go front
    {
        Car_front(); //go forward
    }

    // receive the Bluetooth value to end the obstacle avoidance
function
    if (Serial.available())
    {
        bluetooth_val = Serial.read();
        if (bluetooth_val == 'S') //receive S
        {
            flag = 1; //when assign 1 to flag, end loop
        }
    }
}

/*****Follow*****/

void follow() {
    flag = 0;
    while (flag == 0) {
```



```
distance = checkdistance(); //assign the distance detected by  
ultrasonic sensor to distance
```

```
if (distance >= 20 && distance <= 60) //the range to go front
```

```
{
```

```
    Car_front();
```

```
}
```

```
else if (distance > 10 && distance < 20) //the range to stop
```

```
{
```

```
    Car_Stop();
```

```
}
```

```
else if (distance <= 10) // the range to go back
```

```
{
```

```
    Car_back();
```

```
}
```

```
else //other situations, stop
```

```
{
```

```
    Car_Stop();
```

```
}
```

```
if (Serial.available())
```

```
{
```

```
    bluetooth_val = Serial.read();
```

```
    if (bluetooth_val == 'S')
```

```
{
```



```
flag = 1; //end loop
```

```
}}}
```

//The function to control ultrasonic sensor the function controlling ultrasonic sensor

```
float checkdistance() {
```

```
    digitalWrite(Trig, LOW);
```

```
    delayMicroseconds(2);
```

```
    digitalWrite(Trig, HIGH);
```

```
    delayMicroseconds(10);
```

```
    digitalWrite(Trig, LOW);
```

```
    float distance = pulseIn(Echo, HIGH) / 58.00; //58.20 means
```

```
    2*29.1=58.2
```

```
    delay(10);
```

```
    return distance;
```

```
}
```

//The function to control servo the function controlling servo

```
void procedure(int myangle) {
```

```
    for (int i = 0; i <= 50; i = i + (1)) {
```

```
        pulsewidth = myangle * 11 + 500;
```

```
        digitalWrite(servoPin,HIGH);
```

```
        delayMicroseconds(pulsewidth);
```

```
        digitalWrite(servoPin,LOW);
```

```
        delay((20 - pulsewidth / 1000));
```



```
}}
```

```
/*****Light Follow*****/
```

```
void light_track() {
```

```
    flag = 0;
```

```
    while (flag == 0) {
```

```
        left_light = analogRead(light_L_Pin);
```

```
        right_light = analogRead(light_R_Pin);
```

```
        if (left_light > 650 && right_light > 650) //the value detected  
        by photo resistor, go forward
```

```
        {
```

```
            Car_front();
```

```
        }
```

```
        else if (left_light > 650 && right_light <= 650) //the value  
        detected by photo resistor, turn left
```

```
        {
```

```
            Car_left();
```

```
        }
```

```
        else if (left_light <= 650 && right_light > 650) //the value  
        detected by photo resistor, turn right
```

```
        {
```

```
            Car_right();
```

```
        }
```



```
else //other situations, stop
{
    Car_Stop();
}
if (Serial.available())
{
    bluetooth_val = Serial.read();
    if (bluetooth_val == 'S') {
        flag = 1;
    }}}
/*****Dot Matrix *****/
// this function is used for dot matrix display
void matrix_display(unsigned char matrix_value[])
{
    IIC_start();
    IIC_send(0xc0); //Choose address

    for(int i = 0;i < 16;i++) //pattern data has 16 bits
    {
        IIC_send(matrix_value[i]); //convey the pattern data
    }
    IIC_end(); //end the transmission of pattern data
    IIC_start();
```



```
IIC_send(0x8A); //display control, set pulse width to 4/16

IIC_end();

}

//The condition starting to transmit data
void IIC_start()
{
    digitalWrite(SCL_Pin,HIGH);
    delayMicroseconds(3);
    digitalWrite(SDA_Pin,HIGH);
    delayMicroseconds(3);
    digitalWrite(SDA_Pin,LOW);
    delayMicroseconds(3);
}

//convey data
void IIC_send(unsigned char send_data)
{
    for(char i = 0;i < 8;i++) //each byte has 8 bits
    {
        digitalWrite(SCL_Pin,LOW); //pull down clock pin SCL Pin to
change the signals of SDA
        delayMicroseconds(3);
        if(send_data & 0x01) //set high and low level of SDA_Pin
according to 1 or 0 of every bit
```




```
{  
    digitalWrite(SDA_Pin,HIGH);  
}  
else  
{  
    digitalWrite(SDA_Pin,LOW);  
}  
delayMicroseconds(3);  
digitalWrite(SCL_Pin,HIGH); //pull up clock pin SCL_Pin to  
stop transmitting data  
delayMicroseconds(3);  
send_data = send_data >> 1; // detect bit by bit, so move  
the data right by one  
}}  
//The sign that data transmission ends  
void IIC_end()  
{  
    digitalWrite(SCL_Pin,LOW);  
    delayMicroseconds(3);  
    digitalWrite(SDA_Pin,LOW);  
    delayMicroseconds(3);  
    digitalWrite(SCL_Pin,HIGH);  
    delayMicroseconds(3);
```



```
digitalWrite(SDA_Pin,HIGH);

delayMicroseconds(3);

}

/*****the function to run motor*****/

void Car_front()

{

    digitalWrite(MR_Ctrl,LOW);

    analogWrite(MR_PWM,200);

    digitalWrite(ML_Ctrl,LOW);

    analogWrite(ML_PWM,200);

}

void Car_back()

{

    digitalWrite(MR_Ctrl,HIGH);

    analogWrite(MR_PWM,200);

    digitalWrite(ML_Ctrl,HIGH);

    analogWrite(ML_PWM,200);

}

void Car_left()

{

    digitalWrite(MR_Ctrl,LOW);

    analogWrite(MR_PWM,255);

    digitalWrite(ML_Ctrl,HIGH);
```



```
    analogWrite(ML_PWM,255);  
}  
  
void Car_right()  
{  
    digitalWrite(MR_Ctrl,HIGH);  
    analogWrite(MR_PWM,255);  
    digitalWrite(ML_Ctrl,LOW);  
    analogWrite(ML_PWM,255);  
}  
  
void Car_Stop()  
{  
    digitalWrite(MR_Ctrl,LOW);  
    analogWrite(MR_PWM,0);  
    digitalWrite(ML_Ctrl,LOW);  
    analogWrite(ML_PWM,0);  
}  
  
void Car_T_left()  
{  
    digitalWrite(MR_Ctrl,LOW);  
    analogWrite(MR_PWM,255);  
    digitalWrite(ML_Ctrl,LOW);  
    analogWrite(ML_PWM,180);  
}
```



```
void Car_T_right()
{
    digitalWrite(MR_Ctrl,LOW);
    analogWrite(MR_PWM,180);
    digitalWrite(ML_Ctrl,LOW);
    analogWrite(ML_PWM,255);
}
```

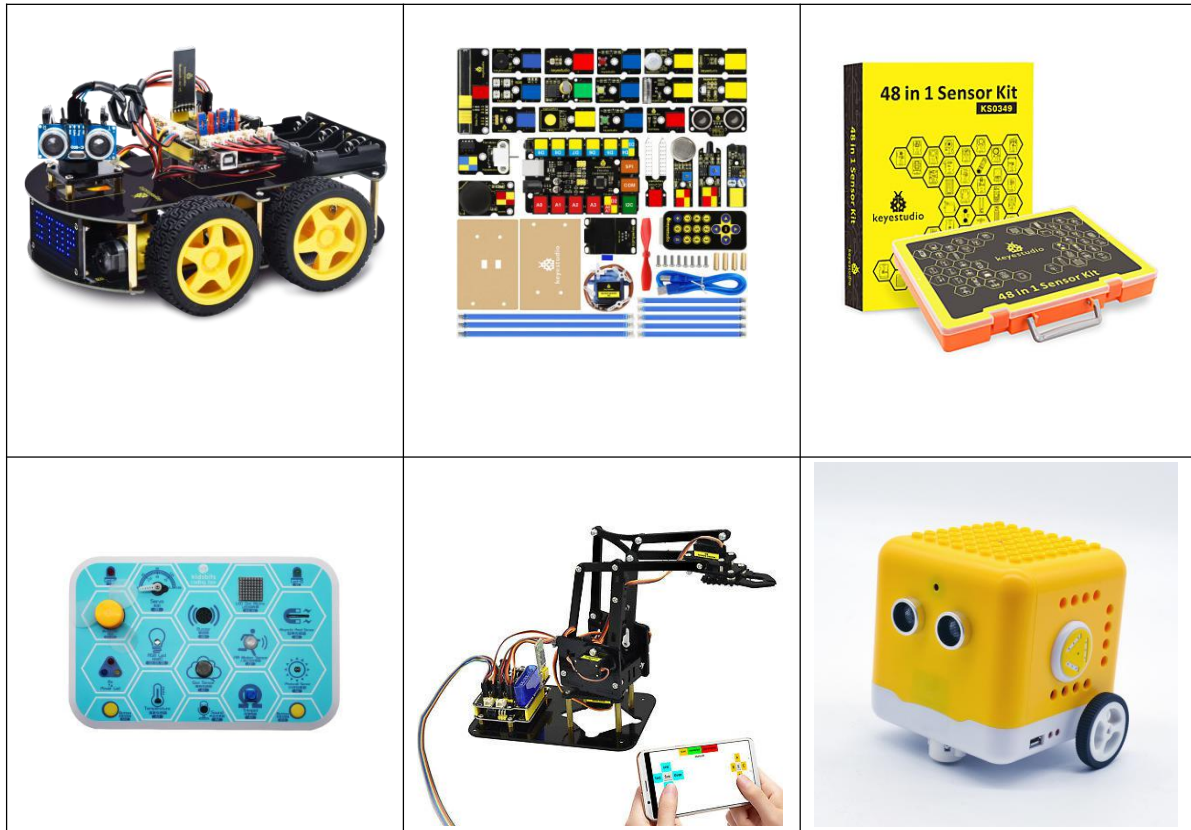
(4) Test Result

Note: Remove the Bluetooth module before uploading test code, otherwise, you will fail to upload test code. Reconnect Bluetooth module after uploading test code

Upload test code successfully, insert Bluetooth module, power on, and connect to Bluetooth. The tank robot can show distinct function by App.

Alright, the whole projects are finished. Please feel free to contact us if you confront some problems.

There are some hot-selling items below. You could log in our website to browse them if you' re interested.



9. Resources

Wiki page: https://wiki.keyestudio.com/Main_Page

Official website: <https://keyestudio.com/>

Assembly Video Link: <http://video.keyestudio.com/ks0428/>