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

Content

About keyestudio

Keyestudio is a best-selling brand owned by KEYES Corporation, our product lines range from Arduino boards, shields, sensor modules, Raspberry Pi, micro:bit extension boards and smart car to complete starter kits designed for customers of any level to learn Arduino knowledge.

All of our products comply with international quality standards and are greatly appreciated in a variety of different markets throughout the world.

Welcome check more contents from our official website:

http://www.keyestudio.com

*References and After-sales Service

1. Download Profile：https://fs.keyestudio.com/KS0464

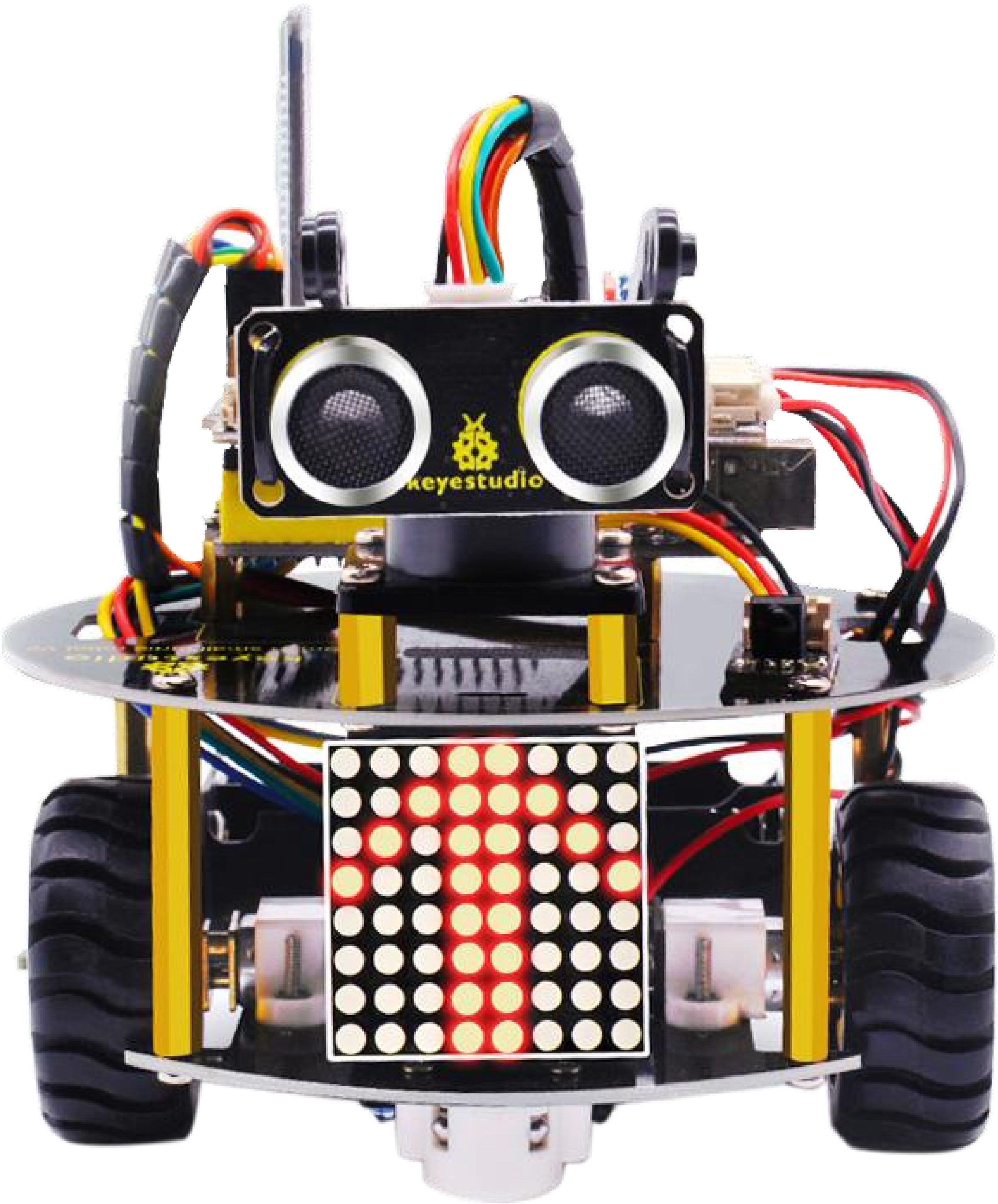
2. Feel free to contact us please, if there is missing part or you encounter some troubles. Welcome to send email to us：**service@keyestudio.com.** We will update projects and products continuously based on your sincere advice.

*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

Keyestudio Smart Little Turtle Robot V3



1. Introduction

Nowadays, technological education such as VR, kids programming, and artificial intelligence, has become mainstream in educational industry. Thereby, people attach importance to STEAM 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 turtle robot. It 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 turtle 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 function: Obstacle avoidance, follow, IR remote control, Bluetooth control, ultrasonic follow and displayed 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℃)

Motor speed: 5V 63 rpm/min

Motor drive mode: dual H bridge drive

Ultrasonic induction angle: <15 degrees

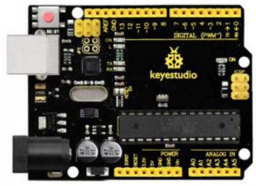
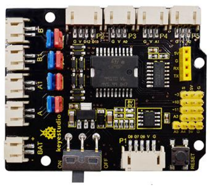
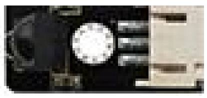
Ultrasonic detection distance: 2cm-400cm

Infrared remote control distance: 10M (measured)

Bluetooth remote control distance: 50M(measured)

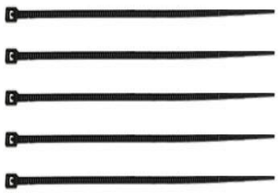
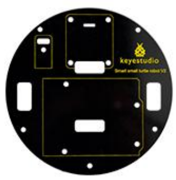
Bluetooth control: support Android and iOS system

4. Product Kit

#	Product Name	QTY	Picture
1	Keyestudio V4.0 Board(UNO compatible)	1	
2	Keyestudio Quick Connectors Motor Driver Shield	1	
3	Keyestudio Quick Connectors IR Receiver	1	
4	Keyestudio Quick Connectors Line Tracking Sensor	1	
5	Keyestudio Quick Connectors 12FN20 Motor Connector A	1	
6	Keyestudio Quick Connectors 12FN20 Motor Connector B	1	

7	keyestudio 8x8 Dot Matrix Module	1	
8	Keyestudio Quick Connectors Ultrasonic Module	1	
9	Keyestudio Bluetooth Module(HC-06)	1	
10	Keyestudio JMFP-4 17 86*40*6.5MM Remote Control（without batteries)	1	
11	Double-head JST-PH2.0MM-5P 24AWG Blue-green-yellow-red-black Wire 15CM	1	
12	Double-head JST-PH2.0MM-4P 24AWG Blue-green-yellow-red-black Wire	1	
13	Double-head JST-PH2.0MM-3P 24AWG Yellow-red-black Wire	1	

14	Double-head JST-PH2.0MM-2P 24AWGred-black Wire 160mm	2	
15	Battery Holder with JST-PH2.0MM-2P Lead,	1	
16	4 Slot AA Battery Holder	1	
17	M2*12MM Round Head Screws	4	
18	M2 Nickel Plated Nuts	4	
19	M3*6MM Round Head Screws	27	
20	M3*6MM Flat Head Screws	2	
21	M3 Nickel Plated Nuts	5	
22	M3*10MM Hexagon Copper Bush	8	
23	M3*40MM Hexagon Copper Bush	4	

24	Keyestudio 9G 23*12.2*29mm Servo	1	
25	N20 Motor Wheel	2	
26	N20 Motor U Type Mount	2	
27	Black Plastic Platform	1	
28	3PI MiniQ Universal Caster 304 Stainless Steel	2	
29	Black-yellow Handle 3*40MM Cross Screwdriver	1	
30	1m Transparent Blue USB Cable	1	
31	Black 3*100MM Ties	5	
32	Keyestudio Smart Turtle Robot V2.0 Baseboard	1	
33	Keyestudio Smart Turtle Robot V2.0 Top Board	1	

34	F-F 20CM/40P/2.54/10 Dupont Cable	0.1	
35	2.54 3pin F-F 20cm Dupont Cable	1	
36	Keyestudio Red LED Module	1	
37	Decorative Board		

5. Assembly Guide

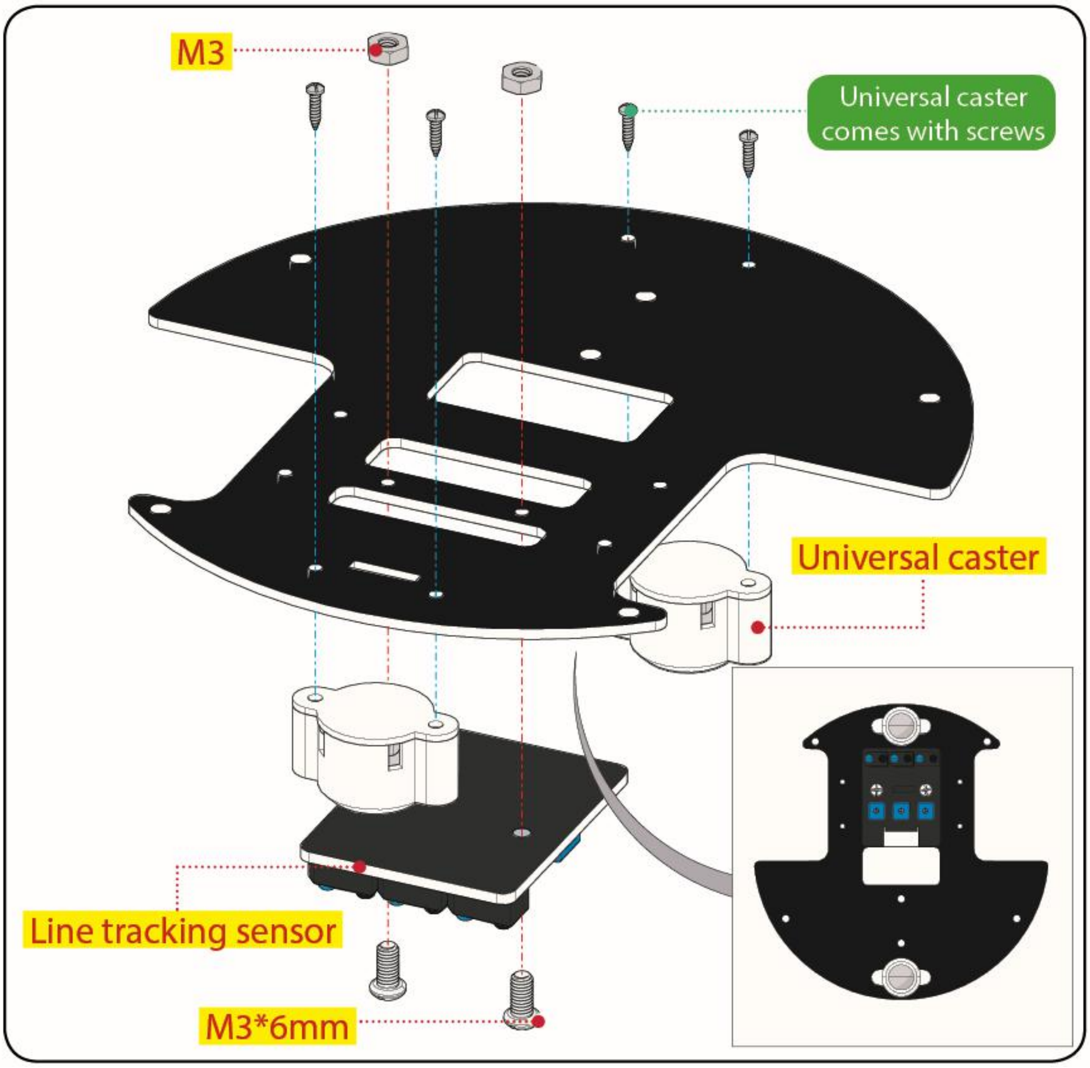
Note: Peel the plastic film off the board first when installing the smart car. To be honest, we never intend to send wood to you.

Step 1: Bottom Motor Wheel

Prepare the parts as follows:

- M3*6MM Round Head Screw *2

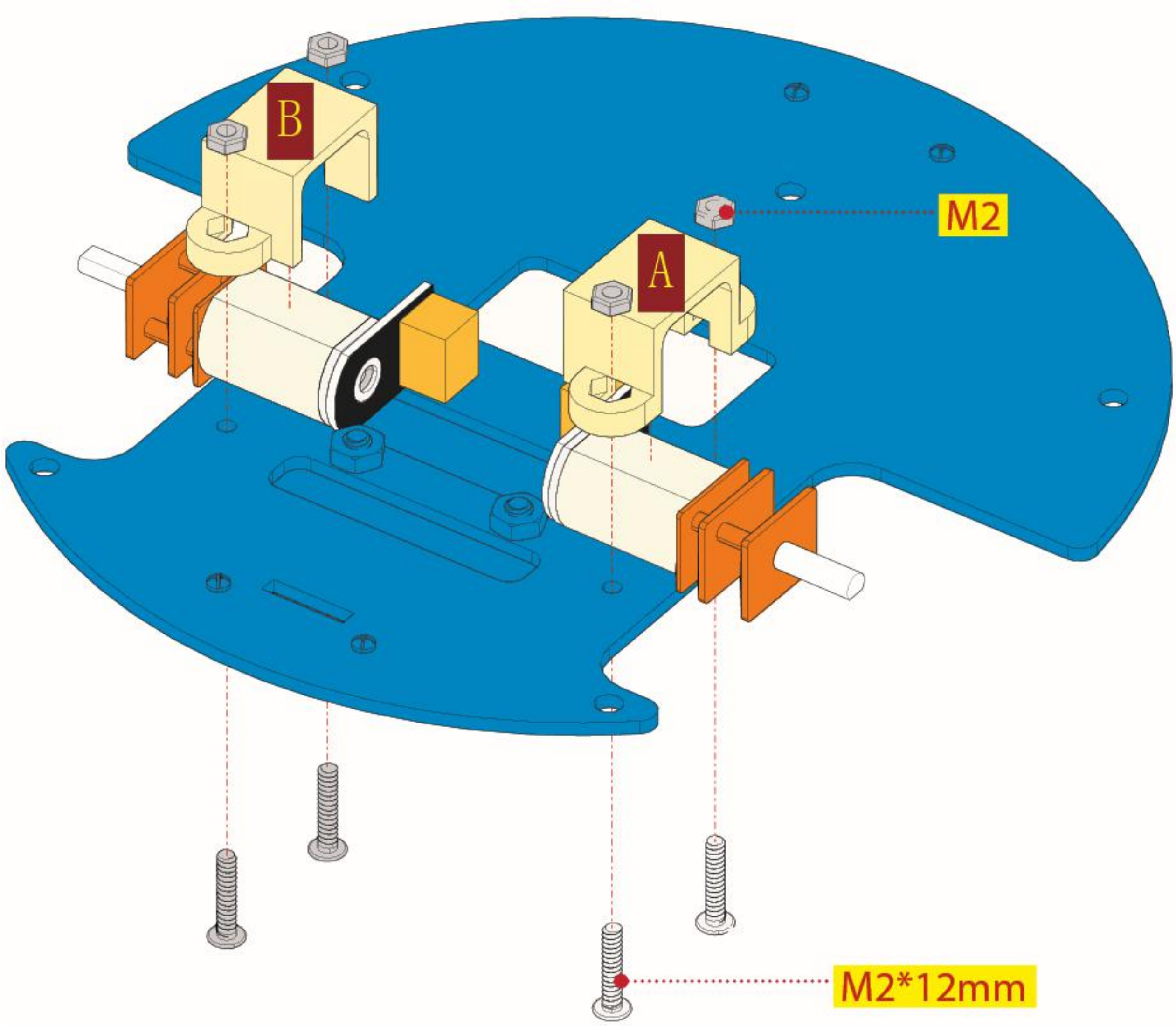
- M3*6MM Flat Head Screw *2
- M3 Nickel Plated Nut *2
- Bottom PCB*1
- Tracking Sensor *1
- Universal Caster *2

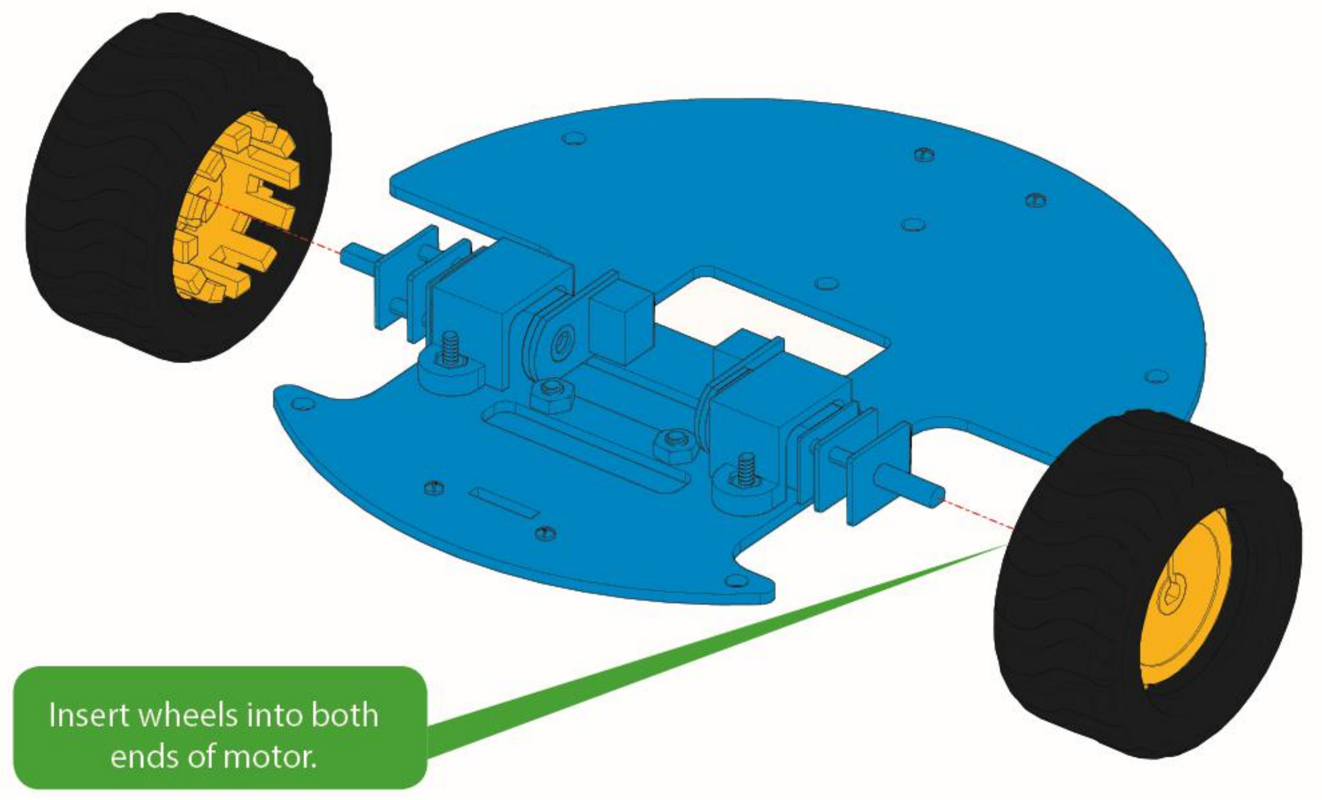


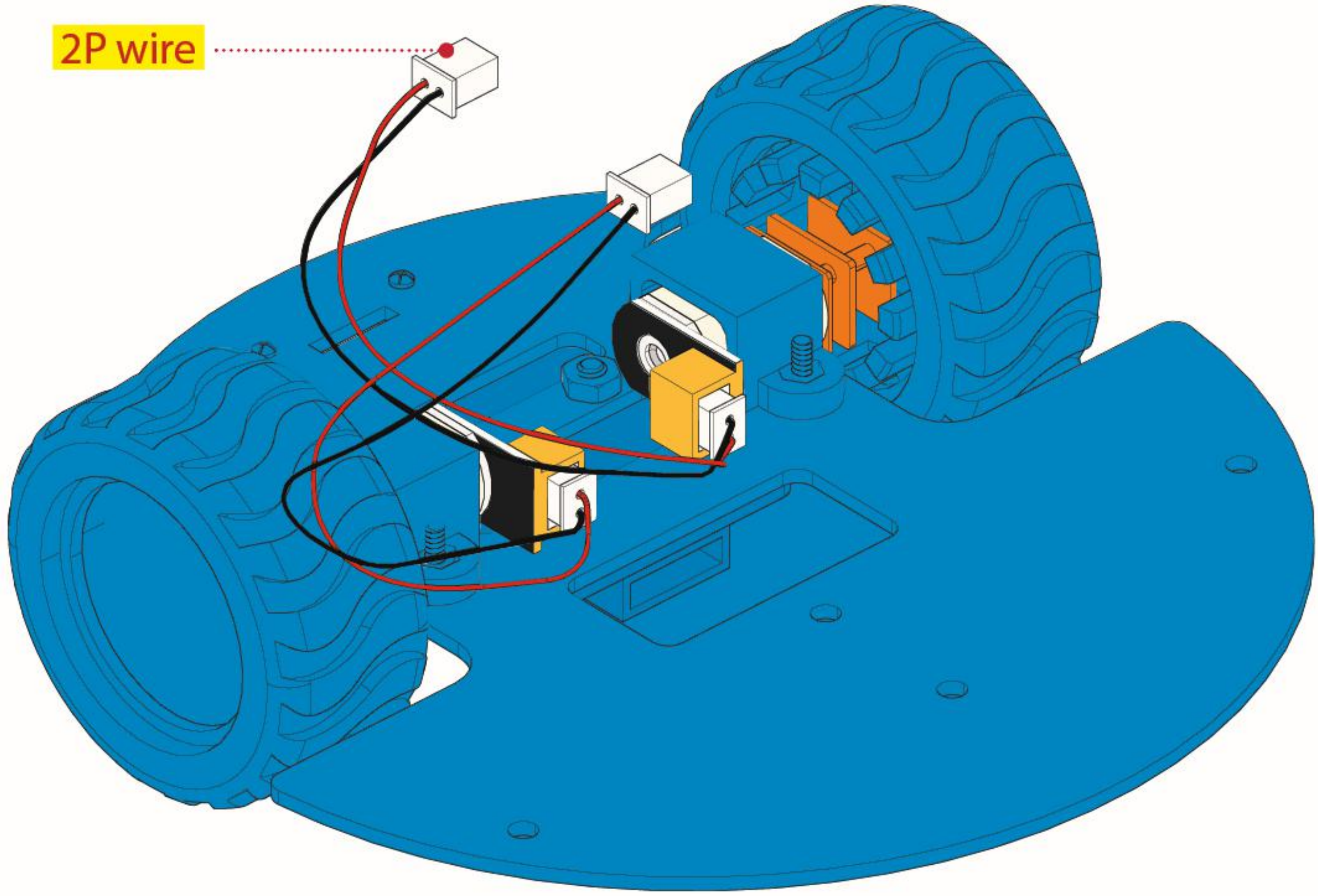
Step 2:Assemble Parts

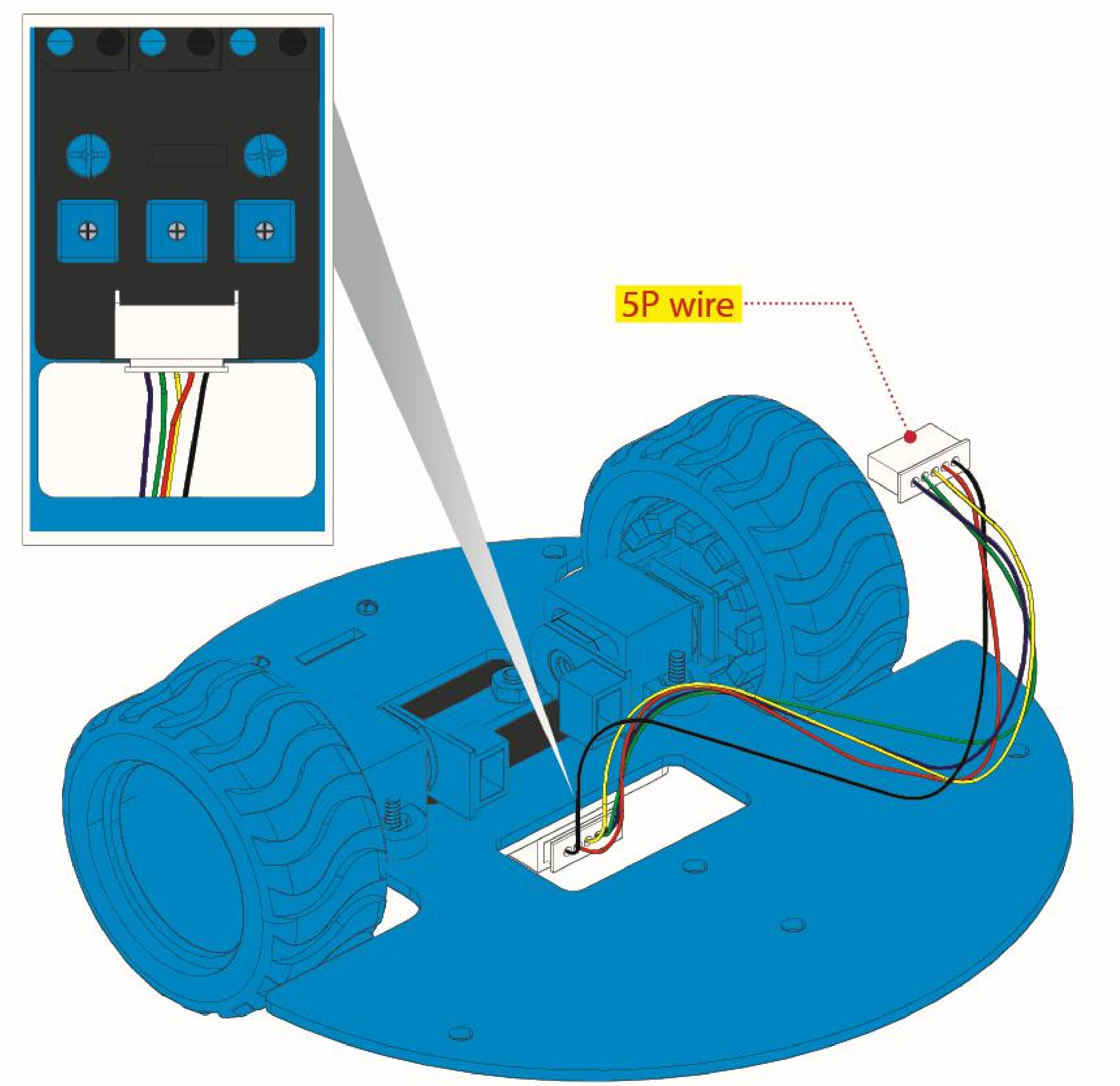
Prepare the parts as follows:

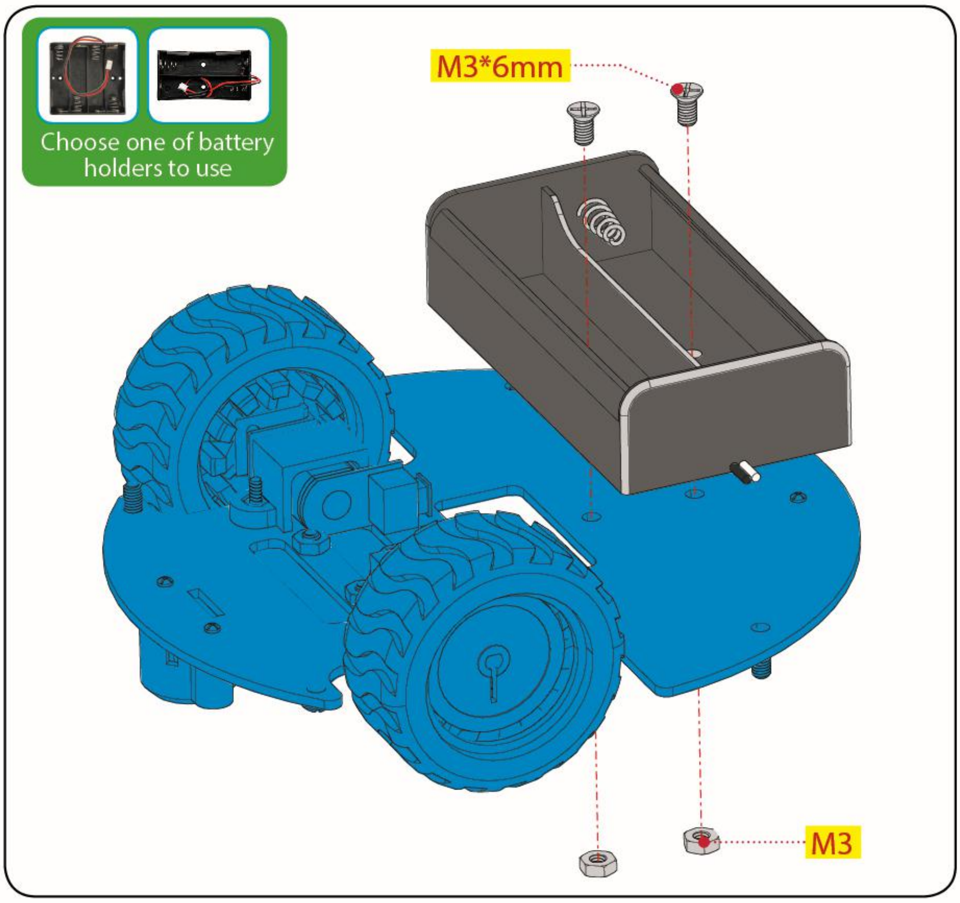
- M3*6MM Round Head Screw *2
- M2 Nut *4
- 12FN20 Motor *2
- U-type Holder* 2
- N20 Motor Wheel *2
- 2P Wire *2
- 5P Wire *1
- M2*12MM Round Head Screw *4
- 2-cell AA Battery Holder *1
- M3*6M Flat Head Screw *2
- M3 Nut *2


B
A
M2
M2*12mm

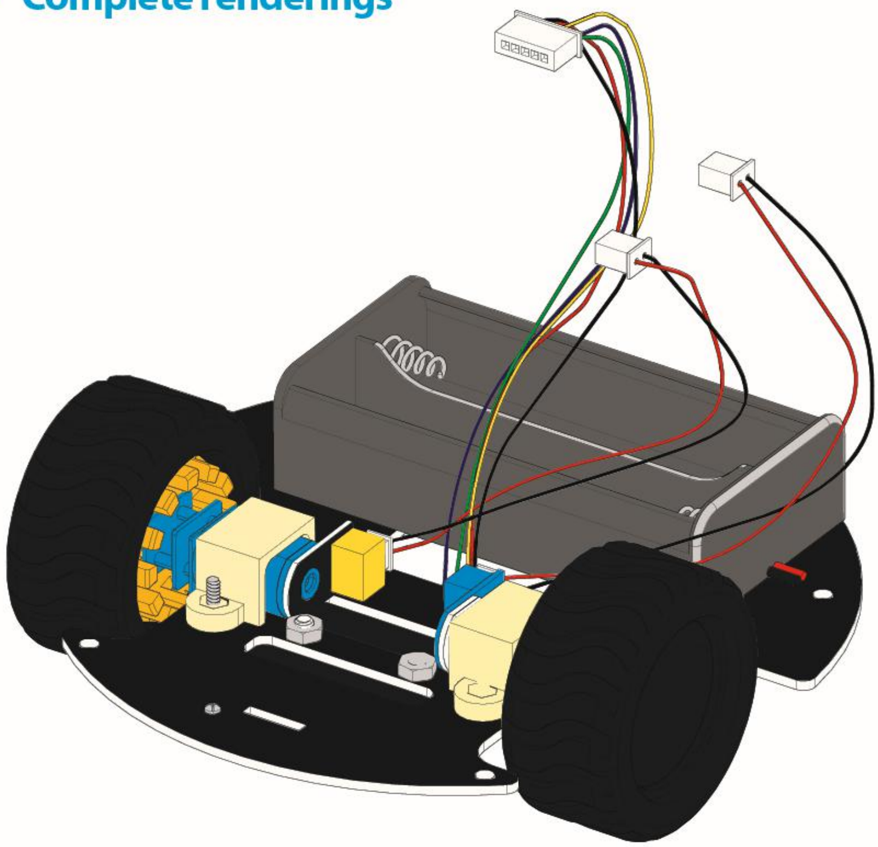

Insert wheels into both ends of motor.


2P wire


5P wire



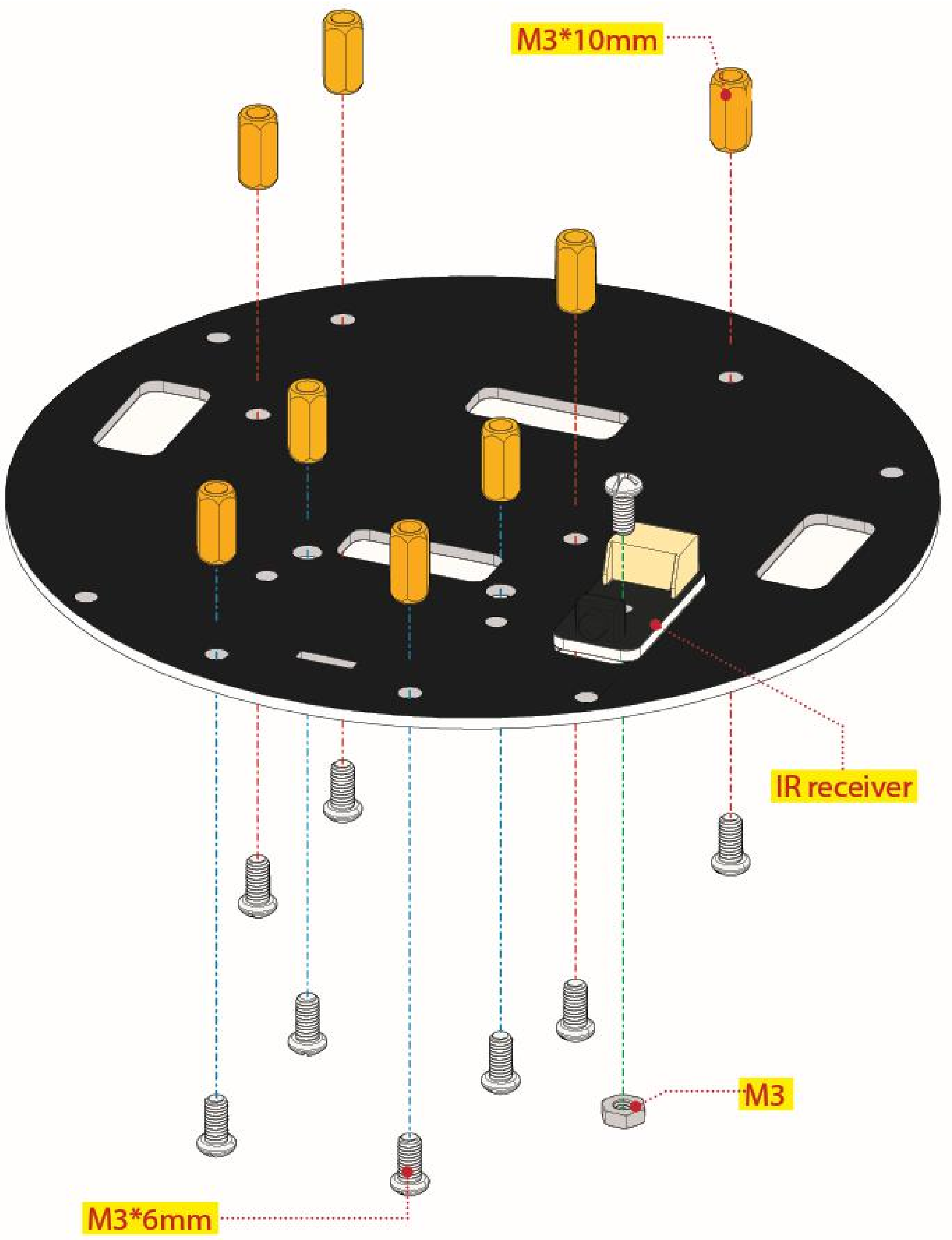
Complete renderings



Step 3: Install Top PCB

Prepare the parts as follows:

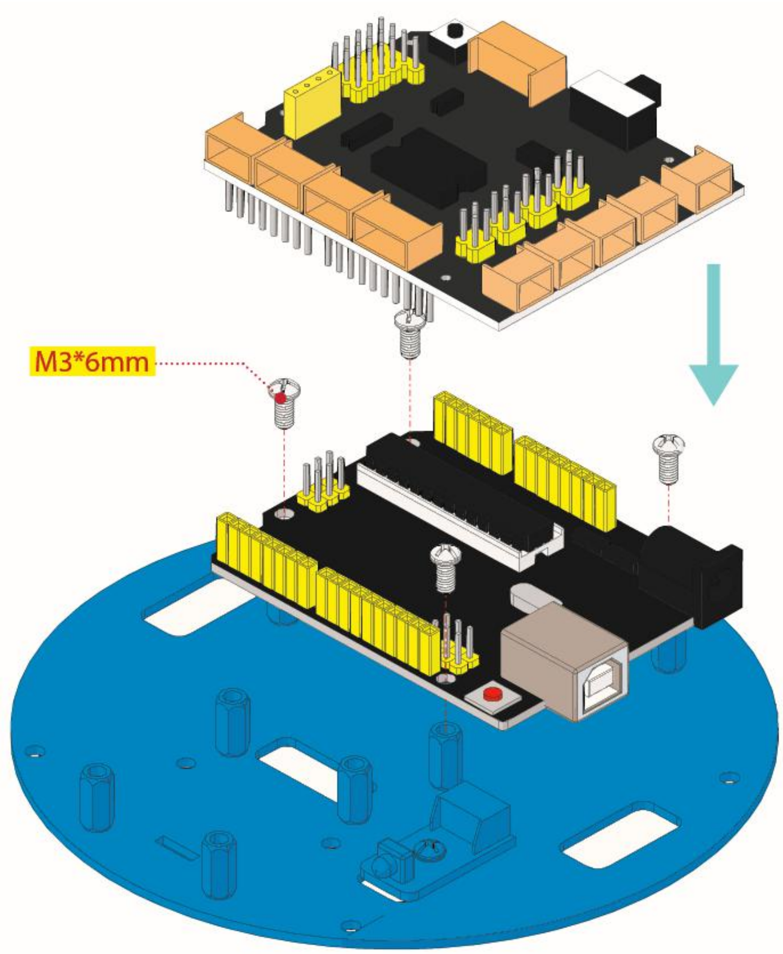
- Top PCB *1
- M3 Nut *1
- M3*6MM Round Head Screw *9
- M3*10MM Hexagon Copper Bush *8
- IR Receiver Sensor *1



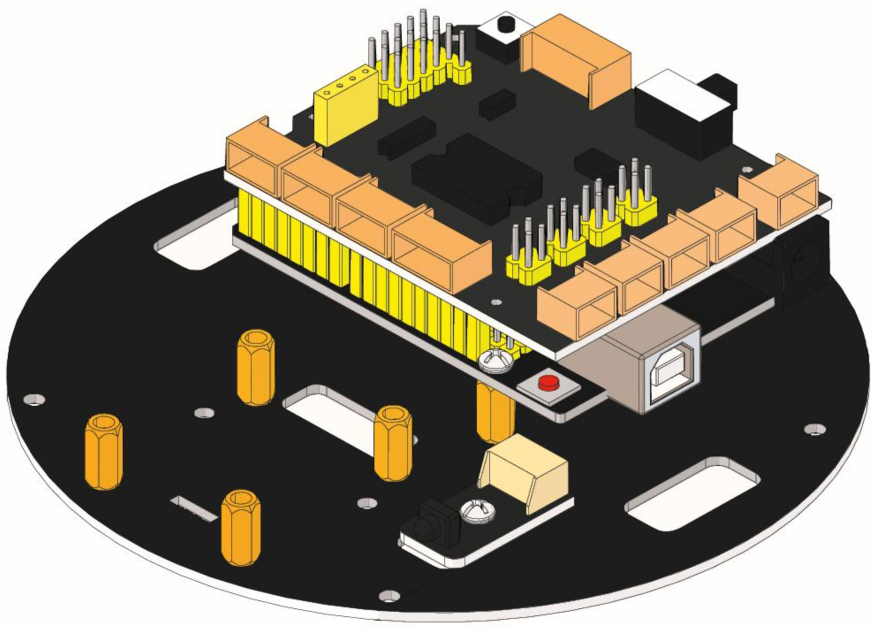
Step 4: Mount Control Board

Prepare the parts as follows:

- V4.0 Board*1
- Motor Drive Shield V2*1
- M3*6MM Round Head Screw *4



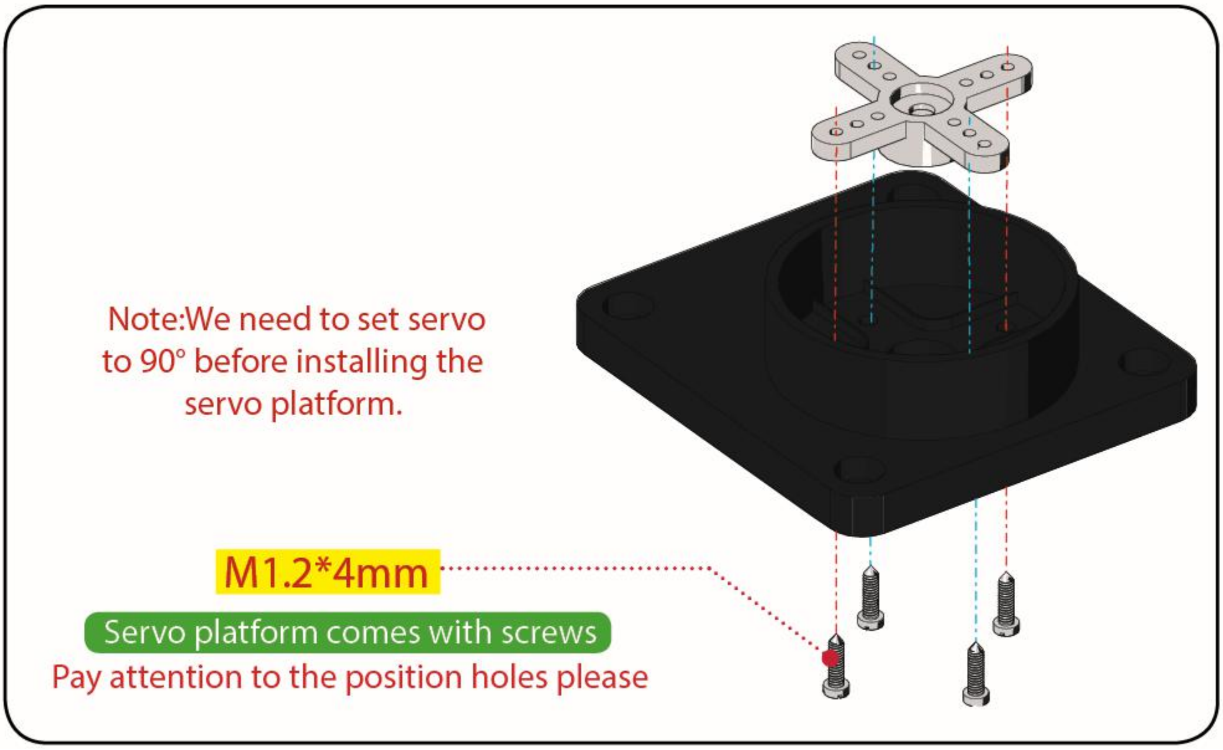
↘ Complete renderings

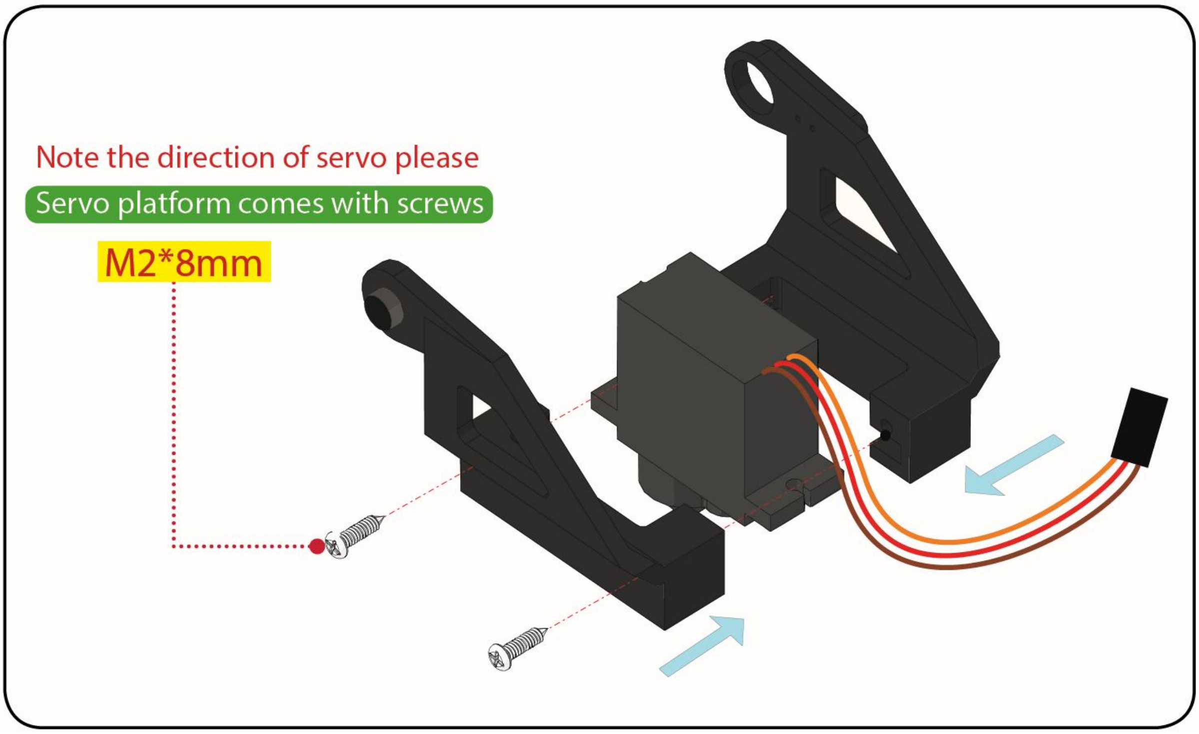


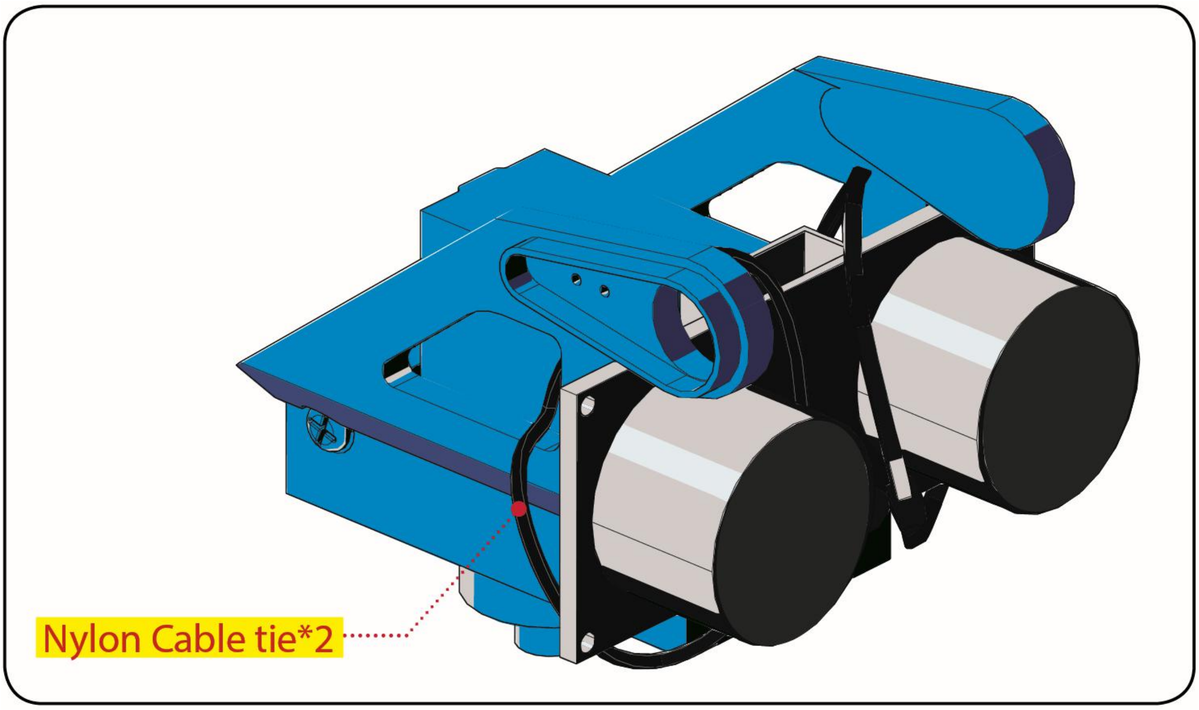
Step 5: Servo Plastic Platform

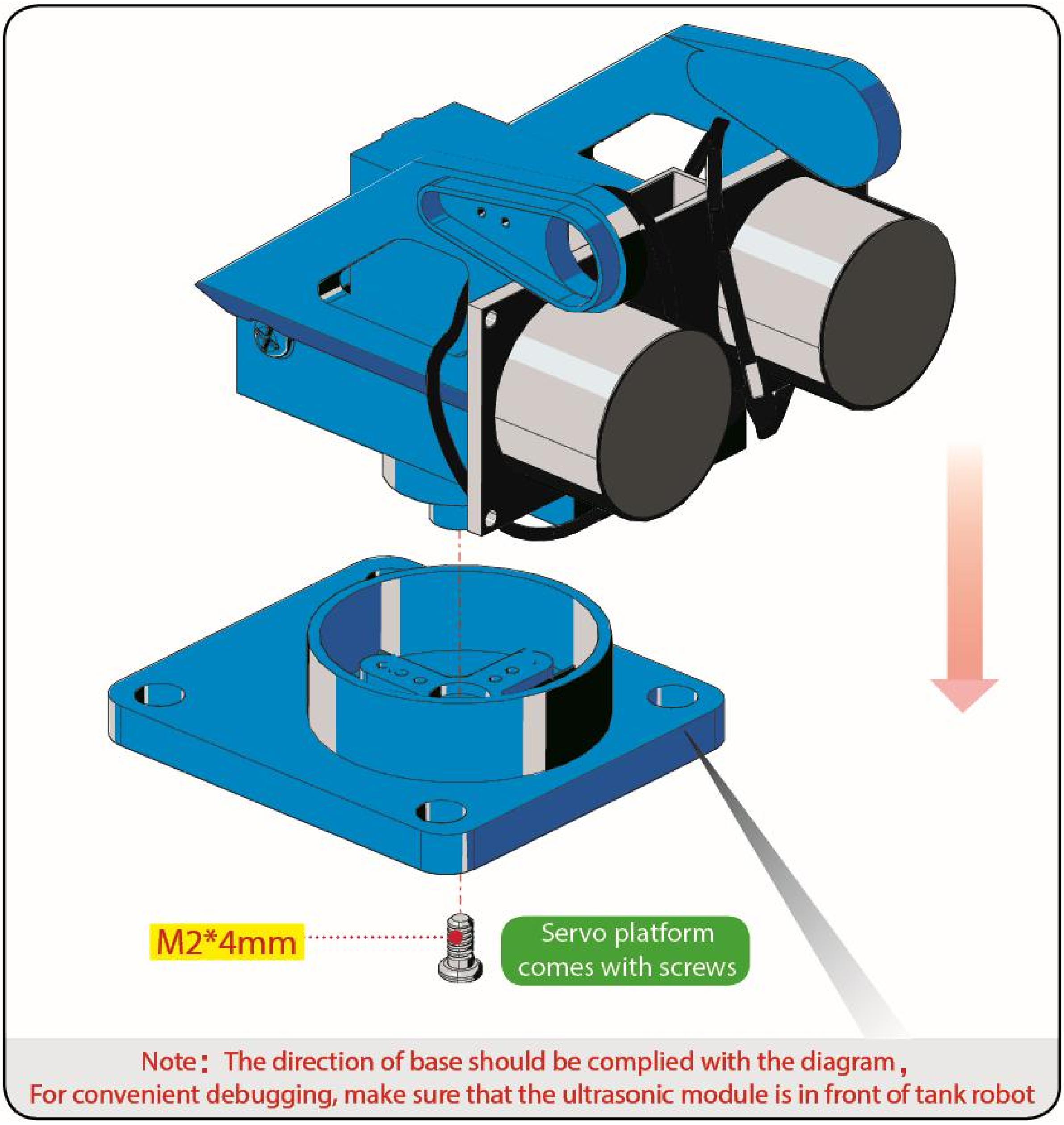
Prepare the parts as follows:

- Servo *1
- M2*4 Screw *1
- Black Tie*2
- Ultrasonic Sensor*1
- Black Plastic Platform *1
- M1.2*4 Tapping Screw *4
- M2*8 Tapping Screw *2

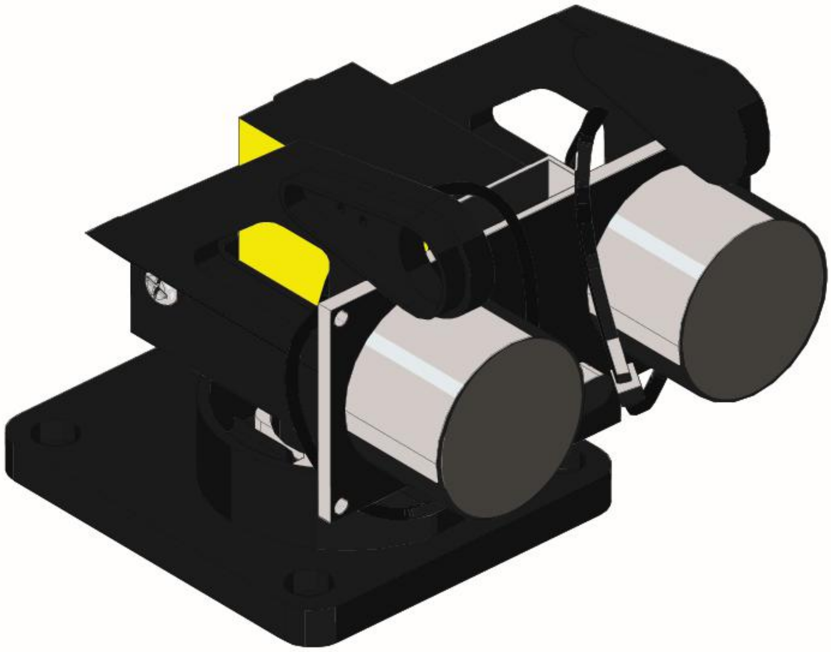



Note the direction of servo please
Servo platform comes with screws
M2*8mm


Nylon Cable tie*2


M2*4mm
Servo platform
comes with screws
Note： The direction of base should be complied with the diagram，
For convenient debugging, make sure that the ultrasonic module is in front of tank robot

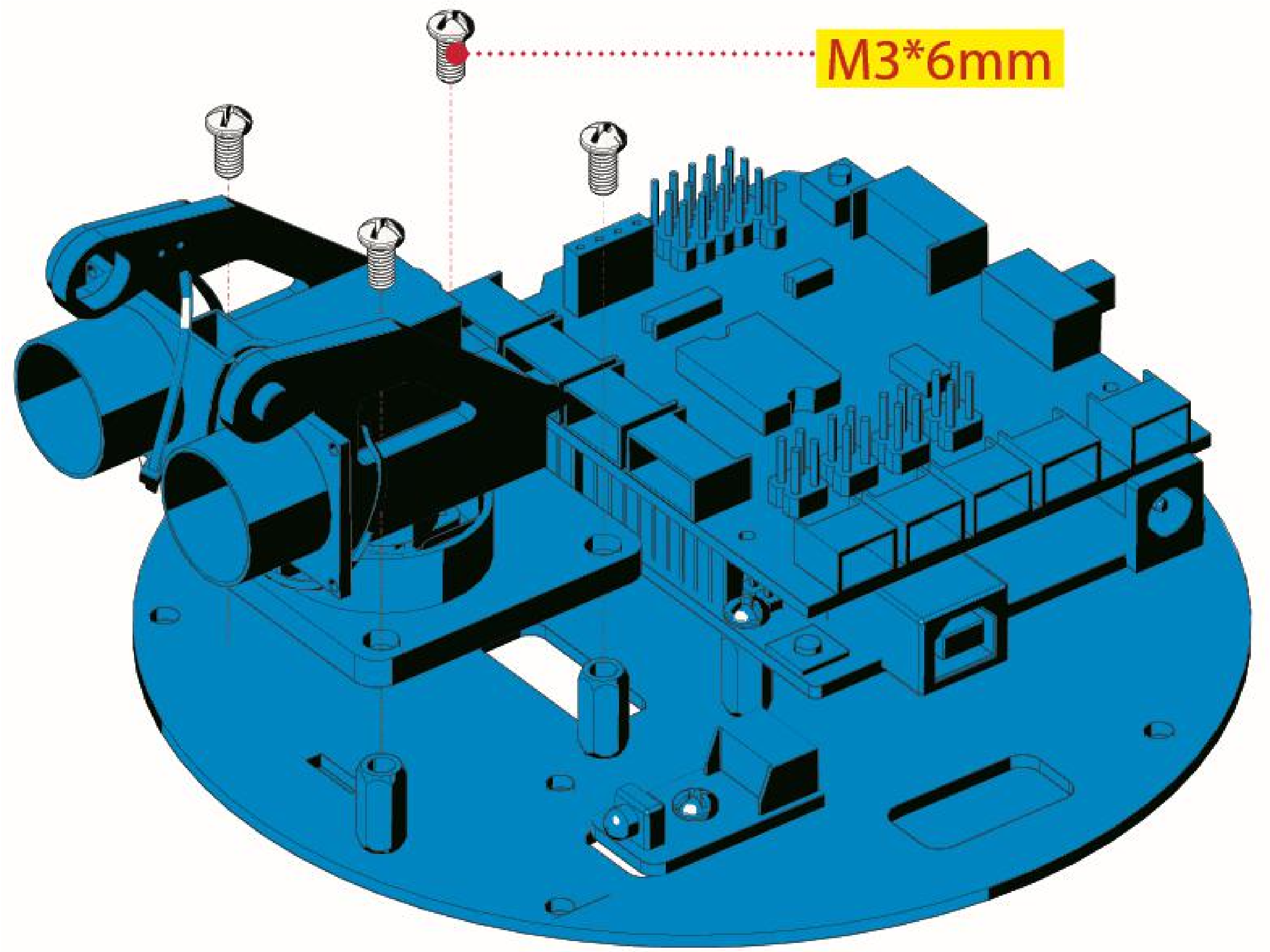
Complete renderings

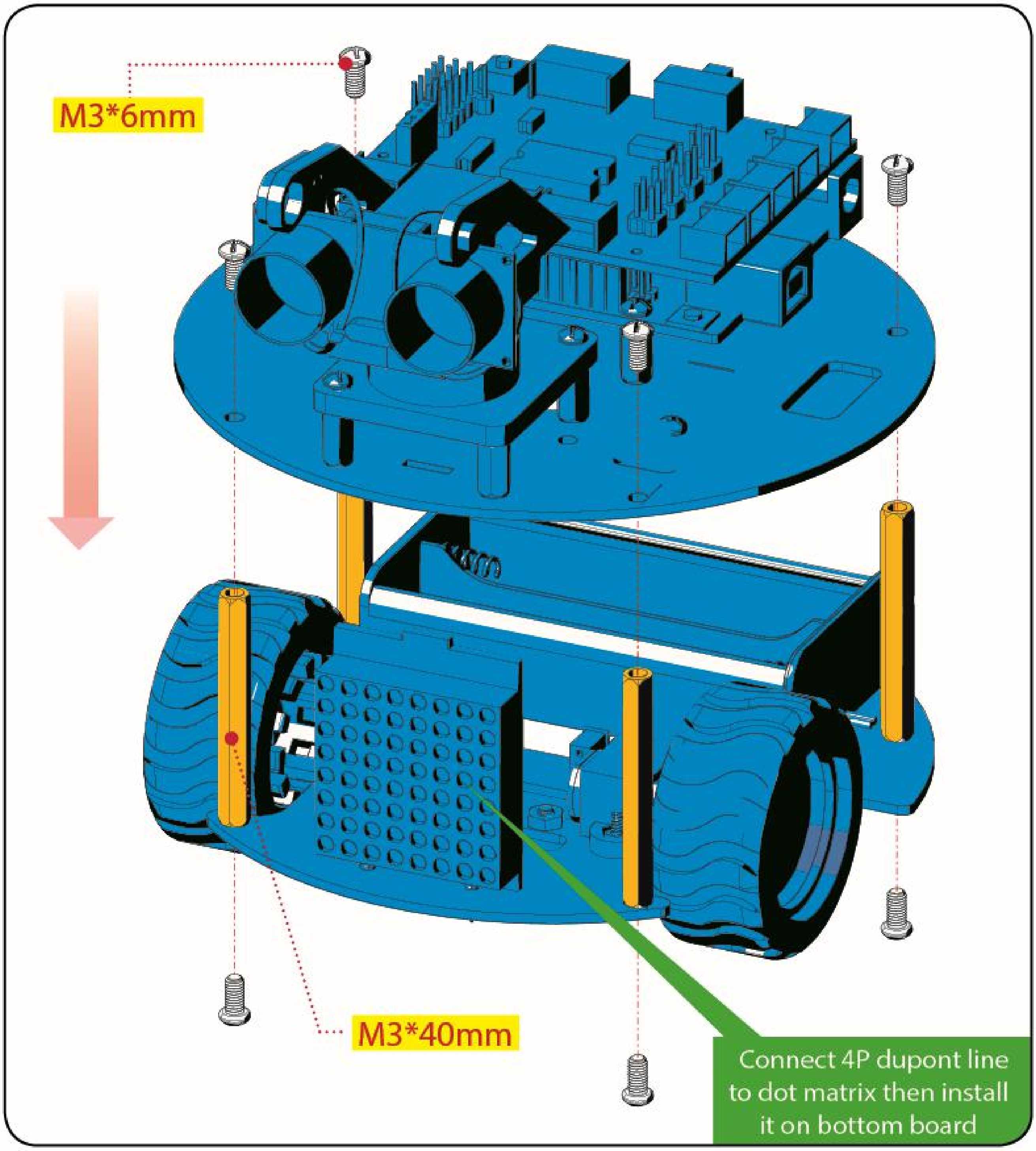


Step 6: Final Assembly

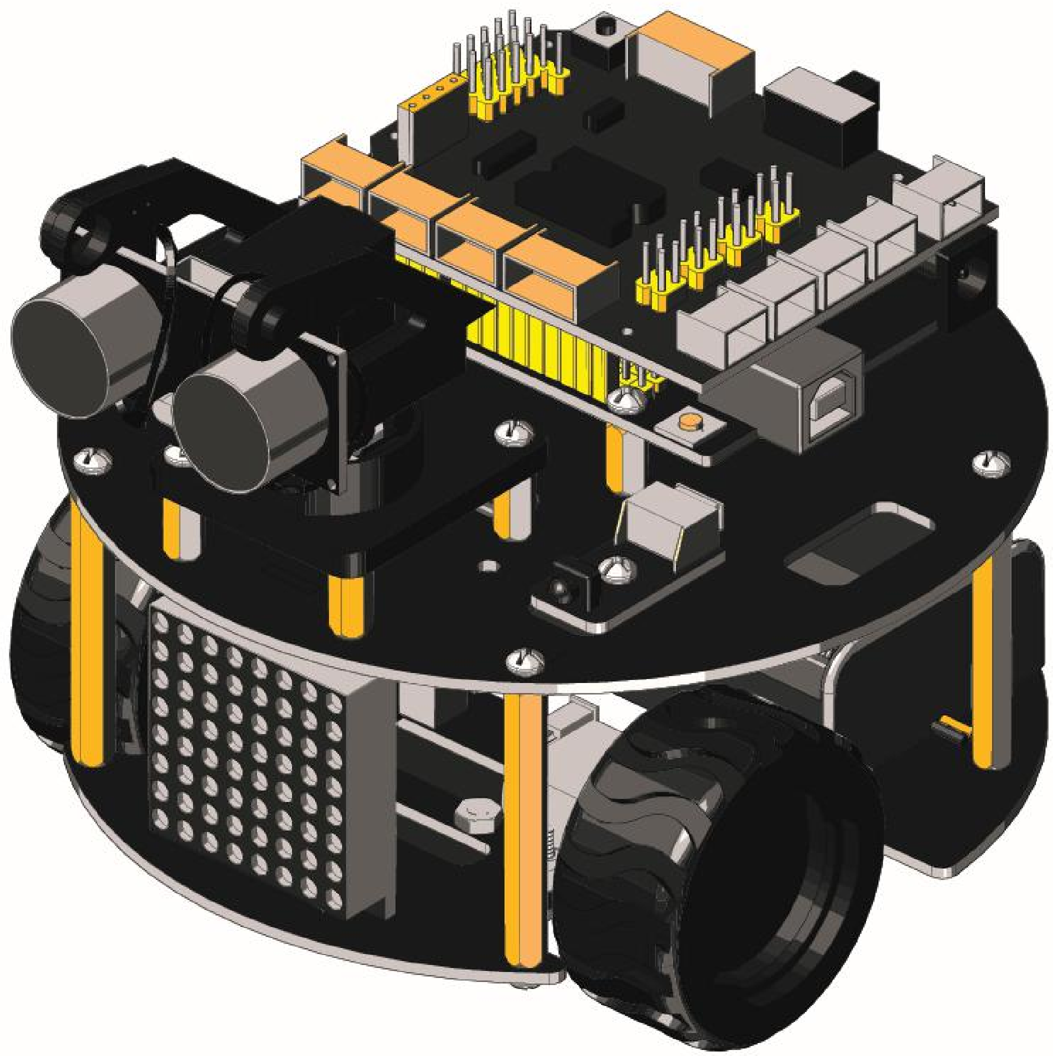
Prepare the parts as follows:

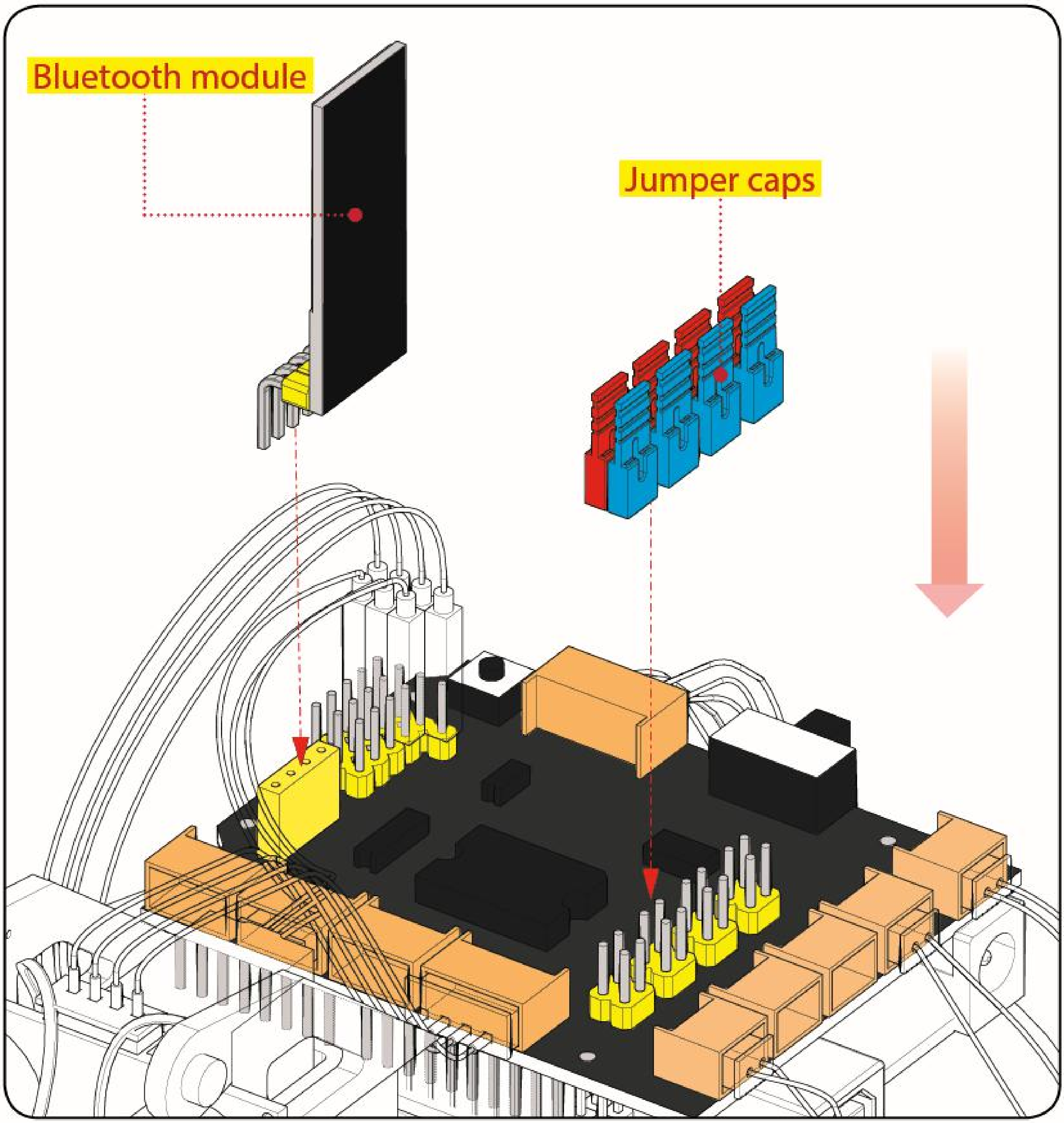
- M3*6MM Round Head Screw *12
- M3*40MM Hexagon Copper Bush*4
- 8x8 Dot Matrix *1
- Jumper Wire *4



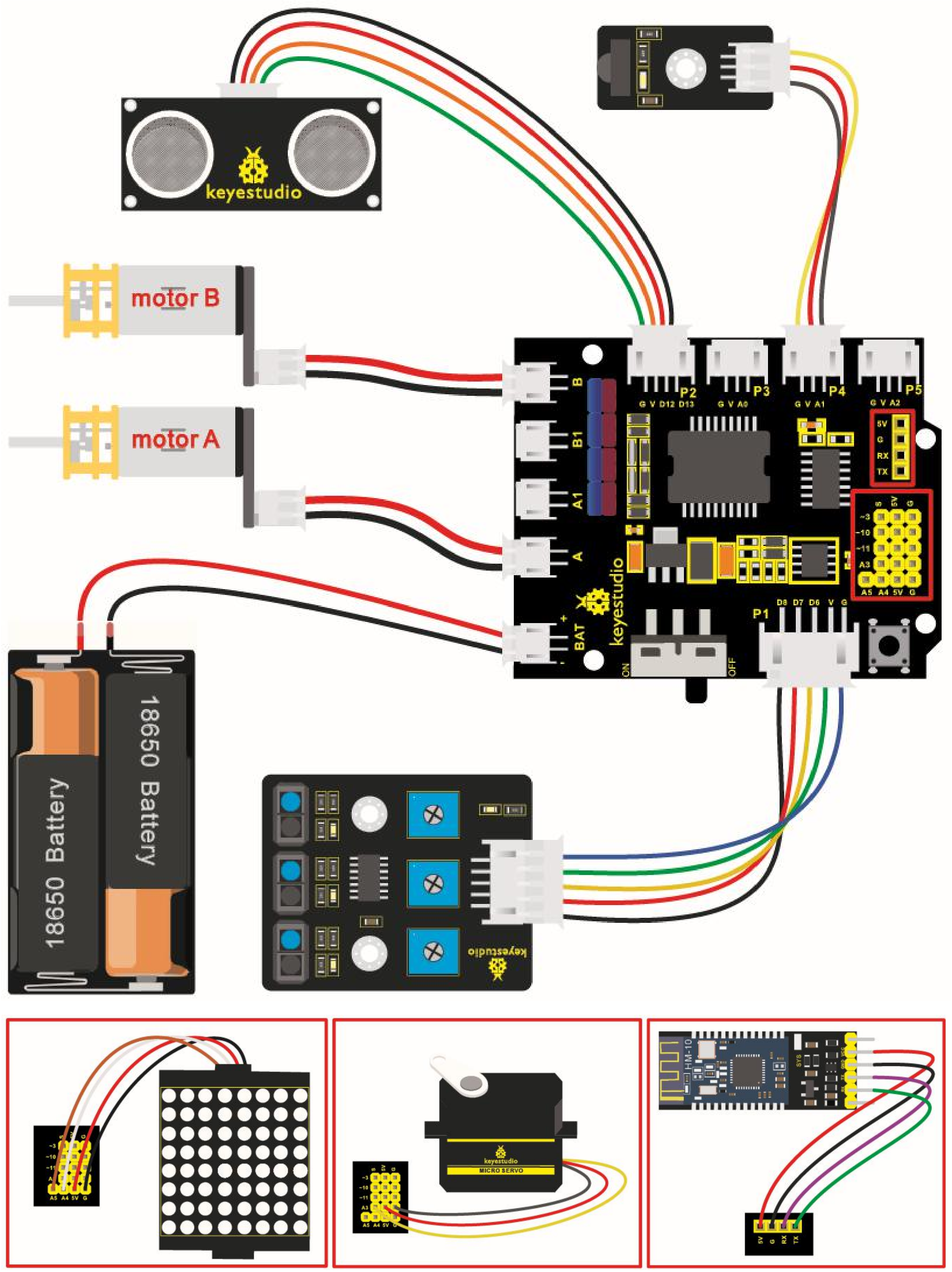

M3*6mm
M3*40mm
Connect 4P dupont line to dot matrix then install it on bottom board

Complete renderings

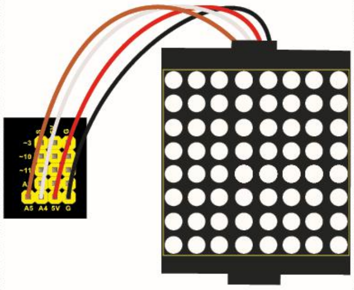
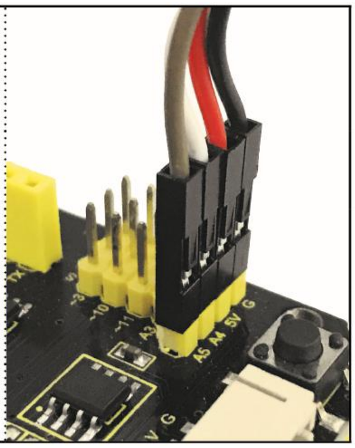



Bluetooth module
Jumper caps

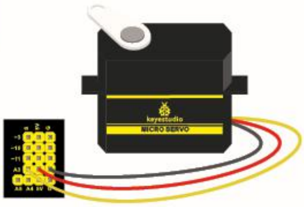
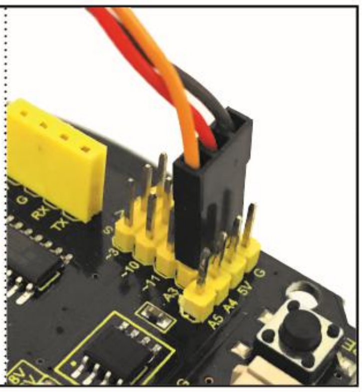
Step 7: Hook-up Guide



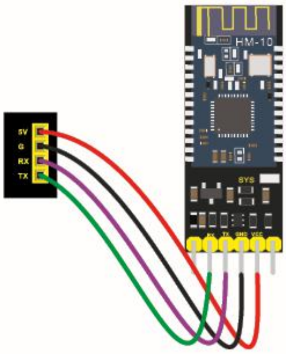
Dot Matrix	L298P Shield
SCL	A5
SDA	A4
5V	5V
G	G

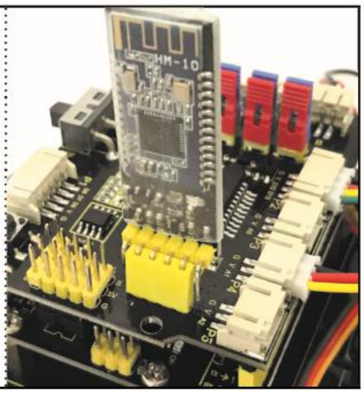



Servo	L298P Shield
Brown wire	G
Red wire	5V
Orange wire	A3

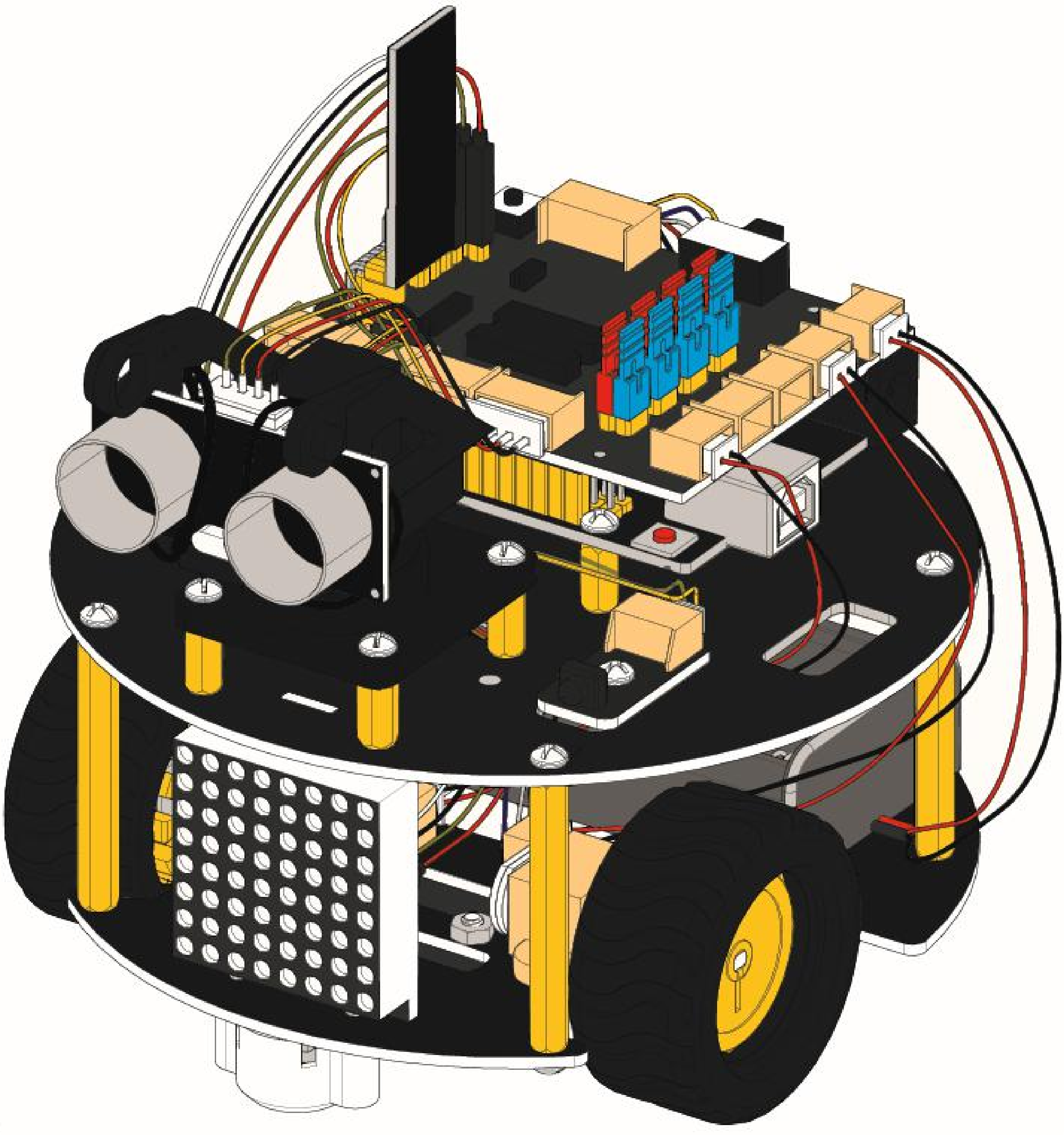



Bluetooth	L298P Shield
RXD	TX
TXD	RX
GND	G
VCC	5V





↘ Final renderings

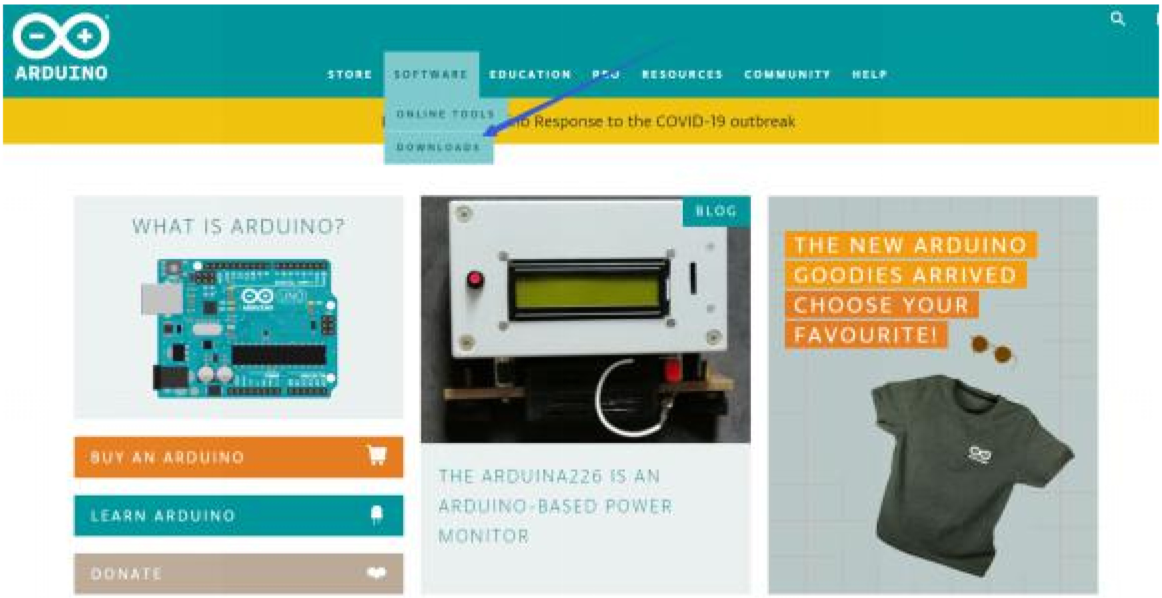


6. Getting Started with Arduino

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:



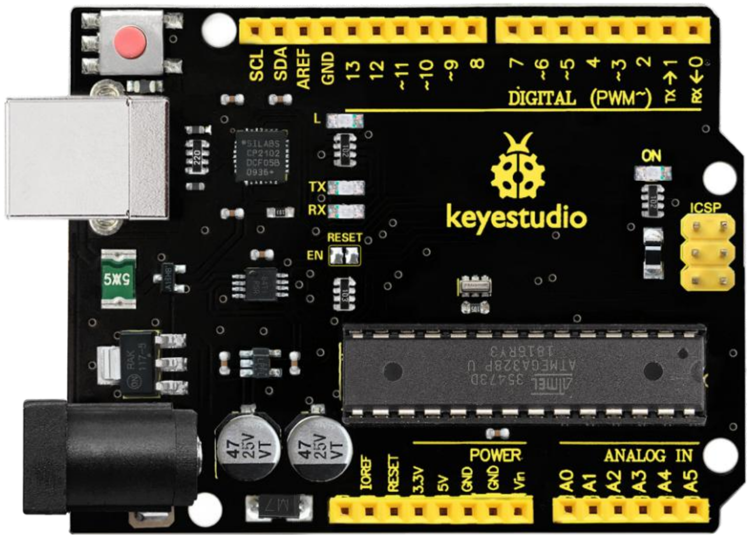
There are various versions Of IDE for Arduino, just download a version that compatible with your system, here we will show you how to download and install the windows version Arduino IDE.

There are two versions of IDE for WINDOWS system, you can choose between the Installer (.exe) and the Zip packages. We suggest you use the first one that installs directly everything you need to use the Arduino Software (IDE), including the drivers. With the Zip package you need to install the drivers manually. The Zip file is also useful if you want to create a portable installation.

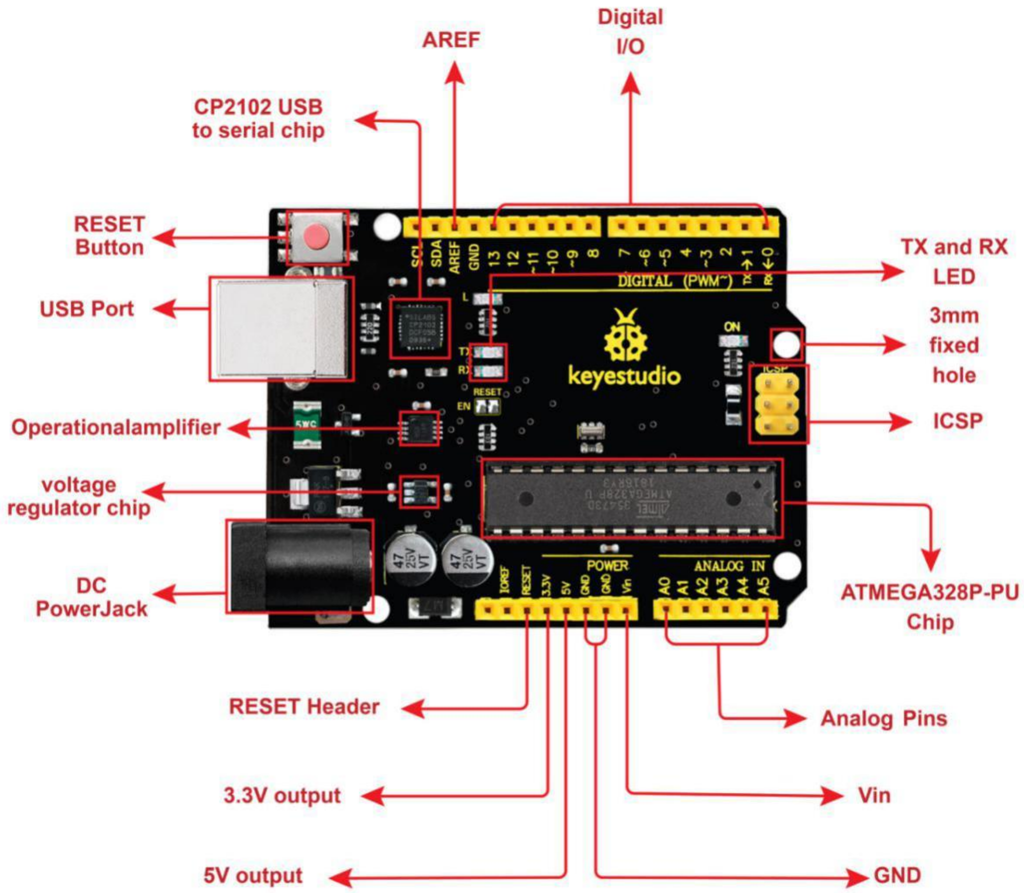
You just need to click JUST DOWNLOAD.

(1) Keyestudio V4.0 Development Board

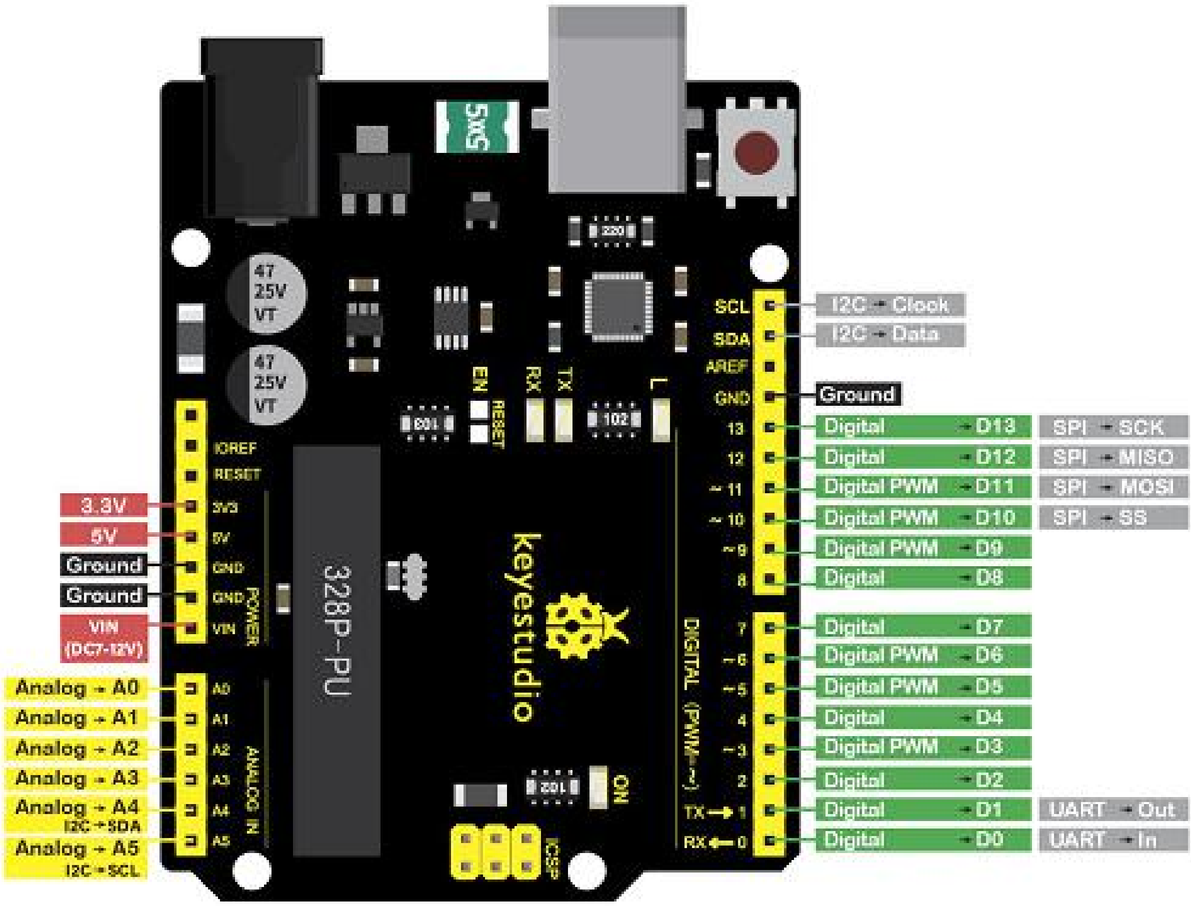
We need to know keyestudio V4.0 development board, as a core of this smart car.



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.

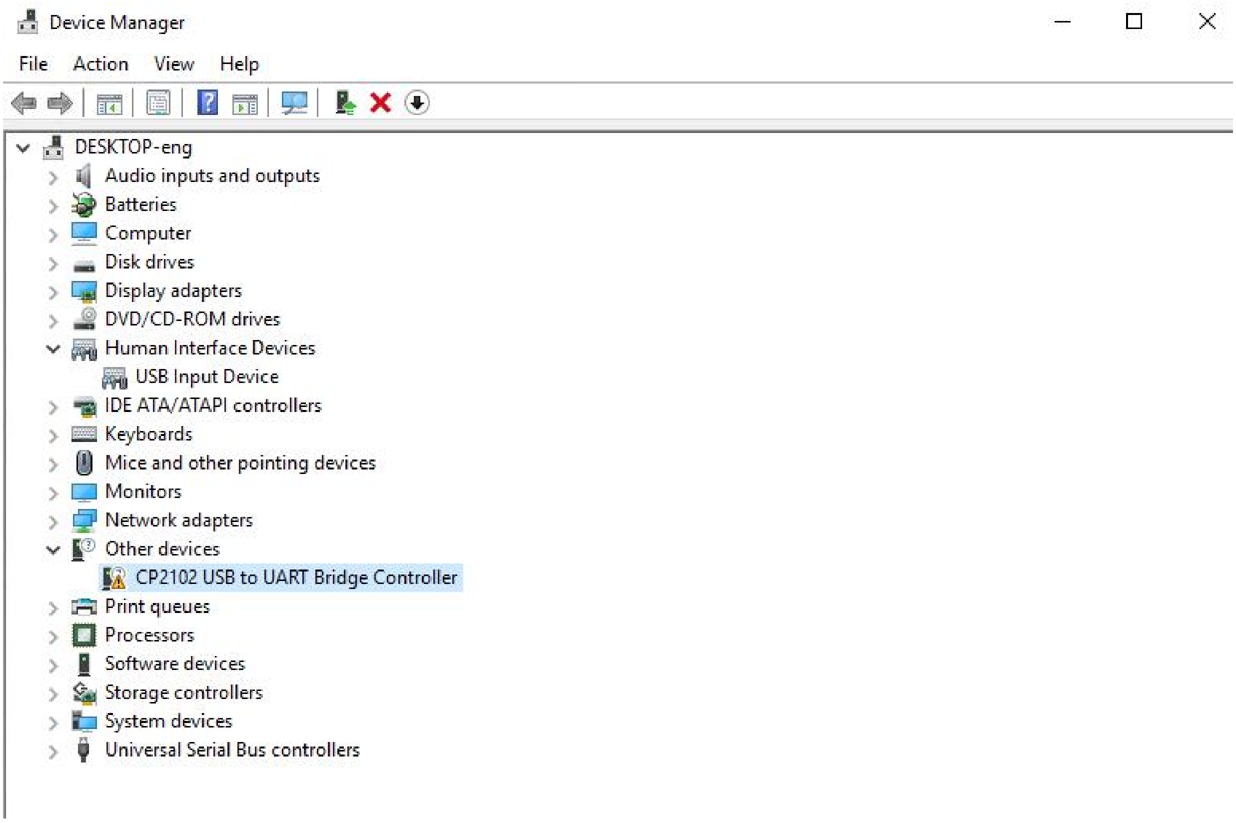
Microcontroller	ATmega328P-PU
Operating Voltage	5V
Input Voltage (recommended)	DC7-12V

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

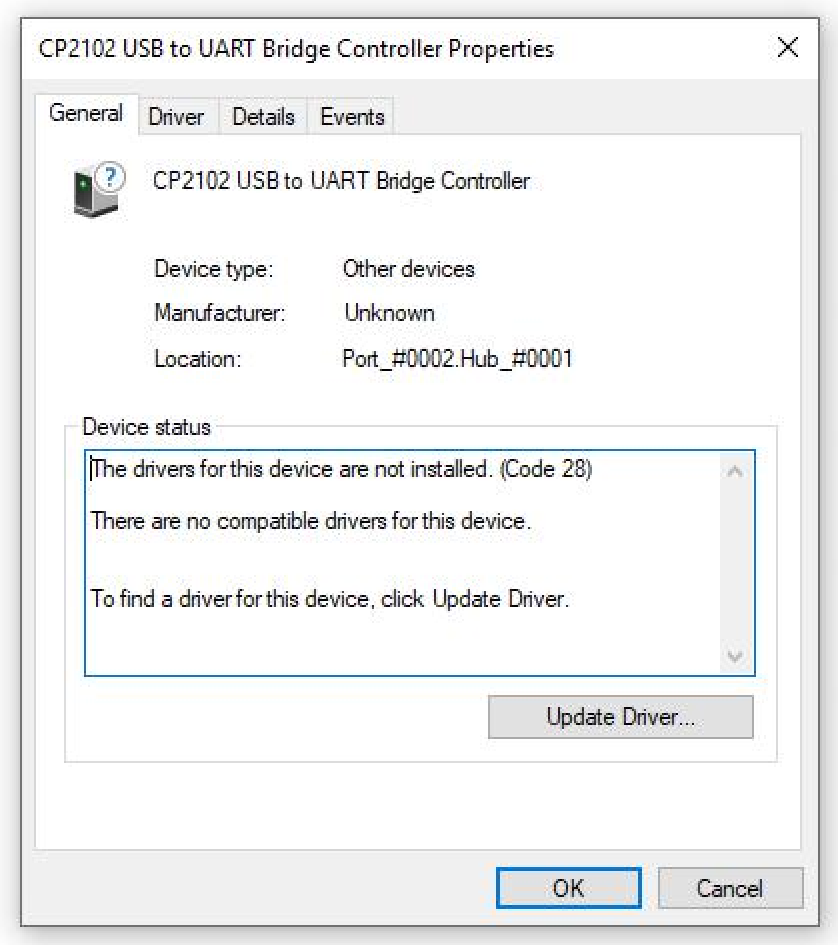
(2) Installing V4.0 board Driver

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.

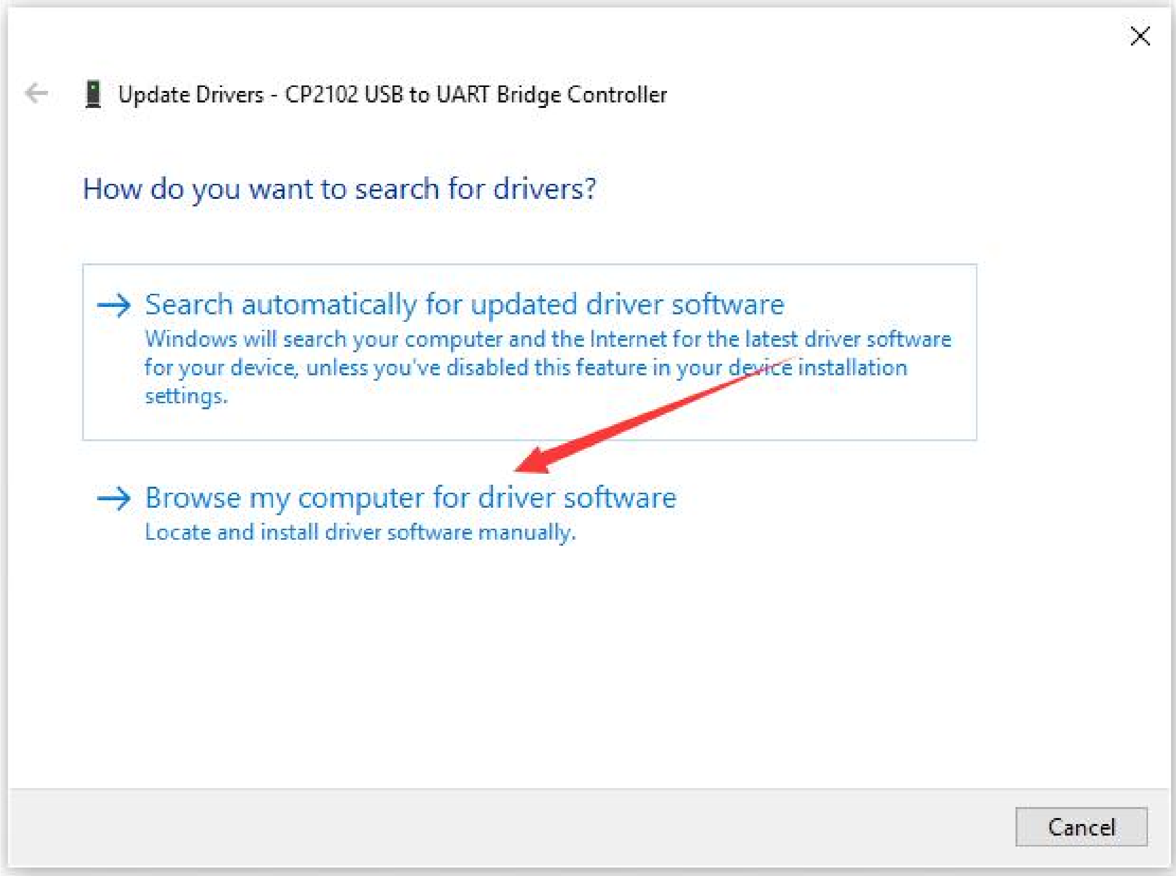
If install unsuccessfully, or you intend to install manually, open the device manager of computer. Right click Computer----- Properties----- Device Manager.



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



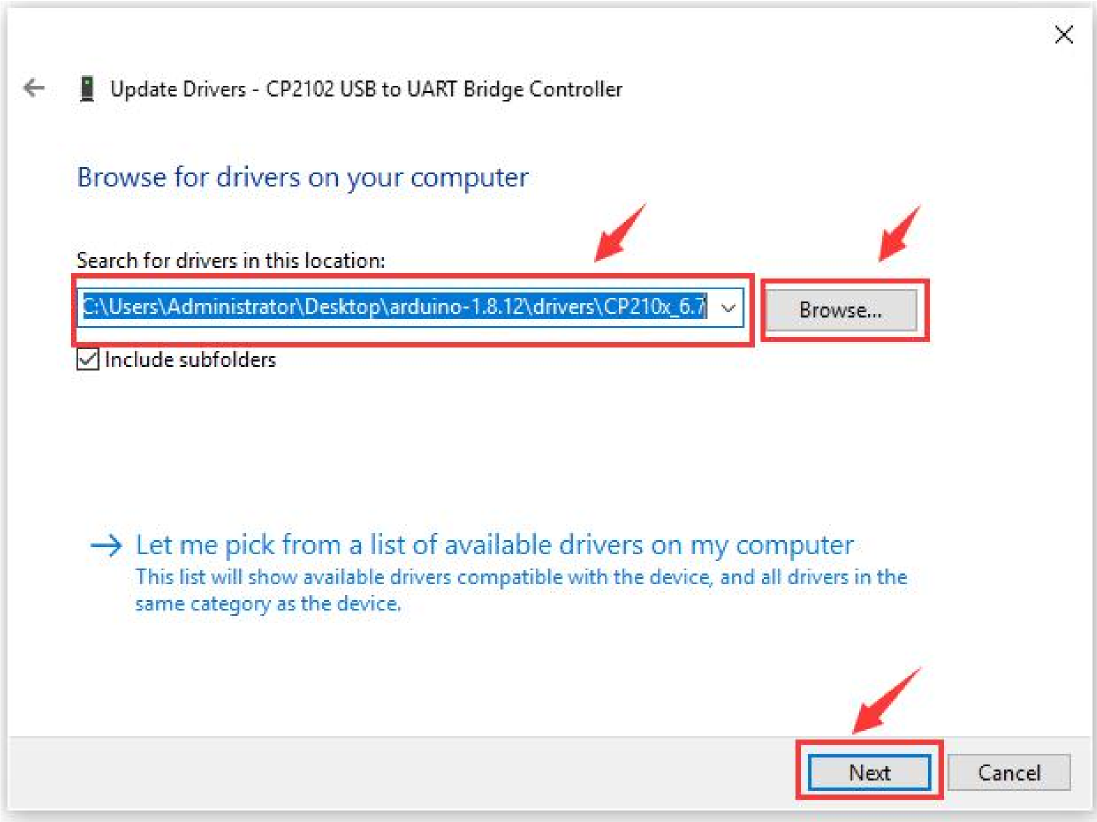
Click “OK” to enter the following page, click “browse my computer for updated driver software”, find out the installed or downloaded ARDUINO software. As shown below:



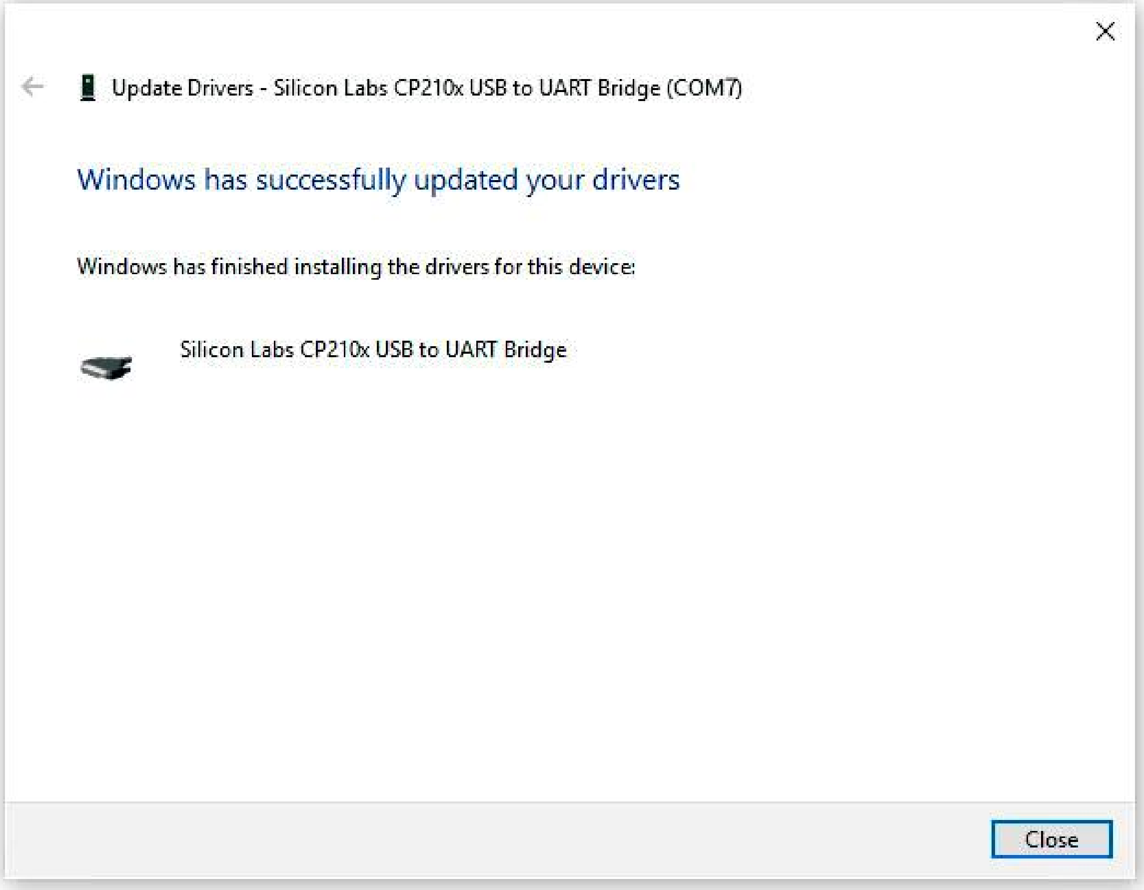
There is a DRIVERS folder in Arduino software installed package (

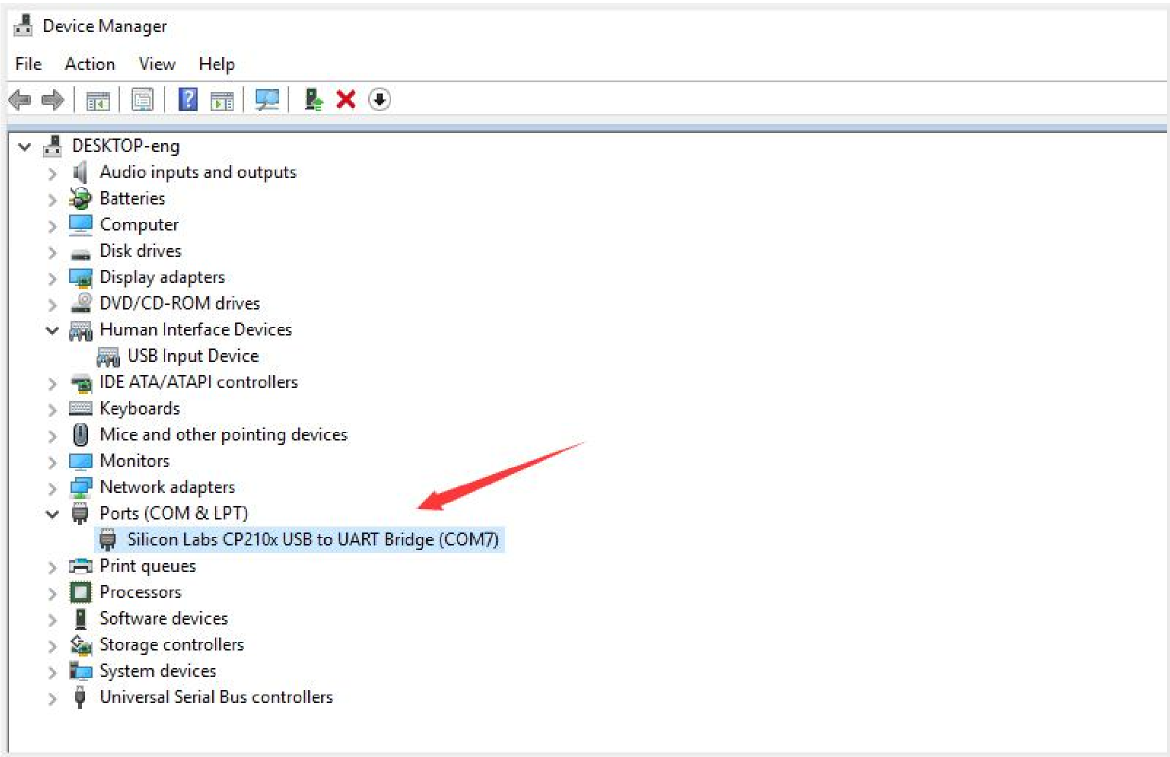
), open driver folder and you can see the driver of CP210X series chips.

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.

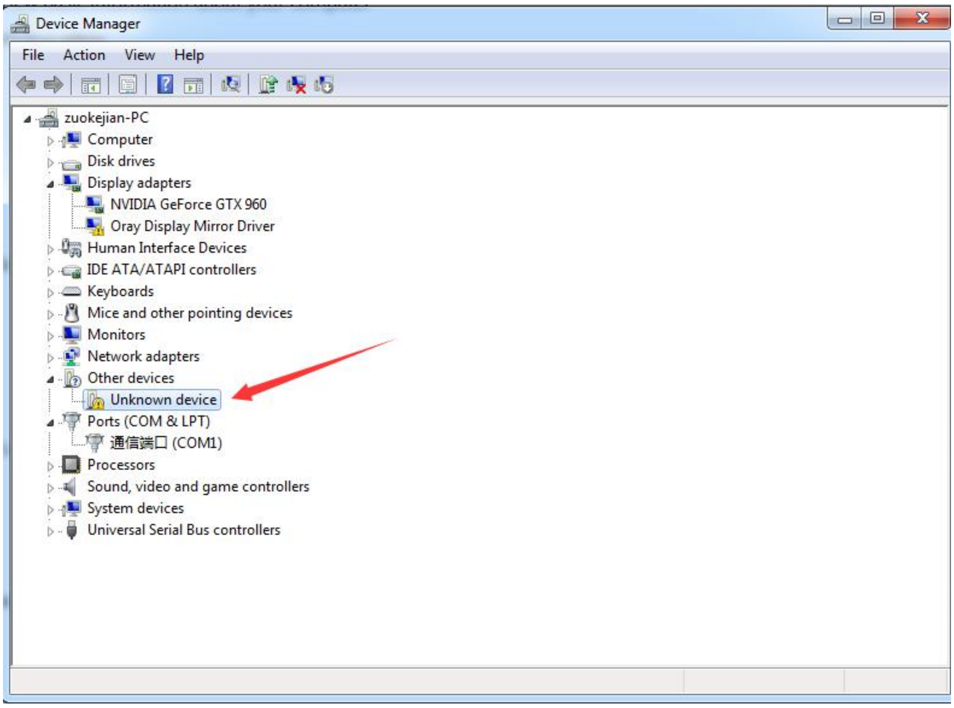

Update Drivers - Silicon Labs CP210x USB to UART Bridge (COM7)
Windows has successfully updated your drivers
Windows has finished installing the drivers for this device:
Silicon Labs CP210x USB to UART Bridge
Close


Device Manager
File
Action
View
Help
DESKTOP-eng
Audio inputs and outputs
Batteries
Computer
Disk drives
Display adapters
DVD/CD-ROM drives
Human Interface Devices
USB Input Device
IDE ATA/ATAPI controllers
Keyboards
Mice and other pointing devices
Monitors
Network adapters
Ports (COM & LPT)
Silicon Labs CP210x USB to UART Bridge (COM7)
Print queues
Processors
Software devices
Storage controllers
System devices
Universal Serial Bus controllers

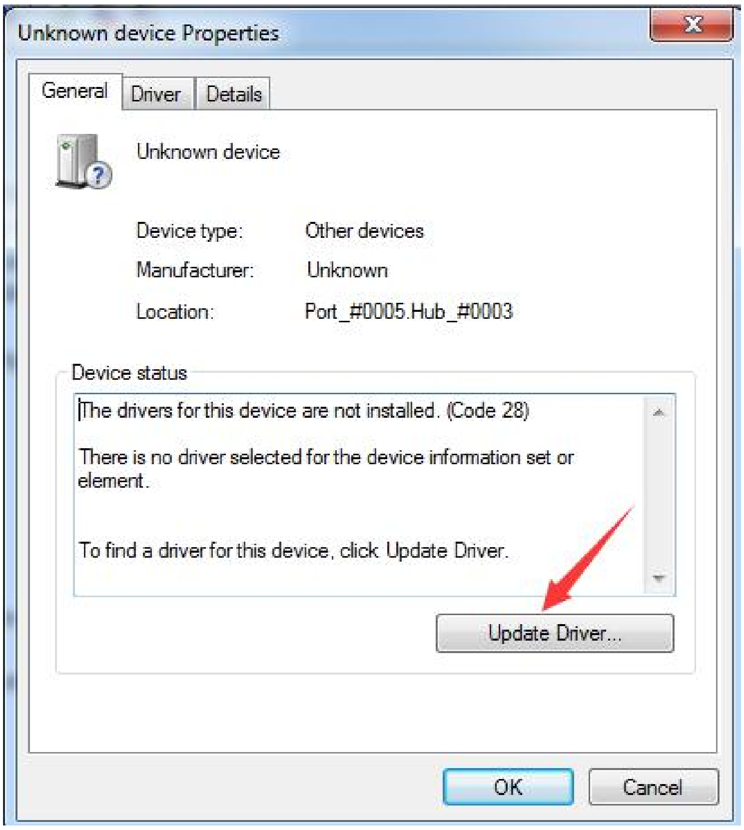
(3) Install other visions of driver

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

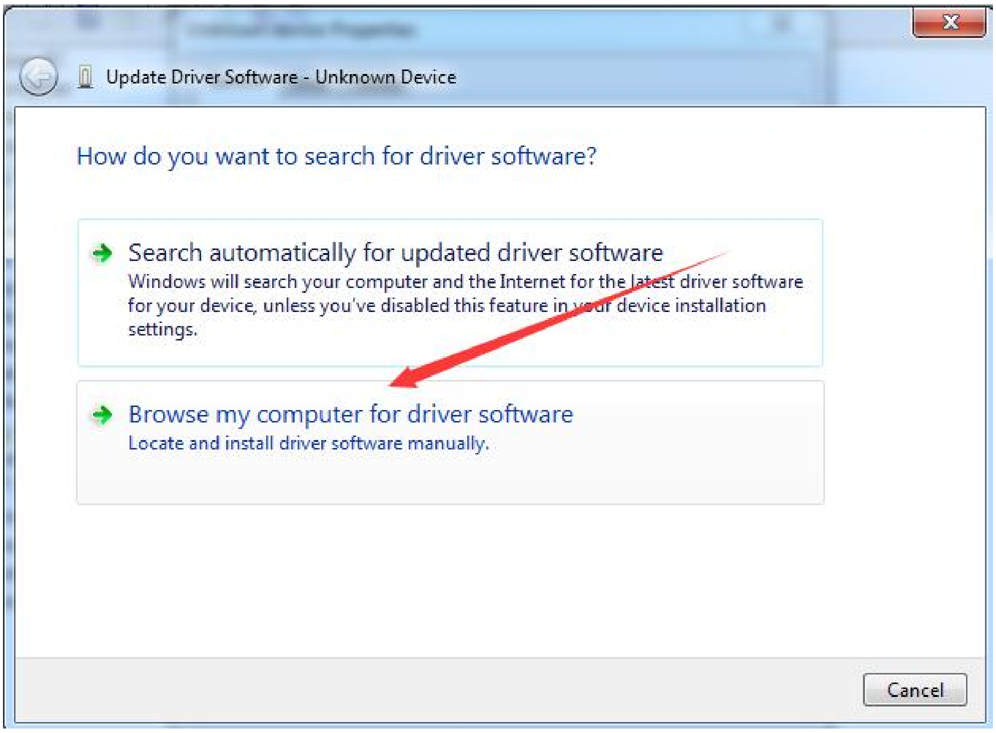
Step 1: Plug in the development board, click Computer----- Properties----- Device Manager, you could see the unknown device is shown.



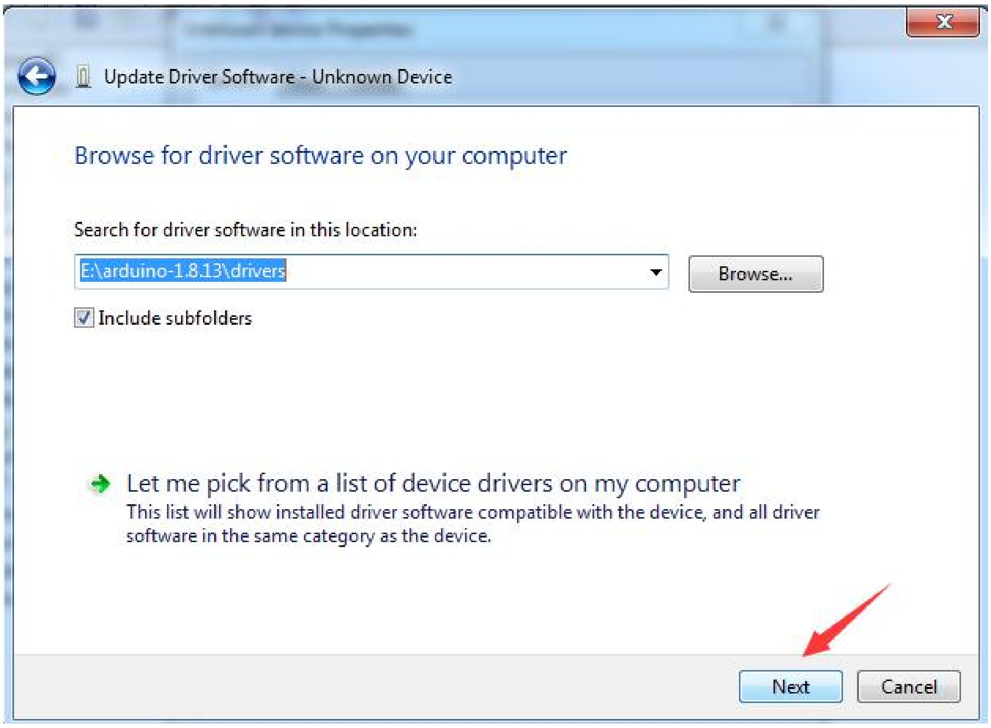
Step 2: Update the driver



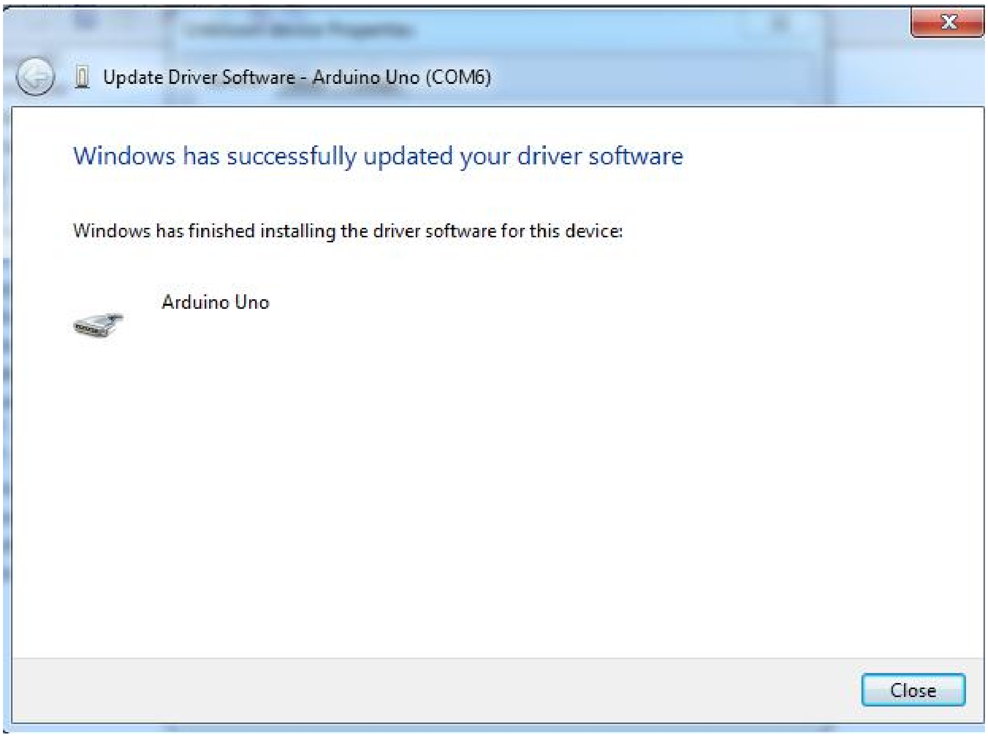
Step 3: click “browse my computer for updated driver software”



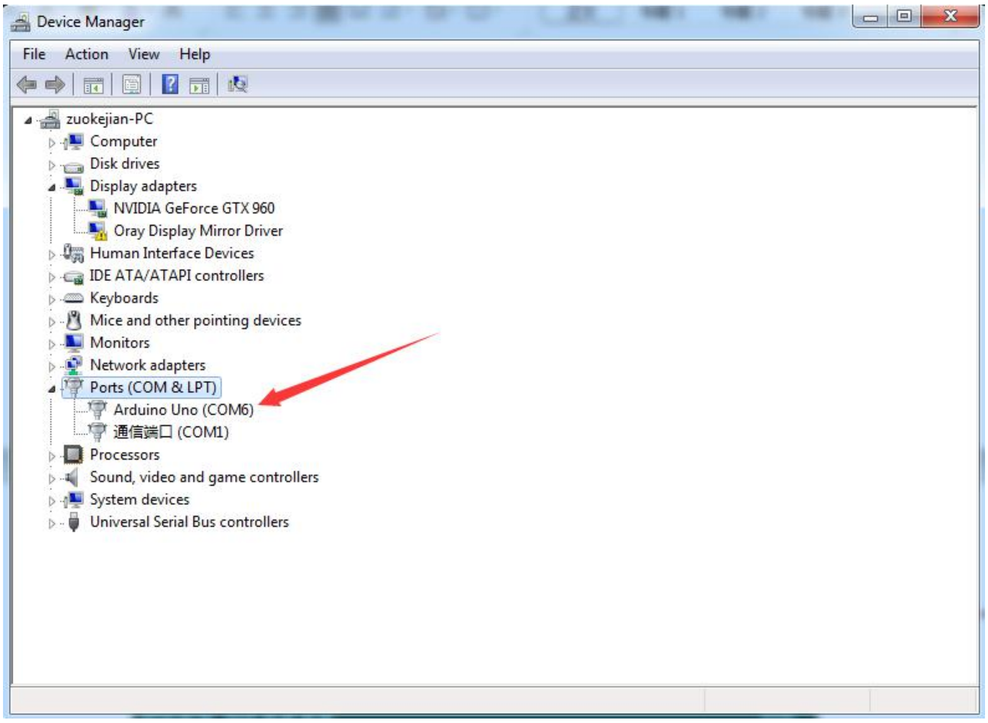
Step 4: find out the folder where the ARDUINO software is installed, click **drivers** folder and tap “Next”



Step 5: the driver is installed successfully.



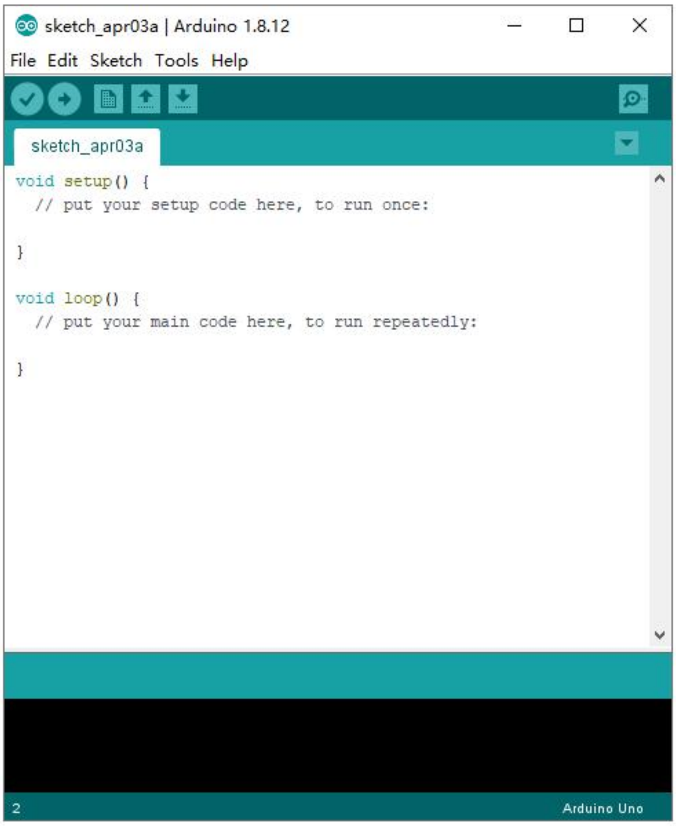
The device manager shows the serial port of Arduino.



(4) Arduino IDE Setting

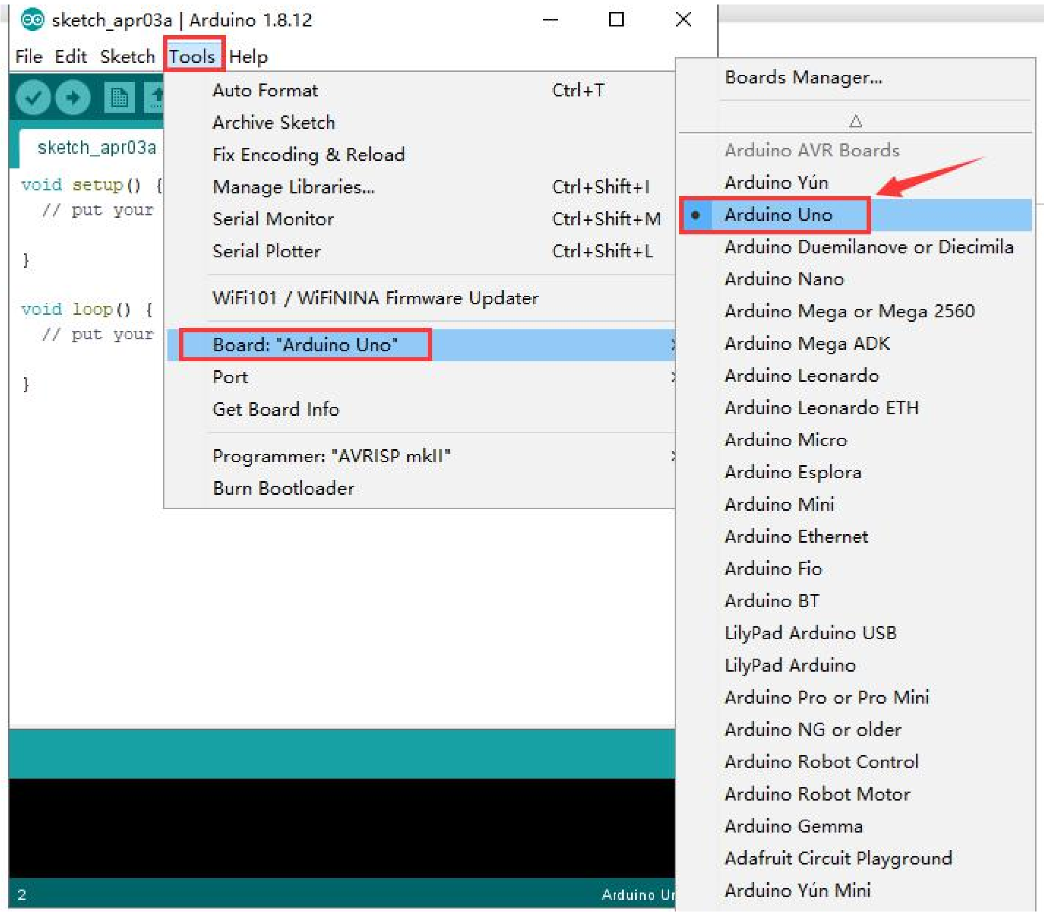
Click 

icon，open Arduino IDE.

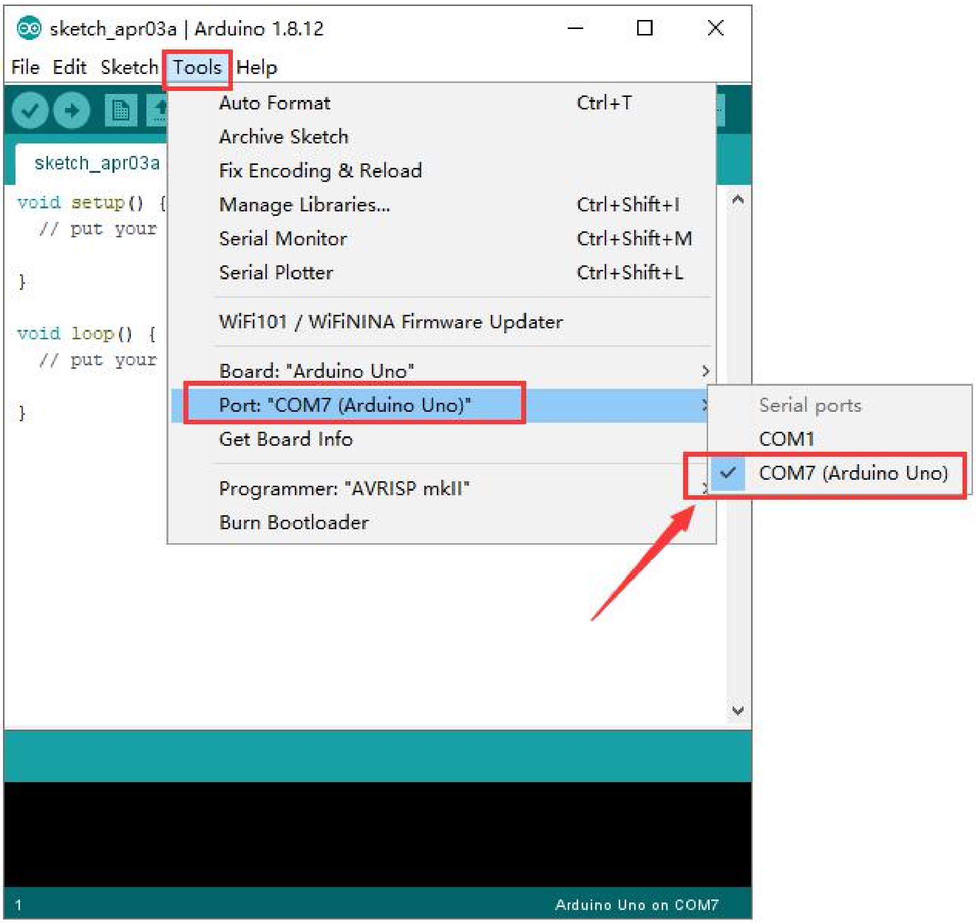


To avoid the errors when uploading the program to the board, you need to select the correct Arduino board that matches the board connected to your computer.

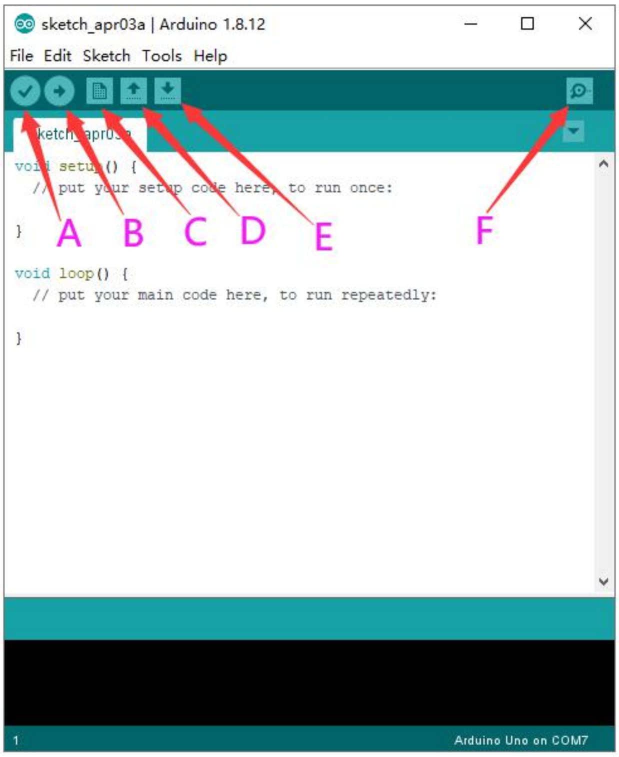
Then come back to the Arduino software, you should click Tools→Board, select the board. (as shown below)



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.

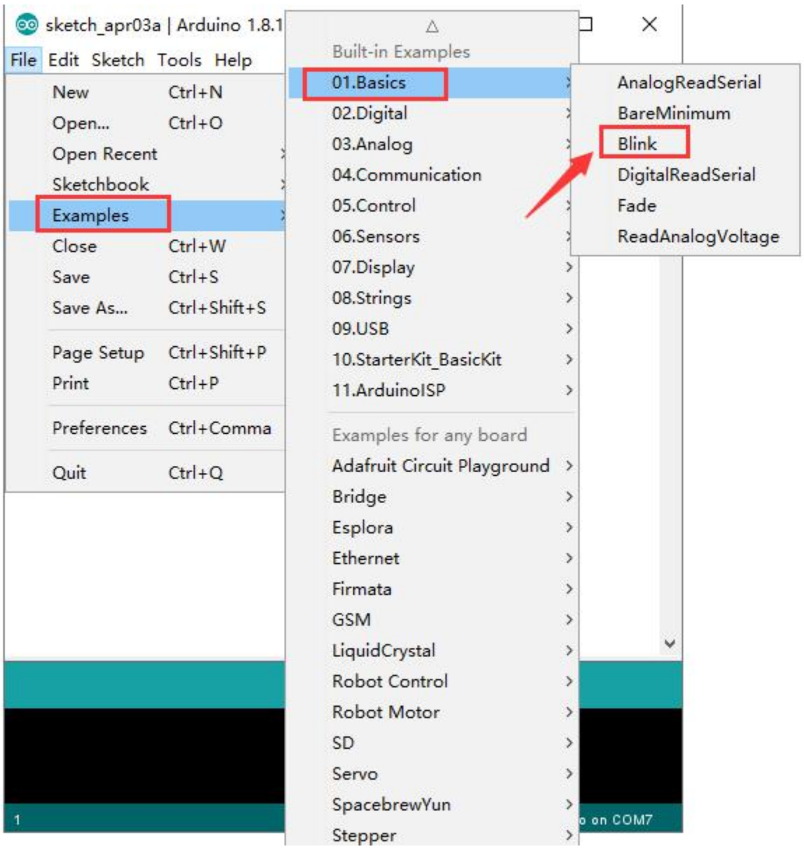
D- Used to directly open an example sketch.

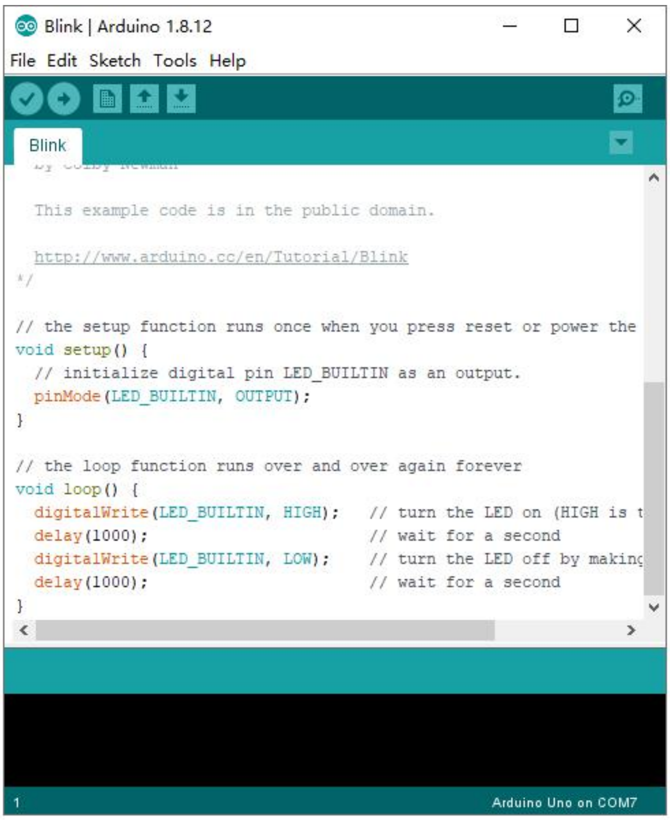
E- Used to save the sketch.

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

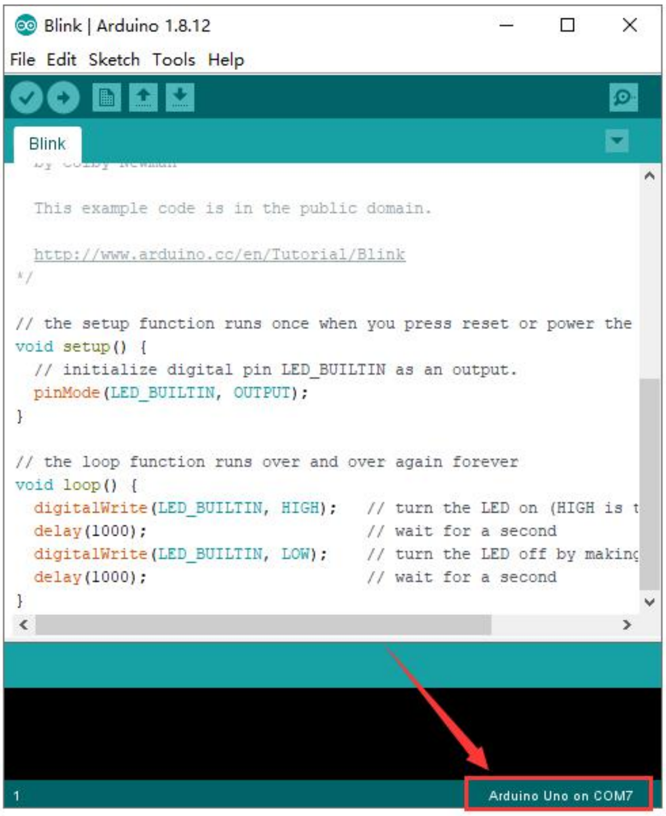
(5) Start First Program

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

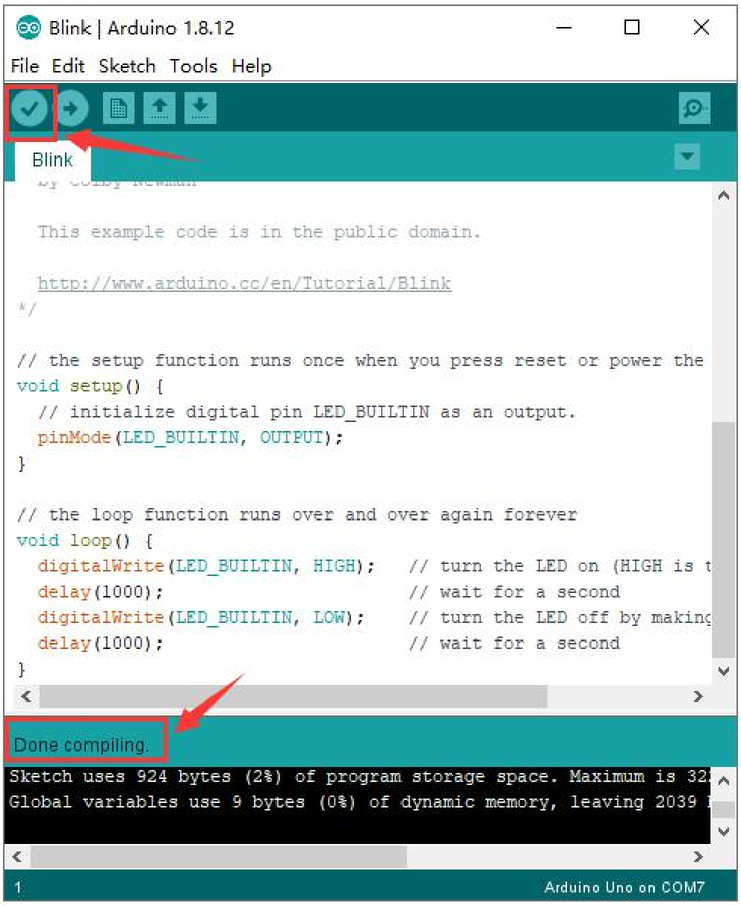


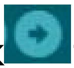


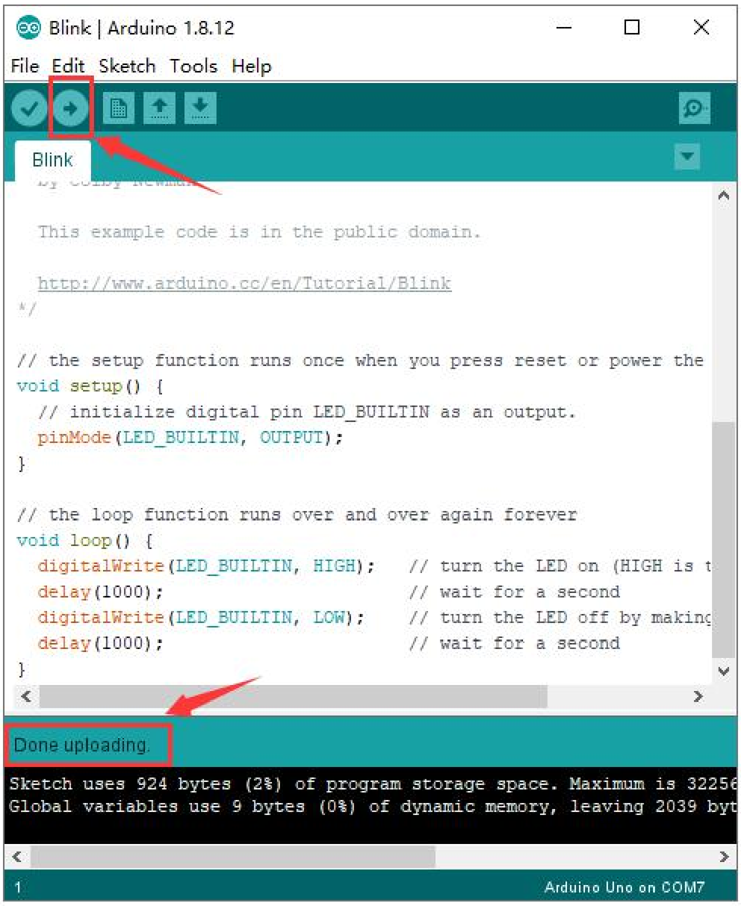
Set board and COM port, the corresponding board and COM port are shown on the lower right of IDE.



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. Add project Libraries

(1) 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.

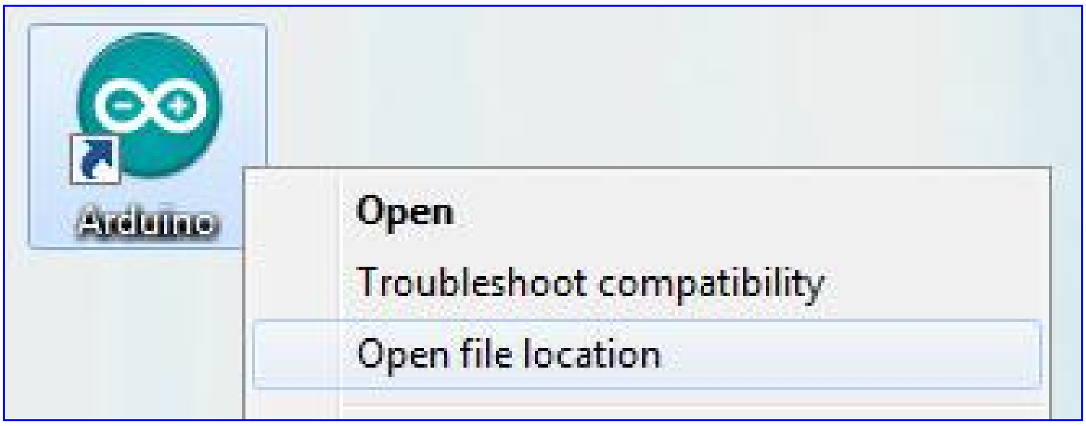
The built-in libraries and some of these additional libraries are listed in the reference.

(2) How to Install a Library ?

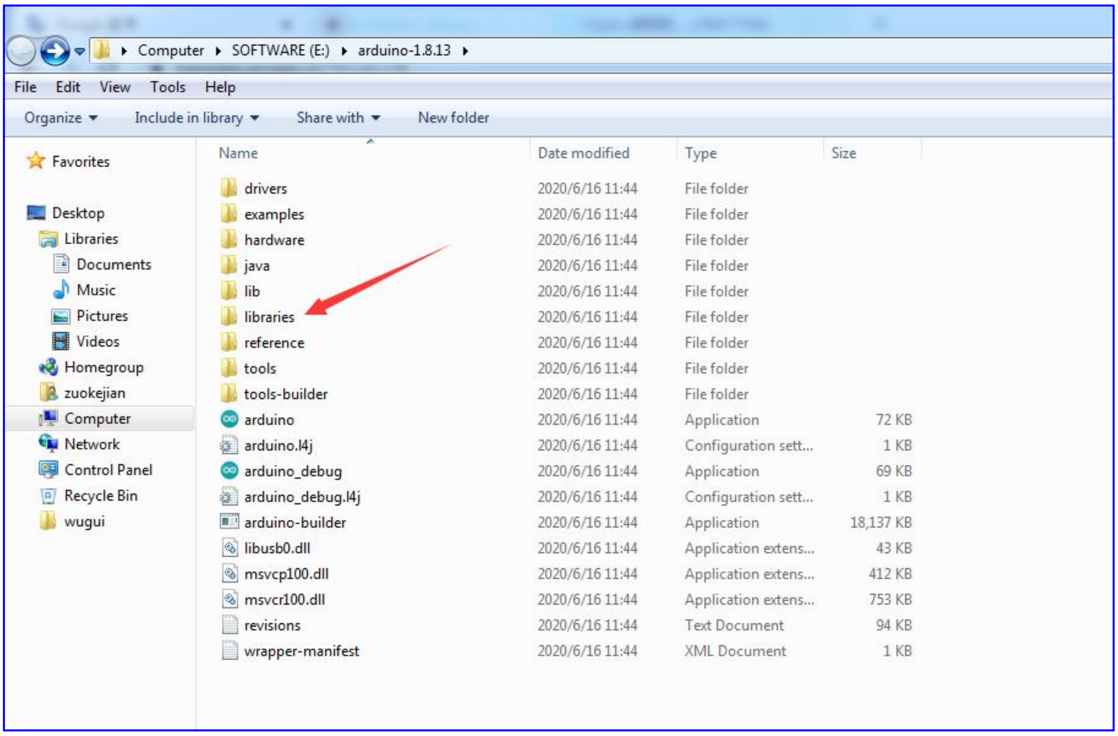
Here we will introduce the most simple way for you to add libraries .

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, this folder is the library file of Arduino.



Step 3： Next to find out the "libraries" folders of turtle robot(seen in the link: https://fs.keyestudio.com/KS0464), you just need to replicate and paste it into the libraries folder of Arduino IDE.

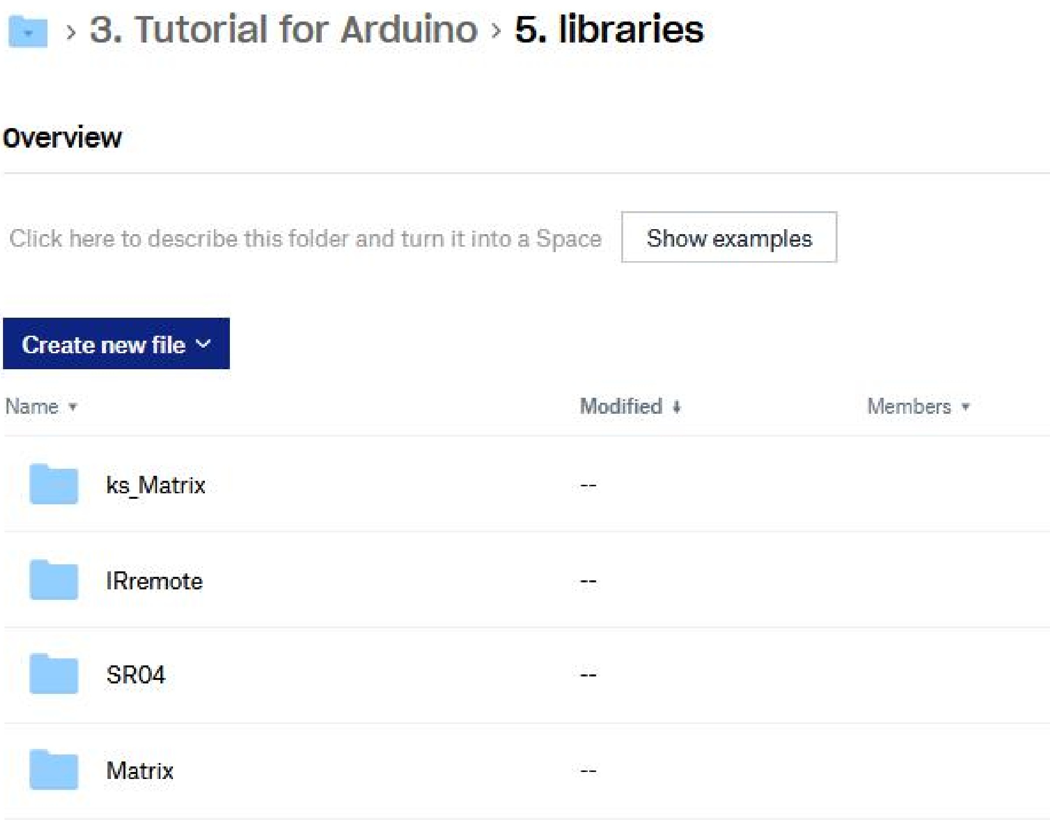
› 3. Tutorial for Arduino

Overview

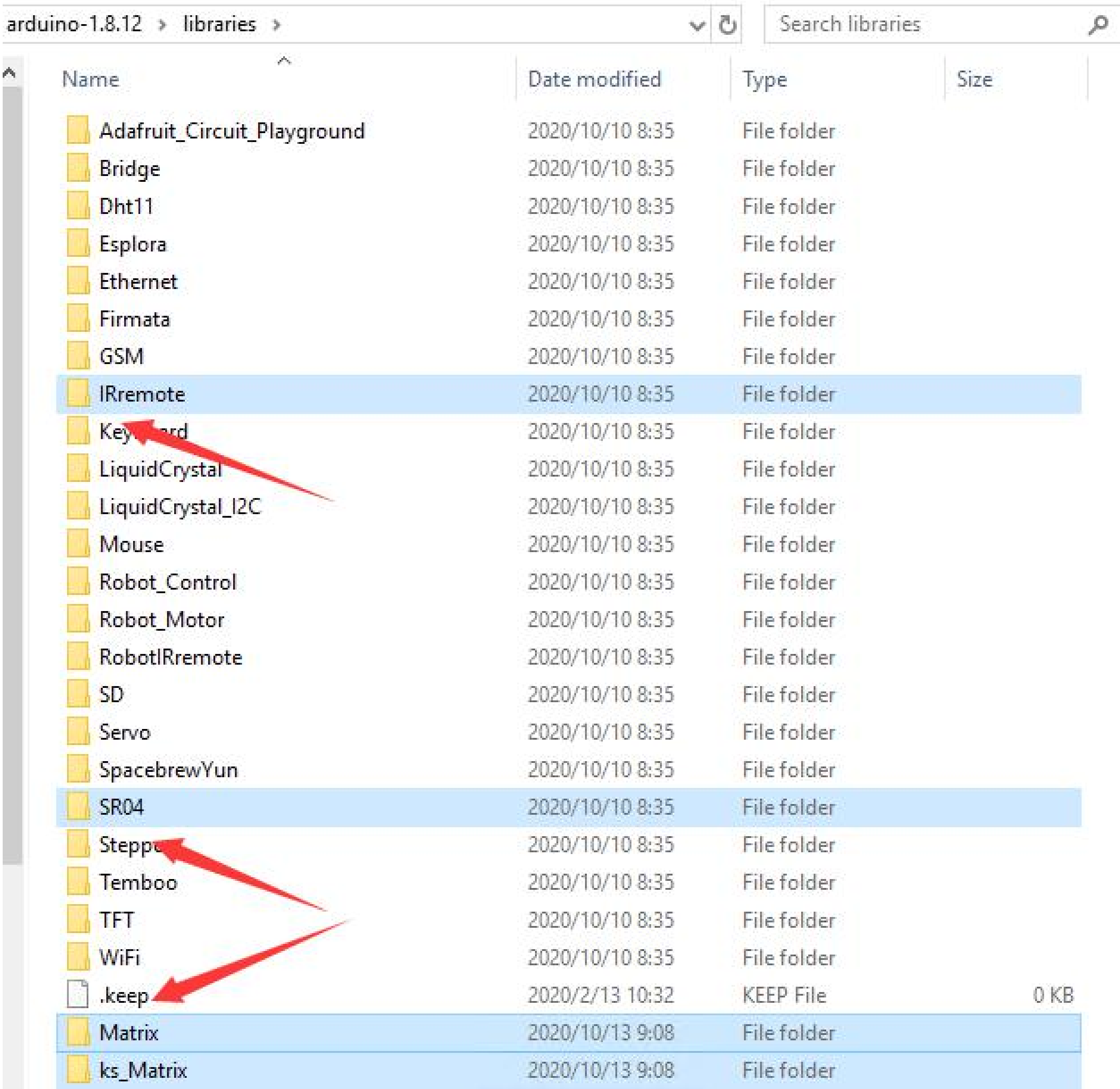
Click here to describe this folder and turn it into a Space Show examples

Create new file

Name	Modified	Members
1. Arduino software	--	Only you
2. Getting started with arduino	--	Only you
3. Tutorial	--	Only you
4. ARDUINO Code	--	Only you
5. libraries	--	Only you



Then the libraries of turtle robot are installed successfully, as shown below:



7. 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.

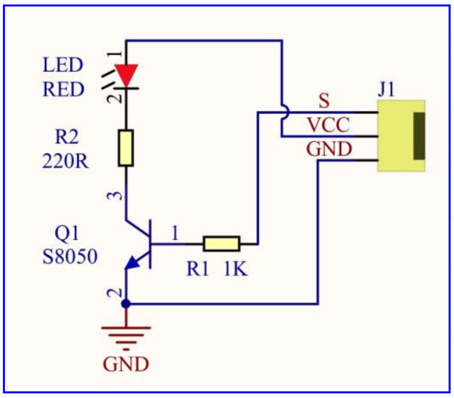
Note: (G), marked on each sensor and module, is negative pole and connected to “G”, ” -” or “GND” on the sensor shield or control board ; (V) is positive pole and linked with V , VCC, + or 5V on the sensor shield or control board.

Project 1: LED Blink

(1) Description

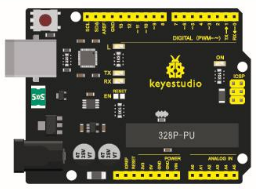
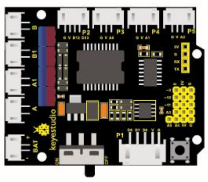
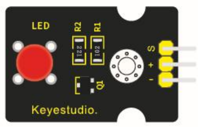
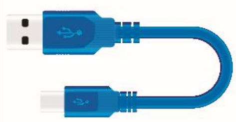
For the starter and enthusiast, this is a fundamental program---LED Blink. LED, the abbreviation of light emitting diodes, consist of Ga, As, P, N chemical compound and so on. The LED can flash diverse color by altering the delay time in the test code. When in control, power on GND and VCC, the LED will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

(2) Specification

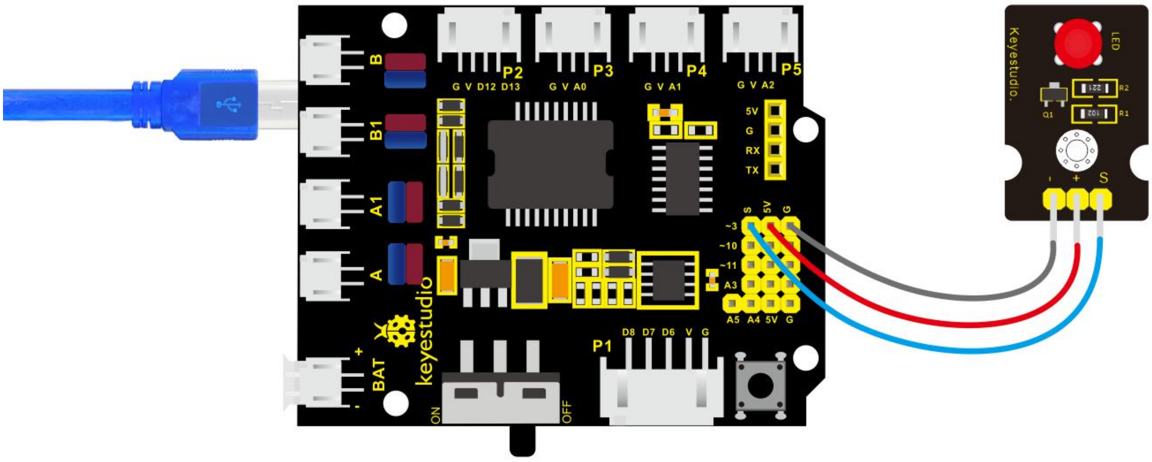


- Control interface: digital port
- Working voltage: DC 3.3-5V
- Pin spacing: 2.54mm
- LED display color: red

(3) Components

Control Board *1	L298P Motor Shield*1	LED Module *1	3Pin Dupont Line *1	USB Cable *1
				

(3) Wiring Diagram



The expansion board is stacked on development board, -, “+” and S pins of LED module are respectively connected to G, 5V and D3 pins of shield.

(4) Test Code

```
/*
  keyestudio smart turtle robot
  lesson 1.1
  Blink
  http://www.keyestudio.com
*/
void setup()
{
    pinMode(3, OUTPUT);// initialize digital pin 3 as an output.
```

```
}

void loop() // the loop function runs over and over again forever
{
  digitalWrite(3, HIGH); // turn the LED on (HIGH is the voltage level)
  delay(1000); // wait for a second
  digitalWrite(3, LOW); // turn the LED off by making the voltage LOW
  delay(1000); // wait for a second
}
//*************************************************************************
```

(5) Test Result:

Upload the program, LED connected to D3 flickers with the interval of 1s.

(6) Code Explanation

pinMode(3， OUTPUT) - This function can denote that the pin is INPUT or OUTPUT

digitalWrite(3, HIGH) - When pin is OUTPUT, we can set it to HIGH(output 5V) or LOW(output 0V)

(7) Extension Practice

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

```
/*
 keyestudio smart turtle robot
 lesson 1.2
 delay
 http://www.keyestudio.com
*/
void setup()
{
  // initialize digital pin 11 as an output.
  pinMode(3, OUTPUT);
}
// the loop function runs over and over again forever
void loop()
{
  digitalWrite(3, HIGH); // turn the LED on (HIGH is the voltage level)
  delay(100); // wait for 0.1 second
  digitalWrite(3, 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 could affect flash frequency.

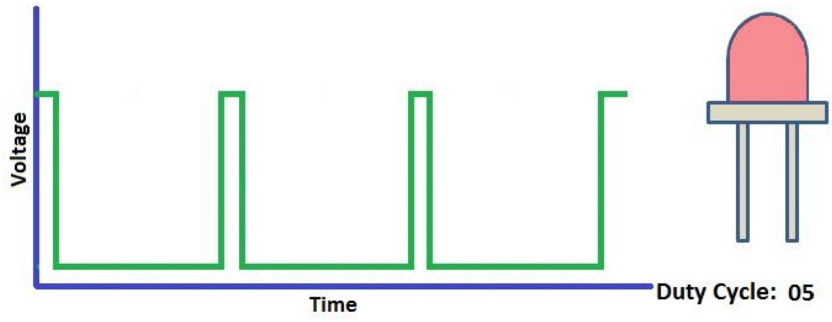
Project 2: Adjust LED Brightness

(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.

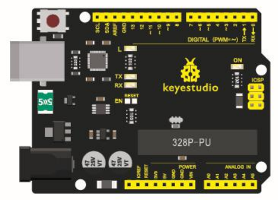
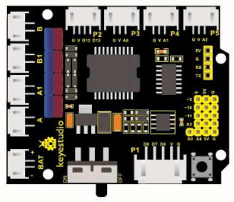
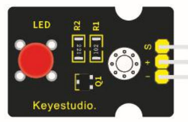
PWM is a means of controlling the analog output via digital means. Digital control is used to generate square waves with different duty cycles (a signal that constantly switches between high and low levels) to control the analog output.In general, the input voltage of port are 0V and 5V. What if the 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.



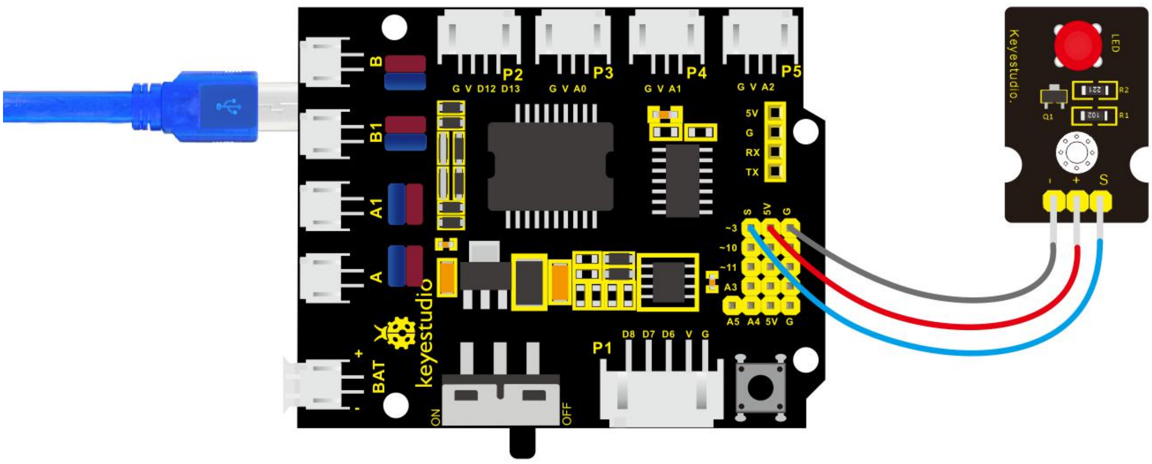
For the Arduino digital port voltage output, there are only LOW and HIGH, which correspond to the voltage output of 0V and 5V. You can define LOW as 0 and HIGH as 1, and let the Arduino output five hundred 0 or 1 signals within 1 second.

If output five hundred 1, that is 5V; if all of which is 1, that is 0V. If output 010101010101 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) Components

Control Board *1	L298P Motor Shield*1	LED Module *1	3Pin Dupont Line *1
			 USB Cable *1 

(3) Hook-up Diagram



(4) Test Code:

```
/*
 keyestudio smart turtle robot
 lesson 2.1
 pwm
 http://www.keyestudio.com
```

```
*/
int ledPin = 3; // Define the LED pin at D3
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 (5); // delay 5MS
  }
  for (value = 255; value> 0; value = value-1)
  {
    analogWrite (ledPin, value); // LED gradually goes out
    delay (5); // delay 5MS
  }
}
```

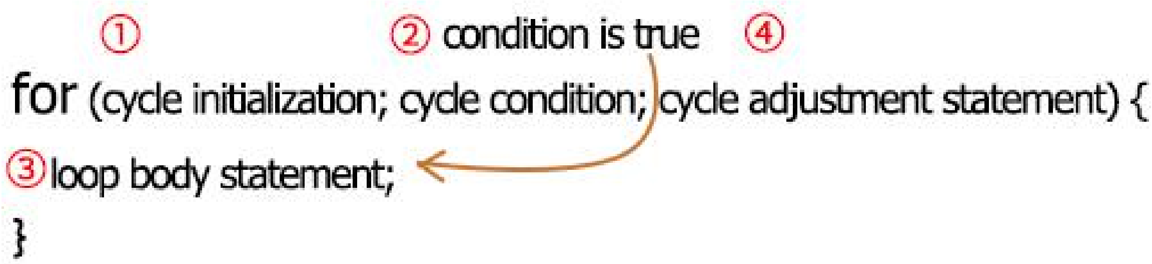
(5) Test Result:

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

(6) Code Explanation

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

FOR statement format is shown below:



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.

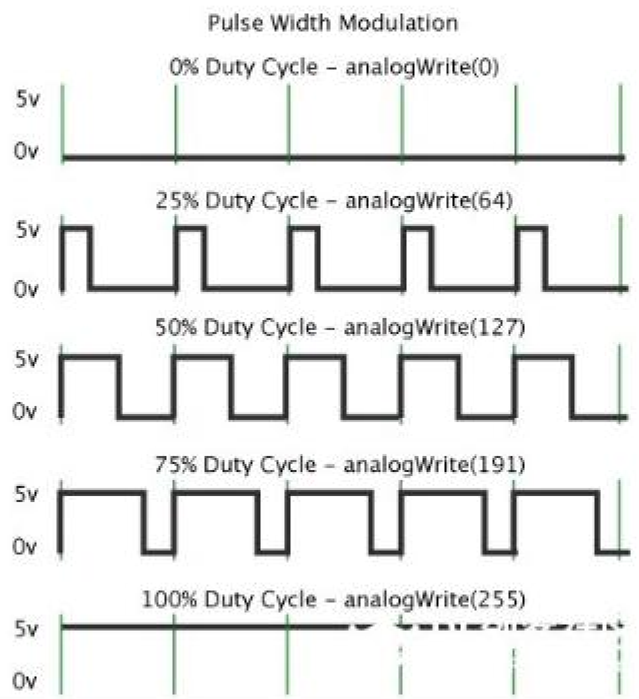
Function format as follows:

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.

(7) Extension Practice:

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

```
/*
 keyestudio smart turtle robot
 lesson 2.2
 pwm
 http://www.keyestudio.com
*/
int ledPin = 3; // Define the LED pin at D3
void setup () {
   pinMode(ledPin, OUTPUT); // initialize ledpin as an output.
}

void loop () {
   for (int value = 0; value <255; value = value + 1) {
     analogWrite (ledPin, value); // LED lights gradually light up
     delay (30); // delay 50MS
   }
   for (int value = 255; value> 0; value = value-1) {
```

```
        analogWrite (ledPin, value); // LED gradually goes out
        delay (30); // delay 50MS
    }
}
//*************************************************************
```

Upload the code to development board, LED flickers more slowly.

Project 3 : Line Tracking Sensor

(1) Description

The tracking sensor is actually an infrared sensor. The component used here is the TCRT5000 infrared tube.

Its working principle is to use the different reflectivity of infrared light to the color, then convert the strength of the reflected signal into a current signal.

During the process of detection, black is active at HIGH level, but white is active at LOW level. The detection height is 0-3 cm.

Keyestudio 3-channel line tracking module has integrated 3 sets of TCRT5000 infrared tube on a single board, which is more convenient for wiring and control.

By rotating the adjustable potentiometer on the sensor, it can adjust the detection sensitivity of the sensor.

(2) Specification:

Operating Voltage: 3.3-5V (DC)

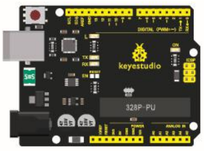
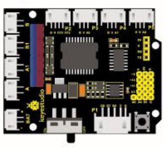
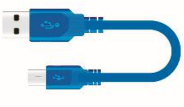
Interface: 5PIN

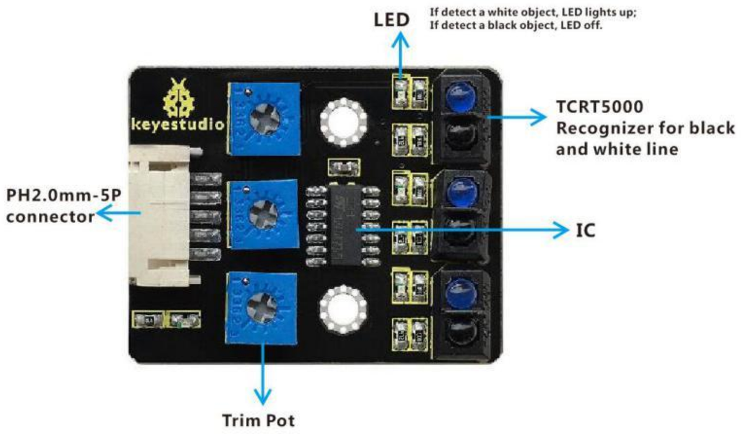
Output Signal: Digital signal

Detection Height: 0-3 cm

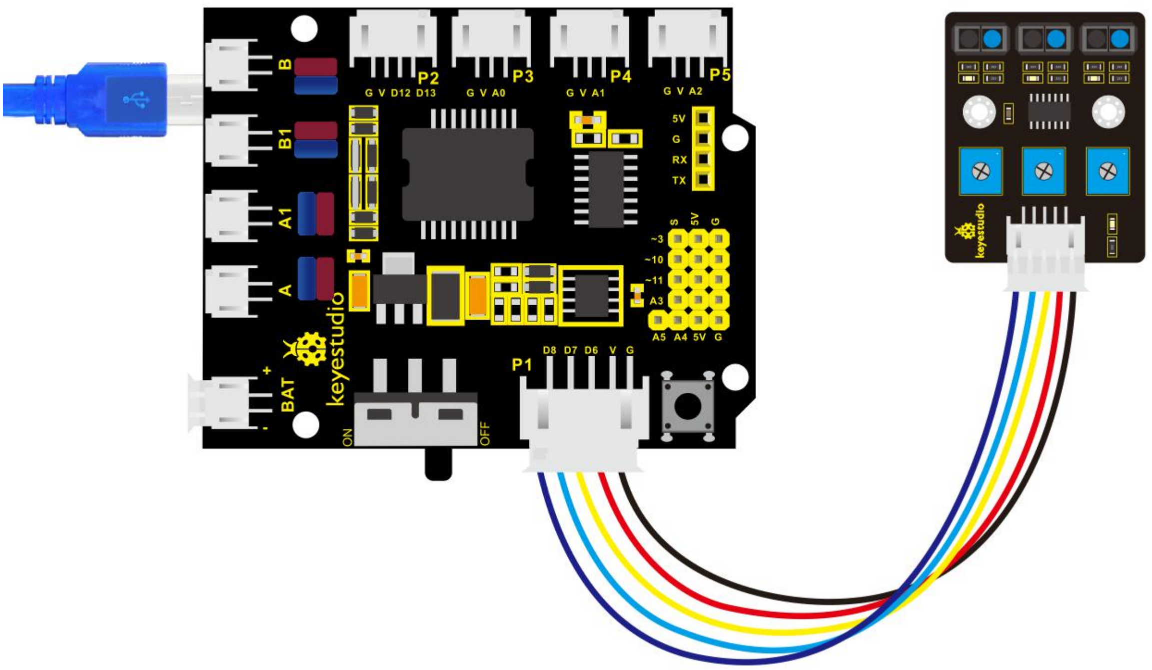
Special note: before testing, turn the potentiometer on the sensor to adjust the detection sensitivity. When adjust the LED at the threshold between ON and OFF, the sensitivity is the best.

(3) Components

V4.0 Control board *1	L298P Motor Shield*1	Channel Line Tracking *1	LED module *1	USB cable *1	3pin Dupont line *1
					 5pin Dupont line *1 



(4) Connection Diagram:



(5) Test Code

/*

keyestudio smart turtle robot

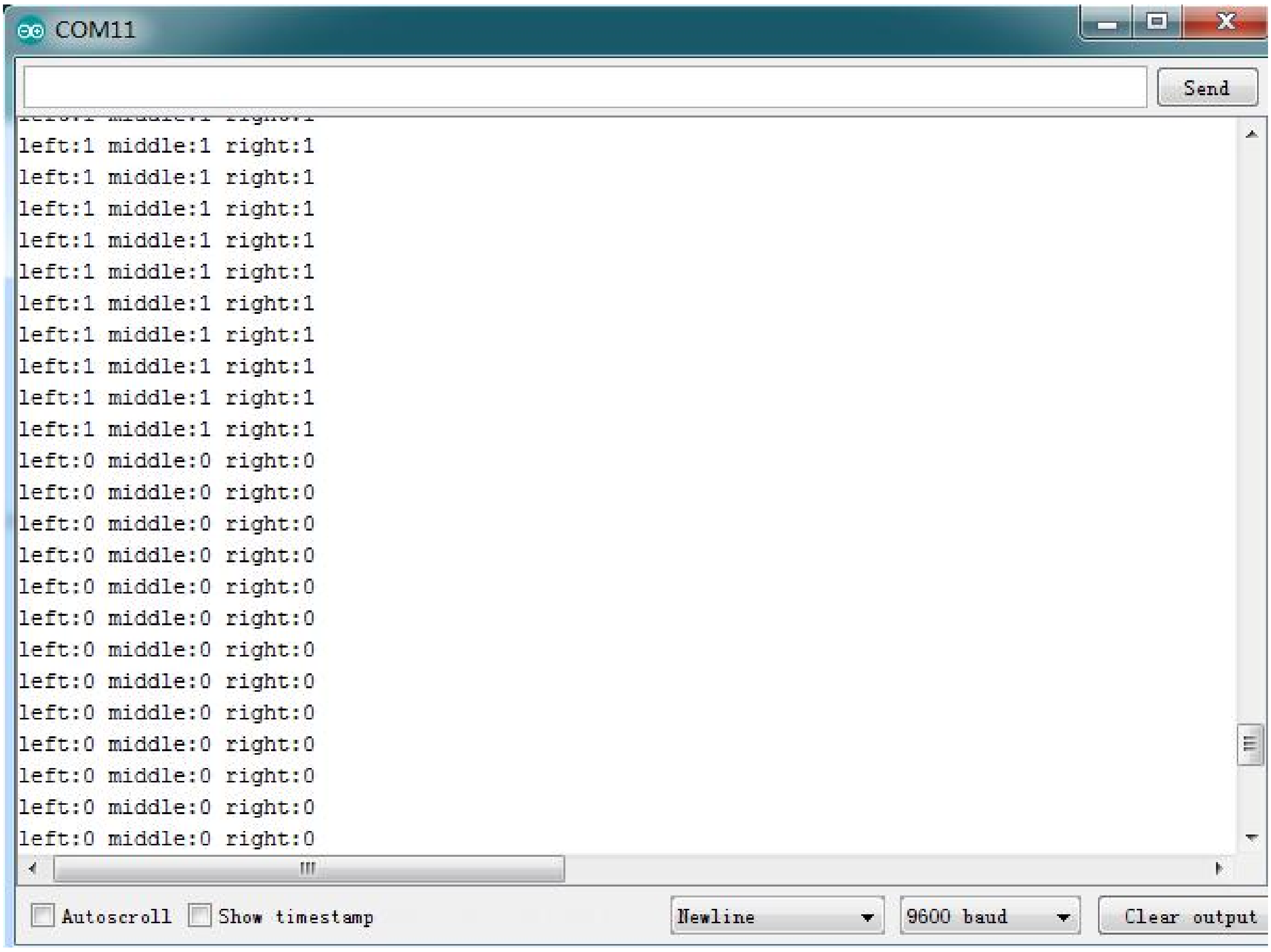
lesson 3.1

```
  Line Track sensor
  http://www.keyestudio.com
*/
int L_pin = 6;   //pins of   left line tracking sensor
int M_pin = 7;   //pins of   middle line tracking sensor
int R_pin = 8;   //pins of   right   line tracking sensor
int val_L,val_R,val_M;// define the variable value of three sensors

void setup()
{
  Serial.begin(9600); // initialize serial communication at 9600 bits per
second
  pinMode(L_pin,INPUT); // make the L_pin as an input
  pinMode(M_pin,INPUT); // make the M_pin as an input
  pinMode(R_pin,INPUT); // make the R_pin as an input
}

void loop()
{
  val_L = digitalRead(L_pin);//read the L_pin:
  val_R = digitalRead(R_pin);//read the R_pin:
  val_M = digitalRead(M_pin);//read the M_pin:
```

```
  Serial.print("left:");
  Serial.print(val_L);
  Serial.print(" middle:");
  Serial.print(val_M);
  Serial.print(" right:");
  Serial.println(val_R);
  delay(500);// delay in between reads for stability
}
//*****************************************************************************
```

(6) Test Result:

Upload the code on development board, open serial monitor to check line tracking sensors. And the displayed value is 1(high level) when no signals are received. The value becomes into 0 when covering sensor with paper.



(7) Code Explanation

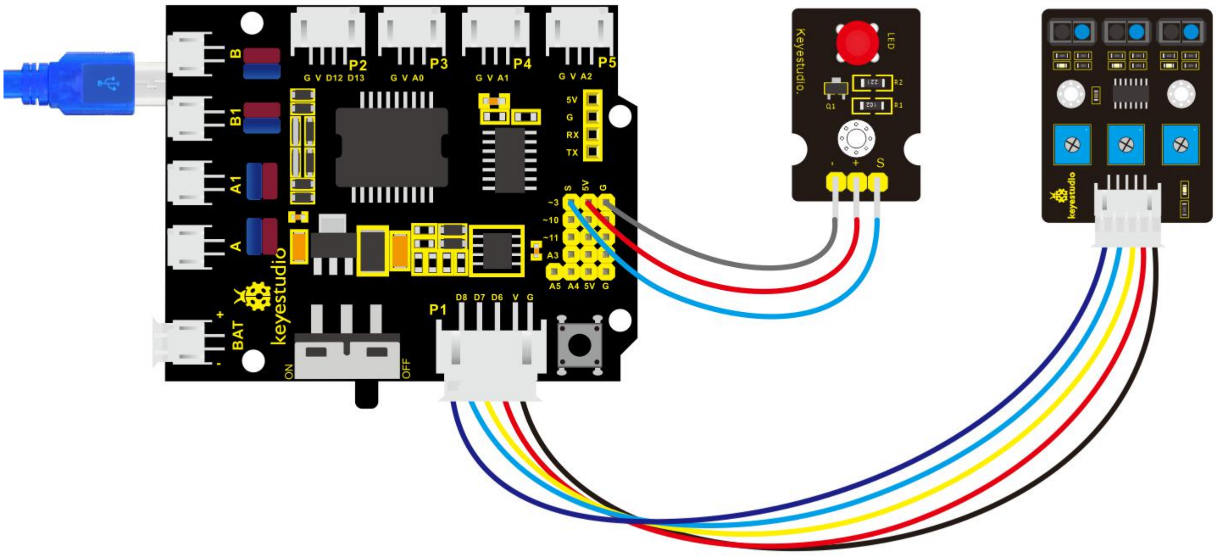
Serial.begin(9600)- Initialize serial port, set baud rate to 9600

pinMode- Define the pin as input or output mode

digitalRead-Read the state of pin, which are generally HIGH and LOW level

(8) Extension Practice

After knowing its working principle, connect an LED to D3. We could control LED by line tracking sensor.



Test Code

```
/*
keyestudio smart turtle robot
lesson 3.2
  Line Track sensor
  http://www.keyestudio.com
*/
int L_pin = 6;   //pins of  left line tracking sensor
int M_pin = 7;   //pins of  middle line tracking sensor
int R_pin = 8;   //pins of  right line tracking sensor
```

```
int val_L,val_R,val_M;// define the variables of three sensors

void setup()
{
  Serial.begin(9600); // initialize serial communication at 9600 bits per
second
  pinMode(L_pin,INPUT); // make the L_pin as an input
  pinMode(M_pin,INPUT); // make the M_pin as an input
  pinMode(R_pin,INPUT); // make the R_pin as an input
  pinMode(3, OUTPUT);
}

void loop()
{
  val_L = digitalRead(L_pin);//read the L_pin:
  val_R = digitalRead(R_pin);//read the R_pin:
  val_M = digitalRead(M_pin);//read the M_pin:
  Serial.print("left:");
  Serial.print(val_L);
  Serial.print(" middle:");
  Serial.print(val_M);
  Serial.print(" right:");
```

```
  Serial.println(val_R);
  delay(500);// delay in between reads for stability
  if ((val_L == LOW) || (val_M == LOW) || (val_R == LOW))//if left line tracking sensor detects signals
  {
    Serial.println("HIGH");
    digitalWrite(3, HIGH);//LED is off
  }
  else//if left line tracking sensor doesn’t detect signals
  {
    Serial.println("LOW");
    digitalWrite(3, LOW);//LED is off
  }
 }
//****************************************************************************
```

Upload the code to development board, we could find LED light up when covering the line tracking sensor by hand

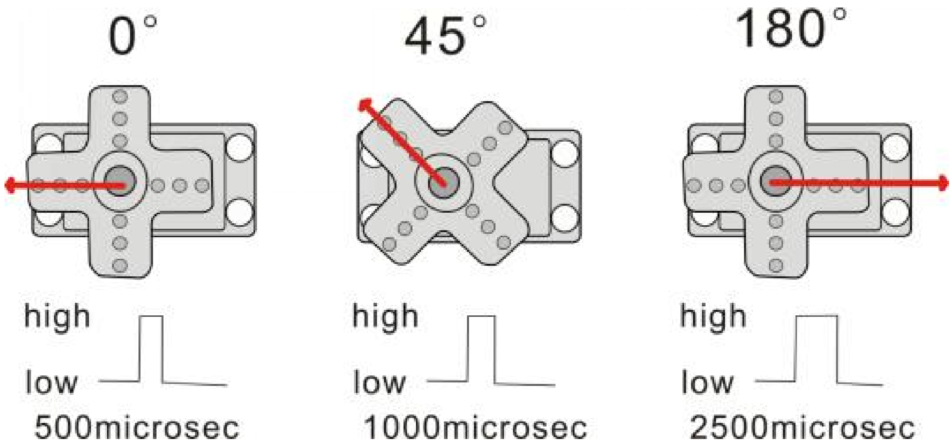
Project 4: Servo Control

(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.



The corresponding servo angles are shown below:

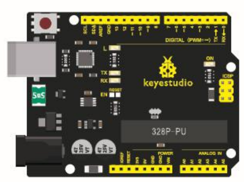
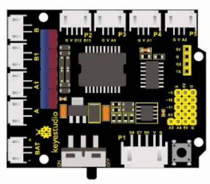
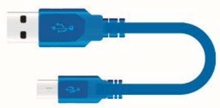
High level time	Servo angle
0.5ms	0 degree
1ms	45 degree
1.5ms	90 degree
2ms	135 degree
2.5ms	180 degree

(2) Specification

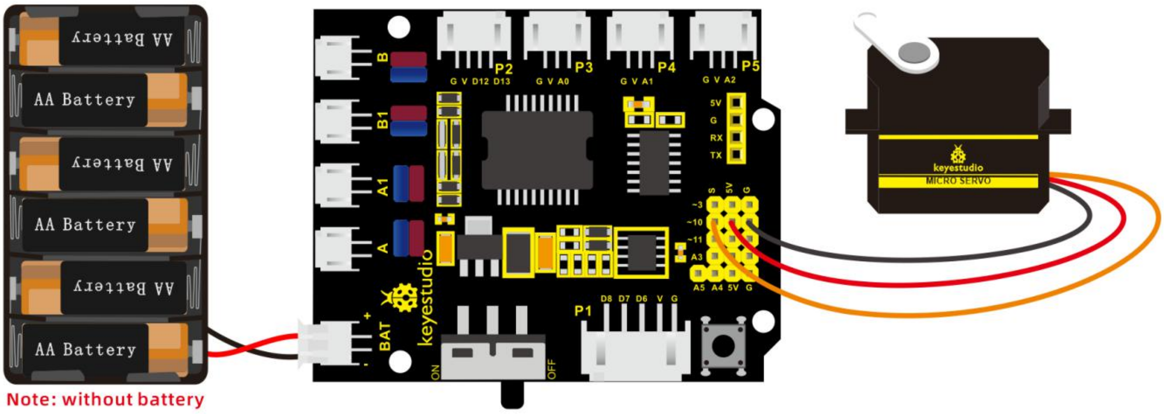
- Working voltage: DC 4.8V ~ 6V

- 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: ≦ 850mA (DC 4.8V) ≦ 1000mA (DC 6V)
- Standby current: 3 ± 1mA (DC 4.8V) 4 ± 1mA (DC 6V)

(3) Equipment

V4.0 Control board *1	L298P Motor Shield*1	Servo motor *1	4 AA battery Holder *1	USB cable *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 10.

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 smart turtle robot
lesson 4.1
Servo
http://www.keyestudio.com
```

```
*/
#define servoPin 10   //servo Pin
int pos; //the angle variable of servo
int pulsewidth; //pulse width variable of servo

void setup() {
  pinMode(servoPin, OUTPUT);   //set the pins of servo to output
  procedure(0); //set the angle of servo to 0 degree
}

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'
```

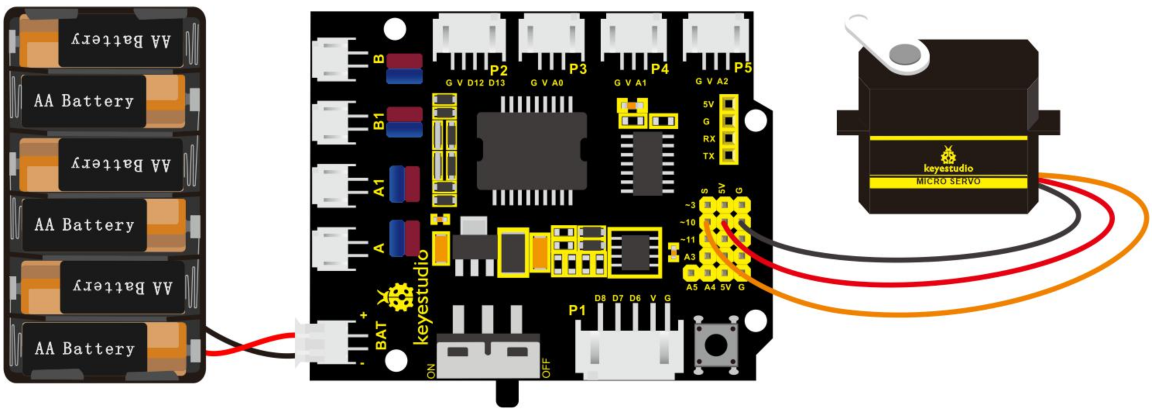
```
      delay(15);
   }
}

//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 smart turtle robot
 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(10);  // 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
2. **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. **attached ()** ——Judge if the parameter of servo is sent to its interface

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.

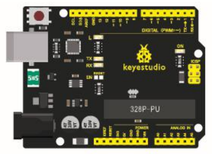
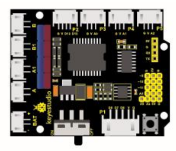
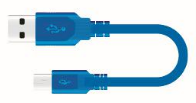
The HC-SR04 or the ultrasonic sensor is being used in a wide range of electronics projects for creating obstacle detection and distance measuring application as well as various other applications. Here we have brought the simple method to measure the distance with arduino and ultrasonic sensor and how to use ultrasonic sensor wit h 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) Components

Control Board *1	L298P Motor Shield*1	Channel Line Tracking *1	LED Module *1	USB Cable *1	3Pin Dupont Line *1
					 5pin 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.

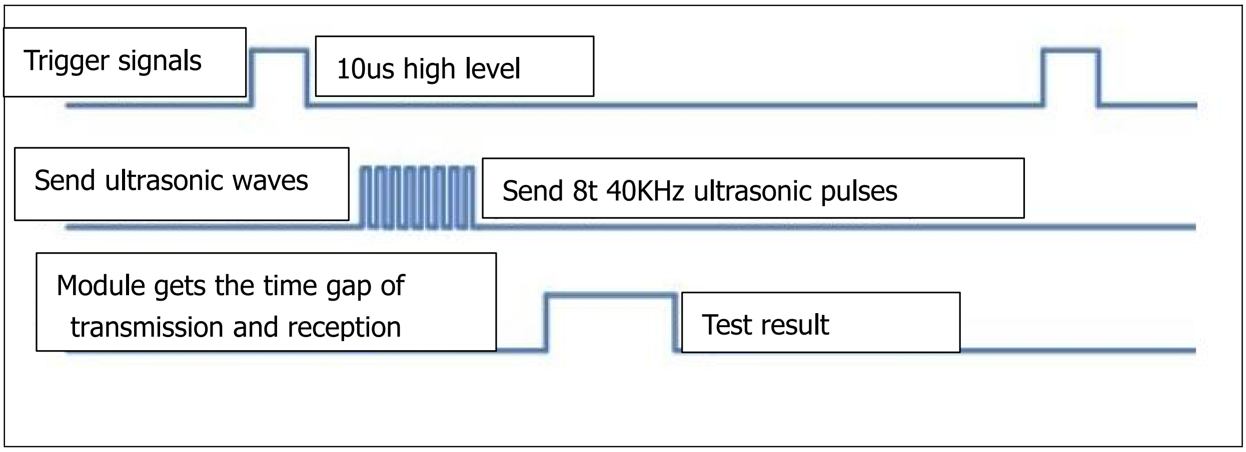
and the propagation speed of sound in the air is about 343m/s, therefore, distance = speed * time, because the ultrasonic wave emits and comes back, which is 2 times of distance, so it needs to be divided by 2, the distance measured by ultrasonic wave = (speed * time)/2

1. Use method and timing chart of ultrasonic module:

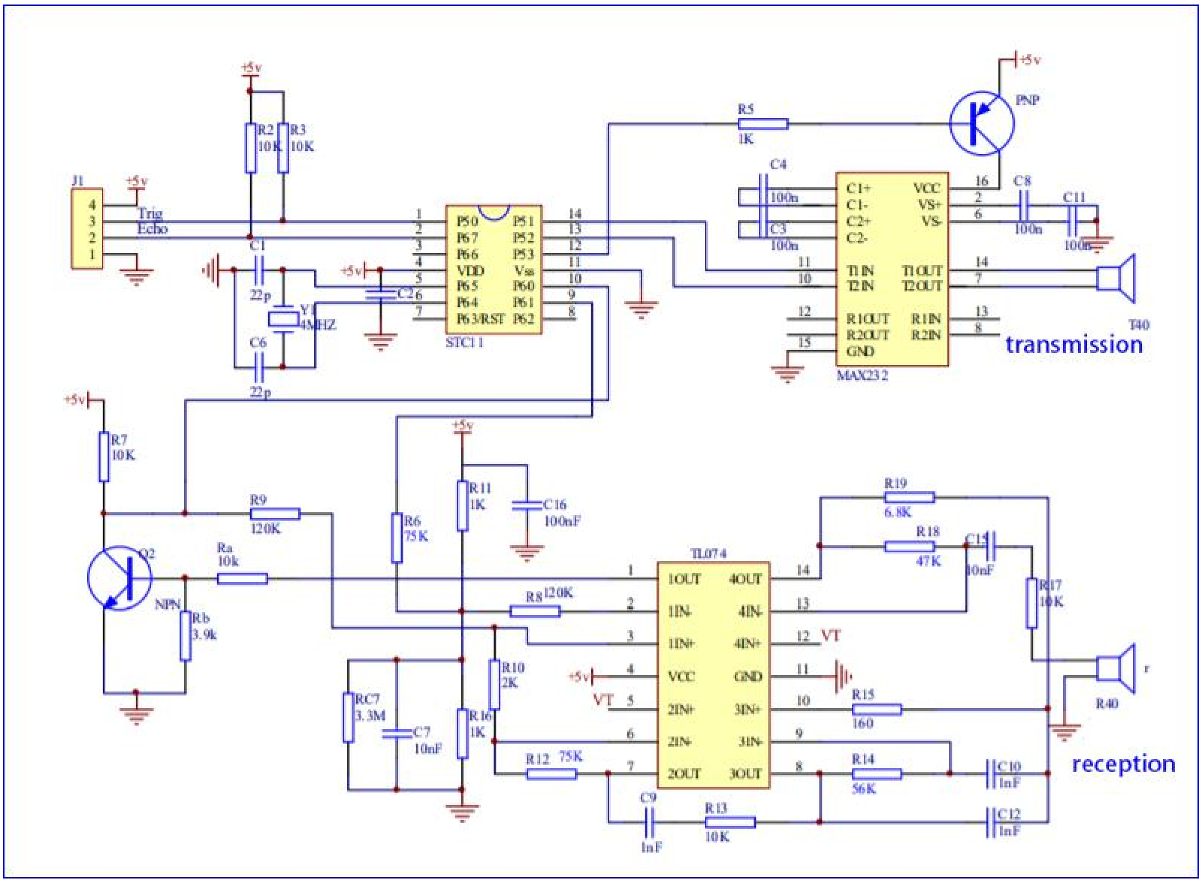
Setting the delay time of Trig pin of SR04 to 10μs at least, which can trigger it to detect distance.

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.

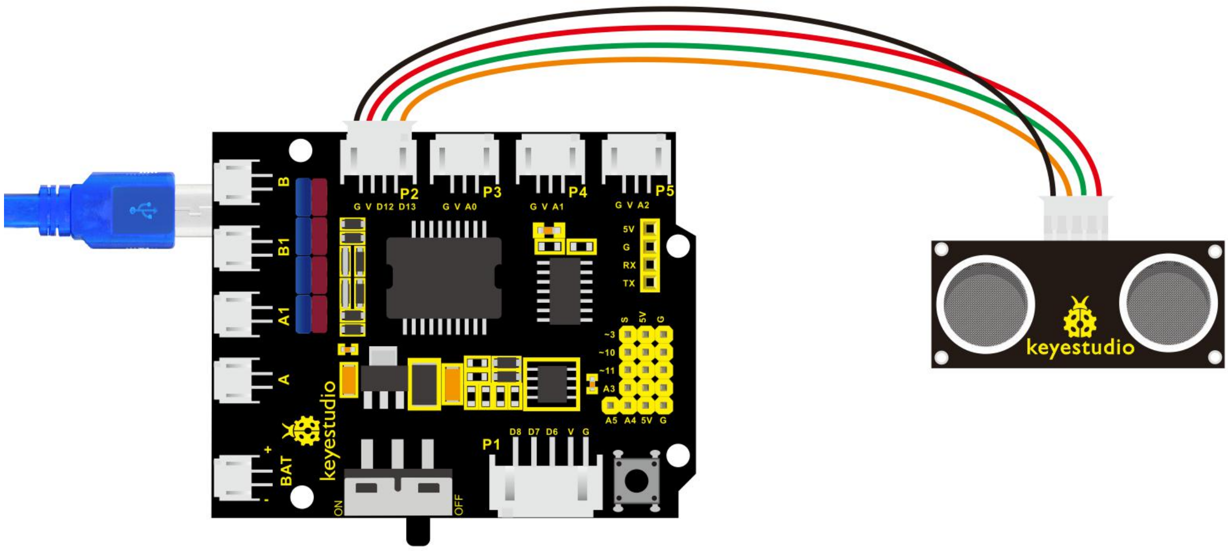
3. If the signal returns, the Echo pin will output a high level, and the duration of the high level is the time from the transmission of the ultrasonic wave to the return.



Circuit diagram of ultrasonic sensor:



(5) Connection Diagram



Wiring guide:

Ultrasonic sensor		keyestudio V5 sensor shield
VCC	→	5v(V)
Trig	→	12(S)
Echo	→	13(S)
Gnd	→	Gnd(G)

(6) Test Code:

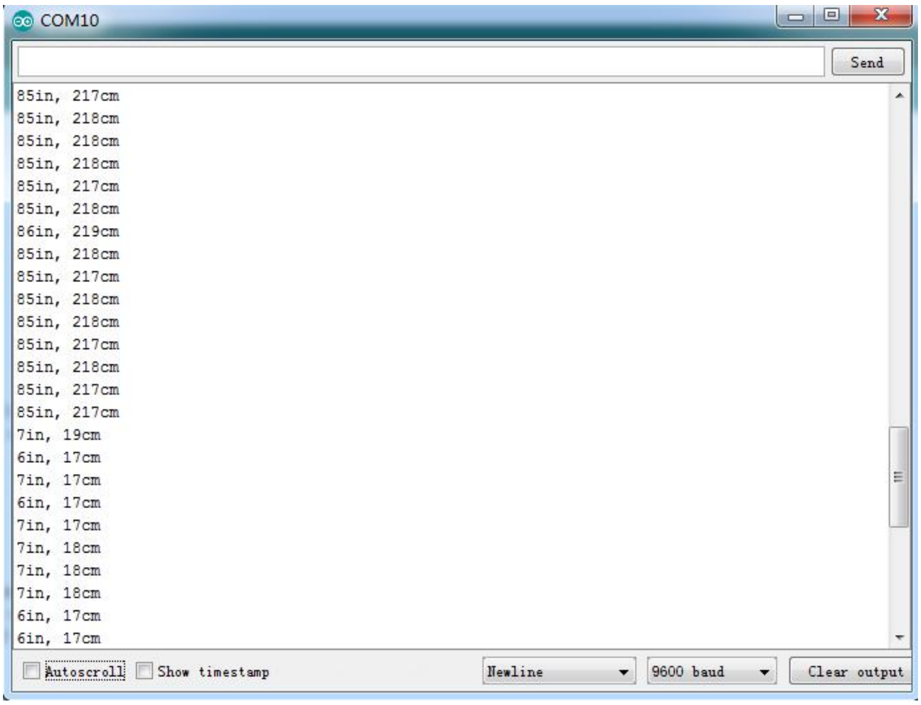
```
/*
 keyestudio smart turtle robot
 lesson 5.1
 Ultrasonic sensor
 http://www.keyestudio.com
*/
int trigPin = 12;    // Trigger
int echoPin = 13;    // Echo
long duration, cm, inches;
void setup() {
  //Serial Port begin
  Serial.begin (9600);
  //Define inputs and outputs
```

```
  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, the unit is cm and inch. Hinder the ultrasonic sensor by hand, the displayed distance value gets smaller.



(8) Code Explanation

int trigPin- this pin is defined to transmit ultrasonic waves, generally output.

int echoPin - this is defined as the pin of reception, generally input

cm = (duration/2) / 29.1-

inches = (duration/2) / 74-

We can calculate the distance by using the following formula:

distance = (traveltime/2) x speed of sound

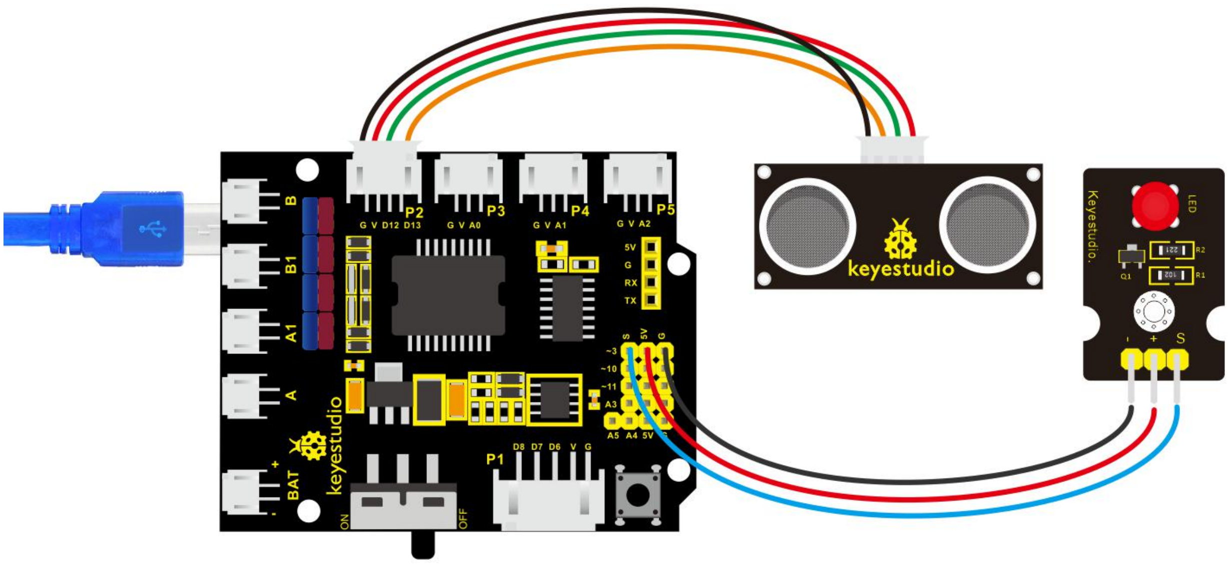
The speed of sound is: 343m/s = 0.0343 cm/uS = 1/29.1 cm/uS

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

We need to divide the traveltime 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 just 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 D3 pin.



```
/*
  keyestudio smart turtle robot
  lesson 5.2
  Ultrasonic LED
  http://www.keyestudio.com
*/
int trigPin = 12;      // Trigger
int echoPin = 13;      // Echo
long duration, cm, inches;

void setup() {
   Serial.begin (9600);   //Serial Port begin
   pinMode(trigPin, OUTPUT);   //Define inputs and outputs
```

```
  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)
  {
    Serial.println("HIGH");
    digitalWrite(3, HIGH);
  }
  else
  {
    Serial.println("LOW");
    digitalWrite(3, LOW);
  }
}
//*************************************************************
```

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.

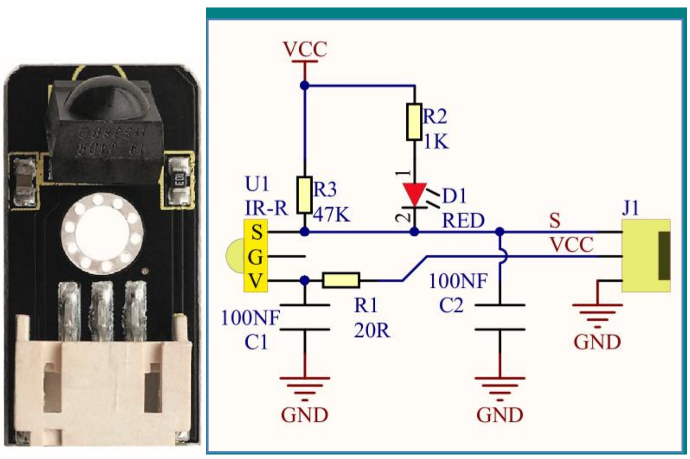
The 38K infrared carrier signal emitted by remote controller is encoded by the encoding chip in the remote controller. It is composed of a section of pilot code, user code, user inverse code, data code, and data inverse code. The time interval of the pulse is used to distinguish whether it is a 0 or 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

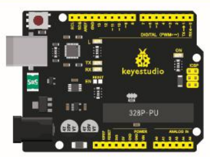
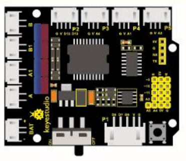
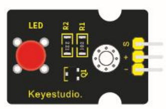
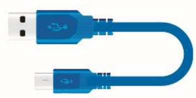
Output Signal: Digital signal

Receiving Angle: 90 degrees

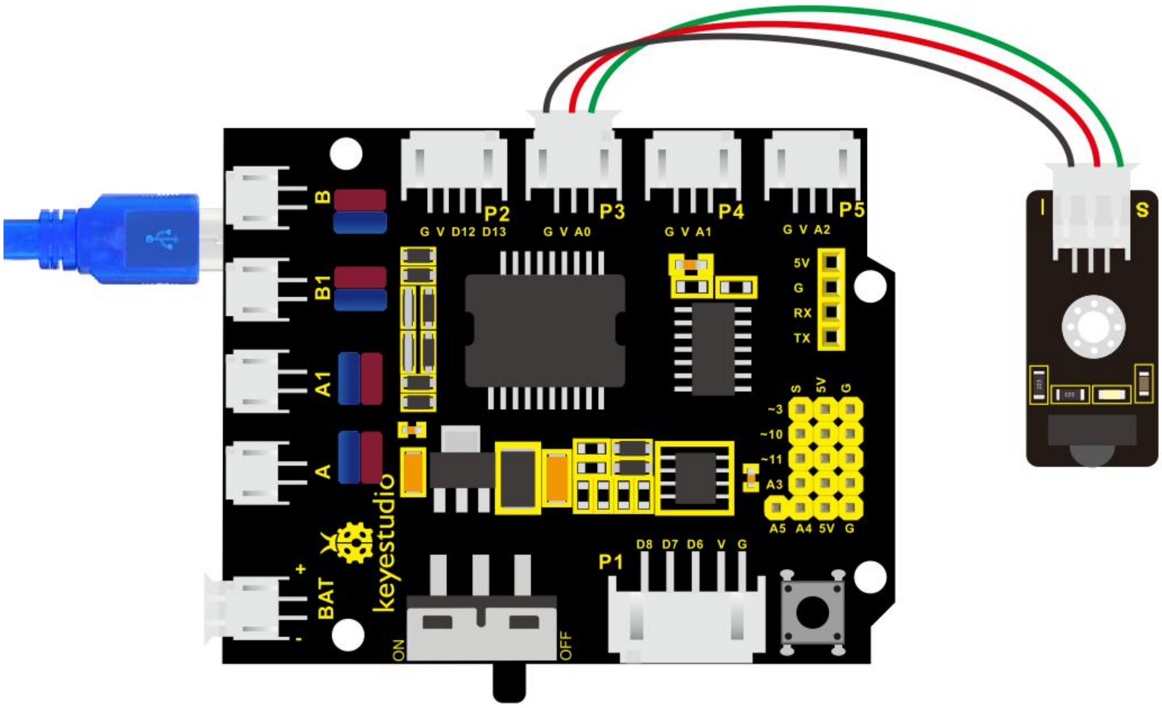
Frequency: 38khz

Receiving Distance: 10m

(3) Components

Control Board *1	L298P Motor Shield*1	IR receiver Module *1	LED Module *1	USB Cable *1	3Pin Dupont Line *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.

Import the library of IR receiver firstly before editing test code.

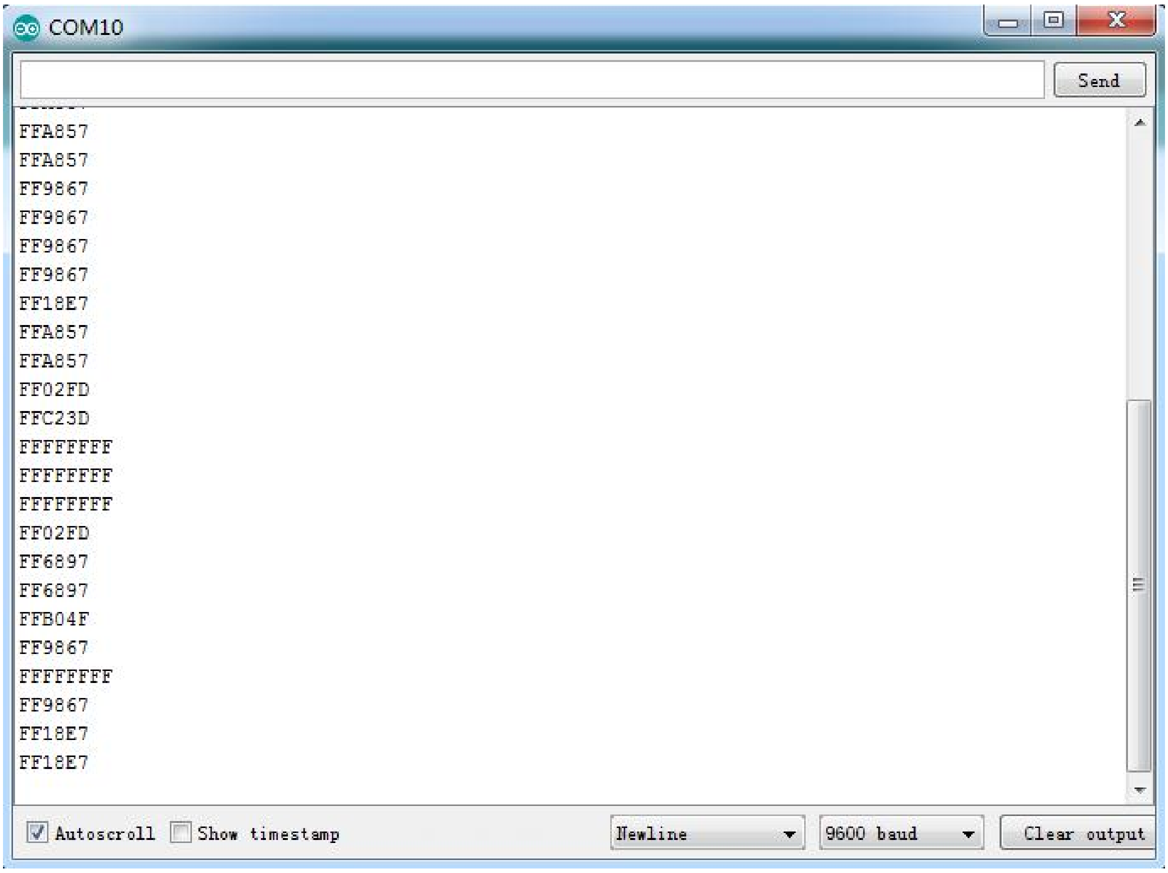
```
/*
  keyestudio smart turtle robot
 lesson 6.1
 IRremote
```

```
 http://www.keyestudio.com
*/
#include <IRremote.h>       //IRremote library statement
int RECV_PIN = A1;          //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);
```

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

(5) 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 could keep it for reference.

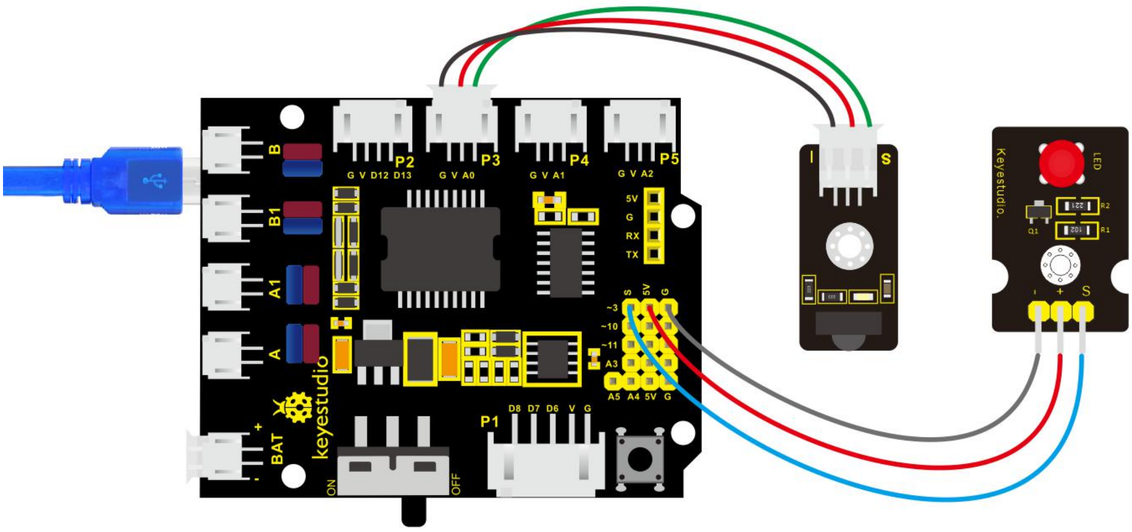
(5) Code Explanation

irrecv.enableIRIn(): after enabling IR decoding, the IR signals will be received, then function "decode()" will check continuously to make ure if decoding 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 continue to receive the next signal.

(6) 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 D3, then press the keys of remote control to make LED light up and off.



```
/*
keyestudio smart turtle robot
lesson 6.2
IRremote
http://www.keyestudio.com
*/
#include <IRremote.h>
int RECV_PIN = A1;//define the pin of IR receiver as A1
int LED_PIN=3;//define the pin of LED as pin 3
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 pin 4 of LED 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
    {
      Serial.println("HIGH");
      digitalWrite(LED_PIN,HIGH);//LED will be on
      a=1;
    }
    else if(results.value==0xFF02FD && (a==1)) //press again
    {
      Serial.println("LOW");
      digitalWrite(LED_PIN,LOW);//LED will go off
```

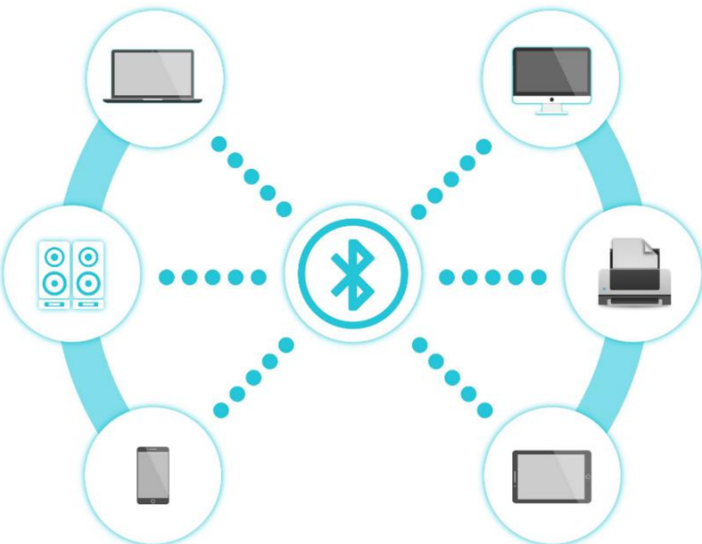
```
            a=0;
        }
        irrecv.resume(); // receive the next value
    }
}
//*****************************************************
```

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.

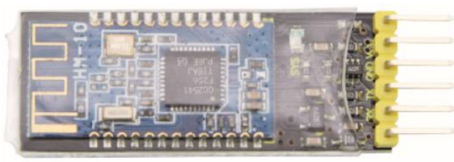


Over the years, there have been many upgrades of Bluetooth standard to keep fulfil the demand of customers and technology according to the need of time and situation.

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: ≤-84dBm at 0.1% BER

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

Security feature: Authentication and encryption

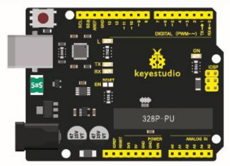
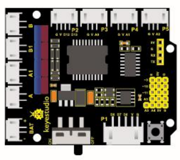
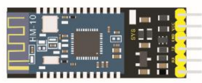
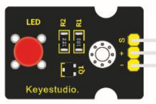
Supporting service: Central & Peripheral UUID FFE0, FFE1

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

Power supply: 5V DC

Working temperature: –5 to +65 Centigrade

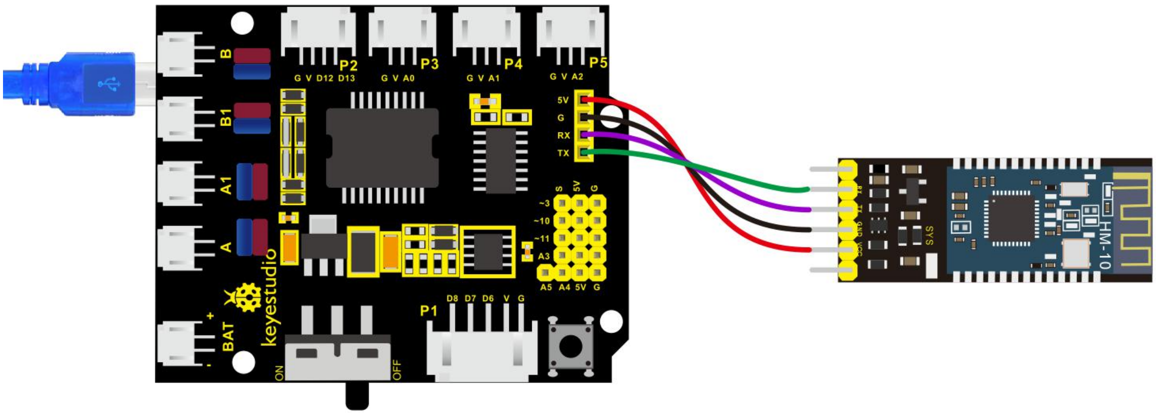
(3) Components

Control Board *1	L298P Motor Shield*1	4.0 Bluetooth Module *1	LED Module *1	3Pin Dupont Line *1
				 USB Cable *1 

(3) 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.



Pay attention to the pin direction when inserting Bluetooth module, and don’t insert it before uploading test code

(4) Test Code

```
/*
    keyestudio smart turtle robot
   lesson 7.1
  bluetooth
  http://www.keyestudio.com
  */
  char ble_val; //character variable, used to store the value received by
```

Bluetooth

```
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.

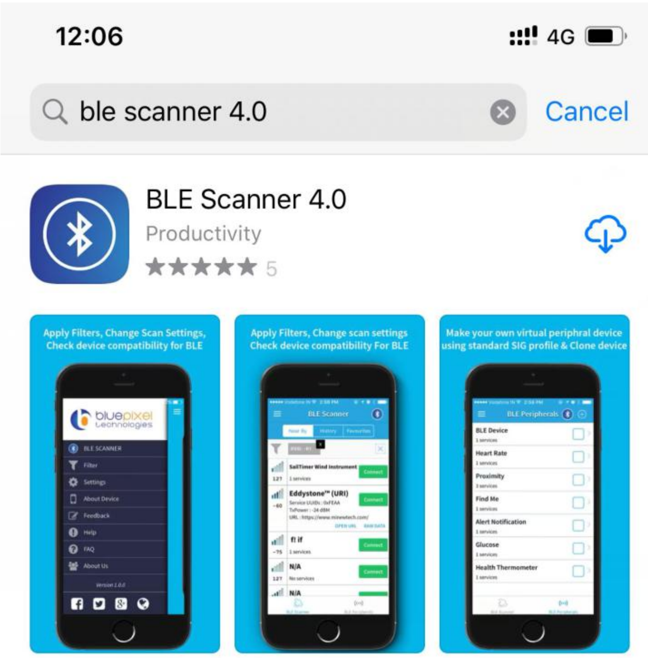
(5) Download APP

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.

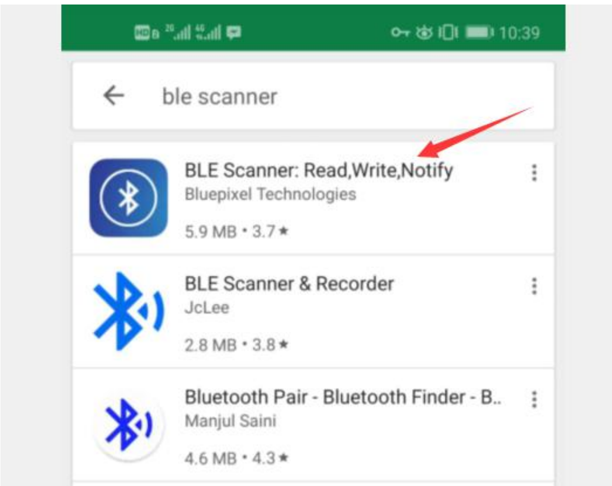
Enter APP STORE to search **BLE Scanner 4.0 to download.**



2. Android system

Enter Google Play to find out **BLE Scanner and download.**

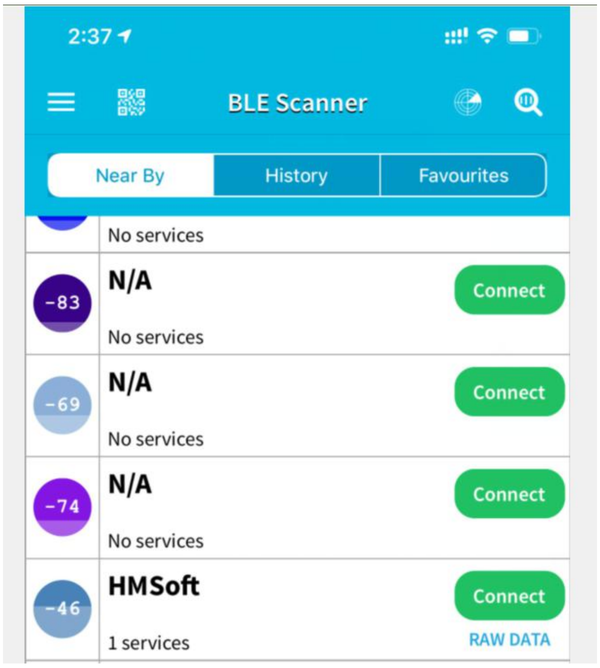
(Enable "location" in settings of your cellphone, otherwise, app may not be searched.)



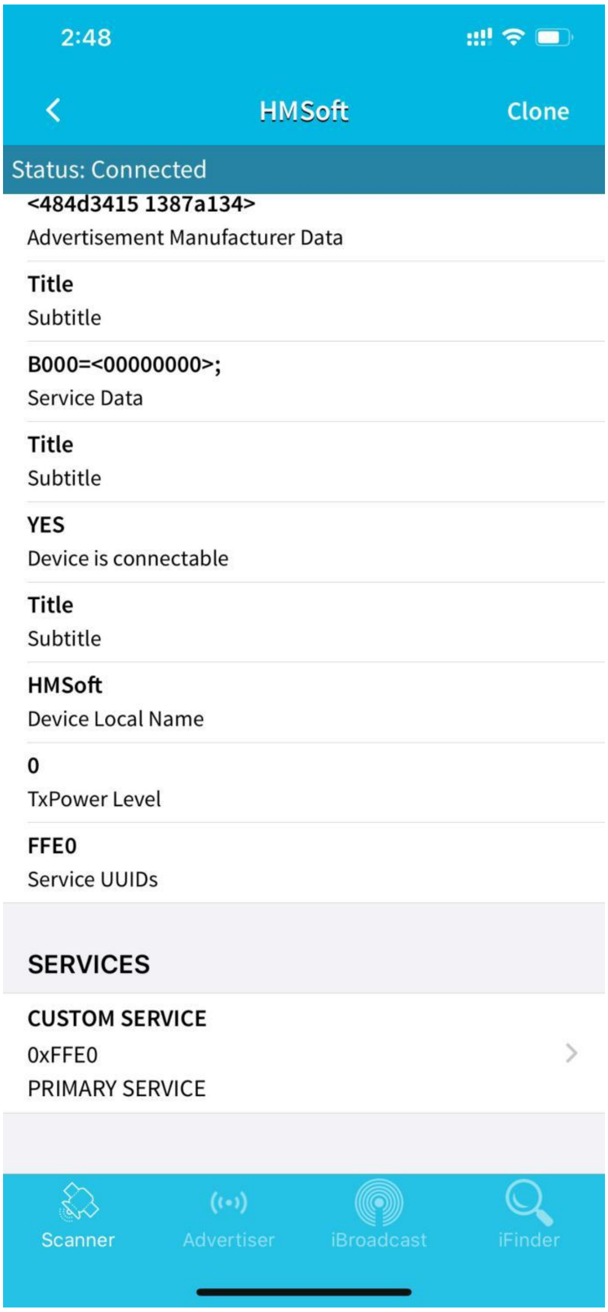
3. After installation, open App and enable "Location and Bluetooth" permission.

4. Open App, the name of Bluetooth module is HMSoft.

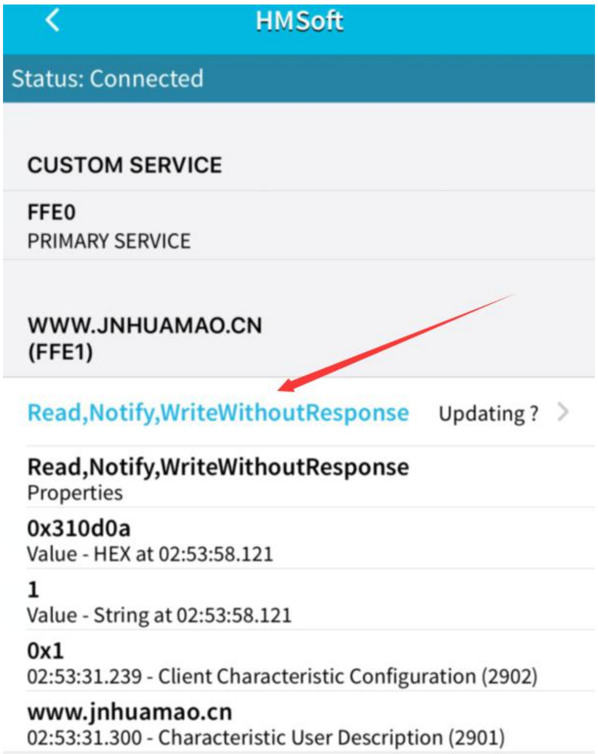
Then click "connect" to link with Bluetooth



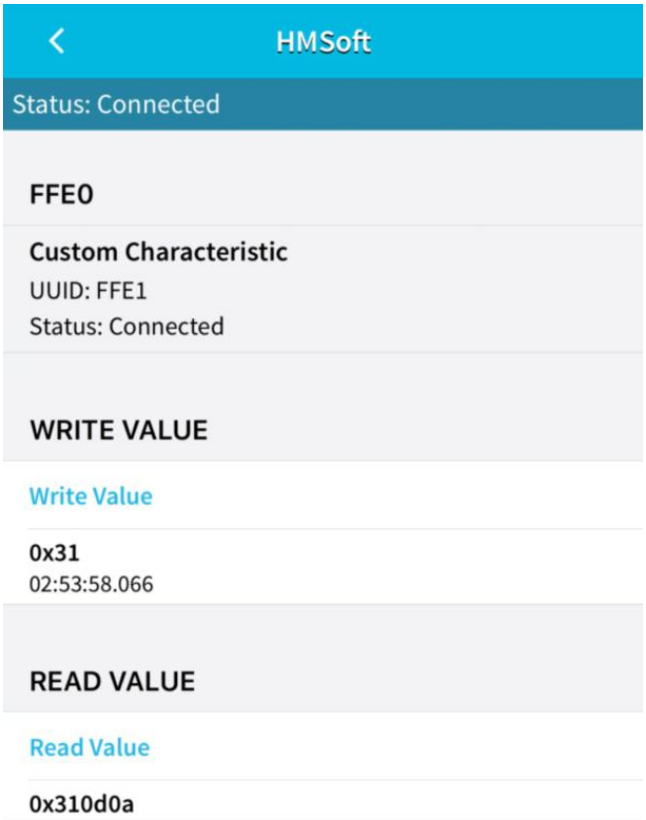
5. After connecting to HMSoft, click it to get multiple options, such as device information, access permission, general and custom service. Choose "CUSTOM SERVICE"



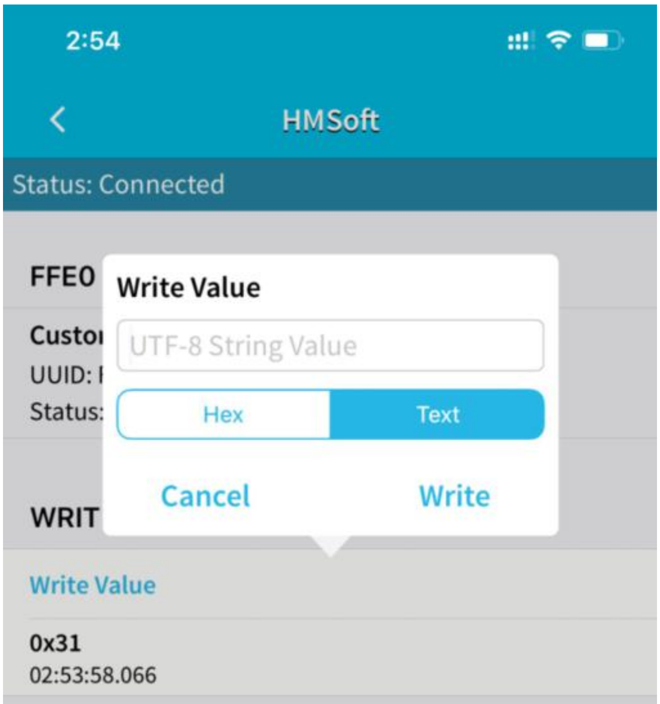
6. Then pop up the following page.



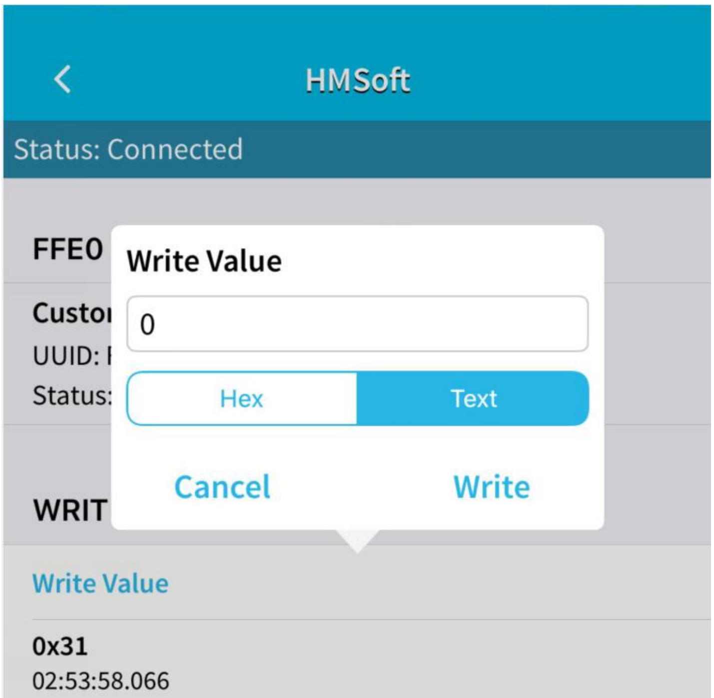
7. Click (Read,Notify,WriteWithoutResponse)to enter the following page



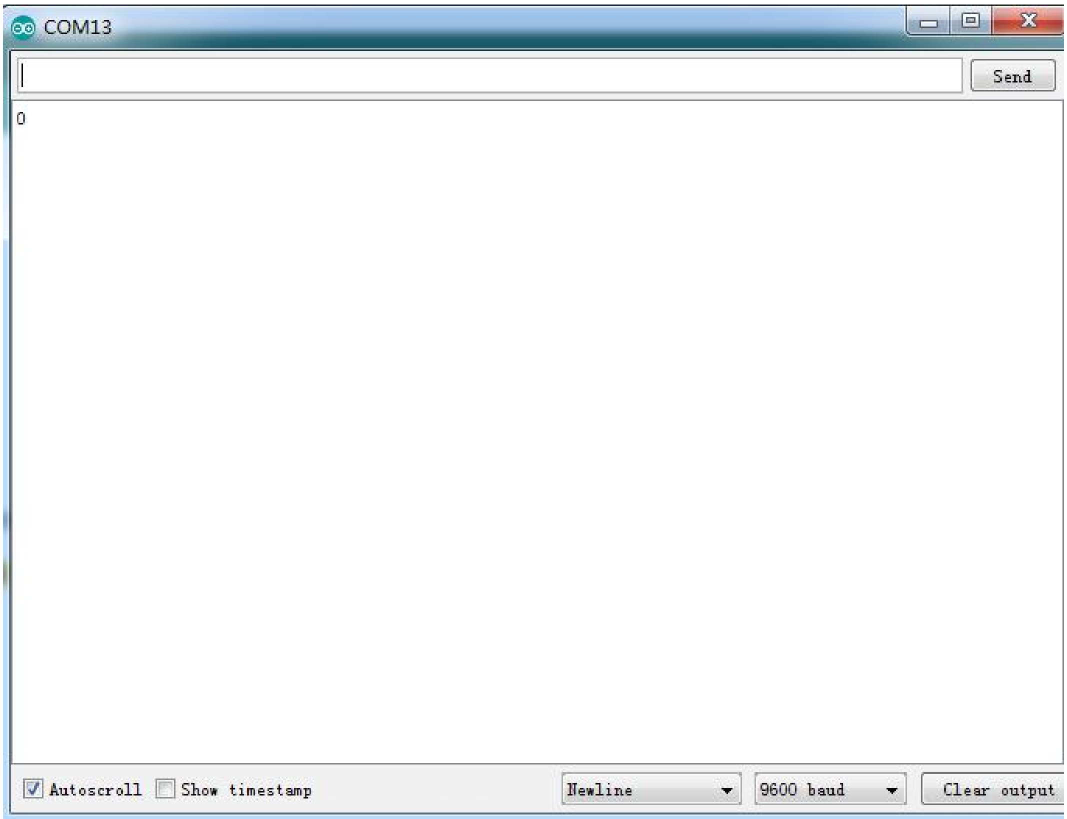
8. Click Write Value to enter HEX or Text.



9. Open the serial monitor on Arduino，enter 0 or other characters on Text interface.



10. Then click “Write”, and open serial monitor to view if there is a “0” signal



(6) Code Explanation

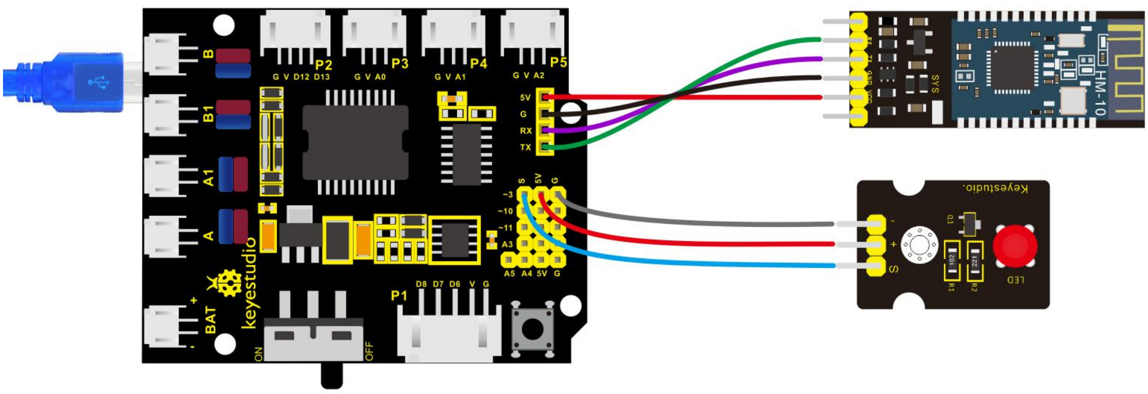
Serial.available() : The current rest characters when return to buffer area. Generally, this function is used to judge if there is data in buffer. When Serial.available()>0, it means that serial receives the data and can be read

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()"

(7) Extension Practice

We could send a command via Bluetooth to turn on and off a LED.

D3 is connected to a LED, as shown below:



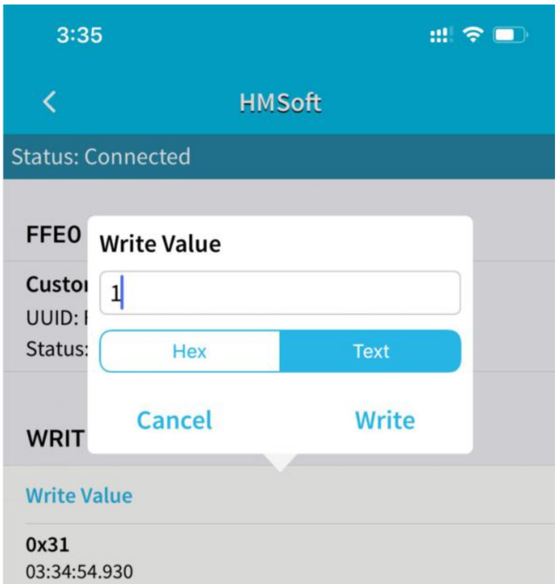
/*

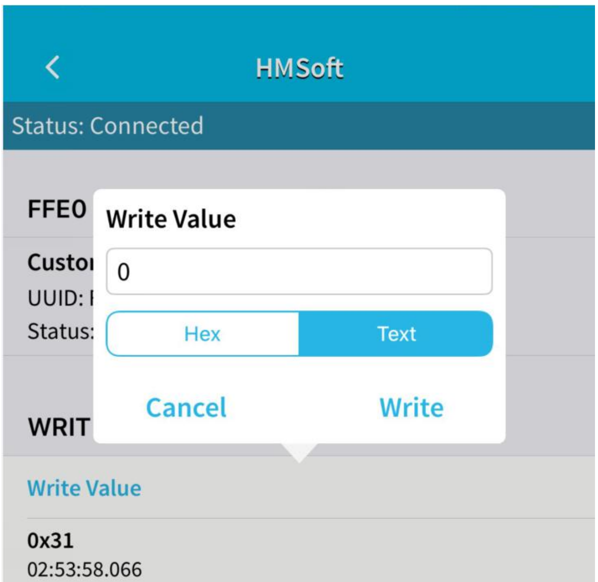
keyestudio smart turtle robot

lesson 7.2

```
  Bluetooth
  http://www.keyestudio.com
*/
int ledpin=3;

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, burning code will be affected)

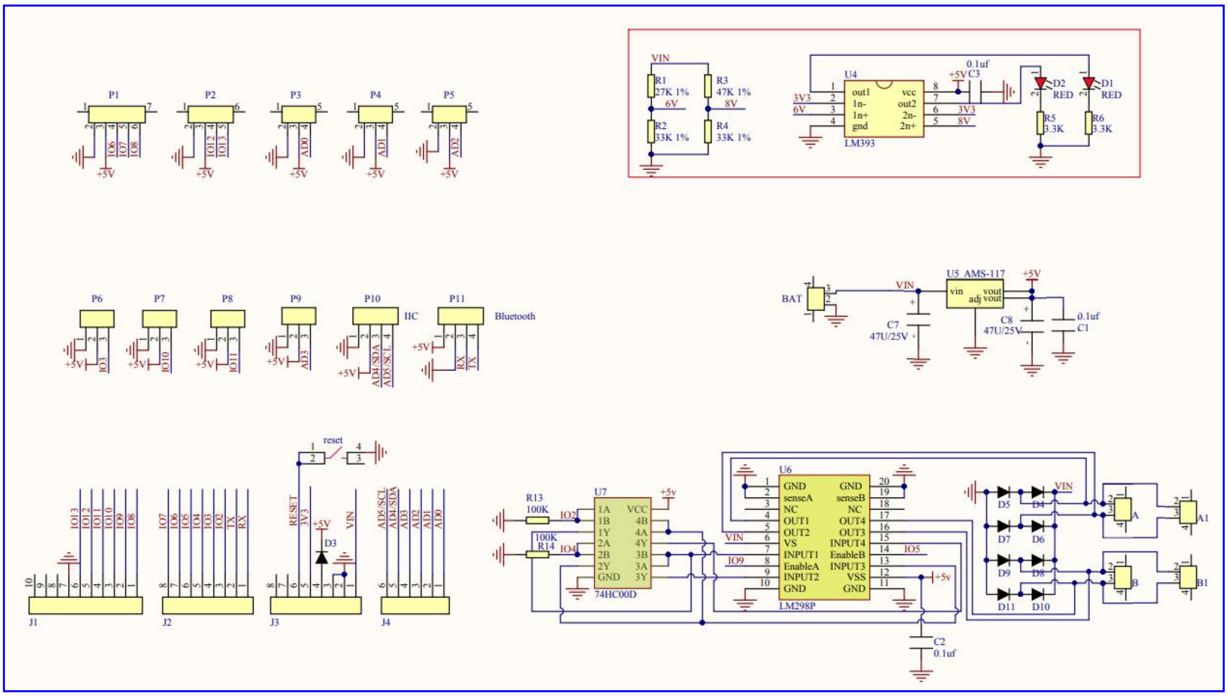
Project 8: Motor Driving and Speed Control

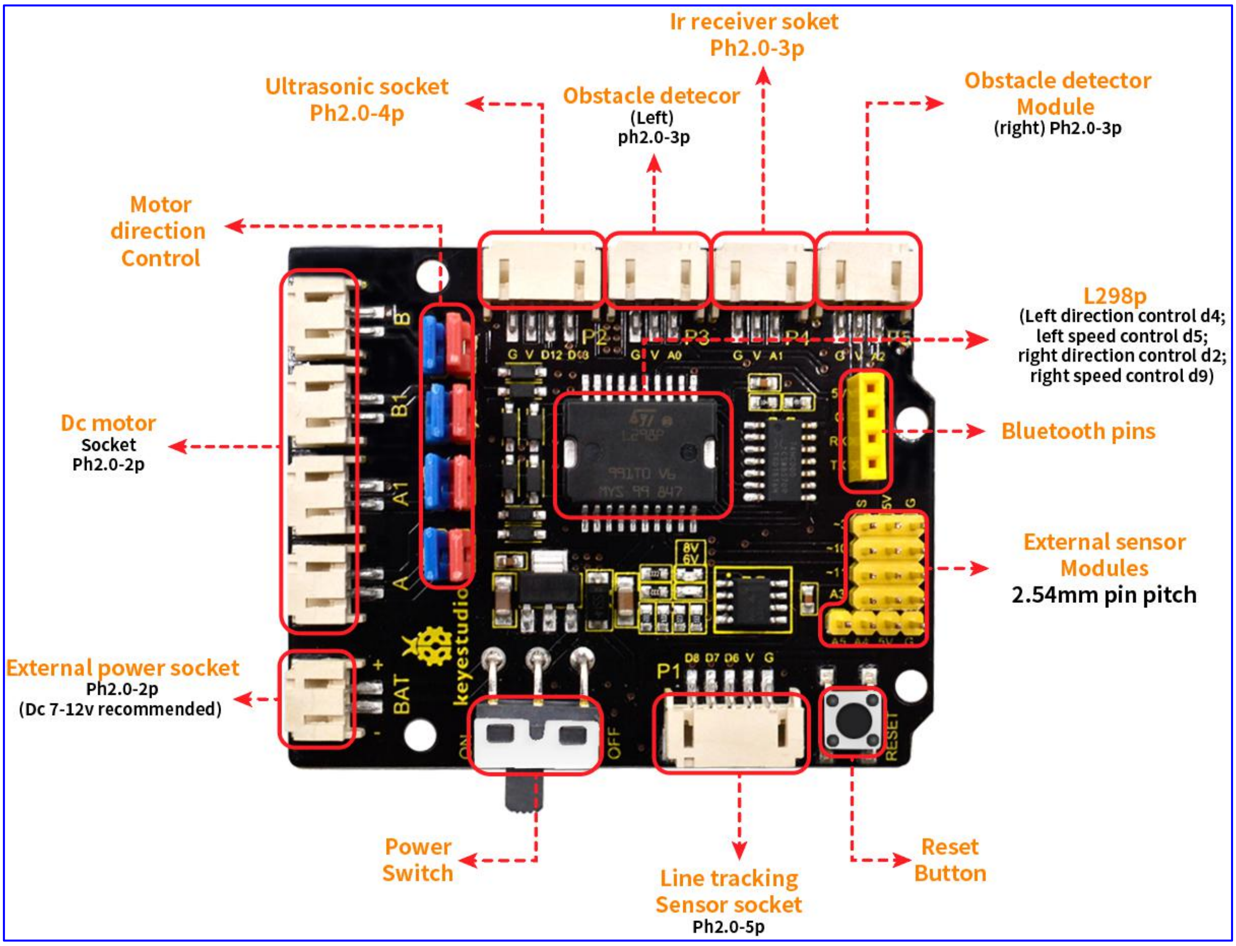
(1) Description

There are many ways to drive the motor. Our robot car 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.


LM393
74HC00D
LM298P
Bluetooth
IIC


Ir receiver soket
Ph2.0-3p
Ultrasonic socket
Ph2.0-4p
Obstacle detecor
(Left)
ph2.0-3p
Obstacle detector
Module
(right) Ph2.0-3p
Motor
direction
Control
L298p
(Left direction control d4;
left speed control d5;
right direction control d2;
right speed control d9)
Dc motor
Socket
Ph2.0-2p
Bluetooth pins
External sensor
Modules
2.54mm pin pitch
External power socket
Ph2.0-2p
(Dc 7-12v recommended)
Power
Switch
Line tracking
Sensor socket
Ph2.0-5p
Reset
Button

(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℃)
6) Working temperature: -25℃～＋130℃
7) Control signal input level: high level 2.3V<Vin<5V, low level -0.3V<Vin<1.5V

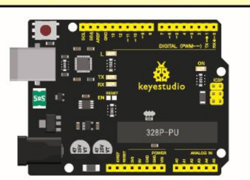
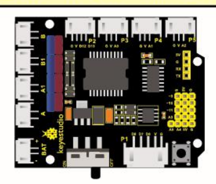
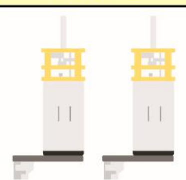
(3) Drive Robot to Move

Through the above diagram, the direction pin of B motor is D4, and speed pin is D5; D2 is the direction pin of A motor, D9 is speed pin.

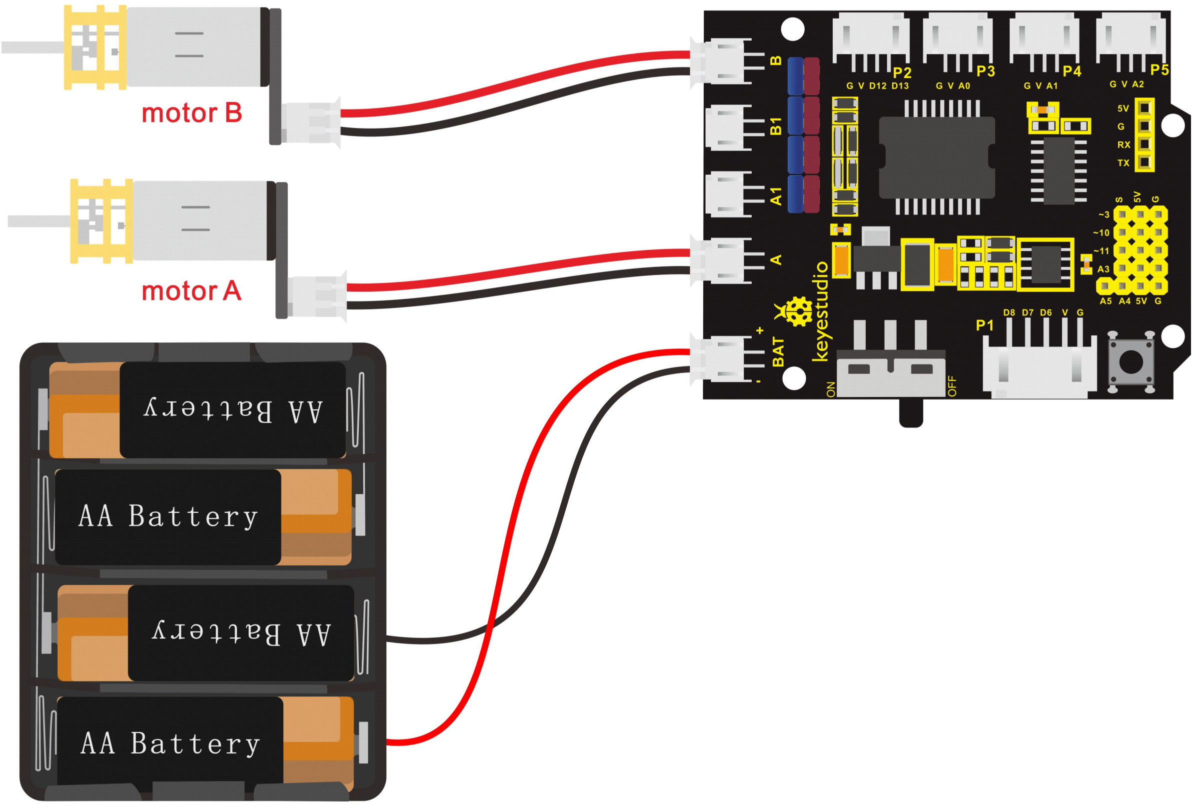
PWM decides 2 motors to rotate so as to drive robot car. The PWM value is in the range of 0-255, the larger the number, the faster the motor rotates.

	D2	D9 (PWM)	Motor(A)	D4	D5 (PWM)	Motor (B)
Go forward	LOW	200	Rotate clockwise	LOW	200	Rotate clockwise
Go back	HIGH	200	Rotate anticlockwise	HIGH	200	Rotate anticlockwise
Rotate anticlockwise	HIGH	200	Rotate anticlockwise	LOW	200	Rotate clockwise
Rotate clockwise	LOW	200	Rotate clockwise	HIGH	200	Rotate anticlockwise
Stop	/	0	Stop	/	0	Stop

(4) Components

Control Board *1	L298P Motor Shield*1	Motor *2	Battery Holder *1	2pin Dupont Line *1
				
				USB Cable *1
				

(5) Connection Diagram



(6) Test Code:

```
/*
  keyestudio smart turtle robot
  lesson 8.1
  motor driver shield
  http://www.keyestudio.com
*/
#define ML_Ctrl 2      //define the direction control pin of A motor
#define ML_PWM 9      //define the PWM control pin of A motor
#define MR_Ctrl 4      //define the direction control pin of B motor
#define MR_PWM 5      //define the PWM control pin of B motor
```

```
void setup()
{
  pinMode(ML_Ctrl, OUTPUT);//set direction control pin of A motor to output
  pinMode(ML_PWM, OUTPUT);//set PWM control pin of A motor to output
  pinMode(MR_Ctrl, OUTPUT);//set direction control pin of B motor to output
  pinMode(MR_PWM, OUTPUT);//set PWM control pin of B motor to output
}
void loop()
{
  //front
  digitalWrite(ML_Ctrl,LOW);//set the direction control pin of A motor to LOW
  analogWrite(ML_PWM,200);//set the PWM control speed of A motor to 200
  digitalWrite(MR_Ctrl,LOW);//set the direction control pin of B motor to LOW
  analogWrite(MR_PWM,200);// set the PWM control speed of B motor to
```

200

delay(2000);//delay in 2000ms

//back

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

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

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

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

delay(2000);//delay in 2000ms

//left

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

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

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

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

delay(2000);//delay in 2000ms

```
  //right
  digitalWrite(ML_Ctrl,LOW);//set the direction control pin of A motor to LOW level
  analogWrite(ML_PWM,200);//set the PWM control speed of A motor to 200
  digitalWrite(MR_Ctrl,HIGH);// set the direction control pin of B motor to HIGH level
  analogWrite(MR_PWM,200);//set the PWM control speed of B motor to 200
  delay(2000);//delay in 2000ms
  //stop
  analogWrite(ML_PWM,0);//set the PWM control speed of A motor to 0
  analogWrite(MR_PWM,0);//set the PWM control speed of B motor to 0
  delay(2000);// delay in 2000ms
}
//*************************************************************************
```

(7) Test Result：

Hook up by connection diagram, upload code and power on, the 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 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.

(8) Extension Practice

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

```
/*
 keyestudio smart turtle robot
 lesson 8.2
 motor driver
 http://www.keyestudio.com
*/
#define ML_Ctrl   2    //define the direction control pin of A motor
#define ML_PWM 9     //define the PWM control pin of A motor
#define MR_Ctrl   4     //define the direction control pin of B motor
```

```
#define MR_PWM 5     //define the PWM control pin of B motor

void setup()
{ pinMode(ML_Ctrl, OUTPUT);//set the direction control pin of A motor to OUTPUT
  pinMode(ML_PWM, OUTPUT);//set the PWM control pin of A motor to OUTPUT
  pinMode(MR_Ctrl, OUTPUT);//set the direction control pin of B motor to OUTPUT

  pinMode(MR_PWM, OUTPUT);//set the PWM control pin of B motor to OUTPUT
}

void loop()
{ digitalWrite(ML_Ctrl,LOW);//set the direction control pin of A motor to low level
  analogWrite(ML_PWM,100);//set the PWM control speed of A motor to 100
  digitalWrite(MR_Ctrl,LOW);//set the direction control pin of B motor to low level
  analogWrite(MR_PWM,100);//set the PWM control speed of B motor to
```

100

//front
delay(2000);//delay in 2000ms
digitalWrite(ML_Ctrl,HIGH);//set the direction control pin of A motor to high level
analogWrite(ML_PWM,100);//set the PWM control speed of A motor to 100
digitalWrite(MR_Ctrl,HIGH);//set the direction control pin of B motor to high level
analogWrite(MR_PWM,100);//set the PWM control speed of B motor to 100

//back
delay(2000);//delay in 2000ms
digitalWrite(ML_Ctrl,HIGH);//set the direction control pin of A motor to HIGH level
analogWrite(ML_PWM,100);// set the PWM control speed of A motor to 100
digitalWrite(MR_Ctrl,LOW);//set the direction control pin of B motor to LOW level
analogWrite(MR_PWM,100);//set the PWM control speed of B motor to

100

//left

delay(2000);//delay in 2000ms

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

analogWrite(ML_PWM,100);//100 set the PWM control speed of A motor to 100

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

analogWrite(MR_PWM,100);//set the PWM control speed of B motor to 100

//right

delay(2000);//delay in 2000ms

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

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

//stop

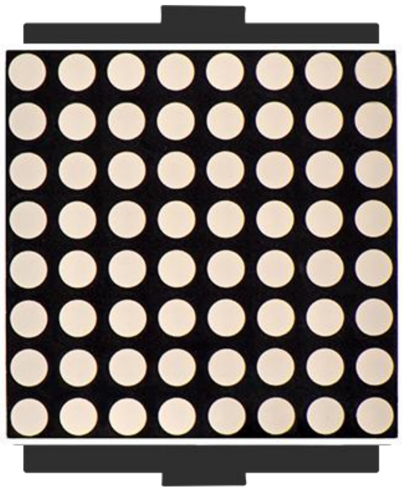
delay(2000);//delay in 2000ms

}

//***

After uploading the code successfully, do you find the motors rotate faster?

Project 9: 8*8 LED Board

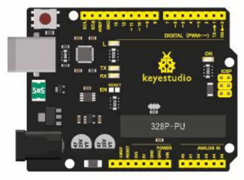
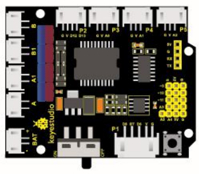
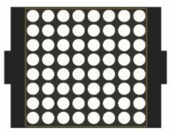


(1) Description

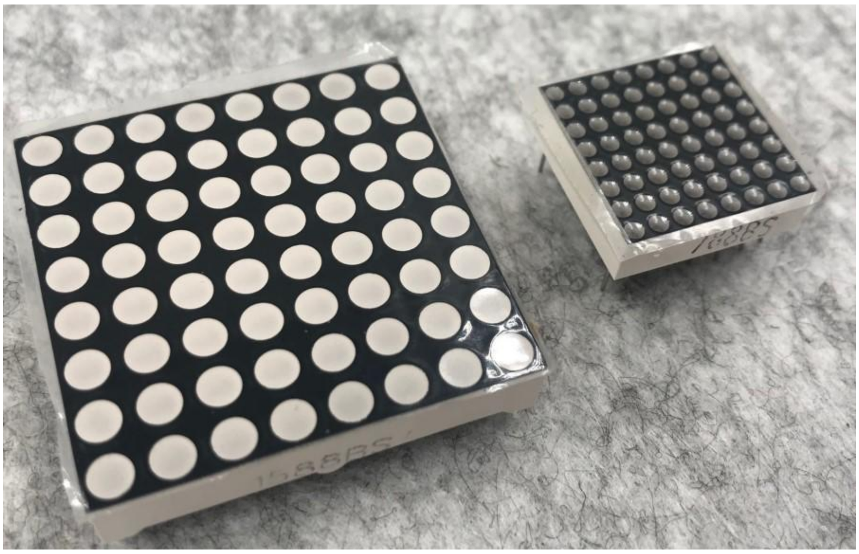
A fun way to make a small display is to use an 8x8 matrix or a 4-digit 7-segment display. Matrices like these are 'multiplexed' - to control 64 LEDs you need 16 pins. That's a lot of pins, and there are driver chips like the MAX7219 that can control a matrix for you, but there's a lot of wiring to set up and they take up a ton of space. After all, wouldn't it be awesome if you could control a matrix without tons of wiring?

We control and drive 8*8 LED Board by HT16K33 chip, which is convenient for wiring and greatly save the resources of microcontroller.

(2) Components

Control Board *1	L298P Motor Shield*1	8x8 matrix *1	Battery Holder *1	4pin Dupont Line *1
				 USB Cable *1 

(3) 8*8 Dot Matrix



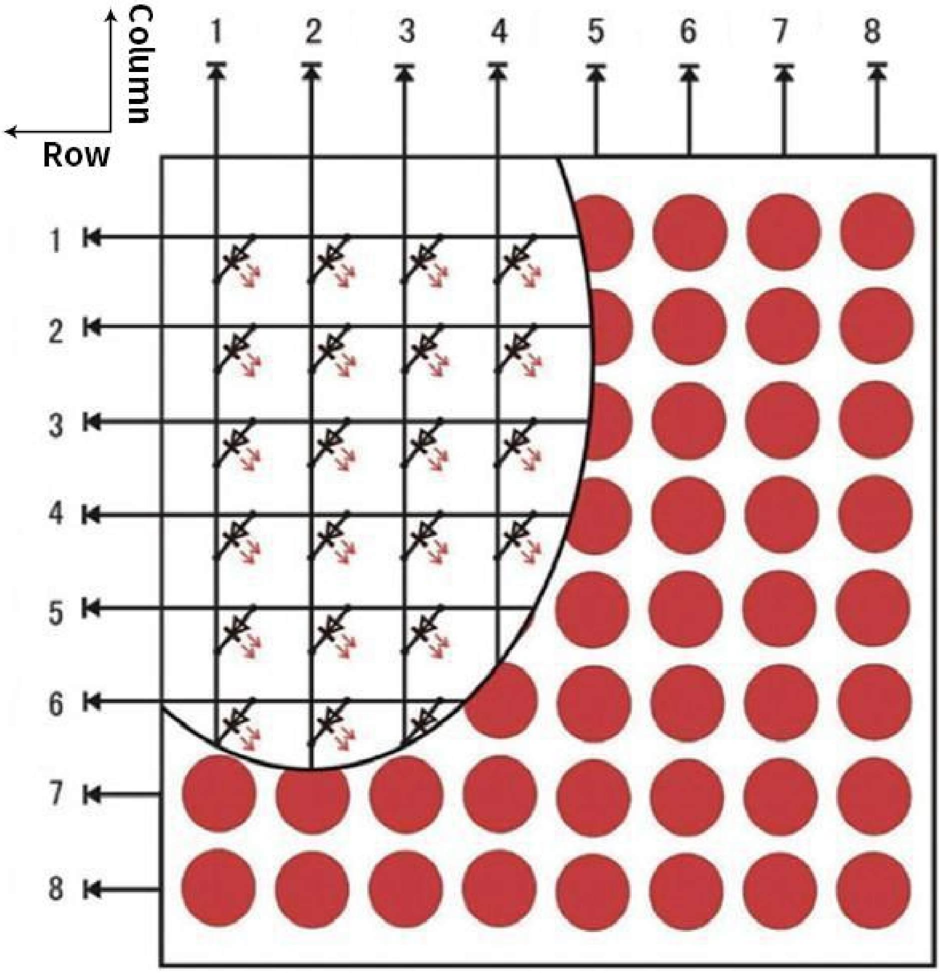
Composed of LED emitting tube diodes, LED dot matrix are applied widely to public information display like advertisement screen and bulletin board, by controlling LED to show words, pictures and videos, etc.

Divided into single-color, double-color, and three-color lights according to emitting color , LED dot matrix could show red, yellow, green and even true color.

There are 4×4, 8×8 and 16×16 different types matrix.

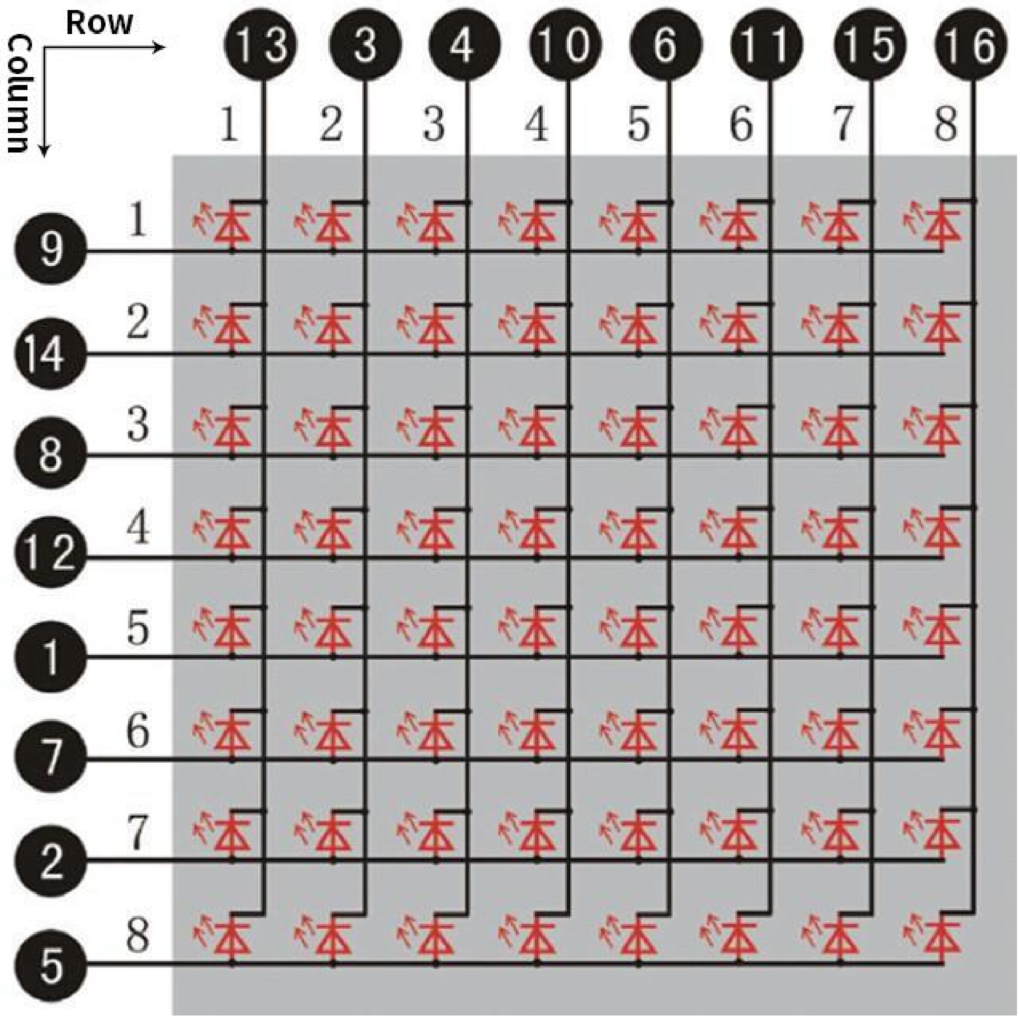
8×8 dot matrix contains 64pcs LEDs.

The inner structure of 8×8 dot matrix is shown below.



Every LED is installed on the cross point of row line and column line. When the voltage on some line increases, and the voltage on some column line is reduced, the LED on the cross point will light up. 8×8 dot matrix has 16 pins. Put the silk-screened side down and the anticlockwise numbers are 1,8, 9 and 16.

The definition inner pins are shown below:

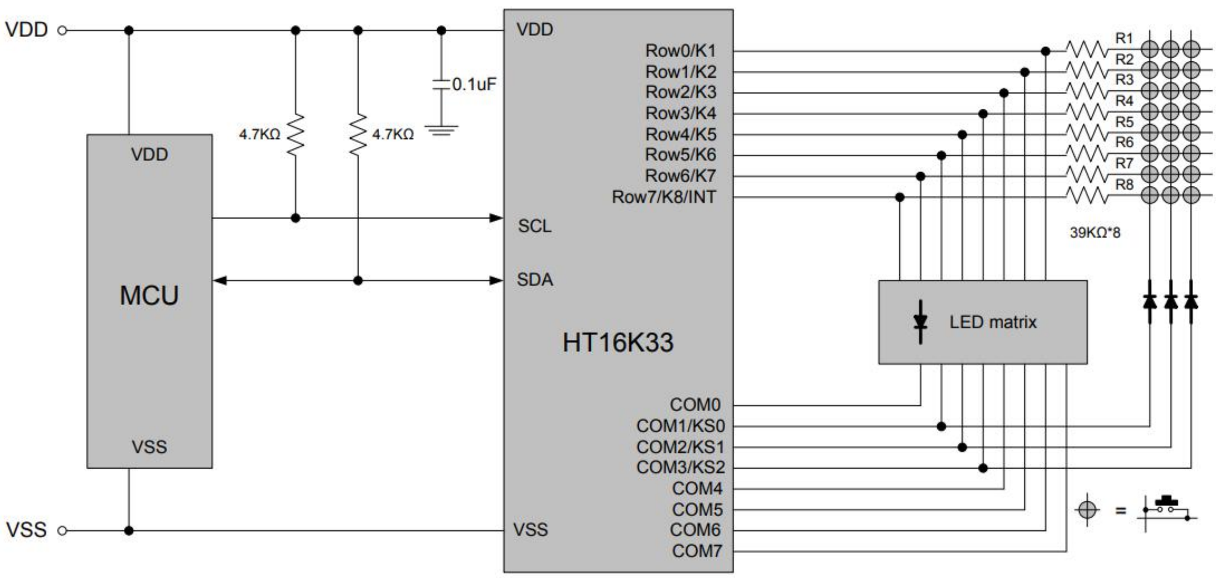


For instance, to light up the LED on row 1 and column 1, increase the voltage of pin 9 and reduce the voltage of pin 13.

(4) HT16K33 8X8 Dot Matrix

The HT16K33 is a memory mapping and multi-purpose LED controller driver. The max. Display segment numbers in the device is 128 patterns (16 segments and 8 commons) with a 13*3 (MAX.) matrix key scan circuit. The software configuration features of the HT16K33 makes it suitable for multiple LED applications including LED modules and display subsystems. The HT16K33 is compatible with most microcontrollers and communicates via a two-line bidirectional I2C-bus.

The working schematic of HT16K33 chip



We design the drive module of 8*8 dot matrix based on the above principle. We could control the dot matrix by I2C communication and two pins of microcontroller, according to the above diagram.

(5) Specification of 8*8 dot matrix

Input voltage: 5V

Rated input frequency: 400KHZ

Input power: 2.5W

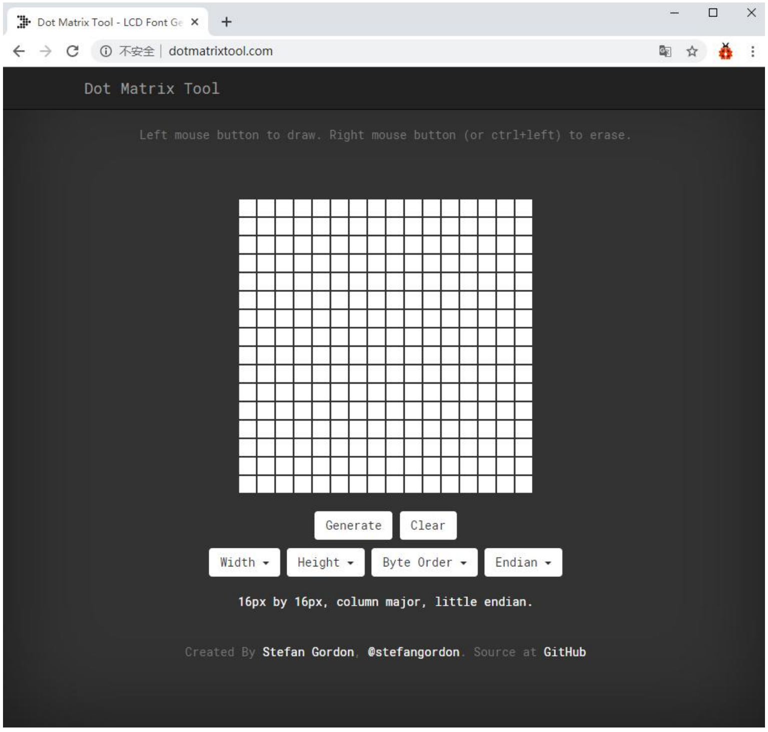
Input current: 500mA

4. Introduction for Modulus Tool

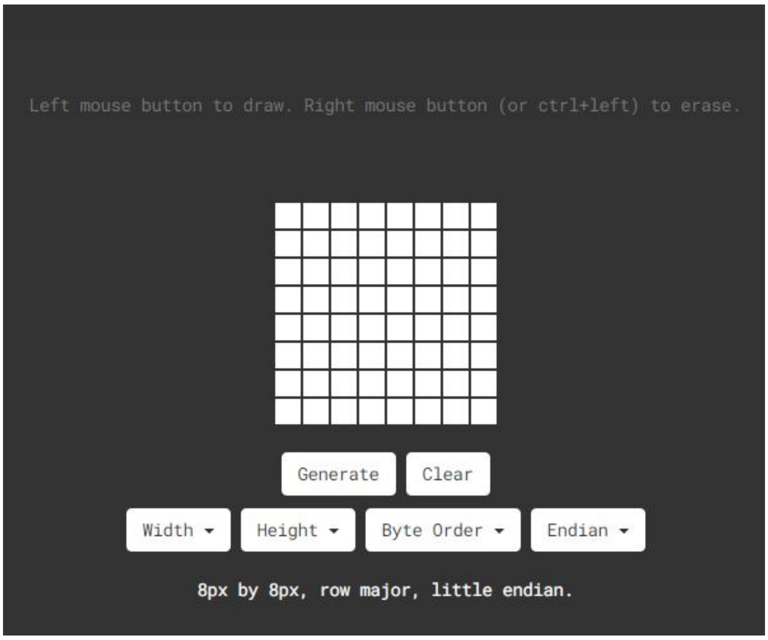
The online version of dot matrix modulus tool:

http://dotmatrixtool.com/#

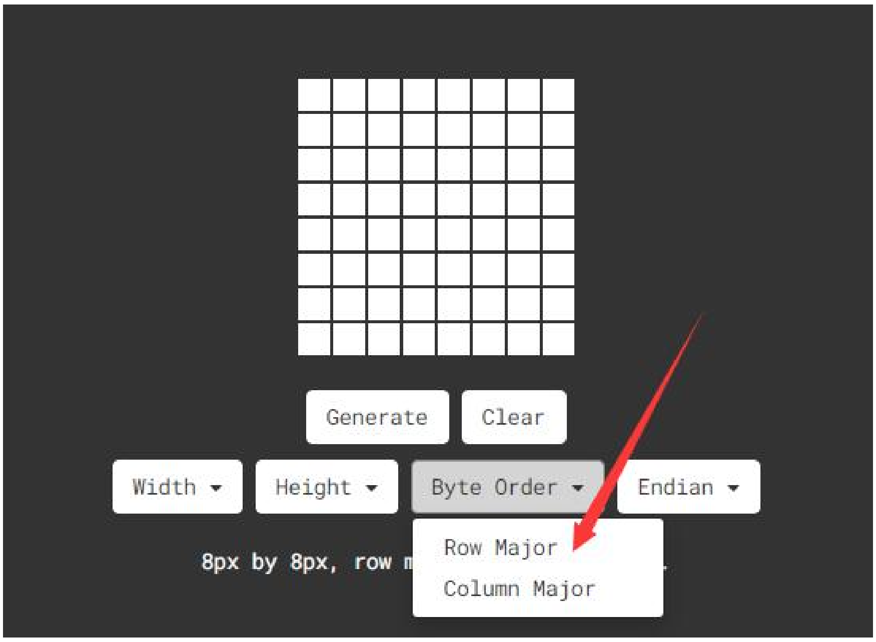
① Open links to enter the following page.



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

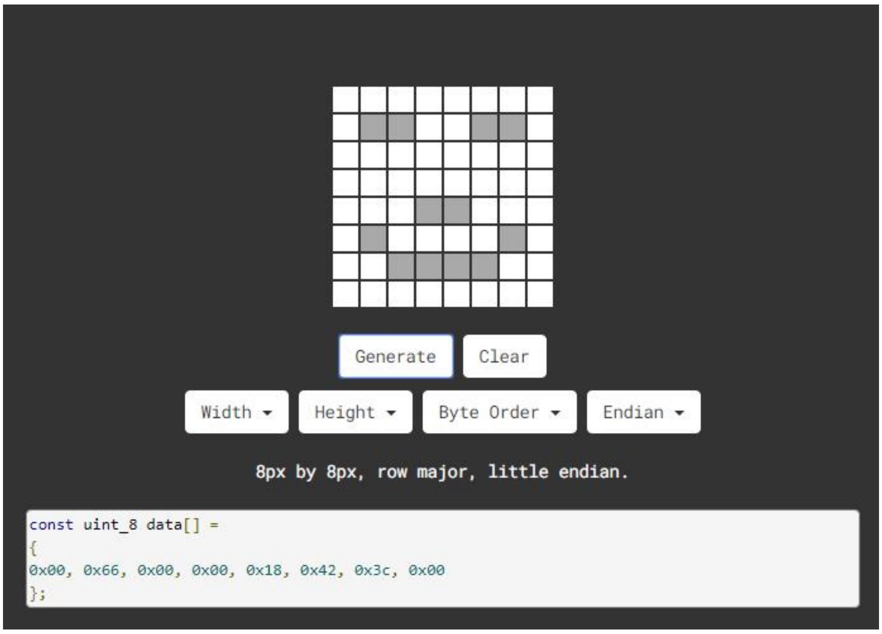


Click Byte order to select "**Row major**"



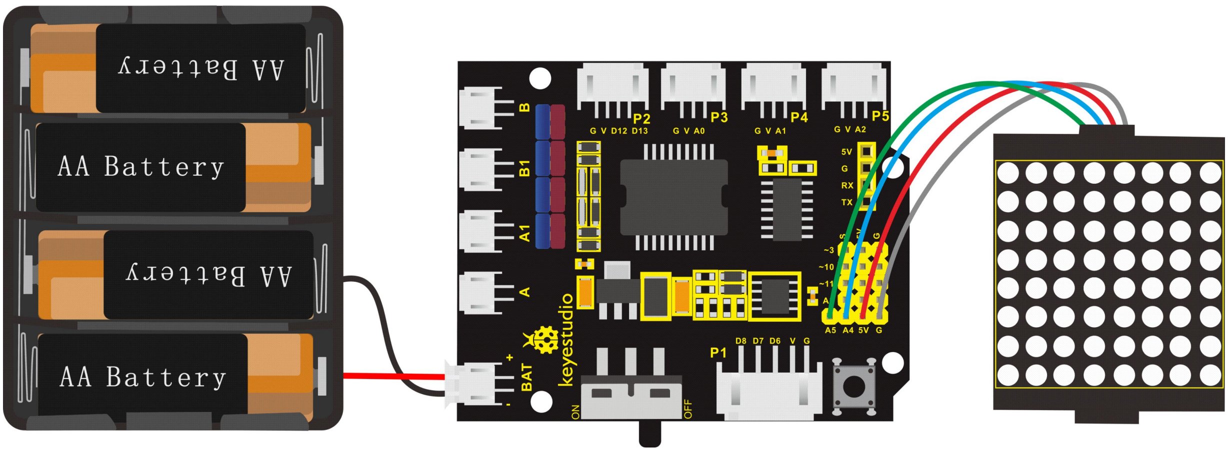
③ Generate hexadecimal data from the pattern

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.



The generated hexadecimal code(0x00, 0x66, 0x00, 0x00, 0x18, 0x42, 0x3c, 0x00) is what we display, and save it.

(6) Connection Diagram



Note: The pin G, V, SDA and SCL of dot matrix module are separately connected to G, 5V, A4 and A5 of motor drive shield. Plug power to BAT interface.

(7) Test Code:

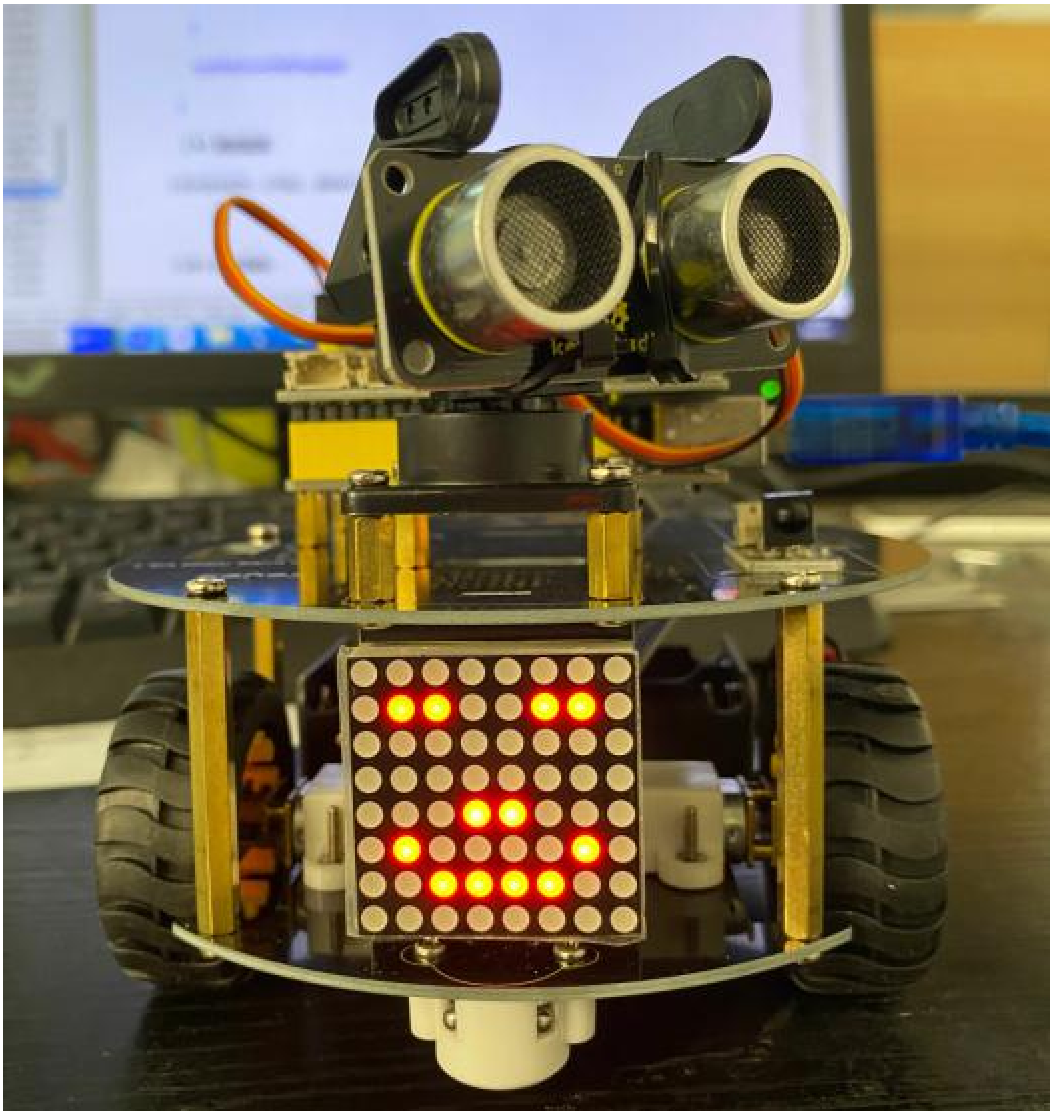
```
/*
 keyestudio smart turtle robot
 lesson 9.1
 Matrix
 http://www.keyestudio.com
*/
#include <Matrix.h>
Matrix myMatrix(A4,A5);       //set pins to communication pins
// define an array
uint8_t LedArray1[8]={0x00, 0x66, 0x00, 0x00, 0x18, 0x42, 0x3c, 0x00};
uint8_t   LEDArray[8]; //define an array(by modulus tool) without initial
value

void setup(){
   myMatrix.begin(0x70);   //communication address
   myMatrix.clear();       //clear matrix
}
```

```
void loop(){
  for(int i=0; i<8; i++)   // there is eight data, loop for eight times
  {
    LEDArray[i]=LedArray1[i];    //Call the emoticon array data in the subroutine LEDArray
    for(int j=7; j>=0; j--)   //Every data(byte) has 8 bit, therefore, loop for eight times
    {
      if((LEDArray[i]&0x01)>0) //judge if the last bit of data is greater than 0
      {
        myMatrix.drawPixel(j, i,1);   //light up the corresponding point
      }
      else   //otherwise
      {
        myMatrix.drawPixel(j, i,0);   //turn off the corresponding point
      }
      LEDArray[i] = LEDArray[i]>>1;   //LEDArray[i] moves right for one bit to judge the previous one bit
    }
  }
```

```
  myMatrix.writeDisplay();   // dot matrix shows
}
//*******************************************
```

(8) Test Result

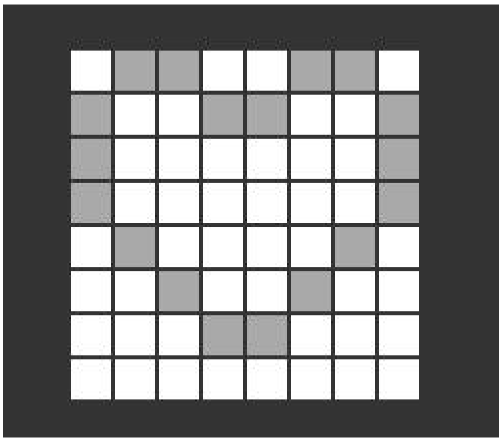
Upload code, plug in power and turn on the switch of the robot car. 8*8 dot matrix shows smile face pattern.



(9) Extension Practice:

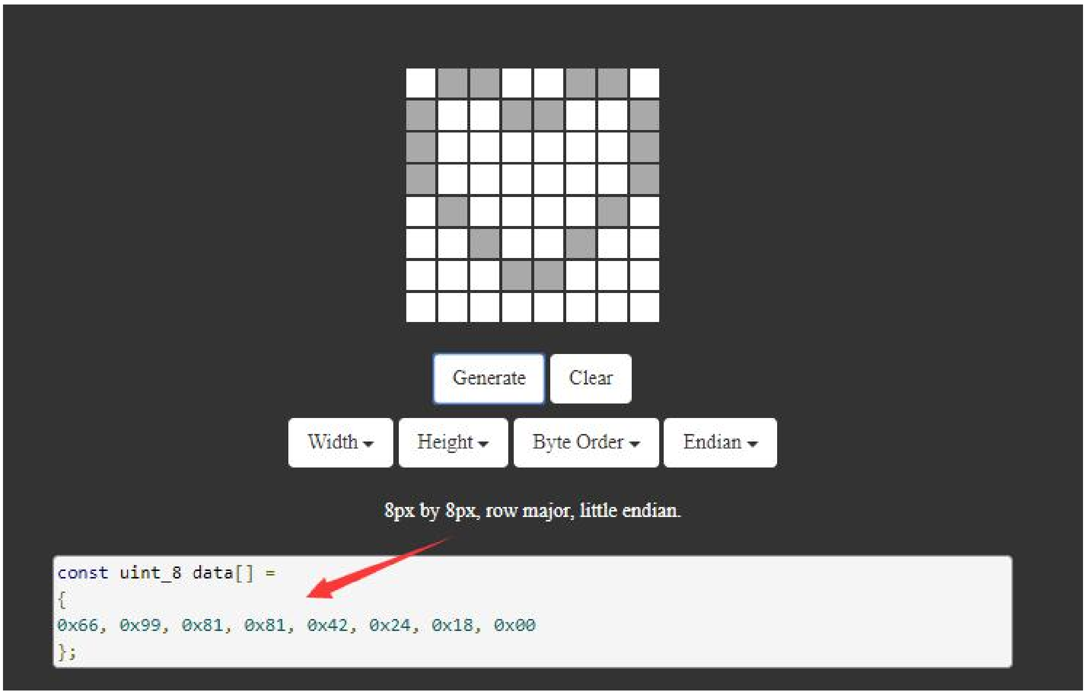
Let’ s make dot matrix draw a heart, just enter the website and draw the following pattern.

http://dotmatrixtool.com/#



,

Then we get the code of heart pattern



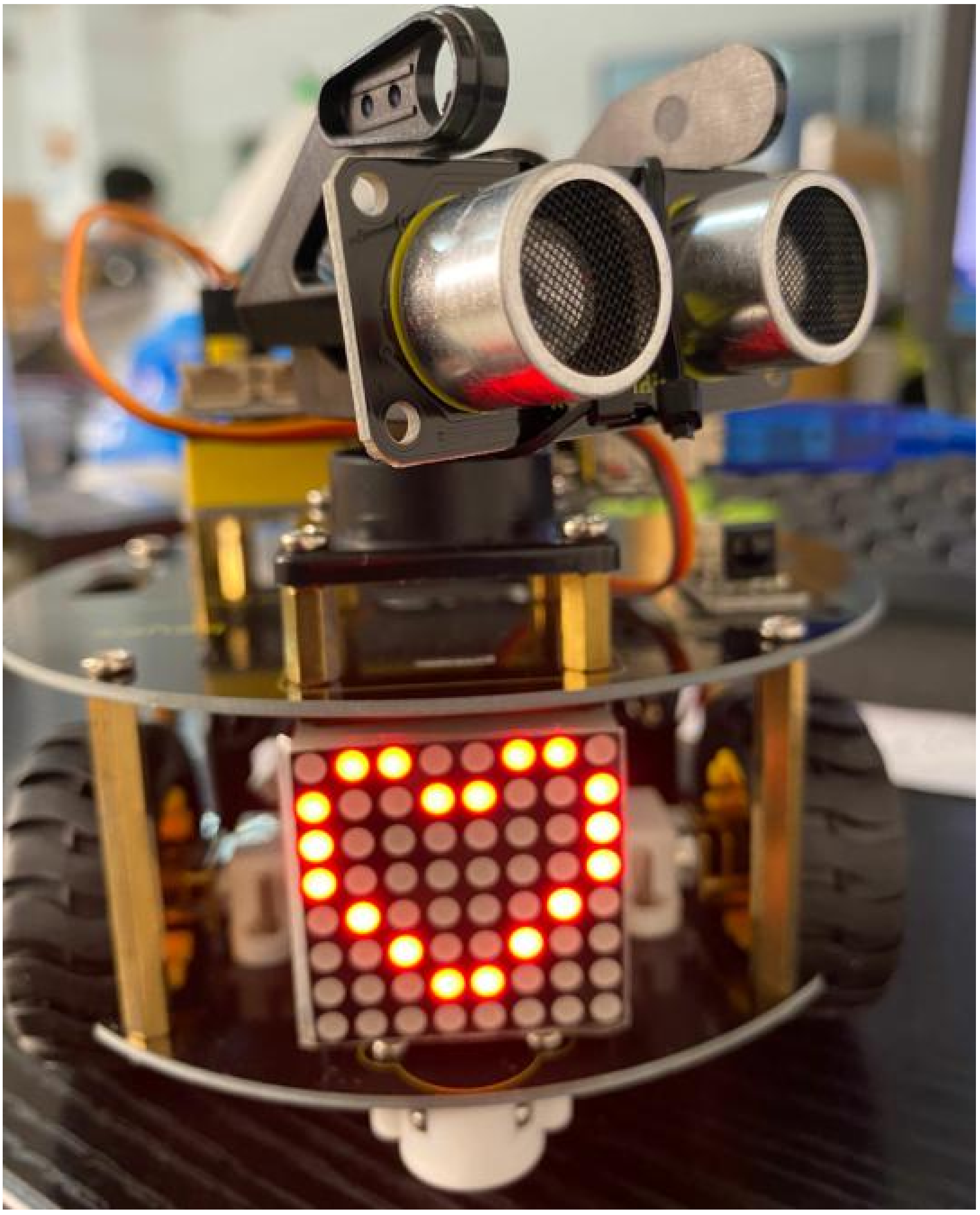
Replace the above code of heart pattern, the complete code is shown below:

```
/*
 keyestudio smart turtle robot
 lesson 9.2
 Matrix
 http://www.keyestudio.com
*/
#include <Matrix.h>
Matrix myMatrix(A4,A5);     //set pins to communication pins
//define an array
uint8_t LedArray1[8]={0x66,0x99,0x81,0x81,0x42,0x24,0x18,0x00};
uint8_t   LEDArray[8]; //define an array(by modulus tool) without initial
value
void setup(){
  myMatrix.begin(0x70);  //communication address
  myMatrix.clear();      //Clear
}
void loop(){
  for(int i=0; i<8; i++)  // there is eight data, loop for eight times
  {
        LEDArray[i]=LedArray1[i];   //Call the emoticon array data in the
```

subroutine LEDArray

```
        for(int j=7; j>=0; j--)   //Every data(byte) has 8 bits, therefore, loop for eight times

    {
      if((LEDArray[i]&0x01)>0) //judge if the last bit of data is greater than 0
      {
        myMatrix.drawPixel(j, i,1);   //light up the corresponding point
      }
      else   //otherwise
      {
        myMatrix.drawPixel(j, i,0);   //turn off the corresponding point
      }
      LEDArray[i] = LEDArray[i]>>1;   //LEDArray[i] moves right for one bit to judge the previous one bit
    }
  }
  myMatrix.writeDisplay();   // dot matrix shows
}
//************************************************************************
```

Upload code, plug in power and turn on the switch of the robot car. 8*8 dot matrix shows the heart pattern.



Project 10: Line Tracking Robot

(1) Description

The previous projects are inclusive of the knowledge of multiple sensors and modules. Next, we will work on a little challenging task.

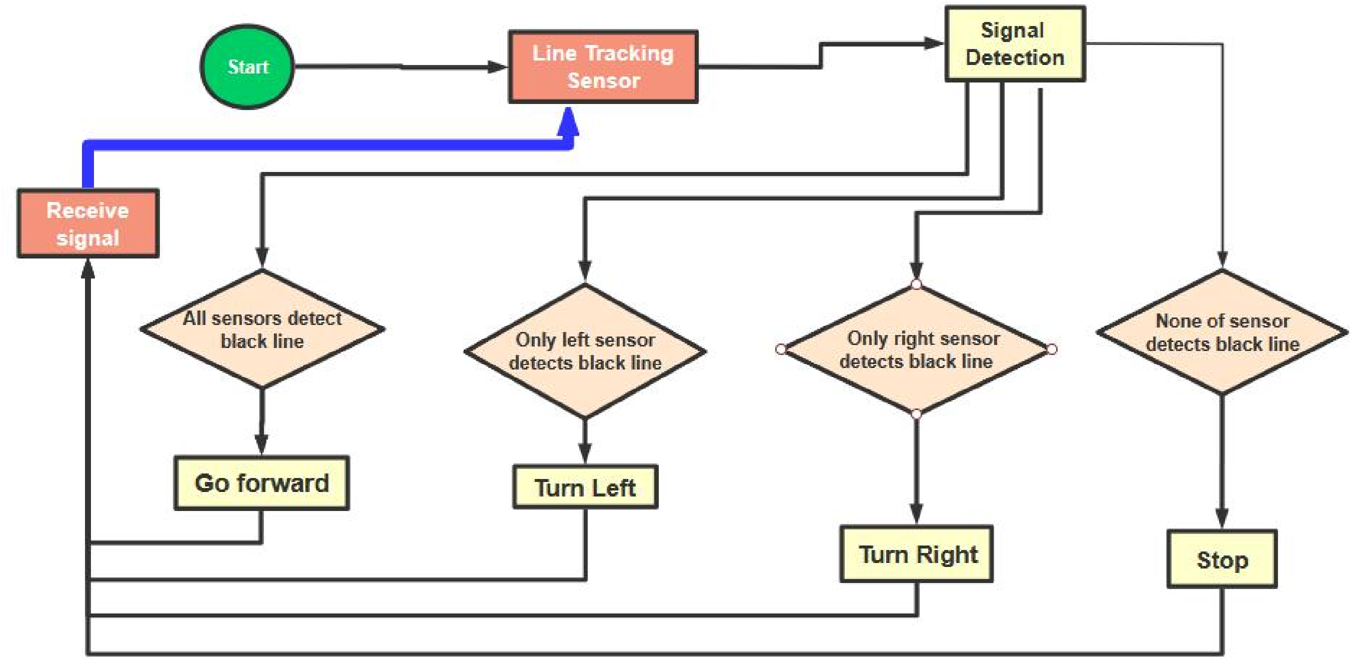
We could make a line tracking car on top of the working principle of line tracking sensor.

(2) Program Process:

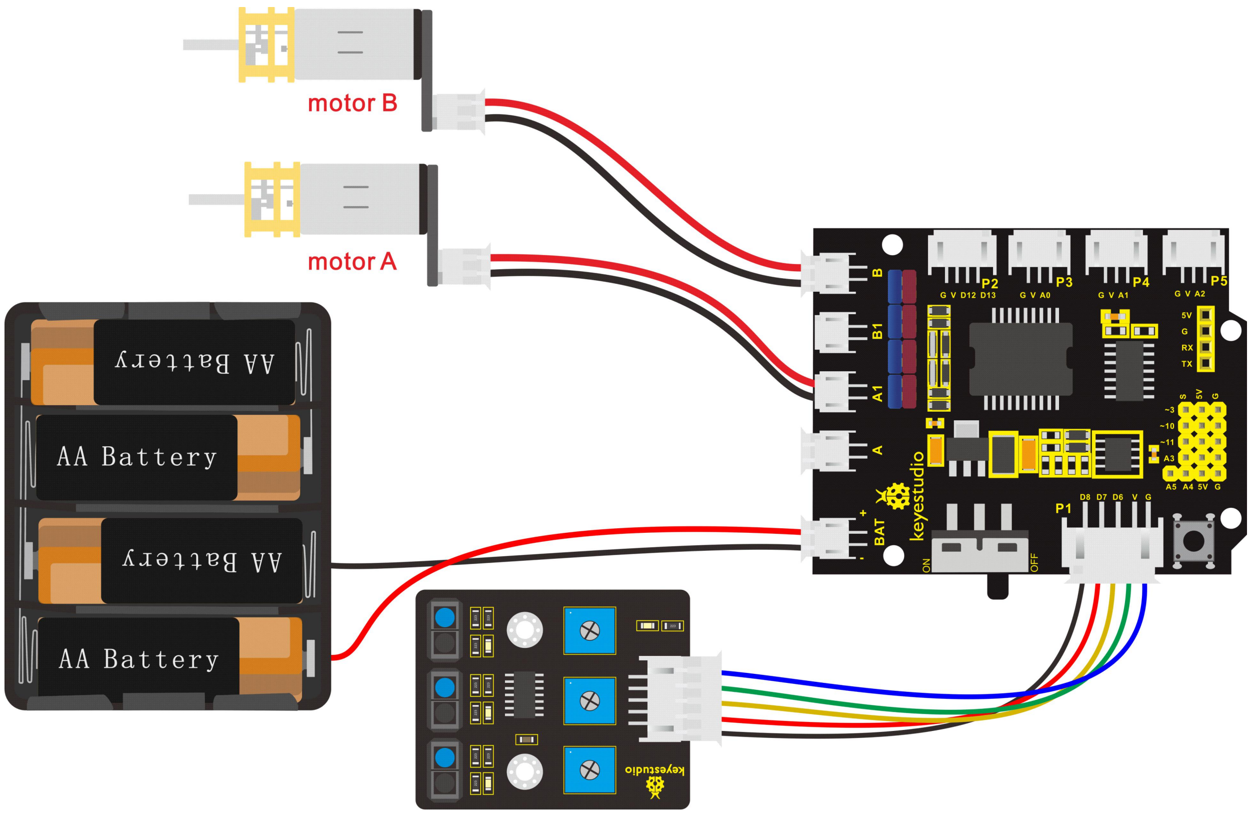
Detection	Middle tracking sensor	detects black line：HIGH
		detects white line：LOW
	Left tracking sensor	etects black line：HIG
		detects white line：LOW
	Right tracking sensor	detects black line：HIGH
		detects white line：LOW
Condition 1	Status 2 detecting the left and the right tracking sensor	Status
Middle tracking sensor detects black line	left tracking sensor detects black line; right sensor detects white line	Rotate to left（Set PWM to 200）
	left tracking sensor detects white line; right sensor detects black line	Rotate to right（Set PWM to 200）

	left and right tracking sensor detect black line	Go front (Set PWM to 200)
	left and right tracking sensor detect white line	Go front (Set PWM to 200)
Middle tracking sensor detects white line	Only left line tracking sensor detects black line	Rotate to left (Set PWM to 200)
	Only right line tracking sensor detects black line	Rotate to right (Set PWM to 200)
	Left and right line tracking sensors detect black line	stop
	Left and right line tracking sensors detect white line	stop

Flow Chart



(3) Connection Diagram



(4) Test Code

```
/*
 keyestudio smart turtle robot
 lesson 10
 Thacking turtle
 http://www.keyestudio.com
*/
int left_ctrl = 2;//define direction control pin of A motor
 int left_pwm = 9;//define PWM control pin of A motor
 int right_ctrl = 4;//define direction control pin of B motor
 int right_pwm = 5;//define PWM control pin of B motor
 int sensor_l = 6;//define the pin of left line tracking sensor
 int sensor_c = 7;//define the pin of middle line tracking sensor
 int sensor_r = 8;//define the pin of right line tracking sensor
int l_val,c_val,r_val;//define these variables

void setup() {
  Serial.begin(9600);//start serial monitor and set baud rate to 9600
  pinMode(left_ctrl,OUTPUT);//set direction control pin of A motor to
OUTPUT
  pinMode(left_pwm,OUTPUT);//set PWM control pin of A motor to
OUTPUT
```

```
  pinMode(right_ctrl,OUTPUT);//set direction control pin of B motor to OUTPUT
  pinMode(right_pwm,OUTPUT);//set PWM control pin of B motor to OUTPUT
  pinMode(sensor_l,INPUT);//set the pins of left line tracking sensor to INPUT
  pinMode(sensor_c,INPUT);//set the pins of middle line tracking sensor to INPUT
  pinMode(sensor_r,INPUT);//set the pins of right line tracking sensor to INPUT
}

void loop()
{
  tracking(); //run main program
}

void tracking()
{
  l_val = digitalRead(sensor_l);//read the value of left line tracking sensor
  c_val = digitalRead(sensor_c);//read the value of middle line tracking sensor
```

```
  r_val = digitalRead(sensor_r);//read the value of right line tracking sensor

  if(c_val == 1)//if the state of middle one is 1, which means detecting black line

  {
    front();//car goes forward
  }
  else
  {
       if((l_val == 1)&&(r_val == 0))//if only left line tracking sensor detects black trace

     {
       left();//car turns left
     }
       else if((l_val == 0)&&(r_val == 1))///if only right line tracking sensor detects black trace

     {
       right();//car turns right
     }
```

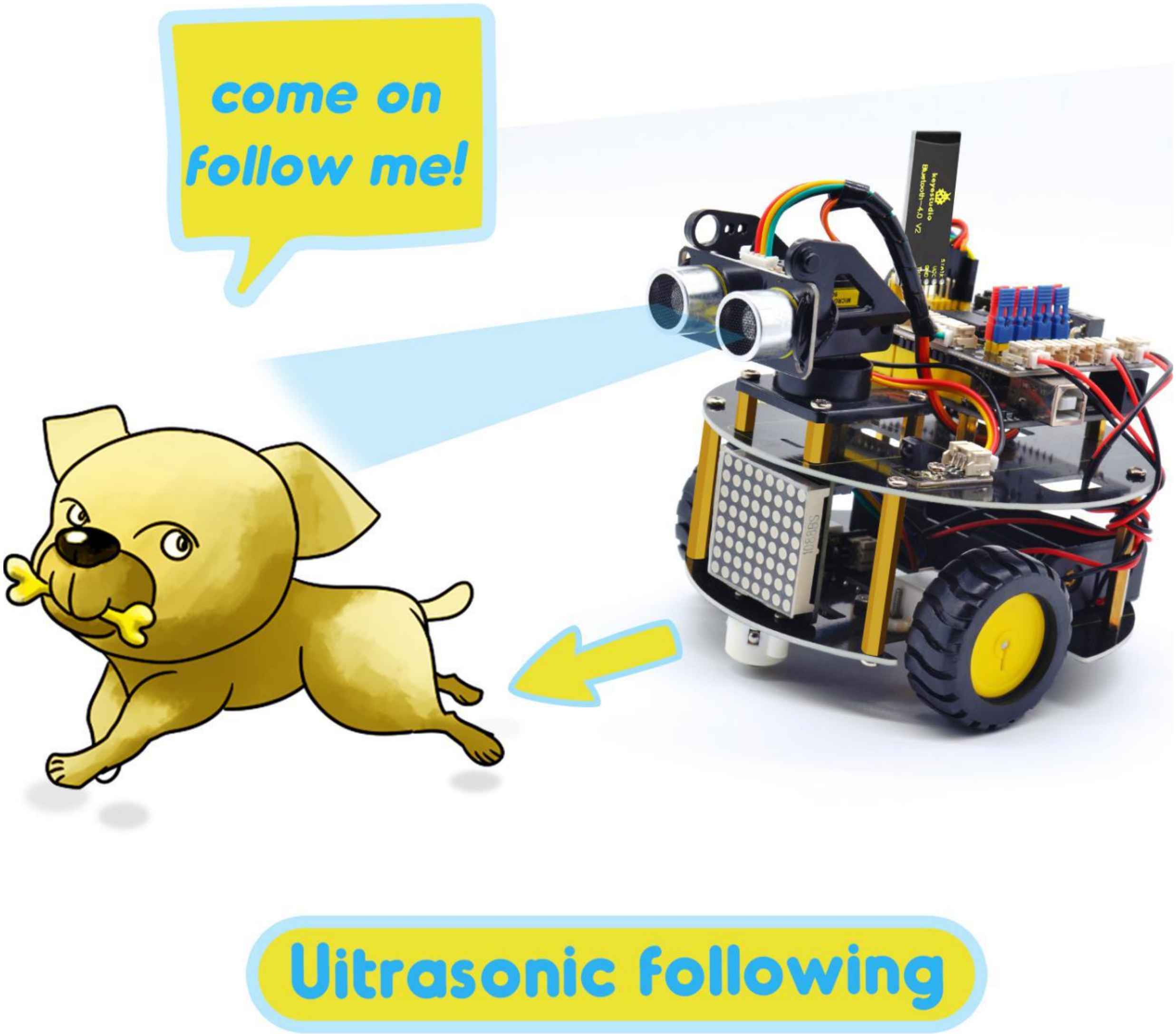
```
    else//if none of line tracking sensor detects black line
    {
      Stop();//car stops
    }
  }
}
void front()//define the status of going forward
{
  digitalWrite(left_ctrl,LOW);
  analogWrite(left_pwm,200);
  digitalWrite(right_ctrl,LOW);
  analogWrite(right_pwm,200);
}
void back()//define the state of going back
{
  digitalWrite(left_ctrl,HIGH);
  analogWrite(left_pwm,200);
  digitalWrite(right_ctrl,HIGH);
  analogWrite(right_pwm,200);
}
void left()//define the left-turning state
{
```

```
  digitalWrite(left_ctrl,HIGH);
  analogWrite(left_pwm,200);
  digitalWrite(right_ctrl,LOW);
  analogWrite(right_pwm,200);
}
void right()//define the right-turning state
{
  digitalWrite(left_ctrl,LOW);
  analogWrite(left_pwm,200);
  digitalWrite(right_ctrl,HIGH);
  analogWrite(right_pwm,200);
}
void Stop()//define the state of stop
{
  analogWrite(left_pwm,0);
  analogWrite(right_pwm,0);
}
//*********************************************************
```

(5) Test Result

Upload the code to the development board, plug in power and turn on the switch on the robot car. Turtle car walks along black lines.

Project 11: Ultrasonic Follow Robot



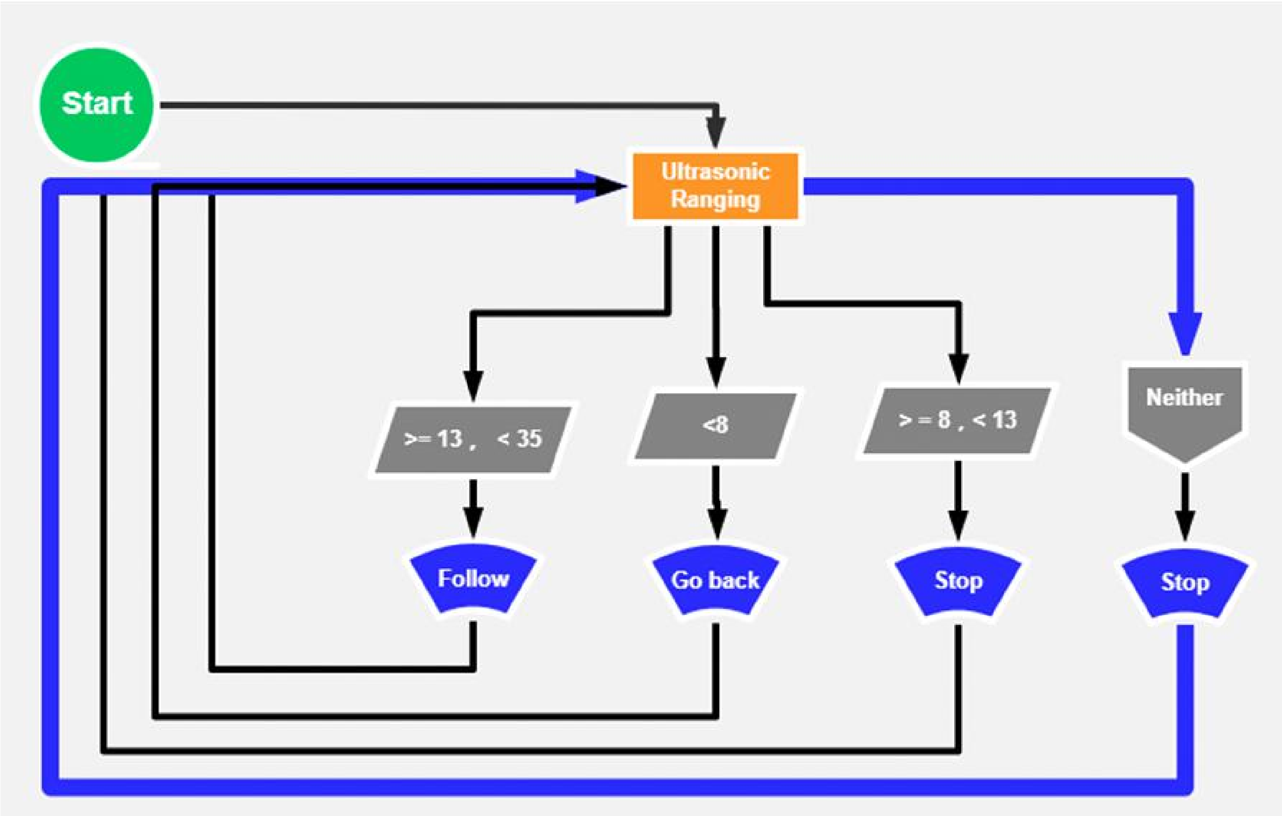
(1) Description

In this project, we detect the distance value of the obstacle to drive two motors so as to make robot car move and 8*8 dot matrix show smile face pattern

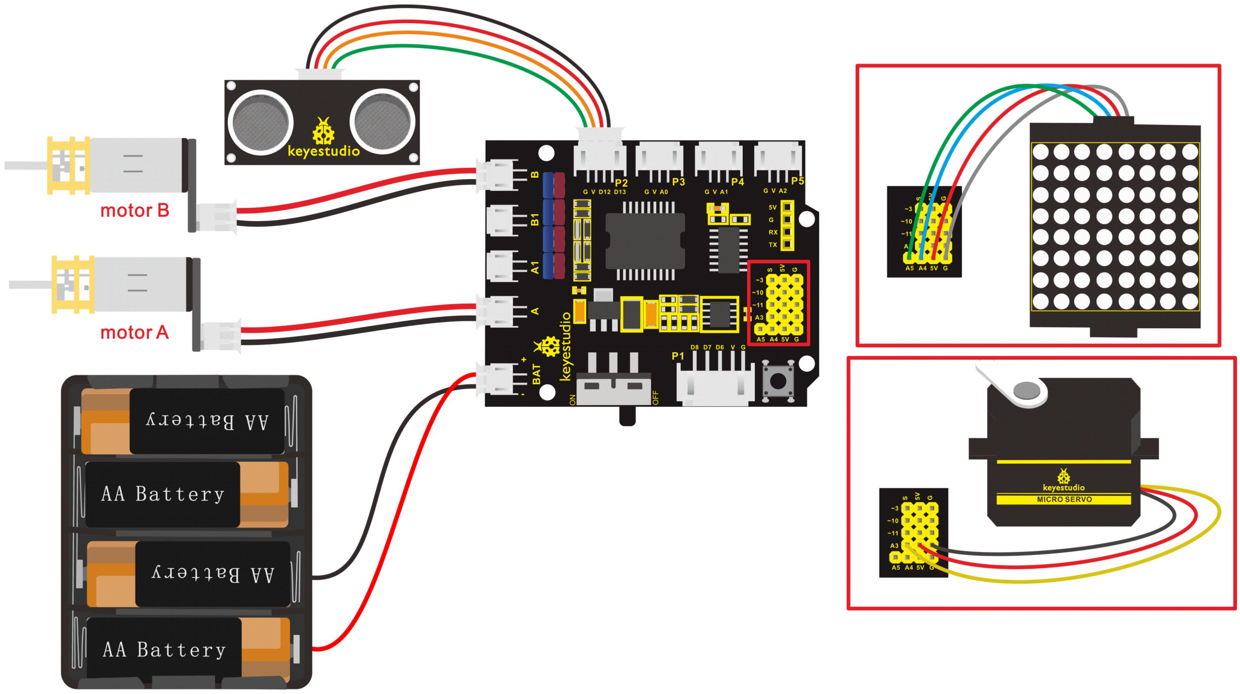
The specific logic of ultrasonic follow robot car is as shown below:

Detection	Measured distance of front obstacles	distance (unit: cm)
Setting	Set servo to 90°	
	Make dot matrix show smile face pattern	
Condition	Distance < 8	
Status	Go back (PWM set to 200)	
Condition	distance≥8 and distance < 13	
Status	Stop	
Condition	distance≥13 and distance < 35	
Status	Go front (PWM set to 200)	
Condition	distance≥35	
Status	stop	

Flow Chart



(2) Hook-up Diagram



(3) Test Code

```
/*
 keyestudio smart turtle robot
 lesson 11
 flowing turtle
 http://www.keyestudio.com
*/

 int left_ctrl = 2;//define the direction control pin of A motor
 int left_pwm = 9;//define the speed control pin of A motor
 int right_ctrl = 4;//define the direction control pin of B motor
```

```
 int right_pwm = 5;//define the speed control pin of B motor
#include "SR04.h" //define the function library of ultrasonic sensor
#define TRIG_PIN 12// set the signal of ultrasonic sensor to D12
#define ECHO_PIN 13// set the signal of ultrasonic sensor to D13
SR04 sr04 = SR04(ECHO_PIN,TRIG_PIN);
long distance;

void setup() {
  Serial.begin(9600);//open serial monitor and set baud rate to 9600
  pinMode(left_ctrl,OUTPUT);//set direction control pin of A motor to OUTPUT
  pinMode(left_pwm,OUTPUT);//set PWM control pin of A motor to OUTPUT
  pinMode(right_ctrl,OUTPUT);//set direction control pin of B motor to OUTPUT
  pinMode(right_pwm,OUTPUT);//set PWM control pin of B motor to OUTPUT

}

void loop() {
  distance = sr04.Distance();//the distance detected by ultrasonic sensor
```

```
  if(distance<8)//if distance is less than 8
  {
    back();//go back
  }
  else if((distance>=8)&&(distance<13))//if 8≤distance＜13
  {
    Stop();//stop
  }
  else if((distance>=13)&&(distance<35))//if 13≤distance＜35
{
    front();//follow
  }
  else//otherwise
  {
    Stop();//stop
  }
}

void front()//define the status of going front
{
  digitalWrite(left_ctrl,LOW);
  analogWrite(left_pwm,200);
```

```
  digitalWrite(right_ctrl,LOW);
  analogWrite(right_pwm,200);
}
void back()//define the status of going back
{
  digitalWrite(left_ctrl,HIGH);
  analogWrite(left_pwm,200);
  digitalWrite(right_ctrl,HIGH);
  analogWrite(right_pwm,200);
}
void left()//define the status of turning left
{
  digitalWrite(left_ctrl,HIGH);
  analogWrite(left_pwm,200);
  digitalWrite(right_ctrl,LOW);
  analogWrite(right_pwm,200);
}
void right()//define the status of right turning
{
  digitalWrite(left_ctrl,LOW);
  analogWrite(left_pwm,200);
  digitalWrite(right_ctrl,HIGH);
```

```
   analogWrite(right_pwm,200);
}
void Stop()//define the state of stop
{
   analogWrite(left_pwm,0);
   analogWrite(right_pwm,0);
}
//*****************************************************
```

(4) Test Result

Upload the code to the development board, and plug in power. Adjust the servo on turtle robot car to 90°, dot matrix will display smile face pattern and follow the obstacle to move.(robot car only moves forward and backward).

Project 12: Ultrasonic Avoiding Robot

(1) Description

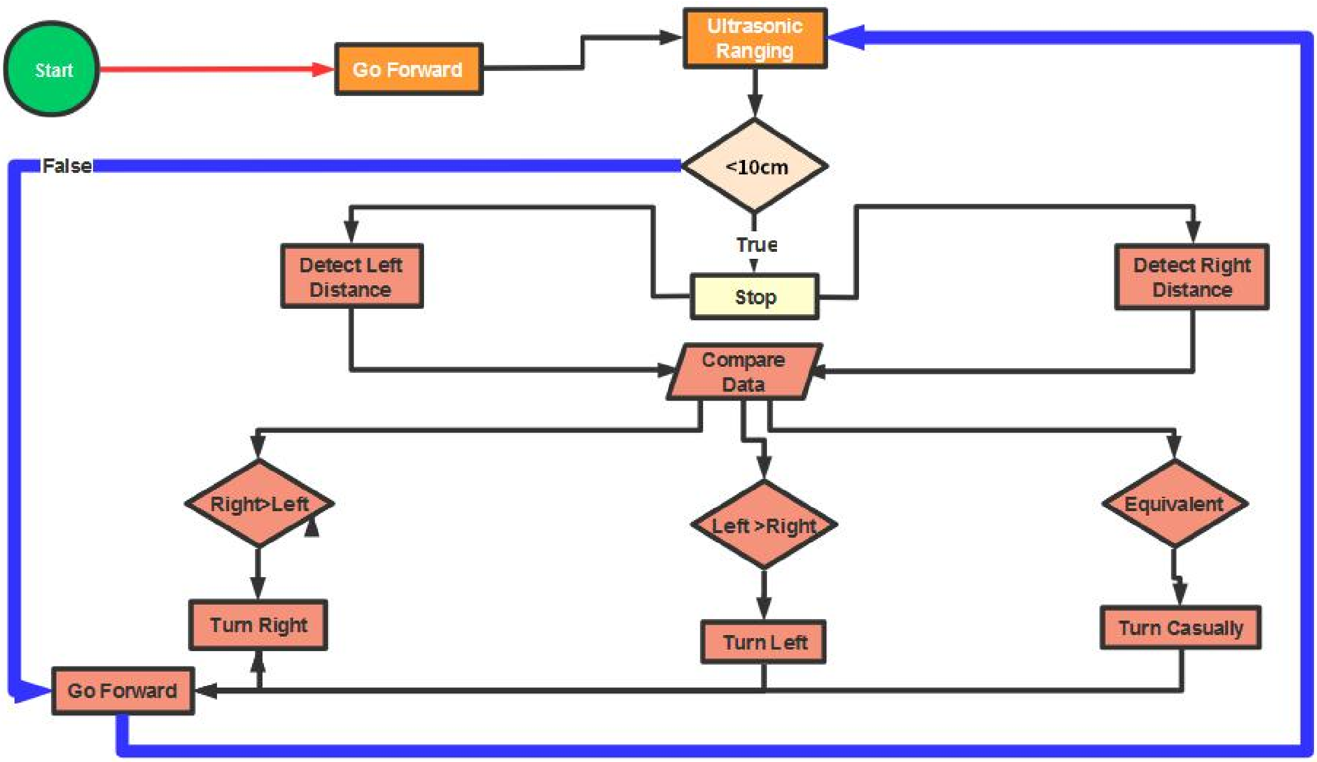
We' ve learned LED matrix, motor drive, ultrasonic sensor and servo in previous lessons. Next, we could make an ultrasonic avoiding robot!

The measured distance between ultrasonic sensor and obstacle can be used to control servo to rotate so as to make robot car move.

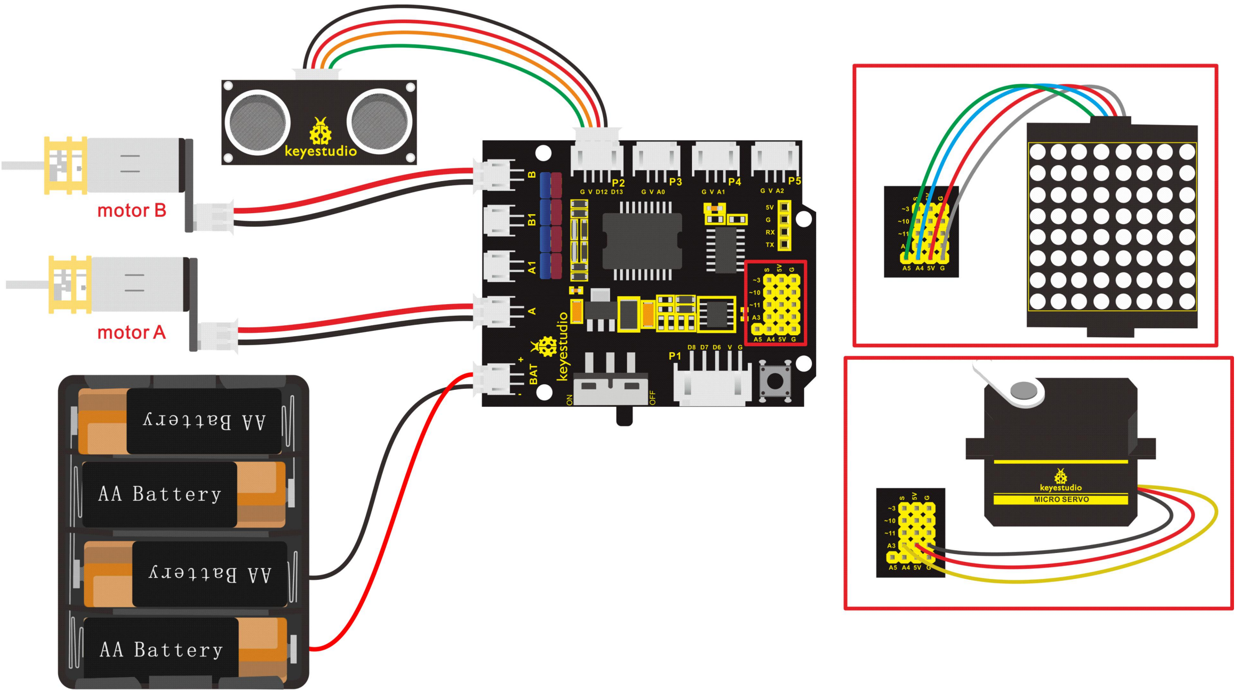
The specific logic of ultrasonic avoiding smart car is shown below:

Detection	measured distance of front obstacle set servo to90°	a (unit: cm)
	measured distance of left obstacle (set servo to 180°)	a1 (unit: cm)
	measured distance of right obstacle (set servo to 0°)	a2 (unit: cm)
Setting	set the initial angle of servo to 90°	
	Dot matrix shows smile face pattern	
Condition1	Status	
a < 10	Stop for 1000ms; set the angle of servo to 180°, read a1, delay in 500ms; set the angle of servo to 0°, read a2, delay in 500ms	
	Condition 2	Status
	a1 > a2	Set the angle of servo to 90°, rotate to left for 400ms (set

		PWM to 200）, and go font (set PWM to 200)
	a1≤a2	Set the angle of servo to 90°, rotate to right for 400ms, (set PWM to 200, and go front (set PWM to 200)
Condition 1	Status	
a≥10	Go front (set PWM to 200)	



(2) Connection Diagram



(3) Test Code

```
/*
 keyestudio smart turtle robot
 lesson 12
 avoiding turtle
 http://www.keyestudio.com
*/
#include <ks_Matrix.h>
Matrix myMatrix(A4,A5);// set the pins of dot matrix to A4 and A5.
//Array, used to store the data of pattern, can be calculated by yourself or
```

```
obtained from the modulus tool
uint8_t matrix_heart[8]={0x66,0x99,0x81,0x81,0x42,0x24,0x18,0x00};
uint8_t matrix_smile[8]={0x42,0xa5,0xa5,0x00,0x00,0x24,0x18,0x00};
uint8_t matrix_front2[8]={0x18,0x24,0x42,0x99,0x24,0x42,0x81,0x00};
uint8_t matrix_back2[8]={0x00,0x81,0x42,0x24,0x99,0x42,0x24,0x18};
uint8_t matrix_left2[8]={0x48,0x24,0x12,0x09,0x09,0x12,0x24,0x48};
uint8_t matrix_right2[8]={0x12,0x24,0x48,0x90,0x90,0x48,0x24,0x12};
uint8_t matrix_stop2[8]={0x18,0x18,0x18,0x18,0x18,0x00,0x18,0x18};
uint8_t  LEDArray[8];
const int left_ctrl = 2;//define direction control pin of A motor
const int left_pwm = 9;//define PWM control pin of A motor
const int right_ctrl = 4;//define direction control pin of B motor
const int right_pwm = 5;//define PWM control pin of B motor
#include "SR04.h"//define the library of ultrasonic sensor
#define TRIG_PIN 12// set the signal input of ultrasonic sensor to D12
#define ECHO_PIN 13//set the signal output of ultrasonic sensor to D13
SR04 sr04 = SR04(ECHO_PIN,TRIG_PIN);
long distance1,distance2,distance3;//define three distance
const int servopin = 10;//set the pin of servo to D10
int myangle;
int pulsewidth;
int val;
```

```
void setup() {
  Serial.begin(9600);//open serial monitor and set baud rate to 9600
  pinMode(left_ctrl,OUTPUT);//set direction control pin of A motor to OUTPUT
  pinMode(left_pwm,OUTPUT);//set PWM control pin of A motor to OUTPUT
  pinMode(right_ctrl,OUTPUT);//set direction control pin of B motor to OUTPUT
  pinMode(right_pwm,OUTPUT);//set PWM control pin of B motor to OUTPUT
  servopulse(servopin,90);//the angle of servo is 90 degree
  delay(300);
  myMatrix.begin(112);
  myMatrix.clear();
}

void loop()
 {
  avoid();//run the main program
}
```

```
void avoid()
{
  distance1=sr04.Distance(); //obtain the value detected by ultrasonic sensor

  if((distance1 < 10)&&(distance1 != 0))//if the distance is greater than 0 and less than 10

  {
    car_Stop();//stop
    myMatrix.clear();
    myMatrix.writeDisplay();//show stop pattern
    matrix_display(matrix_stop2);   //show stop pattern
    delay(100);
    servopulse(servopin,180);//servo rotates to 180°
    delay(200);
    distance2=sr04.Distance();//measure the distance
    delay(100);
    servopulse(servopin,0);//rotate to 0 degree
    delay(200);
    distance3=sr04.Distance();//measure the distance
    delay(100);
```

```
    if(distance2 > distance3)//compare the distance, if left distance is more than right distance
    {
      car_left();//turn left
      myMatrix.clear();
      myMatrix.writeDisplay();
      matrix_display(matrix_left2);      //display left-turning pattern
      servopulse(servopin,90);//servo rotates to 90 degree
      //delay(50);
      myMatrix.clear();
      myMatrix.writeDisplay();
      matrix_display(matrix_front2);     //show forward pattern
    }
    else//if the right distance is greater than the left
    {
      car_right();//turn right
      myMatrix.clear();
      myMatrix.writeDisplay();
      matrix_display(matrix_right2);     //display right-turning pattern
      servopulse(servopin,90);//servo rotates to 90 degree
      //delay(50);
      myMatrix.clear();
```

```
          myMatrix.writeDisplay();
          matrix_display(matrix_front2);   //show forward pattern
        }
    }
    else//otherwise
    {
        car_front();//go forward
        myMatrix.clear();
        myMatrix.writeDisplay();
        matrix_display(matrix_front2);   // show forward pattern
    }
}

void servopulse(int servopin,int myangle)//the running angle of servo
{
    for(int i=0; i<20; i++)
    {
        pulsewidth = (myangle*11)+500;
        digitalWrite(servopin,HIGH);
        delayMicroseconds(pulsewidth);
        digitalWrite(servopin,LOW);
        delay(20-pulsewidth/1000);
```

```
    }

}

void car_front()//car goes forward
{
    digitalWrite(left_ctrl,LOW);
    analogWrite(left_pwm,200);
    digitalWrite(right_ctrl,LOW);
    analogWrite(right_pwm,200);
}
void car_back()//go back
{
    digitalWrite(left_ctrl,HIGH);
    analogWrite(left_pwm,200);
    digitalWrite(right_ctrl,HIGH);
    analogWrite(right_pwm,200);
}
void car_left()//car turns left
{
    digitalWrite(left_ctrl,HIGH);
    analogWrite(left_pwm,200);
```

```
  digitalWrite(right_ctrl,LOW);
  analogWrite(right_pwm,200);
}
void car_right()//car turns right
{
  digitalWrite(left_ctrl,LOW);
  analogWrite(left_pwm,200);
  digitalWrite(right_ctrl,HIGH);
  analogWrite(right_pwm,200);
}

void car_Stop()//stop
{
   analogWrite(left_pwm,0);
  analogWrite(right_pwm,0);
}

//this function is used for dot matrix display
void matrix_display(unsigned char matrix_value[])
{
  for(int i=0; i<8; i++)
    {
```

```
         LEDArray[i]=matrix_value[i];
         for(int j=7; j>=0; j--)
         {
            if((LEDArray[i]&0x01)>0)
            myMatrix.drawPixel(j, i,1);
            LEDArray[i] = LEDArray[i]>>1;
         }
      }
      myMatrix.writeDisplay();
}
```

(4) Test Result

After uploading the code on the keyestudio V4.0 board, wire according to connection diagram. Turn on the switch of robot car, the smart car can automatically avoid obstacles.

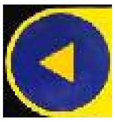
Project 13: IR Remote Control Robot

(1) Description

In this project, we will make IR remote control robot car!

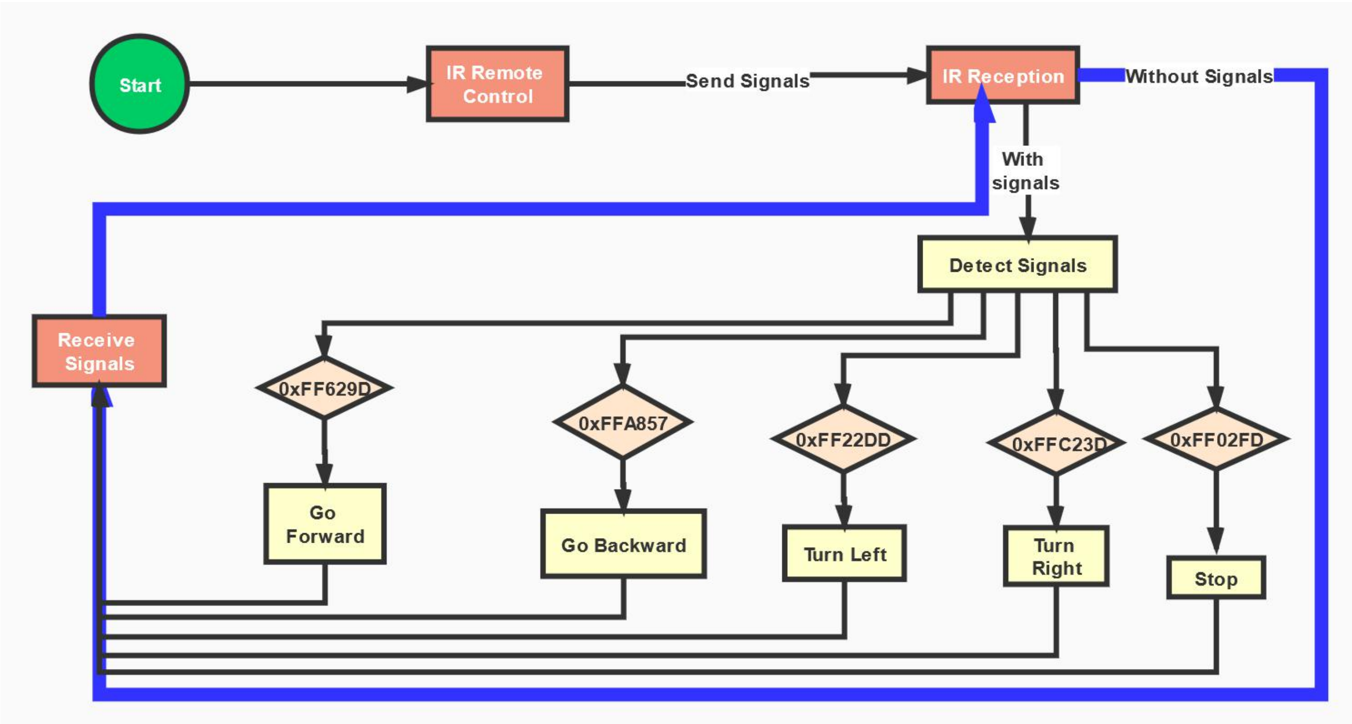
Press the button on IR remote control to drive robot car to move, and the corresponding state pattern is displayed on the 8*16 LED matrix.

The specific logic of IR remote control robot car is shown below:

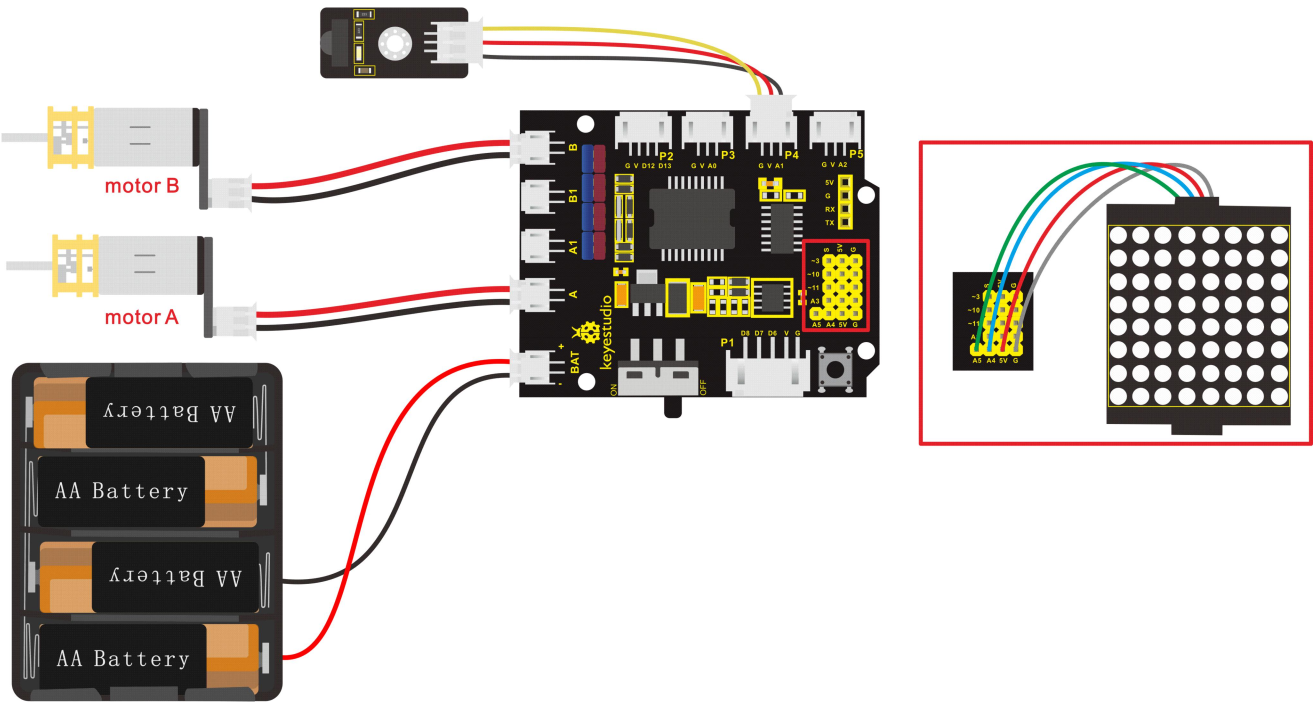
Initial setup	Dot matrix displays smile face	
Remote control	Key Value	Key state
	FF629D	Go front （PWM set to 200）
		8*8 LED matrix shows front icon
	FFA857	Back （PWM set to 200）
		8*8 LED matrix shows back icon
	FF22DD	Rotate to left （PWM set to 200）
		8*8 LED matrix shows leftward icon
	FFC23D	Rotate to right （PWM set to 200）
		8*8 LED matrix shows rightward icon
	FF02FD	Stop
		8*8 LED matrix shows “STOP”
	FF30CF	Turn left
		8*8 LED matrix shows leftward icon
	FF7A85	Turn right

		8*8 LED matrix shows rightward icon

Flow Chart



(2) Hook-up Diagram



Note: IR receiver is connected to P4 interface.

(3) Test Code

```
/*
keyestudio smart turtle robot
lesson 13
remote control turtle
http://www.keyestudio.com
*/
#include <ks_Matrix.h>
```

```
Matrix myMatrix(A4,A5);
//Array, used to store the data of pattern, can be calculated by yourself or obtained from the modulus tool
uint8_t matrix_heart[8]={0x66,0x99,0x81,0x81,0x42,0x24,0x18,0x00};
uint8_t matrix_smile[8]={0x42,0xa5,0xa5,0x00,0x00,0x24,0x18,0x00};
uint8_t matrix_front2[8]={0x18,0x24,0x42,0x99,0x24,0x42,0x81,0x00};
uint8_t matrix_back2[8]={0x00,0x81,0x42,0x24,0x99,0x42,0x24,0x18};
uint8_t matrix_left2[8]={0x48,0x24,0x12,0x09,0x09,0x12,0x24,0x48};
uint8_t matrix_right2[8]={0x12,0x24,0x48,0x90,0x90,0x48,0x24,0x12};
uint8_t matrix_stop2[8]={0x18,0x18,0x18,0x18,0x18,0x00,0x18,0x18};
uint8_t  LEDArray[8];
const int left_ctrl = 4;//define the direction control pin of A motor
const int left_pwm = 5;//define the speed control of A motor
const int right_ctrl = 2;//define the direction control pin of B motor
const int right_pwm = 9;//define the speed control pin of B motor
#include <IRremote.h>//function library of IR remote control
int RECV_PIN = A0;//set the pin of IR receiver to A0
IRrecv irrecv(RECV_PIN);
long irr_val;
decode_results results;
void setup()
{
```

```
    pinMode(left_ctrl,OUTPUT);//
    pinMode(left_pwm,OUTPUT);//
    pinMode(right_ctrl,OUTPUT);//
    pinMode(right_pwm,OUTPUT);//
      Serial.begin(9600);//
    // In case the interrupt driver crashes on setup, give a clue
    // to the user what's going on.
    Serial.println("Enabling IRin");
    irrecv.enableIRIn(); // Start the receiver
    Serial.println("Enabled IRin");
   myMatrix.begin(112);
   myMatrix.clear();
  }
  void loop()
   {
    if (irrecv.decode(&results))
   {
      irr_val = results.value;
      Serial.println(irr_val, HEX);//serial prints the read IR remote signals
      switch(irr_val)
      {
        case 0xFF629D : car_front();
```

```
myMatrix.clear();
myMatrix.writeDisplay();
matrix_display(matrix_front2);
break;

case 0xFFA857 : car_back();
myMatrix.clear();
myMatrix.writeDisplay();
matrix_display(matrix_back2);
break;
case 0xFF22DD : car_left();
myMatrix.clear();
myMatrix.writeDisplay();
matrix_display(matrix_left2);
break;

case 0xFFC23D : car_right();
myMatrix.clear();
myMatrix.writeDisplay();
matrix_display(matrix_right2);
break;
```

```
          case 0xFF02FD : car_Stop();
          myMatrix.clear();
          myMatrix.writeDisplay();
          matrix_display(matrix_stop2);
          break;
        }
           irrecv.resume(); // Receive the next value
    }
}
void car_front()//define the state of going front
{
  digitalWrite(left_ctrl,LOW);
  analogWrite(left_pwm,200);
  digitalWrite(right_ctrl,LOW);
  analogWrite(right_pwm,200);
}
void car_back()//define the status of going back
{
  digitalWrite(left_ctrl,HIGH);
  analogWrite(left_pwm,200);
  digitalWrite(right_ctrl,HIGH);
  analogWrite(right_pwm,200);
```

```
}
void car_left()//set the status of left turning
{
  digitalWrite(left_ctrl,LOW);
  analogWrite(left_pwm,200);
  digitalWrite(right_ctrl,HIGH);
  analogWrite(right_pwm,200);
}
void car_right()//set the status of right turning
{
  digitalWrite(left_ctrl,HIGH);
  analogWrite(left_pwm,200);
  digitalWrite(right_ctrl,LOW);
  analogWrite(right_pwm,200);
}
void car_Stop()//define the state of stop
{
   analogWrite(left_pwm,0);
  analogWrite(right_pwm,0);
}
//The function that dot matrix shows pattern
void matrix_display(unsigned char matrix_value[])
```

```
{
  for(int i=0; i<8; i++)
    {
      LEDArray[i]=matrix_value[i];
      for(int j=7; j>=0; j--)
      {
        if((LEDArray[i]&0x01)>0)
        myMatrix.drawPixel(j, i,1);
        LEDArray[i] = LEDArray[i]>>1;
      }
    }
    myMatrix.writeDisplay();
}
```

(4) Test Result

Upload code and press buttons on IR remote control to make turtle robot car to move.

Project 14: Bluetooth Remote Control

(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.

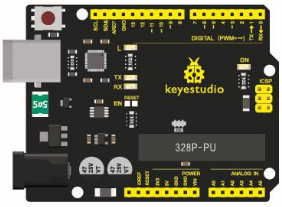
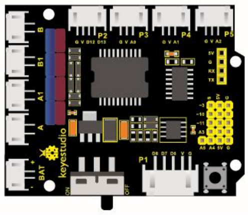
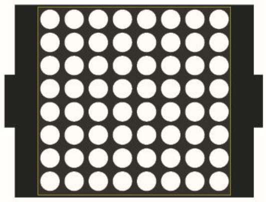
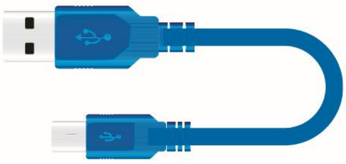
keyes BT car is an APP rolled out by keyestudio team. You could control the robot car by it readily.

(2) Test the key value of App

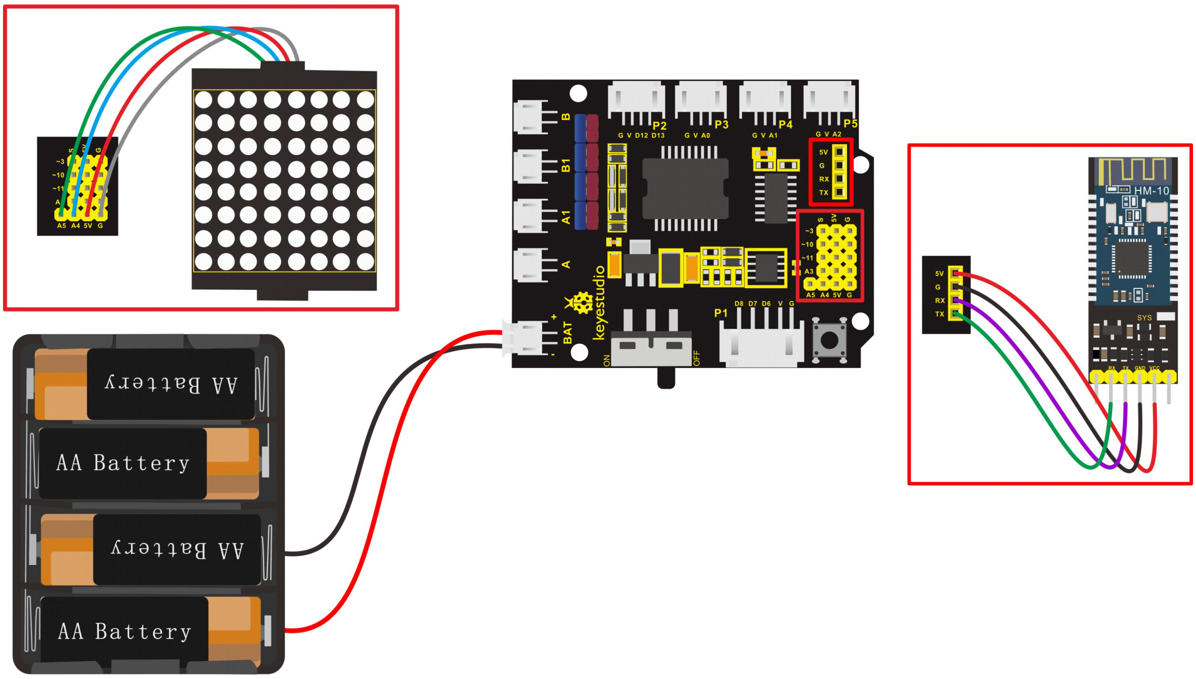
Special Note: Before uploading the test code, you need to remove the Bluetooth module, otherwise the test code will fail to upload. After the code is uploaded successful, then reconnect the Bluetooth module.

```
/*
keyestudio
lesson 14.1
Bluetooth test
http://www.keyestudio.com
*/
char BLE_val;
void setup()
{
  Serial.begin(9600);
}
void loop()
{
```

```
  if(Serial.available()>0)
  {
    BLE_val = Serial.read();
    Serial.println(BLE_val);
  }
}
```

Control Board *1	L298P Motor Shield *1	8x8 matrix *1	4.0 Bluetooth Module *1
			
Battery Holder *1	**USB Cable *1**	**4pin Dupont Line *1**	
			

Upload code to V4.0 development board, and connect to Bluetooth module, as shown below:



Insert a Bluetooth module, LED indicator of Bluetooth module will flash.

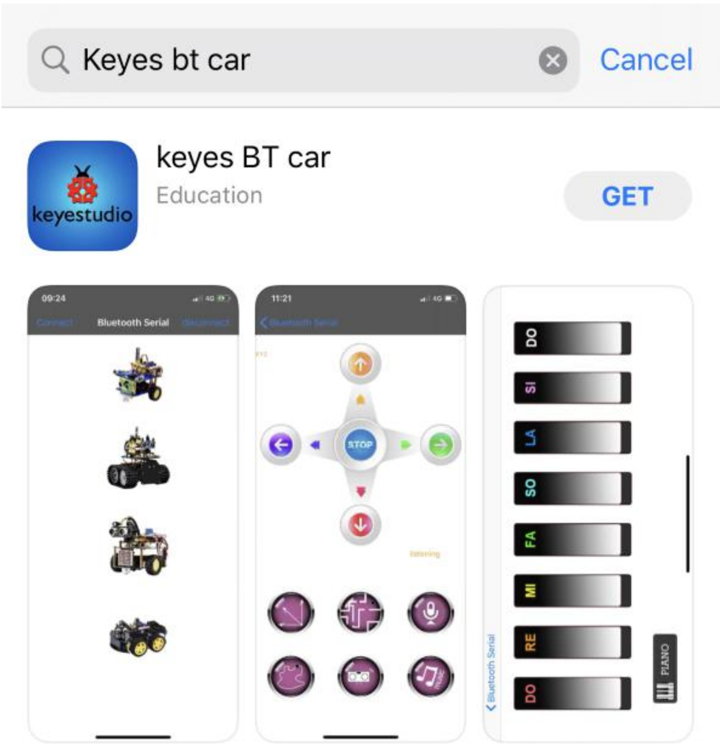
Next to download the App.

Special note: RXD, TXD, GND and VCC of Bluetooth module are respectively connected to TX, RX, - (GND) and + (VCC). The STATE and BRK pins don't need to be connected.

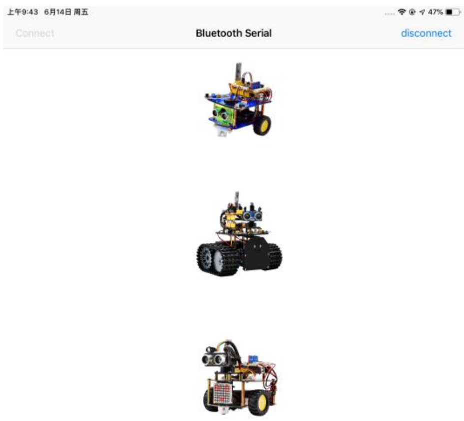
The pin G, V, SDA and SCL of dot matrix are linked with G, 5V, A4 and A5 separately. Plug power to BAT interface.

For iOS system

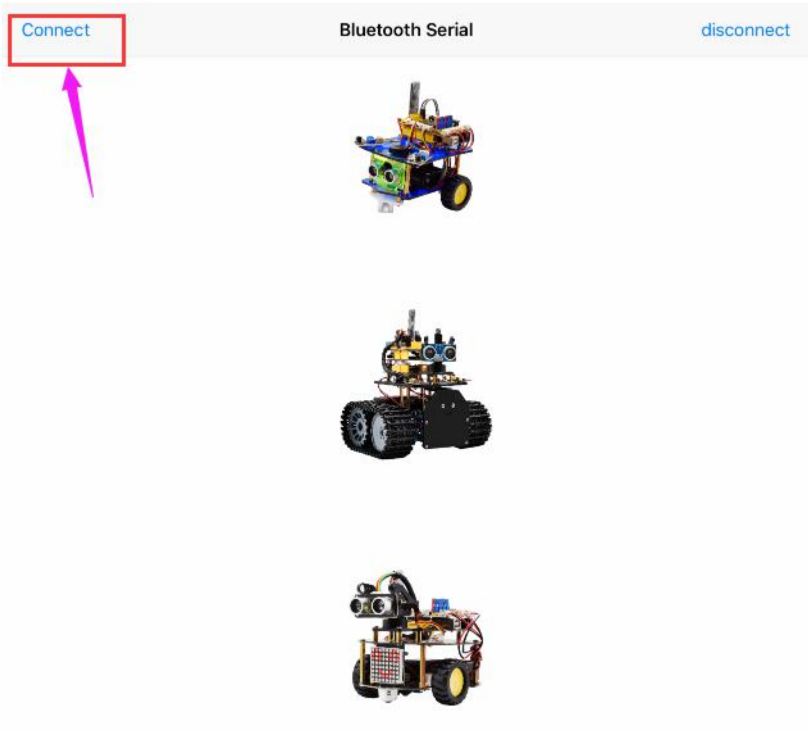
Search keyes BT car in App store

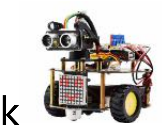


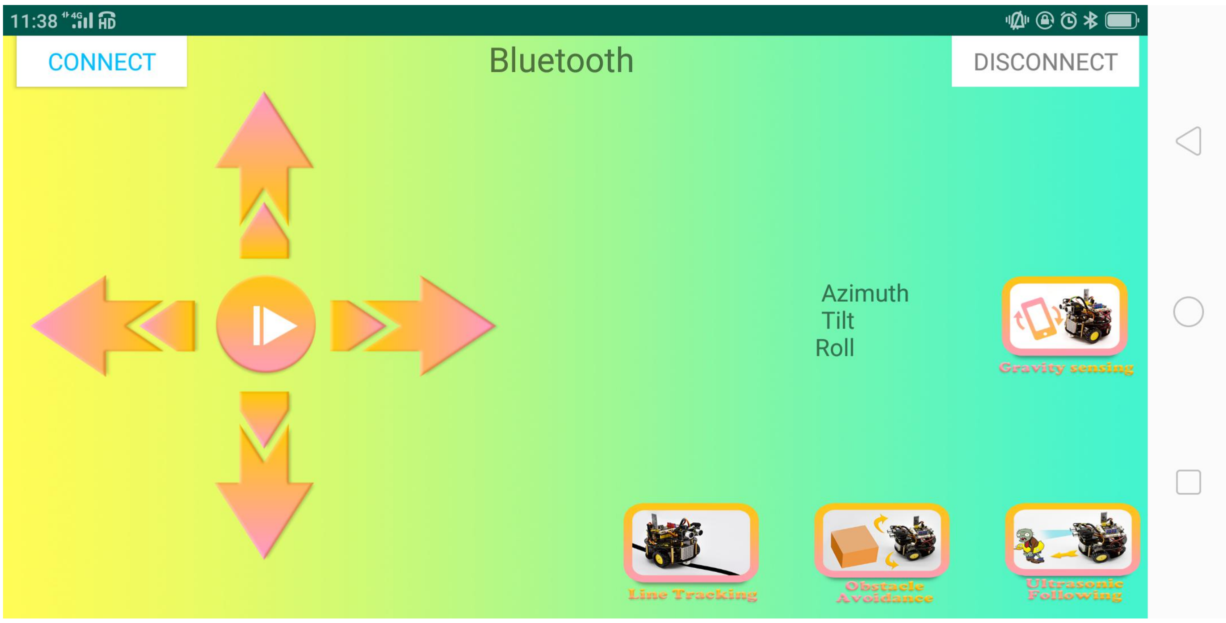
After installation, enter its interface.



Click “Connect” to search and pair Bluetooth.

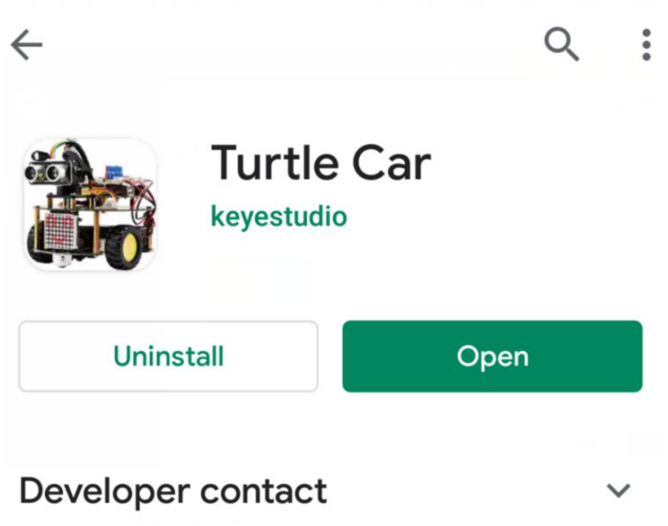


5.Click  to enter the main page of turtle smart car.



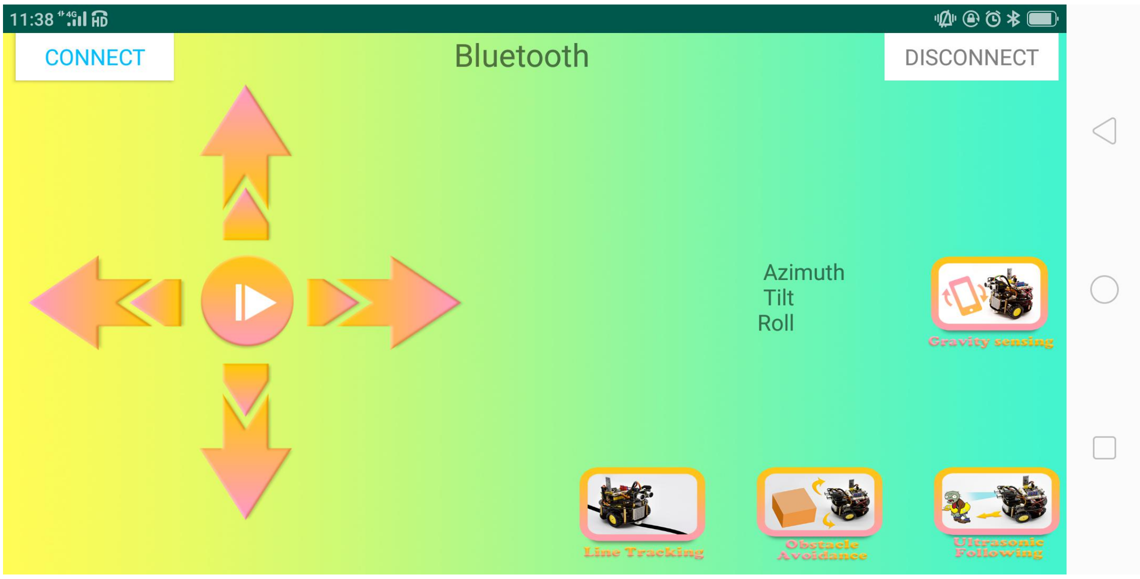
For Android System

1. Enter Google play store to search Turtle Car(**allow APP to access "location", you could enable "location" in settings of your cellphone.**

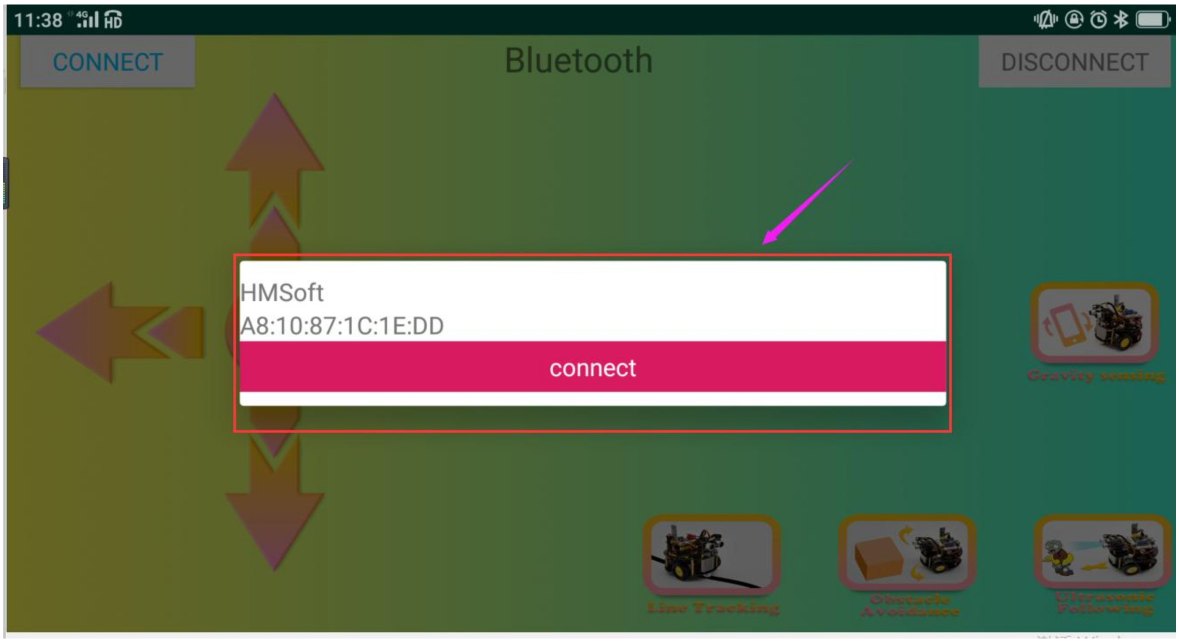


2. The app icon is shown below after installation.

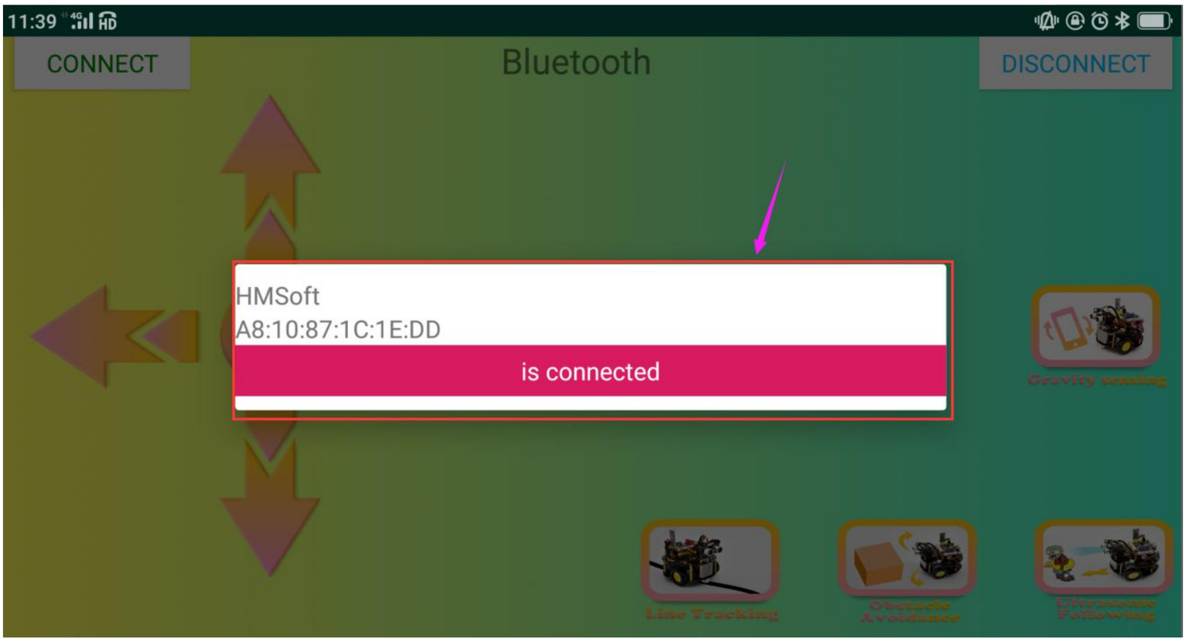
3. Click app to enter the following page.



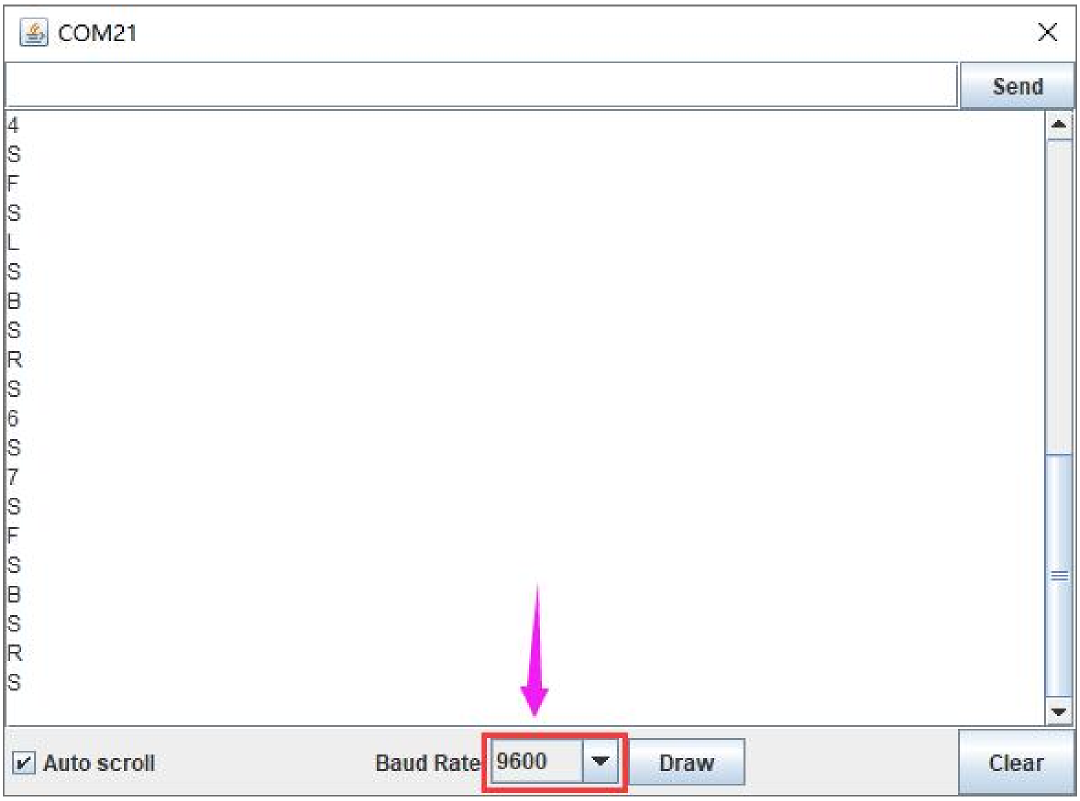
4. After connecting Bluetooth, plug in power and LED indicator of Bluetooth module will flicker. Tap CONNECT to search Bluetooth.

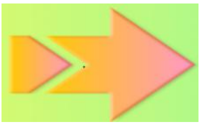


(4) Click "connect" below HMSoft, then the Bluetooth will be connected and its LED indicator will stay on.



After connecting Bluetooth module and open serial monitor to set baud rate to 9600. Press the button of the Bluetooth APP, and the corresponding characters are displayed as shown below:

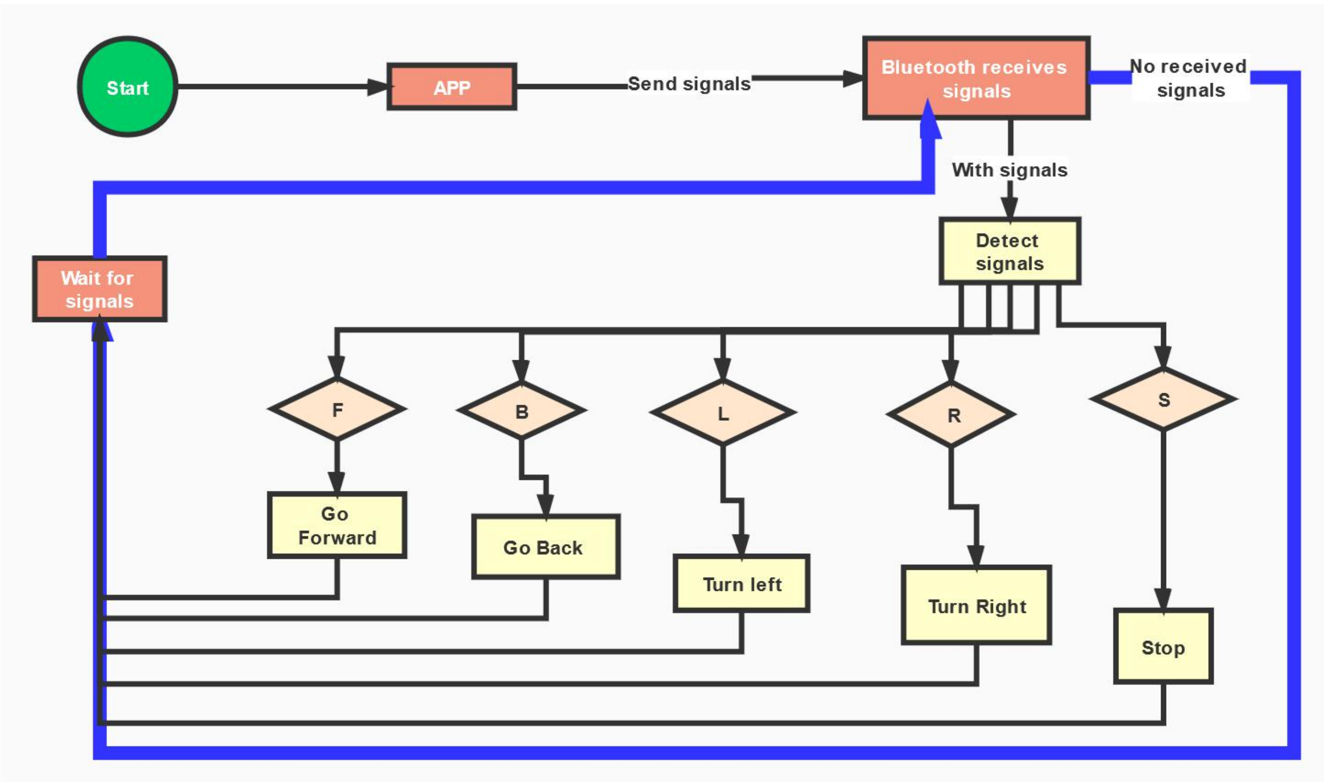


CONNECT	Pair HM-10 Bluetooth module	
Bluetooth	Enter control page of Bluetooth	
DISCONNECT	Disconnect Bluetooth	
	Press: F Release: S	Press the button, robot goes front; release to stop
	Press: L Release: S	Press the button, robot turns left; release to stop
	Click to send “S”	Stop
	Press: R Release: S	Press the button, robot turns right; release to stop
	Press: B Release: S	Press the button, robot goes back; release to stop
	Click to send “Y”	Start Ultrasonic follow function; click Stop to exit
	---	Click to start the mobile gravity sensing; click again to exit
	Click to send “U”	Start ultrasonic avoiding function; click Stop to exit

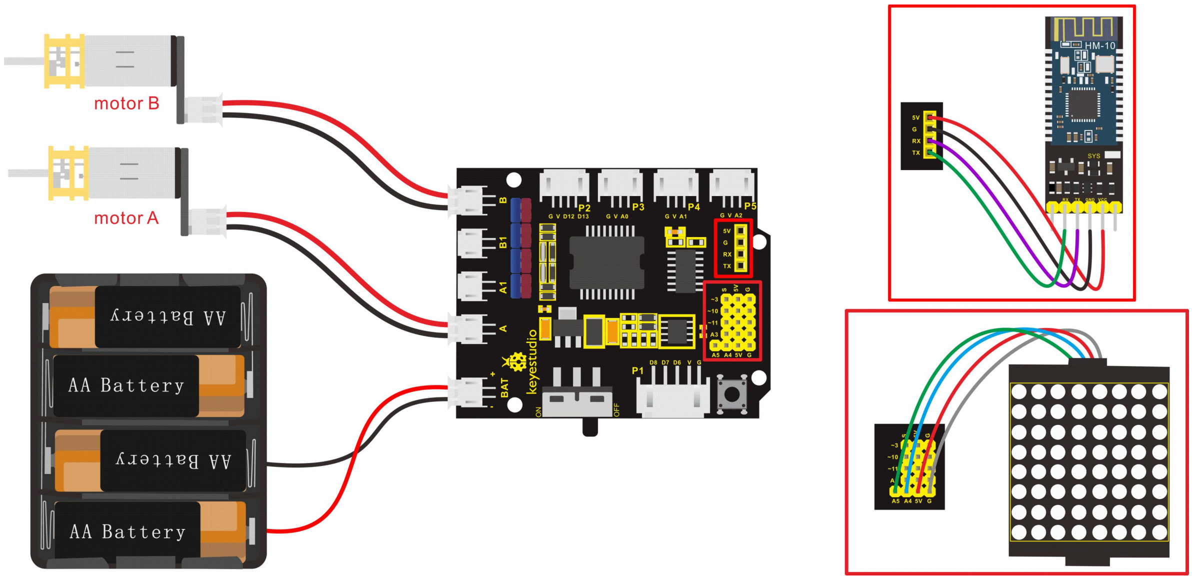
	Click to send "X"	Start line tracking function; click Stop to exit

We have read the character of each key on mobile APP via serial port and know the key function.

Flow Chart



(3) Connection Diagram



(4) Test Code

```
/*
keyestudio smart turtle robot
lesson 14.2
Bluetooth Control turtle
http://www.keyestudio.com
*/
#include <ks_Matrix.h>
Matrix myMatrix(A4,A5);
//Array, used to store the data of pattern, can be calculated by yourself or obtained from the modulus tool
uint8_t matrix_heart[8]={0x66,0x99,0x81,0x81,0x42,0x24,0x18,0x00};
```

```
uint8_t matrix_smile[8]={0x42,0xa5,0xa5,0x00,0x00,0x24,0x18,0x00};
uint8_t matrix_front2[8]={0x18,0x24,0x42,0x99,0x24,0x42,0x81,0x00};
uint8_t matrix_back2[8]={0x00,0x81,0x42,0x24,0x99,0x42,0x24,0x18};
uint8_t matrix_left2[8]={0x48,0x24,0x12,0x09,0x09,0x12,0x24,0x48};
uint8_t matrix_right2[8]={0x12,0x24,0x48,0x90,0x90,0x48,0x24,0x12};
uint8_t matrix_stop2[8]={0x18,0x18,0x18,0x18,0x18,0x00,0x18,0x18};
uint8_t   LEDArray[8];
unsigned char data_line = 0;
unsigned char delay_count = 0;
const int left_ctrl = 2;//define direction control pin of A motor
const int left_pwm = 9;//define PWM control pin of A motor
const int right_ctrl = 4;//define direction control pin of B motor
const int right_pwm = 5;//define PWM control pin of B motor
char BLE_val;
void setup()
{
   Serial.begin(9600);
   pinMode(left_ctrl,OUTPUT);
   pinMode(left_pwm,OUTPUT);
   pinMode(right_ctrl,OUTPUT);
   pinMode(right_pwm,OUTPUT);
  myMatrix.begin(112);
```

```
  myMatrix.clear();
}

void loop()
{
  if(Serial.available()>0)
  {
    BLE_val = Serial.read();
    Serial.println(BLE_val);
  }
  switch(BLE_val)
  {
    case 'F': car_front();
    myMatrix.clear();
    myMatrix.writeDisplay();
    matrix_display(matrix_front2);
    break;

    case 'B': car_back();
    myMatrix.clear();
    myMatrix.writeDisplay();
    matrix_display(matrix_back2);
```

```
        break;

        case 'L': car_left();
        myMatrix.clear();
        myMatrix.writeDisplay();
        matrix_display(matrix_left2);
        break;

        case 'R': car_right();
        myMatrix.clear();
        myMatrix.writeDisplay();
        matrix_display(matrix_right2);
        break;

        case 'S': car_Stop();
        myMatrix.clear();
        myMatrix.writeDisplay();
        matrix_display(matrix_stop2);
        break;
    }

}
```

```
void car_front()//go front
{
   digitalWrite(left_ctrl,LOW);
   analogWrite(left_pwm,200);
   digitalWrite(right_ctrl,LOW);
   analogWrite(right_pwm,200);
}
void car_back()//go backward
{
   digitalWrite(left_ctrl,HIGH);
   analogWrite(left_pwm,200);
   digitalWrite(right_ctrl,HIGH);
   analogWrite(right_pwm,200);
}
void car_left()//turn left
{
   digitalWrite(left_ctrl,HIGH);
   analogWrite(left_pwm,200);
   digitalWrite(right_ctrl,LOW);
   analogWrite(right_pwm,200);
}
void car_right()//turn right
```

```
{
   digitalWrite(left_ctrl,LOW);
   analogWrite(left_pwm,200);
   digitalWrite(right_ctrl,HIGH);
   analogWrite(right_pwm,200);
}

void car_Stop()//stop
{

   analogWrite(left_pwm,0);
   analogWrite(right_pwm,0);
}
// the function that dot matrix shows patterns
void matrix_display(unsigned char matrix_value[])
{
   for(int i=0; i<8; i++)
      {
         LEDArray[i]=matrix_value[i];
         for(int j=7; j>=0; j--)
         {
            if((LEDArray[i]&0x01)>0)
```

```
            myMatrix.drawPixel(j, i,1);
            LEDArray[i] = LEDArray[i]>>1;
          }
        }
        myMatrix.writeDisplay();
    }
    //**************************************************
```

(5) Test Result

Upload program to development board, insert Bluetooth module, open App to connect Bluetooth. Next, press icons on App to control turtle robot car to move.

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

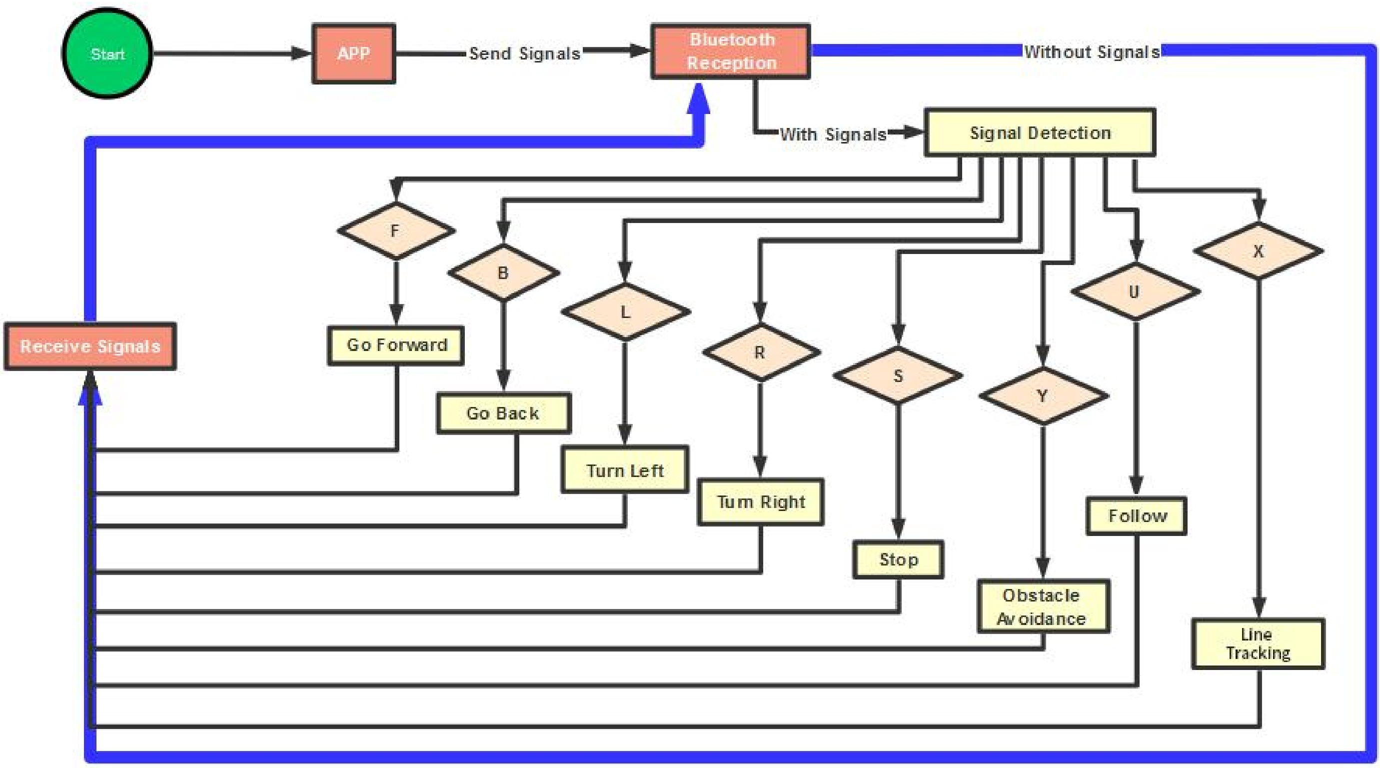
Reconnect the Bluetooth module, after uploading code successful.

Project 15: Multi-purpose Bluetooth Robot

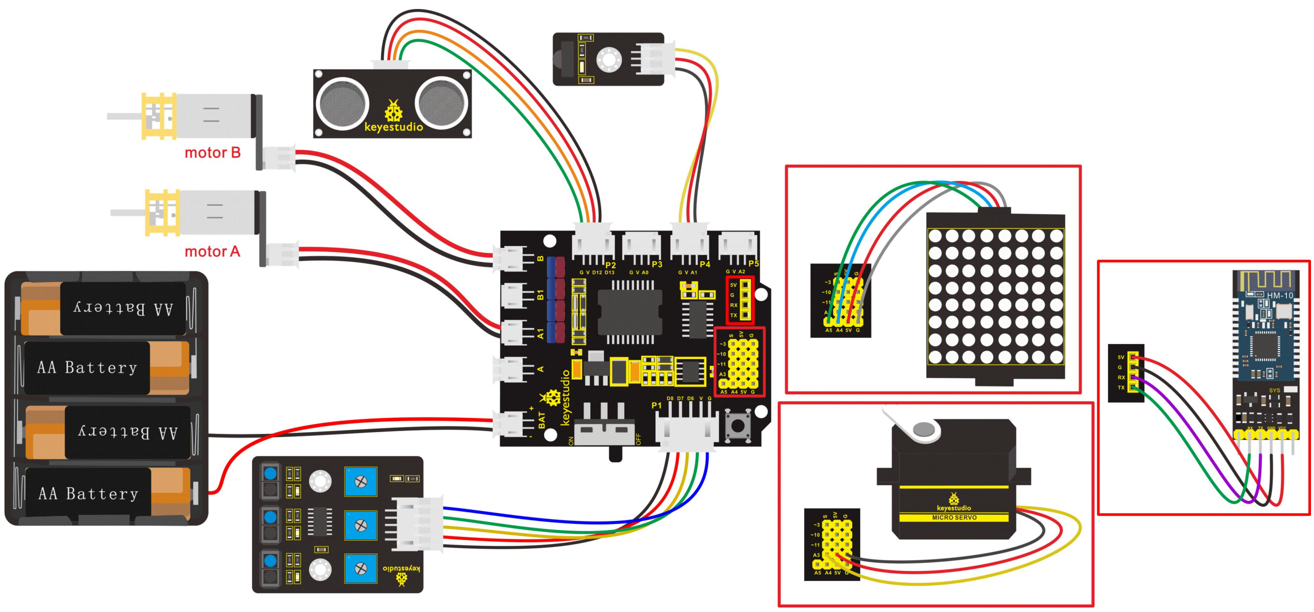
(1) Description

In previous projects, the robot 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



(3) Test Code

```
/*
keyestudio smart turtle robot
lesson 15
Multifunctional turtle robot
http://www.keyestudio.com
*/
#include <ks_Matrix.h>
Matrix myMatrix(A4,A5);
//Array, used to store the data of pattern, can be calculated by yourself or
```

```
obtained from the modulus tool
uint8_t matrix_heart[8]={0x66,0x99,0x81,0x81,0x42,0x24,0x18,0x00};
uint8_t matrix_smile[8]={0x42,0xa5,0xa5,0x00,0x00,0x24,0x18,0x00};
uint8_t matrix_front2[8]={0x18,0x24,0x42,0x99,0x24,0x42,0x81,0x00};
uint8_t matrix_back2[8]={0x00,0x81,0x42,0x24,0x99,0x42,0x24,0x18};
uint8_t matrix_left2[8]={0x48,0x24,0x12,0x09,0x09,0x12,0x24,0x48};
uint8_t matrix_right2[8]={0x12,0x24,0x48,0x90,0x90,0x48,0x24,0x12};
uint8_t matrix_stop2[8]={0x18,0x18,0x18,0x18,0x18,0x00,0x18,0x18};
uint8_t   LEDArray[8];
#include "SR04.h"
#define TRIG_PIN 12
#define ECHO_PIN 13
SR04 sr04 = SR04(ECHO_PIN,TRIG_PIN);
long distance,distance1,distance2,distance3;
const int left_ctrl = 2;
const int left_pwm = 9;
const int right_ctrl = 4;
const int right_pwm = 5;
const int sensor_l = 6;
const int sensor_c = 7;
const int sensor_r = 8;
int l_val,c_val,r_val;
```

```
const int servopin = 10;
int myangle;
int pulsewidth;
int val;
char BLE_val;

void setup() {
  Serial.begin(9600);
  //irrecv.enableIRIn(); // Start the receiver
  servopulse(servopin,90);
  pinMode(left_ctrl,OUTPUT);
  pinMode(left_pwm,OUTPUT);
  pinMode(right_ctrl,OUTPUT);
  pinMode(right_pwm,OUTPUT);
  pinMode(sensor_l,INPUT);
  pinMode(sensor_c,INPUT);
  pinMode(sensor_r,INPUT);
  myMatrix.begin(112);
  myMatrix.clear();
  myMatrix.writeDisplay();
}
```

```
void loop() {
  if(Serial.available()>0)
  {
    BLE_val = Serial.read();
    Serial.println(BLE_val);
  }
  switch(BLE_val)
  {
    case 'F': car_front();
    myMatrix.clear();
    myMatrix.writeDisplay();
    matrix_display(matrix_front2);
    break;
        case 'B': car_back();
    myMatrix.clear();
    myMatrix.writeDisplay();
    matrix_display(matrix_back2);
    break;
    case 'L': car_left();
    myMatrix.clear();
    myMatrix.writeDisplay();
    matrix_display(matrix_left2);
```

```
      break;
      case 'R': car_right();
      myMatrix.clear();
      myMatrix.writeDisplay();
      matrix_display(matrix_right2);
      break;

      case 'S': car_Stop();
      myMatrix.clear();
      myMatrix.writeDisplay();
      matrix_display(matrix_stop2);
      break;
      case 'X': tracking();
      break;
      case 'Y': follow_car();
      break;
      case 'U': avoid();
      break;
   }
}

void avoid()
```

```
{
  myMatrix.clear();
  myMatrix.writeDisplay();
  matrix_display(matrix_smile);
  int track_flag = 0;
  while(track_flag == 0)
  {
    distance1=sr04.Distance();
    if((distance1 < 10)&&(distance1 != 0))
    {
      car_Stop();
      myMatrix.clear();
      myMatrix.writeDisplay();
      matrix_display(matrix_stop2);
      delay(100);
      servopulse(servopin,180);
      delay(100);
      distance2=sr04.Distance();
      delay(100);
      servopulse(servopin,0);
      delay(100);
      distance3=sr04.Distance();
```

```
  delay(100);
  if(distance2 > distance3)
  {
    car_left();
    myMatrix.clear();
    myMatrix.writeDisplay();
    matrix_display(matrix_left2);
    servopulse(servopin,90);
    //delay(100);
  }
  else
  {
    car_right();
    myMatrix.clear();
    myMatrix.writeDisplay();
    matrix_display(matrix_right2);
    servopulse(servopin,90);
    //delay(100);
  }
}
else
{
```

```
        car_front();
        myMatrix.clear();
        myMatrix.writeDisplay();
        matrix_display(matrix_front2);
      }
      if(Serial.available()>0)
      {
        BLE_val = Serial.read();
        if(BLE_val == 'S')
        {
          track_flag = 1;
        }
      }
  }
}

void follow_car()
{
  servopulse(servopin,90);
  int track_flag = 0;
  while(track_flag == 0)
  {
```

```
distance = sr04.Distance();
  if(distance<8)
{
  car_back();
  myMatrix.clear();
  myMatrix.writeDisplay();
  matrix_display(matrix_back2);
}
else if((distance>=8)&&(distance<13))
{
  car_Stop();
  myMatrix.clear();
  myMatrix.writeDisplay();
  matrix_display(matrix_stop2);
}
else if((distance>=13)&&(distance<35))
{
  car_front();
  myMatrix.clear();
  myMatrix.writeDisplay();
  matrix_display(matrix_front2);
}
```

```
      else
      {
         car_Stop();
         myMatrix.clear();
         myMatrix.writeDisplay();
         matrix_display(matrix_stop2);
      }
      if(Serial.available()>0)
      {
         BLE_val = Serial.read();
         if(BLE_val == 'S')
         {
            track_flag = 1;
         }
      }
   }
}

void servopulse(int servopin,int myangle)
{
   for(int i=0;i<20;i++)
   {
```

```
      pulsewidth = (myangle*11)+500;
      digitalWrite(servopin,HIGH);
      delayMicroseconds(pulsewidth);
      digitalWrite(servopin,LOW);
      delay(20-pulsewidth/1000);
   }
}

void tracking()
{
   myMatrix.clear();
   myMatrix.writeDisplay();
   matrix_display(matrix_smile);
   int track_flag = 0;
   while(track_flag == 0)
   {
      l_val = digitalRead(sensor_l);
      c_val = digitalRead(sensor_c);
      r_val = digitalRead(sensor_r);
         if(c_val == 1)
      {
         car_front2();
```

```
    myMatrix.clear();
    myMatrix.writeDisplay();
    matrix_display(matrix_front2);
  }
  else
  {
    if((l_val == 1)&&(r_val == 0))
    {
      car_left();
      myMatrix.clear();
      myMatrix.writeDisplay();
      matrix_display(matrix_left2);
    }
    else if((l_val == 0)&&(r_val == 1))
    {
      car_right();
      myMatrix.clear();
      myMatrix.writeDisplay();
      matrix_display(matrix_right2);
    }
    else
    {
```

```
          car_Stop();
          myMatrix.clear();
          myMatrix.writeDisplay();
          matrix_display(matrix_stop2);
        }
      }
      if(Serial.available()>0)
      {
        BLE_val = Serial.read();
        if(BLE_val == 'S')
        {
          track_flag = 1;
        }
      }
    }
}
void car_front()
{
  digitalWrite(left_ctrl,LOW);
  analogWrite(left_pwm,200);
  digitalWrite(right_ctrl,LOW);
  analogWrite(right_pwm,200);
```

```
}
void car_front2()
{
   digitalWrite(left_ctrl,LOW);
   analogWrite(left_pwm,100);
   digitalWrite(right_ctrl,LOW);
   analogWrite(right_pwm,100);
}
void car_back()
{
   digitalWrite(left_ctrl,HIGH);
   analogWrite(left_pwm,200);
   digitalWrite(right_ctrl,HIGH);
   analogWrite(right_pwm,200);
}

void car_left()
{
   digitalWrite(left_ctrl,HIGH);
   analogWrite(left_pwm,200);
   digitalWrite(right_ctrl,LOW);
   analogWrite(right_pwm,200);
```

```
}
void car_right()
{
   digitalWrite(left_ctrl,LOW);
   analogWrite(left_pwm,200);
   digitalWrite(right_ctrl,HIGH);
   analogWrite(right_pwm,200);
}
void car_Stop()
{
   analogWrite(left_pwm,0);
   analogWrite(right_pwm,0);
}


//the function that dot matrix shows patterns
void matrix_display(unsigned char matrix_value[])
{
   for(int i=0; i<8; i++)
      {
         LEDArray[i]=matrix_value[i];
         for(int j=7; j>=0; j--)
```

```
        {
           if((LEDArray[i]&0x01)>0)
           myMatrix.drawPixel(j, i,1);
           LEDArray[i] = LEDArray[i]>>1;
        }
     }
     myMatrix.writeDisplay();
}
//*****************************************************
```

(5) Test Result

Upload code to development board, plug in power and tun on the switch on robot car. The turtle robot car can go forward and back , turn left and right. After connecting to Bluetooth successfully, we can use the mobile APP to control the smart car to move.

7. Resources

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

Official website: https://keyestudio.com/