Lesson 16 APP Controlled Robot

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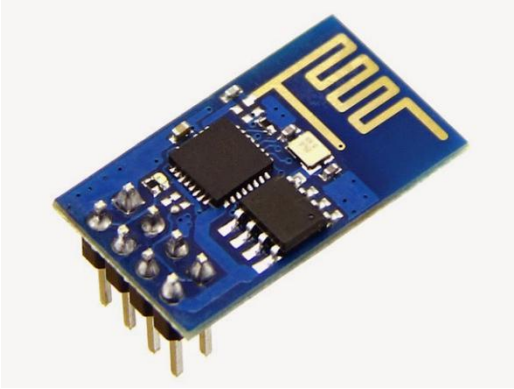
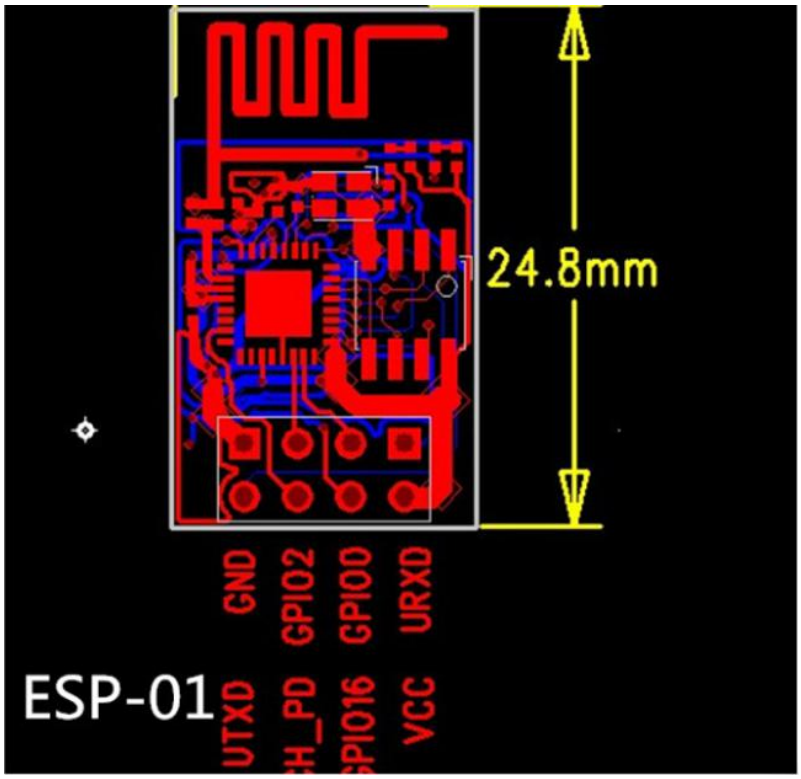
1. ESP8266-01 Module

The ESP8266 ESP-01 is a Wi-Fi module that allows microcontrollers access to a Wi-Fi network.



ESP8266-01 MODULE(hereinafter referred to as ESP-01)

ESP-01 pins



PIN	Description
URXD	UART_RXD，receive
UTXD	UART_TXD，send
GPIO	External Reset signal, reset when low level, work when high level (default high)
GND	GND
VCC	3.3V
GPIO 0	Working mode selection: floating: FlashBoot, working mode; pull down: UARTDownload,
CH_PD	Work at high level; power off at low level

PIN	Description
GPIO 2	(1) It must be high level when powering on, and the hardware pull-down is prohibited; (2) Internal default pull-up

1.1 Introduction to AT commands of ESP-01 module

Basic instructions

command	description
AT	Test AT boot
AT+GMR	View version information
AT+CWMODE	Select WIFI application mode
AT+RST	restart module
client mode	
AT+CWLAP	List currently available router access points
AT+CWJAP	Join access point
AT+CWQAP	exit access point
AT+CIPSTART	Establish TCP, connect to server
AT+CIPCLOSE	Close TCP
AT+CIFSR	Get local IP address
AT+CIPMODE	Set module transfer mode
AT+CIPSEND	Send data
server mode	
AT+ CWSAP	Query and set the WIFI name, password and encryption method in AP (server) mode
AT+ CWLIF	View the IP address of the connected device
AT+CIPMUX	Start multiple connections
AT+CIPSERVER	Configured as server default port 333
AT+CIPSTO	Set server timeout
AT+ CIPSTATUS	Get connection status

1.2 Working mode and commands of ESP-01 module

ESP-01 module acts as a client (transparent transmission)

1. AT: Test AT development mode start
2. AT+GMR: View firmware version information
3. AT+CWMODE=1: Set WIFI application mode
   （1） Station mode
   （2） AP mode
   （3） AP and Station mode, AP refers to as an access point, station refers to as a client station
4. AT+RST：restart
5. AT+CWLAP：list available access points
6. AT+CWJAP="wifiname","wifi passport"：join wifi
7. AT+CIFSR ：get local IP address
8. The PC connects to the router, and the network debugging assistant uses the computer IP address to create a server
9. AT+CIPSTART="TCP","192.168.101.110",8080 Establish a TCP connection with the server
10. AT+CIPMODE=1：Set the transparent transmission mode (you can send it all the time, otherwise you have to use AT+CIPSEND=4 to send the number of bytes; as a server mode, you cannot use the transparent transmission mode)
11. AT+CIPSEND ：Start transparent transmission, the serial port debugging assistant sends data, and the network debugging assistant sends data
12. Received data format: serial port debugging: +IPD, n:xxxxxxxxxx The length of the received data is n bytes, xxxxx is the data; network debugging: [Tcp client 192.168.1.108 2872] 123, TCP mode, client IP address, port number, 123 is the data

ESP-01 WIFI module as client (single connection)

1. AT+CWMODE=1: set WIFI application mode
   (1) Station mode
   (2) AP mode
   (3) AP and Station mode,
   AP refers to as an access point, station refers to as a client station
2. AT+RST：restart
3. AT+CWJAP="wifiname","wifi password": join wifi

4. PC is connected to the router, and the network debugging assistant uses the computer IP address to create a server, and the IP setting is shown in Figure 2 above;
5. AT+CIPSTART="TCP","192.168.101.110",8080 ： Establish a TCP connection with the server
6. AT+CIPSEND=4: Serial port debugging sends four bytes of data, input the content of the four bytes to be sent, no need to press Enter. If the number of bytes sent exceeds the length n set by the command, it will respond busy, and send the first n bytes of data, and respond SEND OK after completion. Network debugging can be sent arbitrarily.

ESP-01 WIFI module as server

1.AT+CWMODE=2 ： set WIFI application mode
(1) Station mode
(2) AP mode
(3) AP and Station mode,
AP refers to as an access point, station refers to as a client station

2.AT+RST：restart

3.AT+CWSAP? ： Query and display the parameters in AP mode，
+CWSAP:"ESP_8266","12345678",11,3,4,0
4.AT+CWSAP="ESP_8266","12345678",11,3 ： access point name, password, channel number, encryption method. 11 is the channel number, it needs to be restarted after modification, and 3 is the encryption method

<ecn>	Encryption	0	OPEN， if set to open, it will not work even if a password is set
		1	WEP
		2	WPA_PSK
		3	WPA2_PSK
		4	WPA_WPA2_PSK

1. AT+CIPMUX=1:start multiple connections
2. AT+CIPSERVER=1:create a server, the default port is 333
3. AT+CIPSTO=300： set the server timeout from 0 to 28800, the unit is s, and the client will be kicked out when the timeout expires.
4. AT+CIFSR :obtain the local IP address in order to set up the network assistant. First, the PC needs to be connected to the hotspot of the WIFI module, and the network debugging assistant on the PC connects to the AP as a client.

5. AT+CWLIF:view connected devices

This lesson uses the ESP-01 module as the working mode of the server:

```
1.AT+RST\r\n        //In the Arduino code, the AT command must end with a carriage return and line feed character "\r\n"
2. AT+CWMODE=3\r\n    //set to soft AP+station mode
3. AT+CWSAP=\"Cokoino_ESP8266-01\",\"12345678\",11,0\r\n
//.   Cokoino_ESP8266-01          ----------WIFI access point name
//.   12345678                    ----------WIFI password
//.   11                          ----------Channel number
//.   0                           ----------Encryption mode    0-OPEN
4. AT+CIPMUX=1\r\n      //start multiple connections
5. AT+CIPSERVER=1,3001\r\n    //Create a server, the default port is 333, modify the port to 3001, consistent with APP
6. AT+CIPSTO=7000\r\n          // Example Set the server timeout period to 7000 seconds
```

2. Install and learn the Smart Robot Car APP

2.1 Install APP

The APK file of the Robot APP is stored in this folder：

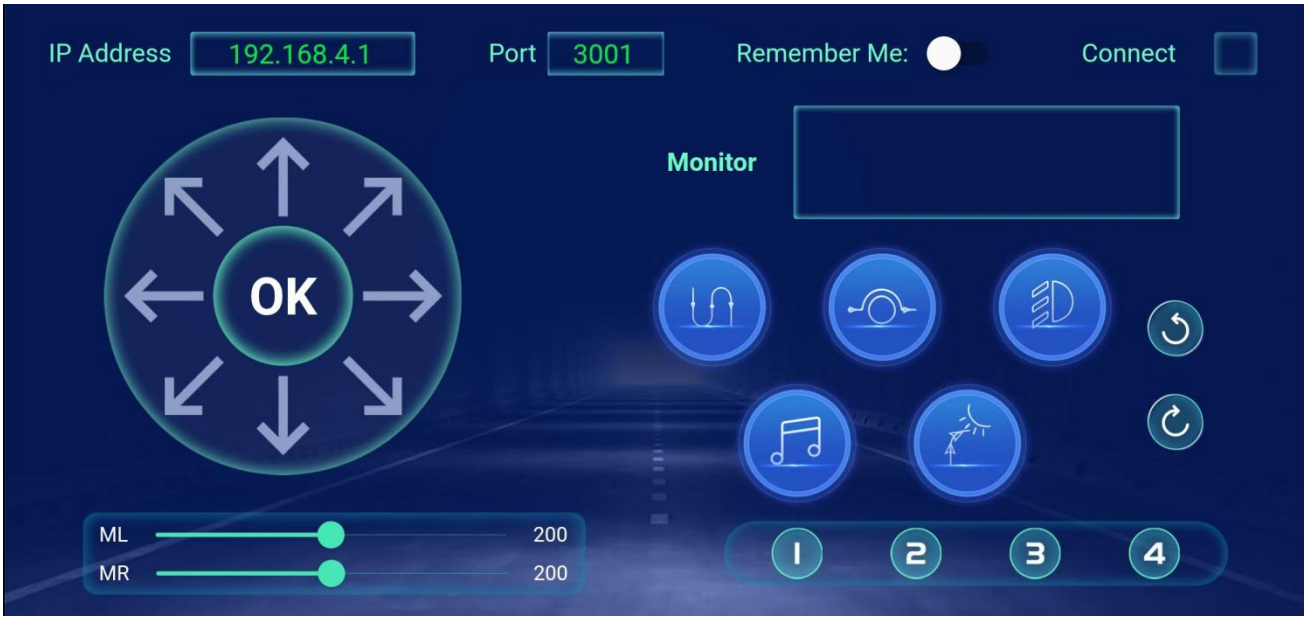
E:\CKK0014-main\Robot apk\app-release.apk

Send the .apk file to the mobile phone for installation. Note: this APP is only compatible with Android phones

If a risk warning pops up during installation, please ignore the risk and choose to continue the installation. We guarantee that the APP is virus-free and risk-free. After the installation is complete, we will see the Robot APP icon as shown below on the phone

2.2 Introduction of Smart Robot Car APP

Click the Robot APP icon on the mobile phone, the APP interface is as follows



Introduction to APP UI

It is the address of the ESP-01 module as a server. It is a fixed value and cannot be changed on the APP interface.

It is the port number of the ESP-01 module as a server, it is set to be a fixed value of 3001 in the app, so when you writing the Arduino code, be sure to use the AT command to set the port number of the ESP-01 module to 3001.

Connect Button. Click "Connect", you can connect the wifi to the ESP-01 module, when the connection is completed, the Monitor will display a successful connection message

This is the data monitoring window, which can simultaneously display the operation instructions and status of the APP


Function button: “following the line”. When the APP is connected to the ESP-01 module of the car, press this button, and the car will follow the line. control command:“trk”。


Function button:“Avoid obstacles”. When the APP is connected to the ESP-01 module of the car, press this button, and the car will drive automatically and avoid obstacles. Control command “aod”.


Function button:“Light Show”， When the APP is connected to the ESP-01 module of the car, press this button, and the led light on the car will be turned on and change various colors. control command:“lgt”.


Function button:“Music”. When the APP is connected to the ESP-01 module of the car, press this button, the buzzer on the car will start playing music with different melodies. control command:“muc”.

 Function button:“Follow Light”. If you add a photosensitive sensor to the car, press this button, the robot will follow the light source in a dark environment. control command:“flt”. Note that our robot car is not equipped with a photosensitive sensor, and this function will not be used in this lesson.

 Function button:“Rotaiton Left”， when the APP is connected to the ESP-01 module of the car, press this button, the car will turn left in a circle. control command:“rtl”.

 Function button:“Rotaiton Right”，when the APP is connected to the ESP-01 module of the car, press this button, the car will turn right in a circle. control command:“rtr”.

 Function button:“Button 1”， it is defined as the rotation of the servo. After the APP is connected to the ESP-01 module on the car, press this button, and the servo on the car will start to work. control command:“bt1”.

Function button:“Button 2”、 “Button 3”、 “Button 4”， control command: “bt2”、 “bt3” 、 “bt4”.Functions are undefined because they are not used in this lesson.

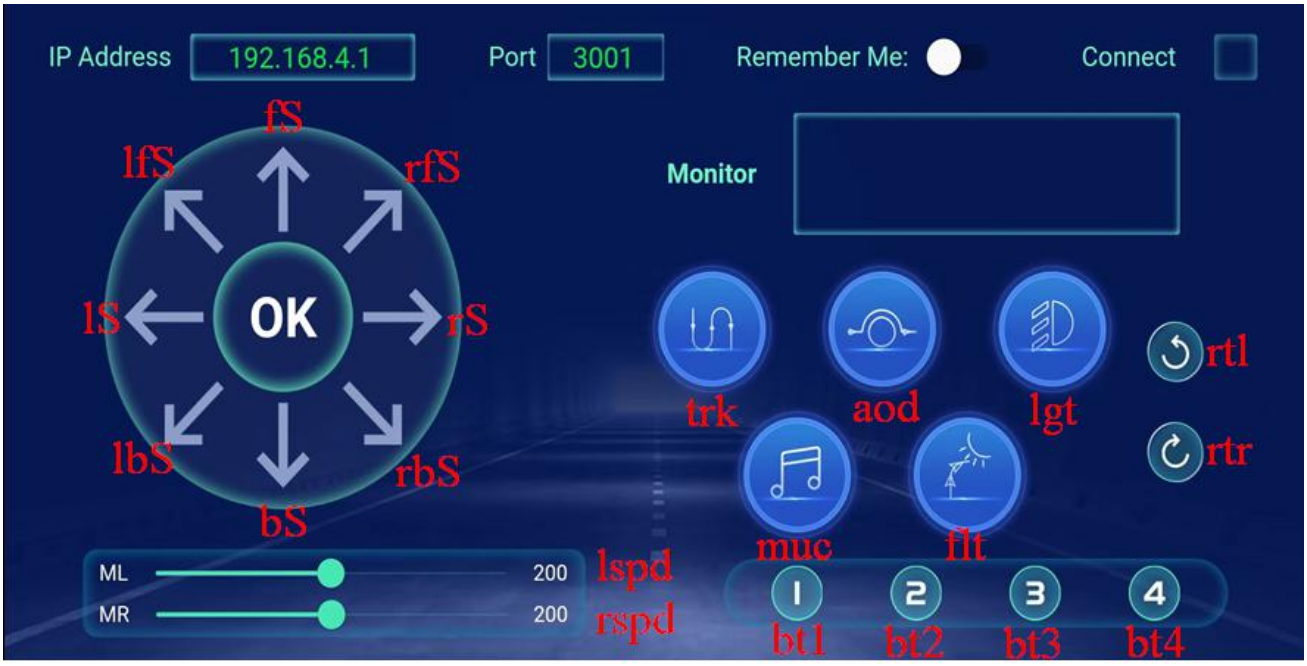
Drag-and-drop button:“Left Speed”、 “Right Speed”，when the APP is connected to the ESP-01 module of the car, dragging these two buttons will change the rotation speed of the left and right wheels of the car. control commands:“lspd”、 “rspd”

Move direction buttons,the arrow is the control button for the driving direction of the car, and there are 8 control directions in total, namely "forward", "left forward", "left_move", "left backward", "backward", "right backward", "right_move", "right forward" ", the middle "OK" button is defined as the stop button.When the APP is connected to the ESP-01 module of the car,You can control the direction of movement of the car with these arrow buttons.

2.3 Introduction to button commands on the APP interface

All function buttons on the APP interface have a fixed command, which is unique and invariable. Therefore, when writing Arduino codes, you need to pay attention to matching the judgment commands in the code with the commands of the APP function button, otherwise the APP will not control the car correctly.

The commands of the function button on the APP interface are as follows:



After you successfully upload the code and connect the APP to the ESP-01 module of the car, press the button in the app, and the ESP-01module will receive the command sent by the APP button and convert it into a string signal. String signals are as follows:

```
/// Car driving direction control button on the app interface, a total of 8 direction buttons.
const String phone1 = "fS";  // forwardStart:
const String phone1_5 = "lfS";  // forward_left_Start
const String phone2 = "lS";    // leftStart
const String phone2_5 = "lbS";  // left_backward_Start
const String phone3 = "bS";    // backwardStart
const String phone3_5 = "rbS";  // backward_right_Start
```

```
const String phone4 = "rS";    // rightStart
const String phone4_5 = "rfS";  // right_forward_Start
/// The other function buttons on the app interface
const String phone5 = "OK";//stop
const String phone6 = "rtl";//rotation left
const String phone7 = "rtr";//rotation right
const String phone8 = "trk";//track line running
const String phone9 = "aod";//Avoid obstacles
const String phone10 = "lgt";//light show
const String phone11 = "muc";//buzzer
const String phone12 = "flt";//fllow light
const String phone13 = "bt1";//button1
```

3. Upload the code

3.1 The code used in this lesson is placed in this folder：

E:\CKK0014-main\Tutorial\sketches\14_1_Wifi_Controlled_Car

3.2 Install Regexp library

For the installation method, please refer to the method of installing the library Servo.h in Lesson 4

3.3 Before uploading the code, turn the ESP-01 switch on the control board to the side away from the "ESP-01" silk screen.

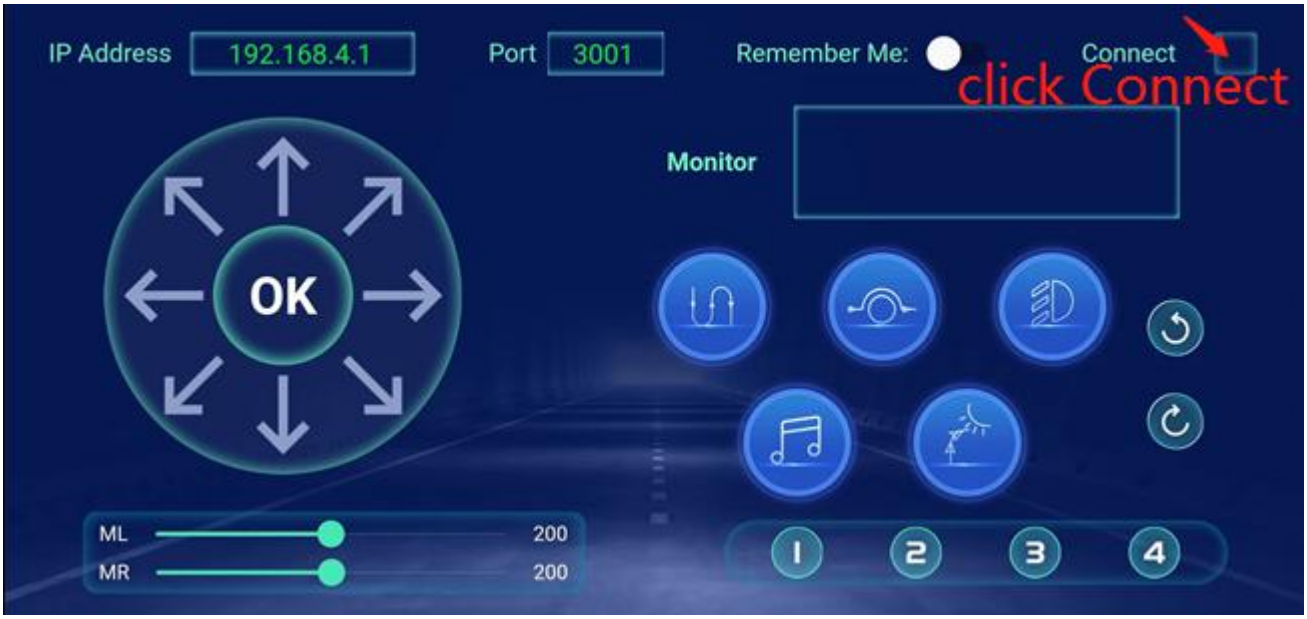
3.4 After uploading the code, unplug the USB cable, put the Smart Robot Car on the ground, turn on the power switch on the control board, turn the ESP-01 switch on the control board to the "ESP-01" silk screen.

3.5 Click "Settings" on the mobile phone, and click "WLAN" on the setting interface to enter the WLAN interface. Then look for the "Cokoino_ESP8266-01" signal in the list of available WLANs

3.6 Click “Cokoino_ESP8266-01”WLAN，enter password 12345678，then click "connect"

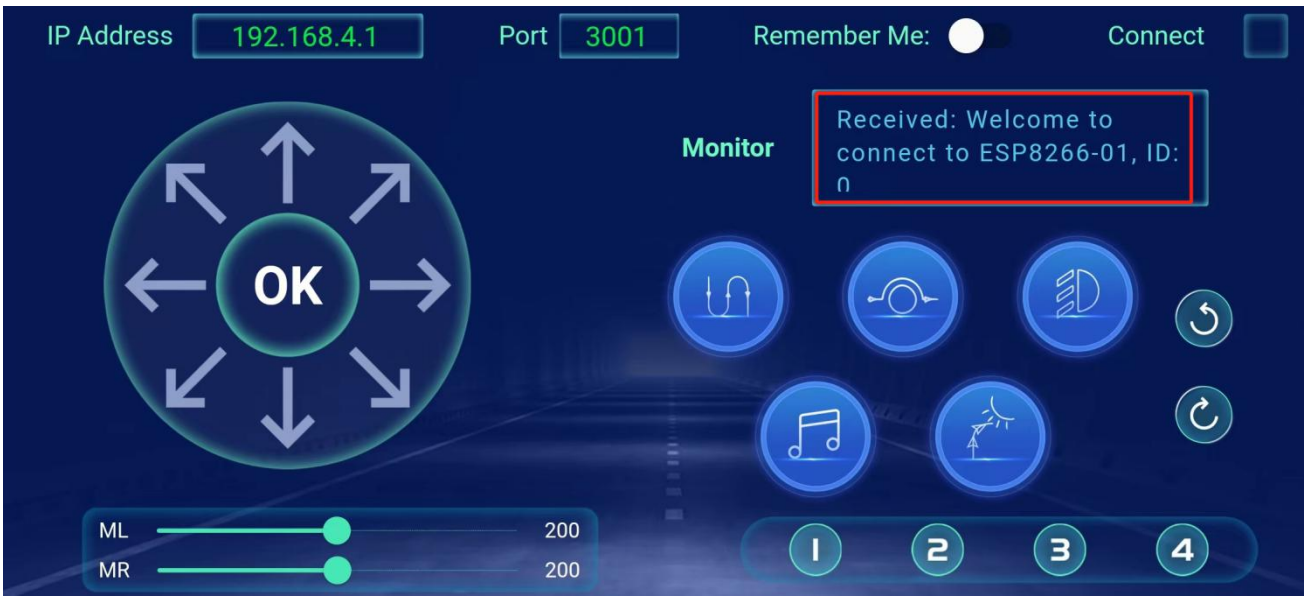
After the connection is successful, if the mobile phone pops up a window prompting that the current WLAN cannot access the Internet, whether to continue to use this WLAN, click "Use"

3.7 Open the Robot APP on the mobile phone and click "Connect"



3.8 After the connection is successful, the Monitor box will display "Received: Welcome to connect to ESP8266-01, ID: 0"

If unable to connect, please exit the app, power on the control board again, and connect again.



3.9 Congratulations, the APP has been successfully connected to the ESP-01 module, and you can start to control the car on the APP interface of the mobile phone.

4. Troubleshooting

4.1 Unable to upload code successfully

Before uploading the code, please check whether the ESP-01 switch on the control board is turned to the side away from the "ESP-01" silk screen

4.2 Cannot find the WLAN signal of ESP-01 module

After the code is successfully uploaded, the switch of the ESP-01 needs to be turned to the side of the "ESP-01" silk screen.

Check if the ESP-01 module is plugged into the correct position on the control board

4.3 The car moves slowly or does not move, and the "hum" sound of the motor can be heard

Check the power of the 18650 battery, if the battery level is low and below 7V, it is recommended to charge it before use. If the battery level is between 7~7.4V, you can try increasing the motor speed in the code. The battery level matched with the motor speed in the example code is between 7.4V and 8.4V.

5. Code

14_1_Wifi_Controlled_Car.ino:

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

 * This code applies to 4WD Mecanum Wheels Robot Car Kit
 * Through this link you can download the source code:
 * https://github.com/Cokoino/CKK0014
 * Company web site:
 * http://cokoino.com/

*************************************************/
/*************************************************
4WD Mecanum Wheels Robot Car Kit

        M4 (------) M3
```

```
------------|   |----------------
------------|   |----------------
         M2 (------) M1
*********************************************************/

#include <Regexp.h>
#include <LiquidCrystal_I2C.h>
LiquidCrystal_I2C lcd(0x27, 16, 2);
#include <Wire.h>
#include <Adafruit_PWMServoDriver.h>
Adafruit_PWMServoDriver pwm = Adafruit_PWMServoDriver();
#include <Servo.h>
Servo carservo;
int pos=0;
#include <Adafruit_NeoPixel.h>
#ifdef __AVR__
#include <avr/power.h> // Required for 16 MHz Adafruit Trinket
#endif
#define WS2812_PIN 5     //WS2812 PIN
#define WS2812_COUNT   12   // How many NeoPixels are attached to the Arduino?
#define BRIGHTNESS 10   // NeoPixel brightness, 0 (min) to 255 (max)
// Declare our NeoPixel strip object:
Adafruit_NeoPixel strip = Adafruit_NeoPixel(WS2812_COUNT, WS2812_PIN, NEO_GRB + NEO_KHZ800);
// Argument 1 = Number of pixels in NeoPixel strip
// Argument 2 = Arduino pin number (most are valid)
// Argument 3 = Pixel type flags, add together as needed:
//    NEO_KHZ600   600 KHz bitstream (most NeoPixel products w/WS2812 LEDs)
#define Trig_Pin 13 //trig PIN
#define Echo_Pin 12   //echo PIN
#define Buzz 11       //buzzer PIN
#define led_R 6       //right green led PIN
#define led_L 9       //left green led PIN

#define Line_L A0     //left line PIN
#define Line_M A1     // middle line PIN
#define Line_R A2     //right line   PIN
#define distance_minimum 30 //The minimum obstacle distance is defined as 30cm
float distance,distance_0,distance_130;//Import the middle, right, and left distance variables
int randNumber=0;
int L_Distance=0;
int M_Distance=0;
int R_Distance=0;
```

```
float cm;

// regular
MatchState ms;
/// Car driving direction control button on the app interface, a total of 8 direction buttons.
const String phone1 = "fS";   // forwardStart:
const String phone1_5 = "lfS";   // forward_left_Start
const String phone2 = "lS";      // leftStart
const String phone2_5 = "lbS";   // left_backward_Start
const String phone3 = "bS";      // backwardStart
const String phone3_5 = "rbS";   // backward_right_Start
const String phone4 = "rS";      // rightStart
const String phone4_5 = "rfS";   // right_forward_Start
/// The other function buttons on the app interface
const String phone5 = "OK";//stop
const String phone6 = "rtl";//rotation left
const String phone7 = "rtr";//rotation right
const String phone8 = "trk";//track line running
const String phone9 = "aod";//Avoid obstacles
const String phone10 = "lgt";//light show
const String phone11 = "muc";//buzzer
const String phone12 = "flt";//fllow light
const String phone13 = "bt1";//button1

String comdata = "";//import the comdata string
char judge = 0;//init the judge

void setup() {

  Serial.begin(115200);
  pwm.begin();
  pwm.setPWMFreq(50); // Set the PWM frequency as 50
  ///Initialize the motor state
  pwm.setPWM(0, 0, 0);
  pwm.setPWM(1, 0, 0);
  pwm.setPWM(2, 0, 0);
  pwm.setPWM(3, 0, 0);
  pwm.setPWM(4, 0, 0);
  pwm.setPWM(5, 0, 0);
  pwm.setPWM(6, 0, 0);
  pwm.setPWM(7, 0, 0);
```

```
  delay(100);   // If the information printed out of the serial port is garbled, extend the delay time to solve the problem.
  while (Serial.read() >= 0)
    continue;
  Serial.flush();
  ESP8266_ATCOMMAND();//esp-01 module AT instruction function
  lcd.init();
  lcd.backlight();
  lcd.clear();

  pinMode(Buzz, OUTPUT);
  pinMode(led_R, OUTPUT);
  pinMode(led_L, OUTPUT);
  pinMode(Trig_Pin, OUTPUT);
  pinMode(Echo_Pin, INPUT_PULLUP);
  carservo.attach(10);//servo PIN
  carservo.write(65);//Initialize the car head in the middle position

  strip.begin();
  strip.show();
  strip.setBrightness(BRIGHTNESS);
}

void loop() {

  while (Serial.available() > 0) {
    comdata += char(Serial.read());
    delay(1);
  }
  judgement();
}

// ESP8266 set the AT instructionS
void ESP8266_ATCOMMAND() {

  Serial.print(F("AT+RST\r\n"));   //F(): Store string constants in Flash flash to avoid memory depletion due to SRAM usage.
  delay(3000);
  Serial.print(F("AT+CWMODE=3\r\n"));   //set to softAP+station mode
  delay(300);
  Serial.print(F("AT+CWSAP=\"Cokoino_ESP8266-01\",\"12345678\",11,2\r\n"));//wifiname:Cokoino_ESP8266-01,wifipassword:12345678
```

```
 //channnel:11 Encryption mode:2 ;Encryption mode should not set to 1,otherwise the wifi can't set successed
  delay(200);
  Serial.print(F("AT+CIPMUX=1\r\n"));//Enable multiple connections
  delay(200);
  Serial.print(F("AT+CIPSERVER=1,3001\r\n"));//Create the server. The default port is 333. Change the port to 3001, which is consistent with the APP
  delay(200);
  Serial.print(F("AT+CIPSTO=7000\r\n"));//Example Set the server timeout period to 7000 seconds
  delay(2000);
}
void judgement() {

  if (comdata.length() > 0) {
    comdata += "\n";   //This sentence must be added, otherwise the matched command character is one less, and the newline is used to assist in the complete match.
    char buf[comdata.length()];
    comdata.toCharArray(buf, comdata.length());
    ms.Target(buf);
    char result = ms.Match("%c*%+IPD, ?[0-9]+, ?[0-9]+: ?([^%c]+)%c*$");
    if (result > 0) {
      ms.GetCapture(buf, 0);
      comdata = String(buf);
      lcd.clear();
      lcd.setCursor(0, 0);
      lcd.print(comdata);
      delay(100);
    } else {
      result = ms.Match("%c*%s?([0-9]),%s?([^%c]+)%c*$");   // esp8266 Multi-channel supports up to 5 connections (id:0-4)
      if (result > 0) {
        char buf0[1];   // esp8266 In multi-channel mode. id of the connection at this time
        ms.GetCapture(buf0, 0);
        ms.GetCapture(buf, 1);
        comdata = String(buf);
        if (comdata == "CONNECT")//The APP successfully connects to the wifi of ESP-01 module
        {
          String receiveOkMs = "Welcome to connect to ESP8266-01, ID: " + String(buf0) + " .";//A successful connection message is displayed
          Serial.println("AT+CIPSEND=" + String(buf0) + "," + receiveOkMs.length() + "\r\n");
          delay(10);
          Serial.print(receiveOkMs);
          lcd.clear();
```

```
            lcd.setCursor(0, 0);
            lcd.print(String(buf0) + ",CONNECT ");
            delay(1500);
            lcd.setCursor(0, 1);
            lcd.print("MSG_Len:");
            lcd.setCursor(9, 1);
            lcd.print(String(receiveOkMs.length()) + "Bytes");   // If the combined variable is a non-string, it needs to be converted to a string for normal display.
            delay(2000);
            lcd.clear();
            lcd.setCursor(0, 0);
            lcd.print("Available Memory");
            lcd.setCursor(0, 1);
            lcd.print(": " + String(availableMemory()));   // If the combined variable is a non-string, it needs to be converted to a string for normal display.
            delay(2000);
          }
        }

        lcd.clear();
        lcd.setCursor(1, 0);
        lcd.print("Not a APP_CMD! ");
      }
      //comdata = "";
      //return; // When debugging communication with the APP, it needs to be commented out when normal use

      if (comdata == phone1) {
        judge = 1;
      }
       else if (comdata == phone1_5) {
        judge = 2;
      } else if (comdata == phone2) {
        judge = 3;
      } else if (comdata == phone2_5) {
        judge = 4;
      } else if (comdata == phone3) {
        judge = 5;
      } else if (comdata == phone3_5) {
        judge = 6;
      } else if (comdata == phone4) {
        judge = 7;
      } else if (comdata == phone4_5) {
```

```
      judge = 8;
    } else if (comdata == phone5) {
      judge = 9;
    } else if (comdata == phone6) {
      judge = 10;
    } else if (comdata == phone7) {
      judge = 11;
    } else if (comdata == phone8) {
      judge = 12;
    } else if (comdata == phone9) {
      judge = 13;
    } else if (comdata == phone10) {
      judge = 14;
    } else if (comdata == phone11) {
      judge = 15;
    } else if (comdata == phone12) {
      judge = 16;
    } else if (comdata == phone13) {
      judge = 17;
    }
    else {
      judge = 9;
    }
   comdata = "";
}

switch (judge) {

  case 1:
    forward();
    delay(50);
    break;
  case 2:
    leftforward();
    delay(50);
    break;
  case 3:
    Left_move();
    delay(50);
    break;
  case 4:
    leftbackward();
```

```
    delay(50);
    break;
  case 5:
    backward();
    delay(50);
    break;
  case 6:
    rightbackward();
    delay(50);
    break;
  case 7:
    Right_move();
    delay(50);
    break;
  case 8:
    rightforward();
    delay(50);
    break;
  case 9:
    Stopcar();
    break;
  case 10:
    left_rotation();
    delay(50);
    break;
  case 11:
    right_rotation();
    delay(50);
    break;
  case 12:
    track_line();
    break;
  case 13:
    obstacle_avoidance();
    break;
  case 14:
    light_show();
    delay(2000);
    judge = 9;
    break;
  case 15:
    music();
```

```
        delay(2000);
        judge = 9;
        break;
    // case 16:
        //follow_light();
        //delay(2000);
        //judge = 9;
        // break;   ;
      case 17:
        shake_head();
        delay(2000);
        judge = 9;
        break;
      default: break;
    }
}

//pwm.setPWM(pwmnum,on, off);
      //(pwmnum, on, off) function is mainly to adjust the output PWM duty cycle.
      // Usually, on is set to 0 and off can be changed.
      // Because the PCA9685 is a 12-bit resolution
      // the value of 0 to 4096 off represents a duty cycle of 0 to 100.
void forward()
{
 //drive M1 Motror forward
 pwm.setPWM(2, 0, 1000);//set pwm signal to BIN2 of DRV8833
 pwm.setPWM(3, 0, -1000);//set pwm signal to BIN1 of DRV8833
 //drive M2 Motror forward
 pwm.setPWM(0,0,-1000);//set pwm signal to AIN1 of DRV8833
 pwm.setPWM(1,0,1000);//set pwm signal to AIN2 of DRV8833
 //drive M3 Motror forward
 pwm.setPWM(6, 0, 1000);//set pwm signal to BIN2 of DRV8833
 pwm.setPWM(7, 0, -1000);//set pwm signal to BIN1 of DRV8833
 //drive M4 Motror forward
 pwm.setPWM(4, 0, -1000);//set pwm signal to AIN1 of DRV8833
 pwm.setPWM(5, 0, 1000);//set pwm signal to AIN2 of DRV8833
}
void leftforward()    // Front 45 degrees to the left
{
 pwm.setPWM(0,0,-1500);
 pwm.setPWM(1,0,1500);
 pwm.setPWM(2, 0, 0);
```

```
 pwm.setPWM(3, 0, 0);
 pwm.setPWM(4, 0, 0);
 pwm.setPWM(5, 0, 0);
 pwm.setPWM(6, 0, 1500);
 pwm.setPWM(7, 0, -1500);
}
void Left_move()       //car move left
{
 pwm.setPWM(0,0,-1200);
 pwm.setPWM(1,0,1200);
 pwm.setPWM(2, 0, -1200);
 pwm.setPWM(3, 0, 1200);
 pwm.setPWM(4, 0, 1200);
 pwm.setPWM(5, 0, -1200);
 pwm.setPWM(6, 0, 1200);
 pwm.setPWM(7, 0, -1200);
}
void leftbackward() //Back 45 degrees to left
{
 pwm.setPWM(0, 0, 0);
 pwm.setPWM(1, 0, 0);
 pwm.setPWM(2, 0, -1500);
 pwm.setPWM(3, 0, 1500);
 pwm.setPWM(4, 0, 1500);
 pwm.setPWM(5, 0, -1500);
 pwm.setPWM(6, 0, 0);
 pwm.setPWM(7, 0, 0);
}
void backward()   //car move backward
{
 pwm.setPWM(0,0,1000);
 pwm.setPWM(1,0,-1000);
 pwm.setPWM(2, 0, -1000);
 pwm.setPWM(3, 0, 1000);
 pwm.setPWM(4, 0, 1000);
 pwm.setPWM(5, 0, -1000);
 pwm.setPWM(6, 0, -1000);
 pwm.setPWM(7, 0, 1000);
}
void rightbackward() //Back 45 degrees to right
{
 pwm.setPWM(0,0,1500);
```

```
 pwm.setPWM(1,0,-1500);
 pwm.setPWM(2, 0, 0);
 pwm.setPWM(3, 0, 0);
 pwm.setPWM(4, 0, 0);
 pwm.setPWM(5, 0, 0);
 pwm.setPWM(6, 0, -1500);
 pwm.setPWM(7, 0, 1500);
}
void Right_move()   //car move to right
{
 pwm.setPWM(0,0,1200);
 pwm.setPWM(1,0,-1200);
 pwm.setPWM(2, 0, 1200);
 pwm.setPWM(3, 0, -1200);
 pwm.setPWM(4, 0, -1200);
 pwm.setPWM(5, 0, 1200);
 pwm.setPWM(6, 0, -1200);
 pwm.setPWM(7, 0, 1200);
}

void rightforward()   //Move 45 degrees right ahead
{
 pwm.setPWM(0, 0, 0);
 pwm.setPWM(1, 0, 0);
 pwm.setPWM(2, 0, 1500);
 pwm.setPWM(3, 0, -1500);
 pwm.setPWM(4, 0, -1500);
 pwm.setPWM(5, 0, 1500);
 pwm.setPWM(6, 0, 0);
 pwm.setPWM(7, 0, 0);
}
void right_rotation()     // car right rotation
{
 pwm.setPWM(0,0,-1500);
 pwm.setPWM(1,0,1500);
 pwm.setPWM(2, 0, -1500);
 pwm.setPWM(3, 0, 1500);
 pwm.setPWM(4, 0, -1500);
 pwm.setPWM(5, 0, 1500);
 pwm.setPWM(6, 0, -1500);
 pwm.setPWM(7, 0, 1500);
}
```

```
void left_rotation()    //car left rotation
{
 pwm.setPWM(0,0,1500);
 pwm.setPWM(1,0,-1500);
 pwm.setPWM(2, 0, 1500);
 pwm.setPWM(3, 0, -1500);
 pwm.setPWM(4, 0, 1500);
 pwm.setPWM(5, 0, -1500);
 pwm.setPWM(6, 0, 1500);
 pwm.setPWM(7, 0, -1500);
}
void turnLeft()
{
 pwm.setPWM(0,0,-1000);
 pwm.setPWM(1,0,1000);
 pwm.setPWM(2, 0, 1600);
 pwm.setPWM(3, 0, -1600);
 pwm.setPWM(4, 0, -1000);
 pwm.setPWM(5, 0, 1000);
 pwm.setPWM(6, 0, 1600);
 pwm.setPWM(7, 0, -1600);
}

void turnRight()
{
 pwm.setPWM(0,0,-1600);
 pwm.setPWM(1,0,1600);
 pwm.setPWM(2, 0, 1000);
 pwm.setPWM(3, 0, -1000);
 pwm.setPWM(4, 0, -1600);
 pwm.setPWM(5, 0, 1600);
 pwm.setPWM(6, 0, 1000);
 pwm.setPWM(7, 0, -1000);
}
void Stopcar()
{
 pwm.setPWM(0, 0, 0);
 pwm.setPWM(1, 0, 0);
 pwm.setPWM(2, 0, 0);
 pwm.setPWM(3, 0, 0);
 pwm.setPWM(4, 0, 0);
 pwm.setPWM(5, 0, 0);
```

```
 pwm.setPWM(6, 0, 0);
 pwm.setPWM(7, 0, 0);
}
//////////////////////////////////////////////////////////Automatic obstacle avoidance
void track_line()
{
  u8 trackingSensorVal = 0;
  trackingSensorVal = getTrackingSensorVal(); //get sensor value

  switch (trackingSensorVal)
  {
    case 0:    //000
      backward();//car backward
      delay(10);
      break;
    case 7:    //111
      forward(); //car forward
      break;
    case 1:    //001
      turnRight(); //car turn right
      delay(120);
      break;
    case 3:    //011
      turnRight(); //car turn right
      delay(120);
      break;
    case 2:    //010
    case 5:    //101
    case 6:    //110
      turnLeft(); //car turn left
      delay(200);
      break;
    case 4:    //100
     turnLeft();//car turn left
      delay(200);
      break;
    default:
      break;
  }
}
u8 getTrackingSensorVal() {
  u8 trackingSensorVal = 0;
```

```
  trackingSensorVal = (digitalRead(Line_L) == 1 ? 1 : 0) << 2 | (digitalRead(Line_M) == 1 ? 1 : 0) << 1 |
(digitalRead(Line_R) == 1 ? 1 : 0) << 0;
  return trackingSensorVal;
}
////////////////////////////////////////////////////////////Automatic obstacle avoidance
void obstacle_avoidance()
{
   digitalWrite(led_R,HIGH);//light the right green LED
   digitalWrite(led_L,HIGH);//light the left green LED
   ultrasonic_distance();
  //Serial.println(distance);
  if(distance>distance_minimum)
    {
    forward();     //forward
    }
  if(distance<=distance_minimum)
    {
    Stopcar();       //stop
    music();          //the buzzer sounds
    servo_wheel(); //The servo rotates, and the ultrasonic module identifies the distance
                   //of the 65-degree obstacle in the left front of the car body
    if((distance_0<=distance_minimum)&&(distance_130<=distance_minimum))
      {backward();//car backward
      delay(300); }
    if(distance_0<distance_130)//The right obstacle is less distant than the left
      {left_rotation();
      delay(150);
     }
    if(distance_0>distance_130)//The left obstacle is less distant than the right
      {right_rotation();
      delay(150);
      }
    if(distance_0==distance_130)
      {
      randNumber = random(1, 2); //randnumber
      if(randNumber==1)
        {leftforward();delay(120);
       }
      if(randNumber==2)
        {rightforward();delay(120);
       }
      }
```

```
    delay(250);
    Stopcar();       //car stop
    }
}
////////////////////////////////////////////////////////ultrasonic ranging
void ultrasonic_distance()
{
delay(100);
digitalWrite(Trig_Pin, HIGH);
delayMicroseconds(10);
digitalWrite(Trig_Pin, LOW);
distance = pulseIn(Echo_Pin, HIGH) * 340 /2/ 10000.0;
if(distance==0)
  distance=300;
delay(100);
}
////////////////////////////////////////////////////////servo rotation
void servo_wheel()
{
carservo.write(0);
delay(250);
ultrasonic_distance();
distance_0=distance;
delay(250);

carservo.write(130);
delay(250);
ultrasonic_distance();
distance_130=distance;
delay(250);

carservo.write(65);
delay(300);
}
////////////////////////////////////////////////////////buzzer sounds
void music()
{
  for(int i = 0;i < 100; i++)
  {
    digitalWrite(Buzz, HIGH);
    delay(1);
    digitalWrite(Buzz, LOW);
```

```
    delay(1);
  }
  for(int j = 0;j< 180; j++)
  {
    digitalWrite(Buzz, HIGH);
    delay(2);
    digitalWrite(Buzz, LOW);
    delay(2);
  }
}
//////////////////////////////////////////////////////////////the car shake it's head
void shake_head()
{
  for (pos = 0; pos <= 130; pos += 1) { // goes from 0 degrees to 130 degrees
    // in steps of 1 degree
    carservo.write(pos);                // tell servo to go to position in variable 'pos'
    delay(15);                          // waits 15 ms for the servo to reach the position
  }
  for (pos = 130; pos >= 0; pos -= 1) { // goes from 130 degrees to 0 degrees
    carservo.write(pos);                // tell servo to go to position in variable 'pos'
    delay(15);                          // waits 15 ms for the servo to reach the position
  }
  delay(50);
  carservo.write(65);                   //Reset the head of the car
}

int availableMemory() {
  // Use 1024 with ATmega168
  int size = 2048;
  byte *buf;
  while ((buf = (byte *)malloc(--size)) == NULL);
  free(buf);
  return size;
}

//////////////////////////////////////////////////////////////light show
void light_show()
{
  LED_show();
  WS2812_show();
}
```

```
void LED_show()
{
  for(int i = 0;i < 15; i++)
  {
    digitalWrite(led_R,HIGH);
    digitalWrite(led_L,HIGH);
    delay(50);
    digitalWrite(led_R,LOW);
    digitalWrite(led_L,LOW);
    delay(50);
    digitalWrite(led_R,HIGH);
    digitalWrite(led_L,HIGH);
    delay(50);
  }
}
void WS2812_show()
{
  colorWipe(strip.Color(255, 0, 0), 10); // Red
  delay(600);
  colorWipe(strip.Color(255, 150, 0), 10); // yellow
  delay(600);
  colorWipe(strip.Color(0, 255, 0), 10); // Green
  delay(600);
  colorWipe(strip.Color(0, 255, 255), 10); // CYAN
  delay(600);
  colorWipe(strip.Color(0, 0, 255), 10); // Blue
  delay(600);
  colorWipe(strip.Color(180, 0, 255), 10); // purple
  delay(600);
  colorWipe(strip.Color(127, 127, 127), 10); // White
  delay(600);
  colorWipe(strip.Color(0, 0, 0), 30); // Clear
  Serial.println("OK");
}

void colorWipe(uint32_t c, uint8_t wait)
{
  for(uint16_t i=0; i<strip.numPixels(); i++) {
    strip.setPixelColor(i, c);
    strip.show();
    delay(wait);
  }
```

```
}

//Theatre-style crawling lights.
void theaterChase(uint32_t c, uint8_t wait) {
  for (int j=0; j<10; j++) {  //do 10 cycles of chasing
    for (int q=0; q < 3; q++) {
      for (int i=0; i < strip.numPixels(); i=i+3) {
        strip.setPixelColor(i+q, c);    //turn every third pixel on
      }
      strip.show();

      delay(wait);

      for (int i=0; i < strip.numPixels(); i=i+3) {
        strip.setPixelColor(i+q, 0);        //turn every third pixel off
      }
    }
  }
}
```

6. Any questions and suggestions are welcome

Thank you for reading this document!

If you find any errors and omissions in the tutorial, or if you have any suggestions and questions, please feel free to contact us at:

cokoino@outlook.com

We will do our best to make changes and publish revisions as soon as possible.

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