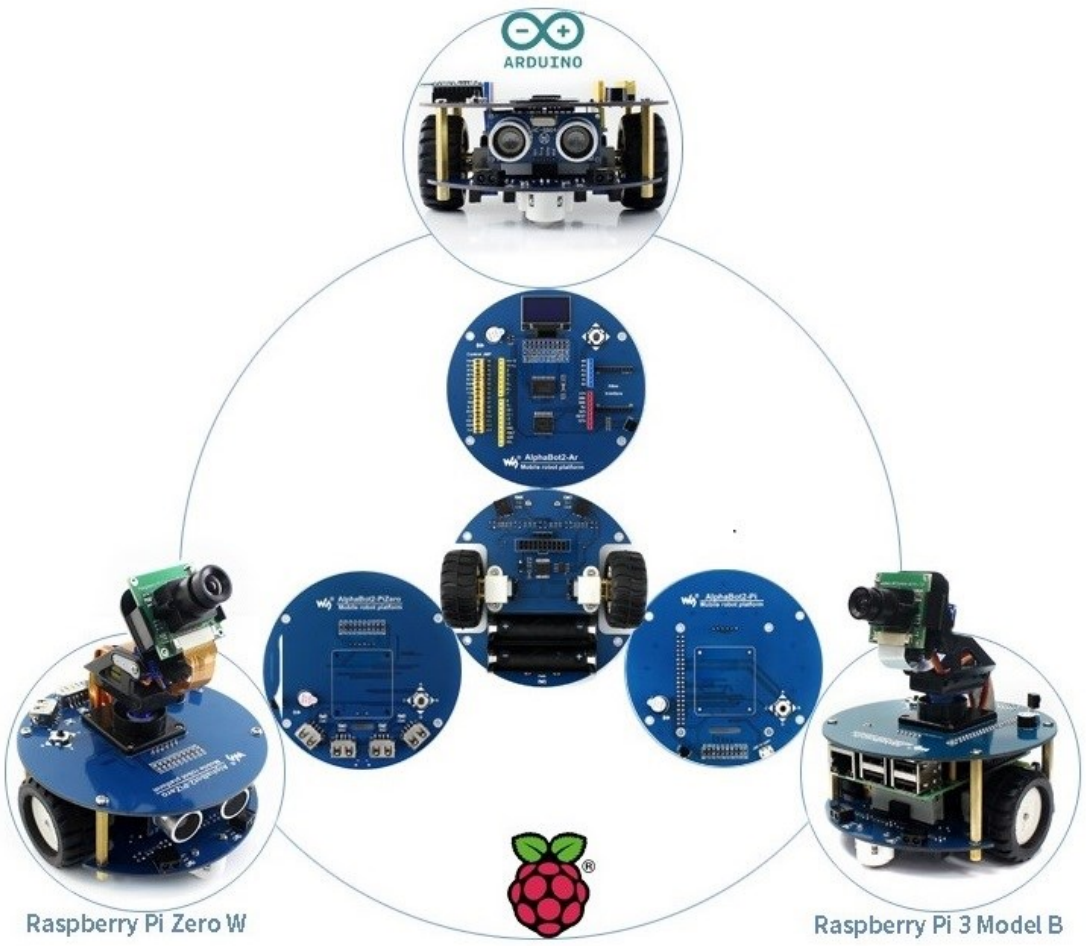
AlphaBot 2

User Manual

August 2017

V1.3



To the Reader

Selection Guide

Note: Accessories may be different in different product package. This manual describes all the compatible accessories but perhaps the product you bought doesn’t contain some of them.

Note:

AlphaBot2-Ar Acc Pack requires an Arduino compatible controller, if you don't have one in hand, please consider the all-in-one kits: AlphaBot2-Ar.

AlphaBot2-Pi Acc Pack requires the controller Raspberry Pi, if you don't have one in hand, please consider the all-in-one kit: AlphaBot2-Pi.

AlphaBot2-PiZero Acc Pack requires the controller Raspberry Pi Zero/Zero W, which should be purchased separately.

Due to the structure design, ultrasonic sensor module can NOT be used with the AlphaBot2-Pi kit.

Recommendation

Reading this document can be a challenge for a freshman. We advise that the reader need to have some knowledge of the programming in Raspberry Pi Python or Arduino, which can be helpful for understanding the programming fundamentals. Due to space constraint, only a few of the programming fundamentals can be explored here. If you want to have a thorough understand of them, please check the source code. Here, we will describe more about the practical experience of smart robot development.

Raspberry Pi tutorial:

http://www.waveshare.com/wiki/Raspberry_Pi_Tutorial_Series

Due to the electrical characteristic limitation, user should be more careful to use this product in a safe and correct matter, to prevent the Raspberry Pi board or Arduino board from irreversible damage by the smart robot chassis. For your first time in using this product, please follow the steps described in the document.

Get details

Waveshare Wiki provides detailed data of AlphaBot2, including user manual, schematic diagram, Demos, data sheet and the likes. Users can apply the product in a safe and correct matter by reading them.

☺ Resource Link: www.waveshare.com/wiki/AlphaBot2

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What's on board?

Introduction

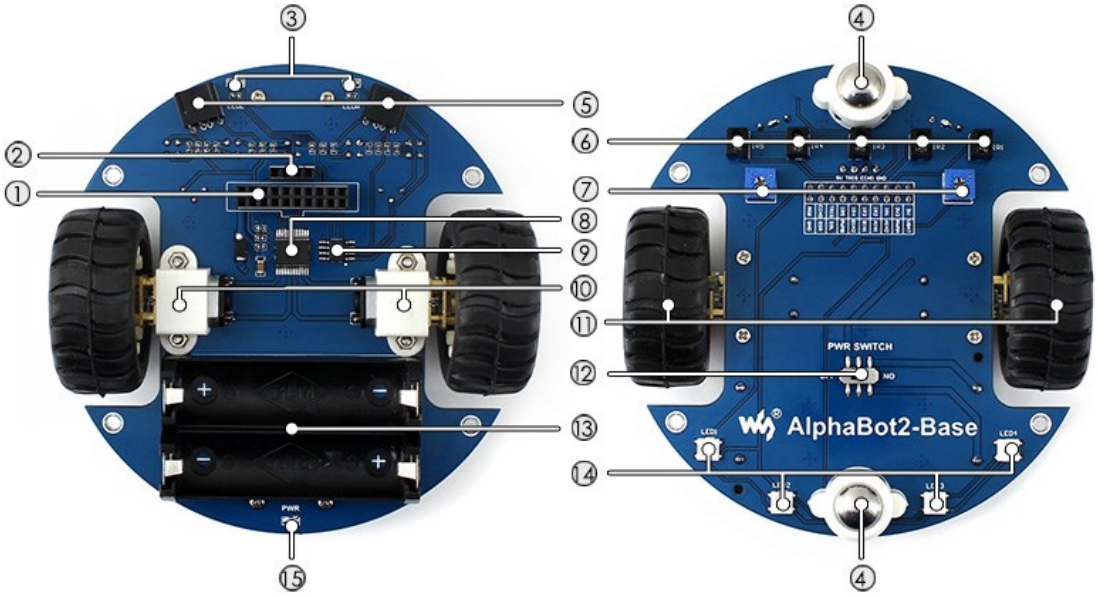
AlphaBot2 robot kits includes a chassis (AlphaBot2-Base chassis) and an adapter board (one of the adapter boards AlphaBot2-Ar / AlphaBot2-Pi / AlphaBot2-PiZero). The robot supports Arduino / Raspberry Pi 3 Model B / Raspberry Pi Zero W with different adapter boards.

It features rich common robot functions including line tracking, obstacle avoiding, Bluetooth / infrared / WiFi remote control, video monitoring, etc.

Thanks to the highly integrated modular design, it is fairly easy to assemble by a snap, no soldering, no wiring. After a few minutes spent on hardware assembling, you're almost there, our open source demo codes is ready to help you get started fast.

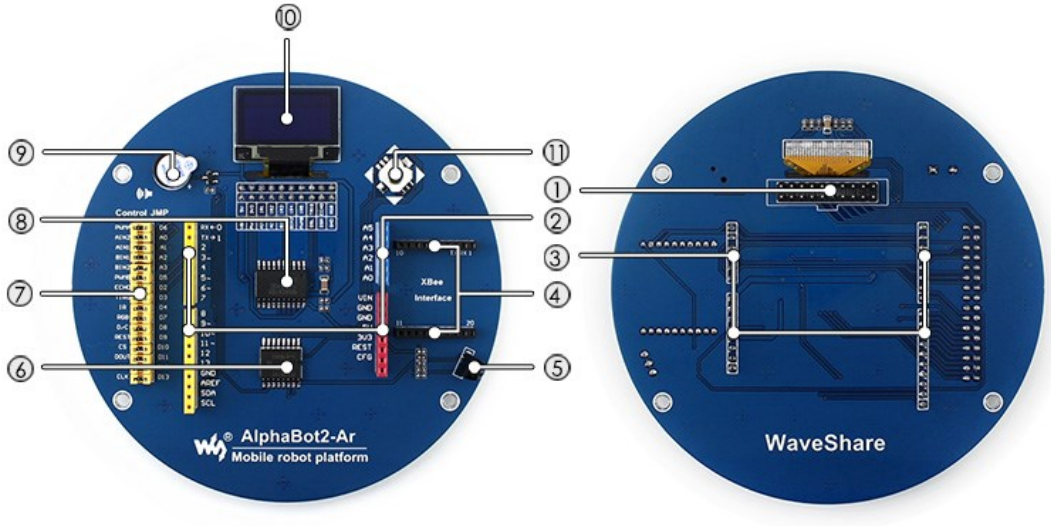
Accessories may be different in different product package. This manual describes all the compatible accessories but perhaps the product you bought doesn't contain some of them.

AlphaBot2-Base



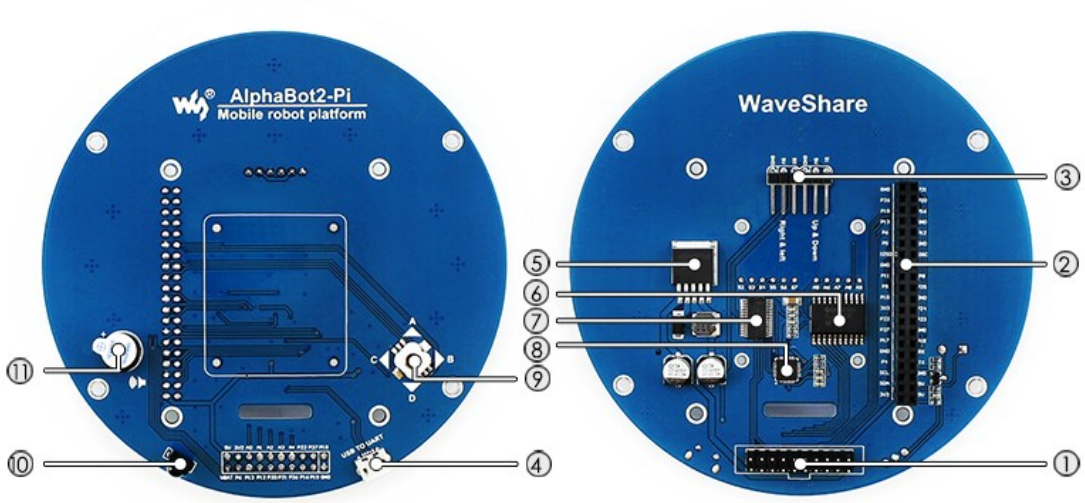
1. **AlphaBot2 control interface:** for connecting sorts of controller adapter board
2. **Ultrasonic module interface**
3. **Obstacle avoiding indicators**
4. **Omni-direction wheel**
5. **ST188**: reflective infrared photoelectric sensor, for obstacle avoiding
6. **ITR20001/T**: reflective infrared photoelectric sensor, for line tracking
7. **Potentiometer** for adjusting obstacle avoiding range
8. **TB6612FNG** dual H-bridge motor driver
9. **LM393** voltage comparator
10. **N20 micro gear motor** reduction rate 1:30, 6V/600RPM
11. **Rubber wheels** diameter 42mm, width 19mm
12. **Power switch**
13. **Battery holder**: supports 14500 batteries
14. **WS2812B:** true color RGB LEDs
15. **Power indicator**

AlphaBot2-Ar



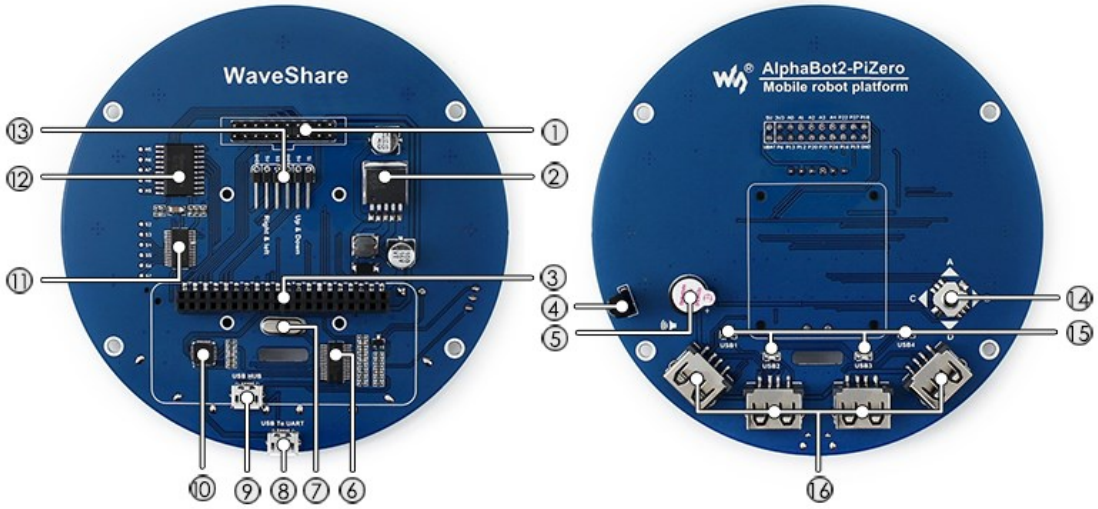
1. **AlphaBot2 control interface**: for connecting AlphaBot2-Base
2. **Arduino expansion header**: for connecting Arduino shields
3. **Arduino interface**: for connecting Arduino compatible controller
4. **Xbee connector**: for connecting dual-mode Bluetooth module, remotely control the robot via Bluetooth
5. **IR receiver**
6. **PC8574**: I/O expander, SPI interface
7. **Arduino peripheral jumpers**
8. **TLC1543**: 10-bit AD acquisition chip
9. **Buzzer**
10. **0.96inch OLED** SSD1306 driver, 128x64 resolution
11. **Joystick**

AlphaBot2-Pi



1. **AlphaBot2 control interface**: for connecting AlphaBot2-Base
2. **Raspberry Pi interface**: for connecting Raspberry Pi 3 Model B
3. **Servo interface**
4. **USB TO UART**: easy for controlling the Pi via UART
5. **LM2596**: 5V voltage regulator
6. **TLC1543**: 10-bit AD acquisition chip, allows the Pi to use analog sensors
7. **PCA9685**: servo controller, make it more smoothly to rotate the pan head
8. **CP2102**: USB TO UART converter
9. **Joystick**
10. **IR receiver**
11. **Buzzer**

AlphaBot2-PiZero



1. **AlphaBot2 control interface**: for connecting AlphaBot2-Base
2. **LM2596**: 5V voltage regulator
3. **Raspberry Pi interface**: for connecting Raspberry Pi Zero/Zero W
4. **IR receiver**
5. **Buzzer**
6. **FE1.1S**: USB HUB chip
7. **12M crystal**
8. **USB TO UART**: easy for controlling the Pi via UART
9. **USB HUB interface**: extends the USB port of Raspberry Pi Zero/Zero W
10. **CP2102**: USB TO UART converter
11. **PCA9685**: servo controller, make it more smoothly to rotate the pan head
12. **TLC1543**: 10-bit AD acquisition chip, allows the Pi to use analog sensors
13. **Servo interface**
14. **USB indicators**
15. **USB ports**: more USB capability

Quick start

We have provided the control programs for Arduino and Raspberry Pi, which can implement many functions, such as tracking, obstacle avoidance, remote control, video monitoring and so on.

You can get the example programs described in the following sections from the website of Waveshare Wiki. To apply these examples to your application, you need to copy the file libraries under the directory of Arduino into the folder libraries under the installation directory of Arduino IDE. Then, restart the Ariduino IDE, and click File-> Example to see if there is an option TRSensors. If yes, it means the libraries are imported successfully. When using the Raspberry Pi, you should extract the example programs and place them in the directory of /home/pi under the operation system of Raspbian.

Arduino examples

Motor testing

Compile and download the program Run-Test. Normally, the smart robot moves forward when the program runs and drives the motor to rotate. In case that the direction of motion is wrong, you may need to modify the motor wring or change the pin settings in your program. We recommend the latter one. If left wheels of the robot run in a wrong direction, you should exchange the settings of AIN1 and AIN2. For right wheels, exchange the settings of BIN1 and BIN2.

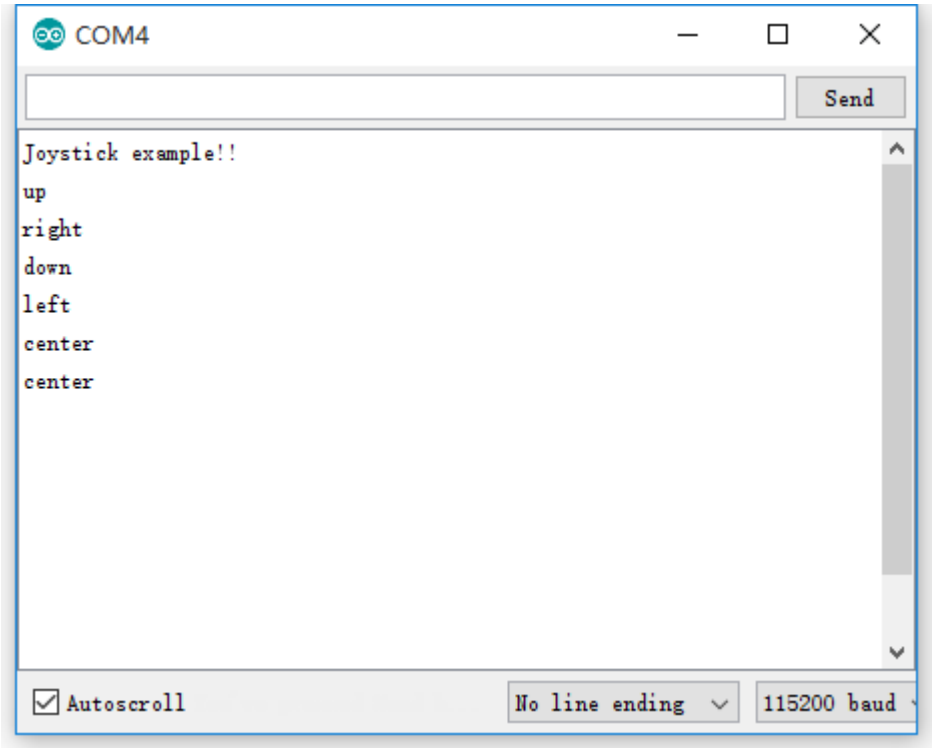
In the event that all the wheels run in a wrong direction, you should modify the

settings in the demos, like:

```
#define PWMA   5          //Left Motor Speed pin (ENA)
#define AIN2   A0         //Motor-L forward (IN2).
#define AIN1   A1         //Motor-L backward (IN1)
#define PWMB   6          //Right Motor Speed pin (ENB)
#define BIN1   A2         //Motor-R forward (IN3)
#define BIN2   A3         //Motor-R backward (IN4)
```

5-way Joystick

Compile and download the program Joystick. This Joystick has 5 control directions: Up, Down, Left, Right and Center (Enter). Open the serial monitor, and set the baud rate to 115200. Then, the monitor displays the current key press. When there is a key pressed down, the buzzer sounds and the motor rotates in the direction according to the key. If the wheel(s) runs in the wrong direction, you should modify the settings of the corresponding pins.



Infrared remote control

Compile and download the program IR. You can control the smart robot by pressing down the numeric keys on the infrared remote controller, in which, "2" is for go forwards, "8" for go backwards, "4" for turn left, "6" for turn right, and "5" for stop. Keys "- " and "+" can adjust the speed of the robot, and "EQ" can restore the default setting of the speed.

The key encoding may change with different Infrared remote controller. You can modify the program as required.



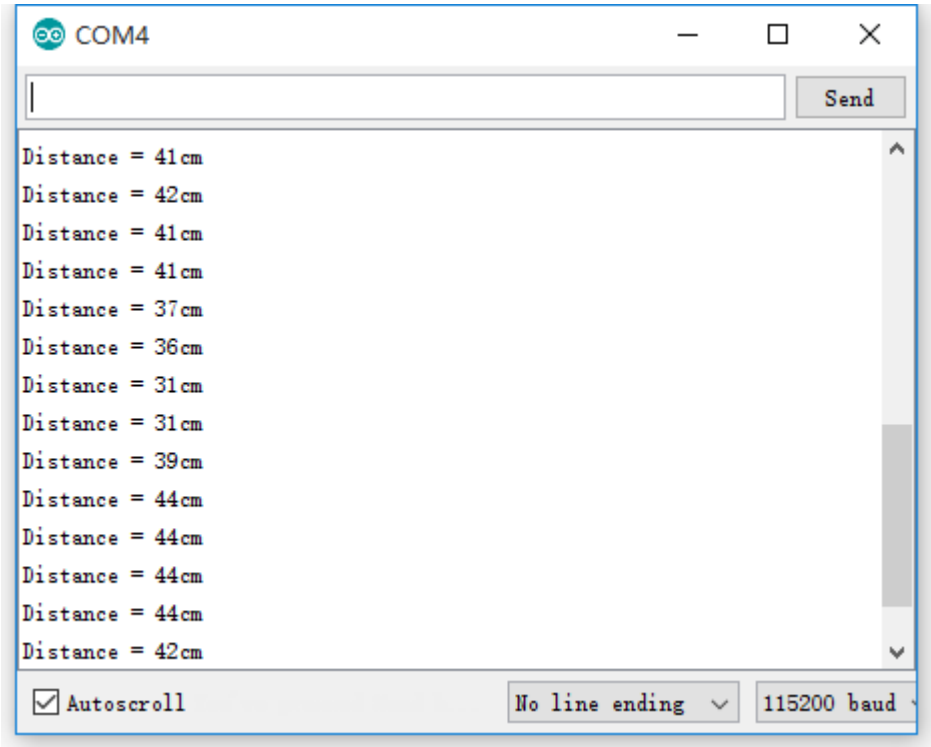
Infrared obstacle avoidance

Compile and download the program Infrared-Obstacle-Avoidance. When there is no obstacle ahead of the robot, the green LEDs on the robot are off. When the obstacle is detected, the green LEDs will light up. In case that the LEDs are always off or always on, you can try to adjusted the potentiometers on the bottom of the robot to make the LEDs work properly.

In this example, the robot goes straight when there is no obstacle, and turns right when obstacle is detected.

Ultrasonic distance measurement

Compile and download the program Ultrasonic_Ranging. Open the serial monitor, and set the baud rate to 115200. Then, the monitor displays the current measured distance.



Ultrasonic obstacle avoidance

Compile and download the program Ultrasonic-Obstacle-Avoidance. In this example, the robot goes straight when there is no obstacle, and turns right when obstacle is detected. Since the ultrasonic can be reflected, if the obstacle is not in the front of the robot, but is at an angle with the robot, the distance measured between the robot and the obstacle may be inaccurate.

Ultrasonic infrared obstacle avoidance

Compile and download the program Ultrasonic-Infrared-Obstacle-Avoidance. In this example, the robot goes straight when there is no obstacle, and turns right when obstacle is detected.

Tracker sensor testing

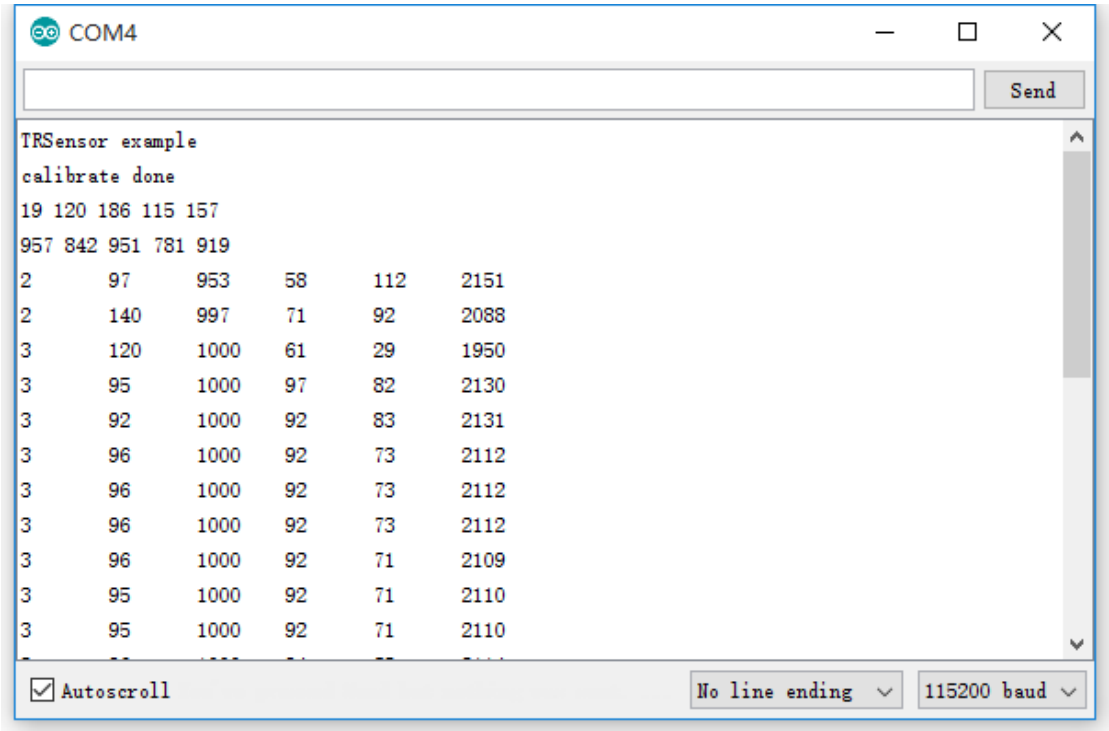
Import the library TRSensors to the file libraries under the installation directory of Arduino IDE. Then, click File -> Example -> TRSensors ->TRSensorExample to open the project. Compile and download the program to the development board Arduino. The tracker sensor can detect the black line in the background color of white. You can choose a black adhesive tape with 15cm width, and paste it to a white KT board to create the smart robot tracking line scenario. The dark background color will reduce the capability of the smart robot on the tracking line.

Open the serial monitor, and set the baud rate to 115200. When the monitor displays the characters "TRSensor example" , you should hold the robot in the middle of the black line and close to the ground, then swing the robot from side to side. Then, the smart robot goes into the calibration mode, identifying the Max. and the Min. threshed of each sensor. Calibration can have a direct influence to the tracking line capability of the robot.

After the calibration, the monitor shows the Max. and the Min. threshed of each sensor. And then, the measured values of sensors are displayed as well. The larger

value means the deeper color. The last column of values indicate the position of the black line, in which "2000" means the black line is in the middle of the robot, "0" means the black line is on the leftmost side of the robot, and "4000" means the black line is on the rightmost side of the robot.

When this program runs well, the line tracking sensor works properly. Or else, the sensor cannot perform line tracking.



Infrared line tracking

Compile and download the program Infrared-Line-Tracking. Turn on the power adapter, and hold the robot in the middle of the black line and close to the ground, then swing the robot from side to side. The smart robot goes into the calibration mode, identifying the Max. and the Min. threshed of each sensor. Calibration can have a direct influence to the tracking line capability of the robot. When the wheels

of the robot begin to move, you can release the robot and it will run along with the black line.

RGB LEDs

Compile and download the program W2812. There are 4 RGBn LEDs (red, green, blue and yellow, respectively) on the bottom of the robot.

To run this program, you should import the corresponding library to Arduino IDE.

OLED

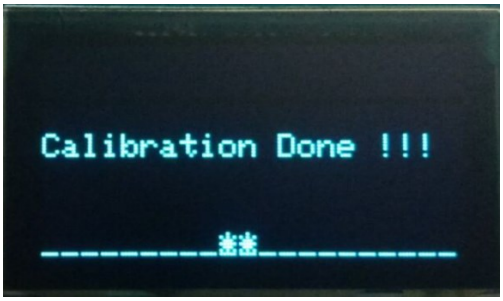
Compile and download the program OLED. The example program demonstrates the basic functions of character display and drawing operation, including drawing line, cycle, rectangle box and the likes. To run this program, you should import the corresponding library to Arduino IDE.

Comprehensive program

Compile and download the program Line-Tracking. Turned on the power adapter, you can see the OLED display the characters “AlphaBot2”. Then, place the robot on the black line and press down the key. Now, the smart robot goes into the calibration mode, moving to left and then right. And the RGB LED is in green. When the calibration finished, the RGB LED is in blue. OLED shows the information as the figure below on the right, in which “**” indicates the current position of the black line. When the smart robot moves to left or right, this symbol will be moved along. Pressing down the key again, the smart robot runs along with the black line, and

the RGB LED shows different colors. When there is an obstacle detected, the smart robot stops and the buzzer sounds. When the obstacle disappears, the smart robot continue to run. If you take up the robot, it will stop as well. Then, place it on the black line, it will run again.





Smart robot running mazes

Compile and download the program MazeSolver. Turned on the power adapter, you can see the OLED display the characters “AlphaBot2”. Then, place the robot on the black line and press down the key. Now, the smart robot goes into the calibration mode, moving to left and then right. And the RGB LED is in green. When the calibration finished, the RGB LED is in blue. OLED shows the information as the figure below on the right, in which “**” indicates the current position of the black line. When the smart robot moves to left or right, this symbol will be moved along. If the smart robot comes across the right angle, it will take a turn and look for the end automatically. The smart robot stops when it arrives the end. Now, put the smart robot to the start again, and press down the key, you will find that the smart robot runs to the end along with the shortest route.

Here are some requirements in making the maze: the corner should be a right angle, and the maze should not has any loop.

About the program: when the smart robot detects any corner, it will slow down and detects if there is a corner once again. As the difference at motor and operation voltage in used, the smart robot may be unable to identify the corner. In this case, you can modify the speed setting and delay time in the program. Further, when the smart robot has to turn a corner, it need to increase delay time to judge the degree of the angle. Therefore, if there is any problem in turning a corner, you can modify the speed setting and delay time in the program as well.

```
  follow_segment();

  // Drive straight a bit.  This helps us in case we entered the
  // intersection at an angle.
  // Note that we are slowing down - this prevents the robot
  // from tipping forward too much.
  SetSpeeds(30, 30);
  delay(40);

  // These variables record whether the robot has seen a line to the
  // left, straight ahead, and right, whil examining the current
  // intersection.
  unsigned char found_left = 0;
  unsigned char found_straight = 0;
  unsigned char found_right = 0;

  // Now read the sensors and check the intersection type.
trs.readLine(sensorValues);

  // Check for left and right exits.
  if (sensorValues[0] > 600)
    found_left = 1;
  if (sensorValues[4] > 600)
    found_right = 1;

  // Drive straight a bit more - this is enough to line up our
  // wheels with the intersection.
  SetSpeeds(30, 30);
  delay(100);

  // Check for a straight exit.
  trs.readLine(sensorValues);
  if (sensorValues[1] > 600 || sensorValues[2] > 600 || sensorValues[3] > 600)
    found_straight = 1;
```

```
void turn(unsigned char dir)
{
 // if(millis() - lasttime >500)
  {
    switch(dir)
    {
    case 'L':
      // Turn left.
      SetSpeeds(-100, 100);
      delay(190);
      break;
    case 'R':
      // Turn right.
      SetSpeeds(100, -100);
      delay(190);
      break;
    case 'B':
      // Turn around.
      SetSpeeds(100, -100);
      delay(400);
      break;
    case 'S':
      // Don't do anything!
      break;
    }
  }
```

Bluetooth control smart robot

Compile and download the program Bluetooth. You should remove the Bluetooth module from the smart robot before downloading, or else the program cannot be loaded. When finished, you should insert the Bluetooth module to the smart robot again.

Then, scan the QR code below with your mobile phone, and download the relative APP according to your mobile phone OS. For iOS, Bluetooth BLE is applied to

communicate with the module, and iphone4S or above is required. For Android, Bluetooth EDR is applied.

Startup the APP, and click the option “Scan” (Note: Turn on the Bluetooth on your mobile phone). Then, insert the Bluetooth module to the smart robot. After a few second, you can find the corresponding Bluetooth device in the list. For iOS, select “Waveshare_BLE” device. For Android, select “Waveshare_ERD” device. Then, enter the next page, and choose “remote control mode”.



Note: If your Android mobile phone support Bluetooth BLE as well, it will scan two devices. At this moment, please select the device with the MAC address of 00:0E:0E.



Select "Remote control mode", and click the option Settings to configure the commands according to the program. When there is key pressed down, it will trigger corresponding command. And when the key is released and bound up, it will trigger the "Stop" command.

```
if(strcmp(command, "Forward") == 0)          //Forward
  forward();
else if(strcmp(command, "Backward") == 0)    //Backward
  backward();
else if(strcmp(command, "Left") == 0)        //Left
  left();
else if(strcmp(command, "Right") == 0)       //Right
  right();
else if(strcmp(command, "Stop") == 0)        //Stop
  stop();
else if(strcmp(command, "Low") == 0)         //Low
  Speed = 50;
else if(strcmp(command, "Medium") == 0)      //Medium
  Speed = 150;
else if(strcmp(command, "High") == 0)        //High
  Speed = 250;
```

When the color of the speed button changes from gray to black, it means the program has been linked. Now, pressing down the key, you can control the smart robot. At a meanwhile, the RGB LED display different colors.

For more information about **Dual-mode Bluetooth,** please refer to the corresponding user manual

Chinese user manual: http://www.waveshare.net/wiki/Dual-mode_Bluetooth

English user manual: http://www.waveshare.com/wiki/Dual-mode_Bluetooth

Bluetooth control smart robot (JSON formatted command)

Remove the Bluetooth module, then, compile and download the program Bluetooth-json. Next, startup the APP, and insert the Bluetooth module to the robot. Then, select the option "Remote control mode" to control the robot, and choose the option "Peripheral control" to control the buzzer to sound and RGD LED to display different colors. (RGD LED may be unavailable in other robot. So you may not control it on other robot.)

Raspberry Pi examples

Extract the package AlphaBot2.tar.gz and place it to the directory of /home/pi under raspbian system.

Before using this extension board, you should install the library python to your Raspberry Pi.

In case that the example is unable to be performed after installing the library, you can try to apply the command chmod +x filename to grant the program the executable permission.

Explanation: For the freshmen of Raspberry Pi, please refer to the Raspberry Pi Tutuiral. You can optionally read the following content.

① Raspberry Pi Tutuiral Serial: Access your Pi

② Libraries Installatin for RPi (Only python need to be operated)

Motor testing

Enter the Linux terminal, and input the following commands:

```
cd ~/AlphaBot2/python
sudo python AlphaBot2.py
```

Expectation result: The smart robot moves forward when the program runs and drives the motor to rotate.

In case that the direction of motion is wrong, you may need to modify the motor wring or change the pin settings in your program. We recommend the latter one. If left wheels of the robot run in a wrong direction, you should exchange the settings of ain1 and ain2. For right wheels, exchange the settings of bin1 and bin2.

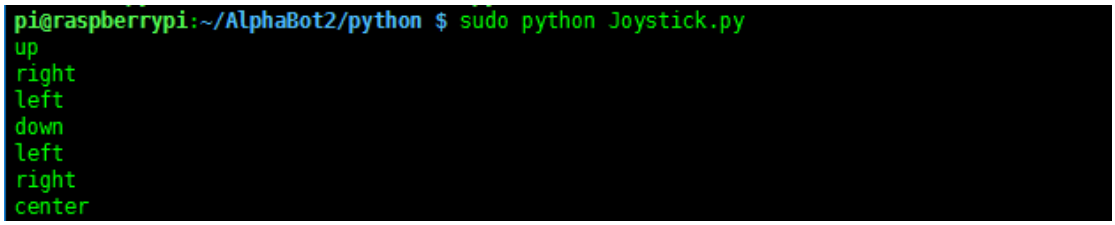
```
def __init__(self,ain1=12,ain2=13,ena=6,bin1=20,bin2=21,enb=26):
```

5-way joystick

Enter the Linux terminal, and input the following commands:

```
cd ~/AlphaBot2/python
sudo python Joystick.py
```

Expectation result: This Joystick has 5 control directions: Up, Down, Left, Right and Center (Enter). Open the serial monitor, and set the baud rate to 115200. Then, the monitor displays the current key press. When there is a key pressed down, the buzzer sounds and the motor rotates in the direction according to the key. If the wheel(s) runs in the wrong direction, you should modify the settings of the corresponding pins.



Infrared remote control

Enter the Linux terminal, and input the following commands:

```
cd ~/AlphaBot2/python
sudo python IRremote.py
```

Expectation result: You can control the smart robot by pressing down the numeric keys on the infrared remote controller, in which, "2" is for go forwards, "8" for go backwards, "4" for turn left, "6" for turn right, and "5" for stop. Keys "-" and "+" can adjust the speed of the robot, and "EQ" can restore the default setting of the speed.

(Note: The key encoding may change with different Infrared remote controller. You can modify the program as required.)

Infrared obstacle avoidance

Enter the Linux terminal, and input the following commands:

```
cd ~/AlphaBot2/python
sudo python Infrared_Obstacle_Avoidance.py
```

When there is no obstacle ahead of the robot, the green LED on the robot is off. When the obstacle is detected, the green LED will light up. In case that the LED is always off or always on, you can try to adjusted the potentiometers on the bottom of the robot to make the LED work properly.

Expectation result: The robot goes straight when there is no obstacle detected by the sensor on the left, and turns right when obstacle is detected.

Ultrasonic distance measurement (Raspberry Pi 3B kit does not contain ultrasonic unit)

Enter the Linux terminal, and input the following commands:

```
cd ~/AlphaBot2/python
sudo python Ultrasonic_Rangeing.py
```

Expectation result: The terminal will display the current measured distance.

```
pi@raspberrypi:~/AlphaBot2/python $ sudo python Ultrasonic_Ranging.py
Distance:21.15 cm
Distance:21.45 cm
Distance:21.85 cm
Distance:21.49 cm
Distance:10.95 cm
Distance:7.96 cm
Distance:8.06 cm
```

Ultrasonic distance measurement (Raspberry Pi 3B kit does not contain ultrasonic unit)

Enter the Linux terminal, and input the following commands:

```
cd ~/AlphaBot2/python
sudo python Infrared_Obstacle_Avoidance.py
```

Expectation result: The robot goes straight when there is no obstacle detected by

the sensor on the left, and turns right when obstacle is detected.

RGB LED

Install libraries:

```
sudo gpt-get install python-pip
sudo pip install rpi_ws281x
Open Terminal and execute commands as below to test:
cd ~/AlphaBot2/python
sudo python ws2812.py
```

Expectation result:

The four RGB LEDs on the bottom of the smart robot will be in red, green, blue and yellow, respectively.

If they display the wrong color, you can find out the file /boot/config.txt and add the lines below into it. Restart the module to make the lines take effect. The RGB LED use DMA control, which can occupy the audio output DMA channels on the Raspberry Pi. So, adding these lines may cause the earphone interface to be unavailable.

```
hdmi_force_hotplug=1
hdmi_force_edid_audio=1
```

Tracker sensor testing

Enter the Linux terminal, and input the following commands:

```
cd ~/AlphaBot2/python
sudo python TRSensors.py
```

Expectation result: You can see five set of data printed on the terminal, they are corresponding to five sensors. When the smart robot is placed on the white KT board, the data value will be in the range of 800~900. When it is held in the air, the value can be in the range of 0~100. And, when it on the black line, the value can be

in the range of 100~300.

Infrared line tracking

Enter the Linux terminal, and input the following commands:

```
cd ~/AlphaBot2/python
sudo python LineFollow.py
```

Expectation result: While the program is running, the smart robot goes into the calibration mode, moving to left and then right. When the calibration finished, you can swing the smart robot side to side, and the terminal will display the current position of the black line and the values of five sensors. Place the smart robot on the black line, and press down the center key on the joystick. Now, you can see the smart robot run along with the black line, and the RGB LEDs on the bottom of the robot display different colors.

Servo

Enable I2C interface first:

```
sudo raspi-config
```

And choose Interfacing Options->I2C->Yes

Enter the Linux terminal, and input the following commands:

```
cd ~/AlphaBot2/python
sudo python PCA9685.py
```

Expectation result:: The servo will move to left and right, and its rotational range can reach 180 degree.

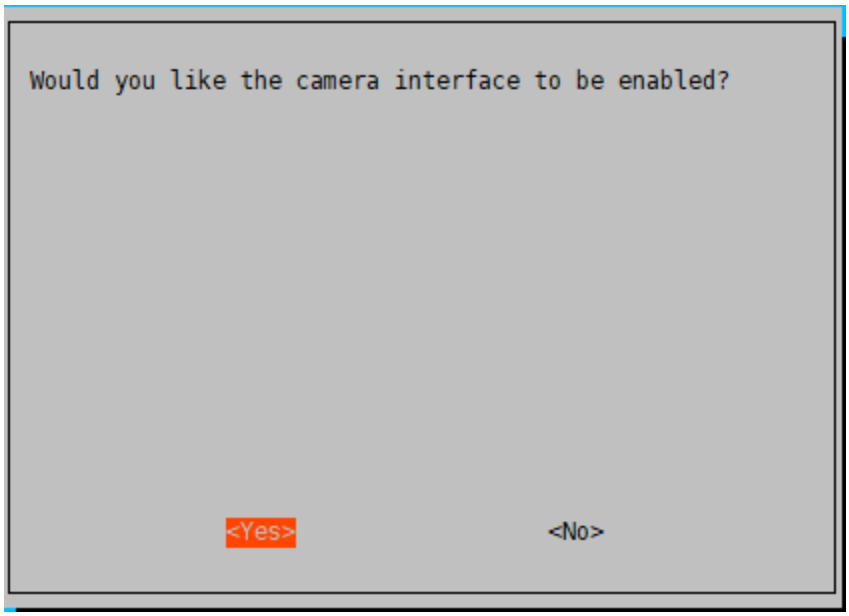
mjpg-streamer software real-time monitoring

"MJPG-streamer" takes JPGE from the web camera, and streams them over an IP-based network to various types of viewers.

a) Run the command raspi-config to start up the camera before using it:

`sudo raspi-config`

Select `Enable Camera` and Choose `Yes`



b) For the camera with CSI interface, the system may be unable to find out the device under the directory of /dev/video0. In this case, you should add a line, bcm2835-v4l2, into the file /etc/modules.

`sudo nano /etc/modules`

Add the line: `bcm2835-v4l2`

```
# This file contains the names of kernel modules that should be loaded
# at boot time, one per line. Lines beginning with "#" are ignored.

bcm2835-v4l2
```

Note: l in the statement is character "l" but not the number 1

c) After reboot, the system will load the module name stored in this file, and find out the device video0 under the directory of /dev.

```
pi@raspberrypi:~/code/AlphaBot2/AlphaBot2 $ ls /dev/video*
/dev/video0  /dev/video10  /dev/video11  /dev/video12
```

Note: After performing the steps a), b) and c) , if you still cannot find out the device video0 under the directory of /dev, and all the operations and commands are correct, you should run the command: rpi-update.

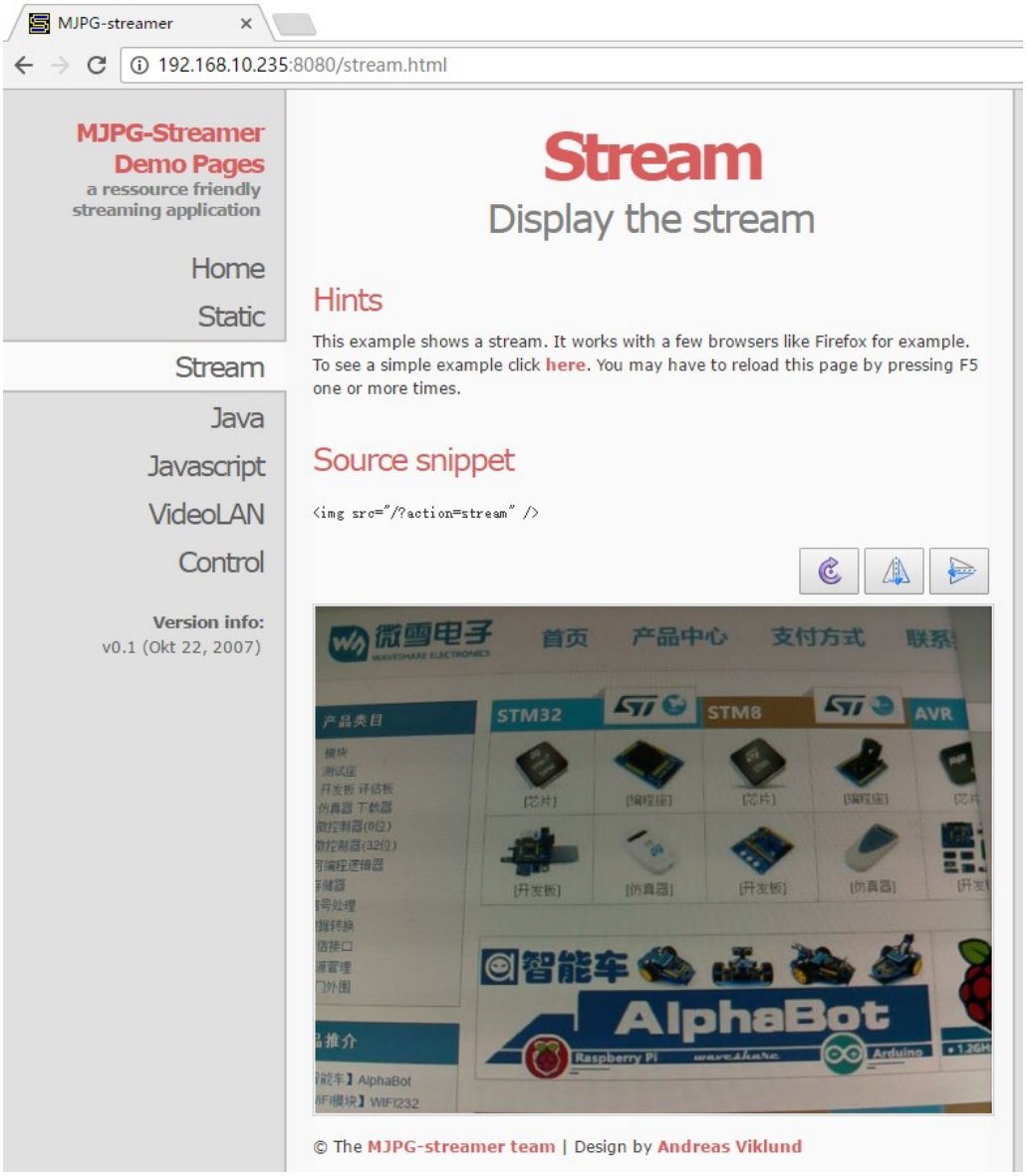
d) Execute Commands below:

```
sudo apt-get update
sudo apt-get install libjpeg8-dev cmake
cd AlphaBot2/mjpg-streamer-master/mjpg-streamer-experimental
sudo make clean all
sudo ./start.sh
```

Then, open the browser (recommend Chrome), and enter the IP address of RPi and the port number: 8080 into the address bar. The website will show the information about the M-JPEG streamer. Click the option Stream, it will real-time display the image captured by the camera.

For more information about mjpg-steamer, you can refer to this link:

https://github.com/jacksonliam/mjpg-streamer



Under the terminal, pressing the keys Ctrl + C can end the program. However, we recommend you to keep the program running, since we still need it in the following operations.

Remote control via Bottle

Bottle is a simple and effective micro python Web framework complying with WSGI. By Bottle, you can fast and easily implement Web control.

1) Install the library:

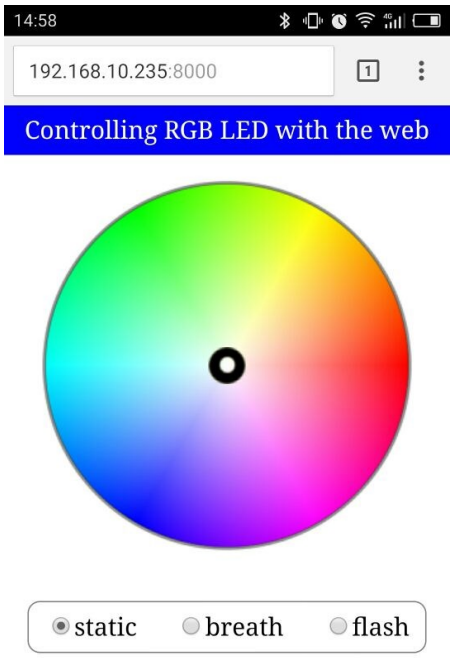
```
sudo apt-get install python-bottle
```

2) Perform web control RGB LED via Bottle

```
cd ~/AlphaBot2/Web-RGB
sudo python main.py
```

3) Then, enter the IP address of your Pi and the port number 8002 into the address bar of the browser. Clicking different position of the pallet, you can see RGB LED displays different colors. There are 3 display modes selectable, static, breath and flash.

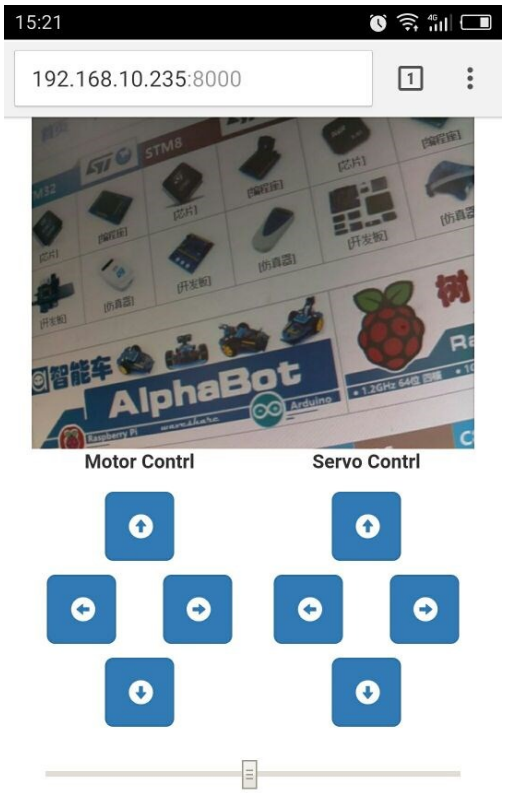
(Note: This web-RGB program only support the mobile phone browser. It is unavailable for PC browser.)



To implement web video control the smart robot by Bottle, you should modify the IP address for the video stream.

```
cd ~/AlphaBot2/Web-Control
sudo python main.py
```

Then, open the browser, and enter the IP address of RPi and the port number: 8000 into the address bar. (Notices: the port number here is 8000, other than 8080.) Then, you can see the following webpage. Clicking the direction icon on the website can control the action of the robot



You can set the program to be started up on boot. Open the file /etc/rc.local with your editor and add the following line into it.

```
sudo vi /etc/rc.local
```

Add the commands following the comments. Please make sure the line exit 0 is the last line. And then, save the modification and exit.

```
cd /home/pi/AlphaBot2/Web-Contrl
sudo python main.py &
```

Since the Raspberry Pi uses dynamic IP which may change each time the device restart, you can add the following lines under the directory of /etc/dhcpcd.comf to set the static IP:

```
interface wlan0
static ip_address = 192.168.1.114/24
static routers = 192.168.1.1
```

In here, “192.168.1.1” is the router IP address, and “192.168.1.114” is the IP

address to be set, following which the "/24" should not be removed.

Remote control via software

To implement video control the smart robot via the software on your mobile phone or PC, you should modify the IP address in the program firstly.

```
cd ~/AlphaBot2/App-Control
vi main.py
```

Find out the line below, and change the IP address to the actual RPI address and set the port to the stream port.

```
Host = '192.168.10.235'
```

Then, run the following command to start the program:

```
sudo python main.py
```

Open a new terminal to run the mjpg-streamer.

```
cd /home/pi/AlphaBot2/mjpg-streamer/ mjpg-streamer-experimental
sudo ./start.sh
```

Run the program AlphaBot.exe on your PC, and enter the IP address, the port numbers of mjpg-stream and smart robot Soket sever.

Click the button Viedeo Connet to connect to the video. When the connection is built up, the button will turn to green. Then, click the button Cmd Connect to connect to the smart robot sever. You will see the button turn to green, if the connection is successful. Now, you can control the action of the smart robot by pressing down the keys on the left, and control the camera and steer by the keys on the right.



Then, scan the QR code below with your mobile phone, and download the relative APP.





Enter the actual IP address of RPi, and click the button Connect. Then, you can see the images captured by the camera. Next, click the button Connect under the image. When the control port has been connected to the program, this button will change from green to blue. Now, you can control the actions of the smart robot and the steer by pressing down the corresponding keys. By dragging the slider, you can change the speed of the robot.

Open the file /etc/rc.local with your editor to add the following commands:

```
sudo vi /etc/rc.local
```

Add the commands following the comments. Please make sure the line exit 0 is the last line. And then, save the modification and exit.

```
cd /home/pi/AlphaBot/App-Contrl
sudo python main.py &
```

You should connect the Raspberry Pi to the router at every restart. Of course, you

can enable the AP function of the RPi wireless network adapter, taking the RPi as sever. For more information about the operation, please refer to the Raspberry Pi tutorial.

Remote control via RPi Bluetooth

1) Upgrade the relative packages of the Bluetooth, and install the depended-upon software.

```
sudo apt-get update
sudo apt-get upgrade -y
sudo apt-get dist-upgrade -y
sudo apt-get install pi-bluetooth bluez bluez-firmware blueman
```

2) Add the pi user to the Bluetooth group.

```
sudo usermod –G Bluetooth –a pi
```

3) Restart the Raspberry Pi.

```
sudo reboot
```

4) Start/Add the SPP, and turn on the Bluetooth device.

```
sudo vi /etc/systemd/system/dbus-org.bluez.service
```

Modify two lines in the following file:

```
[Unit]
Description=Bluetooth service
Documentation=man:bluetoothd(8)

[Service]
Type=dbus
BusName=org.bluez
ExecStart=/usr/lib/bluetooth/bluetoothd -C
ExecStartPost=/usr/bin/sdptool add SP
NotifyAccess=main
#WatchdogSec=10
#Restart=on-failure
CapabilityBoundingSet=CAP_NET_ADMIN CAP_NET_BIND_SERVICE
LimitNPROC=1

[Install]
WantedBy=bluetooth.target
Alias=dbus-org.bluez.service
```

After restarted the RPi, enter the command hciconfig (similar to the command

ifconfig) to check the Bluetooth service.

```
pi@raspberrypi:~ $ sudo hciconfig
hci0:   Type: BR/EDR  Bus: UART
        BD Address: B8:27:EB:2D:00:87  ACL MTU: 1021:8  SCO MTU: 64:1
        UP RUNNING
        RX bytes:717 acl:0 sco:0 events:42 errors:0
        TX bytes:1532 acl:0 sco:0 commands:42 errors:0
```

If the Bluetooth has been working, you will see the device hci0 displayed on the screen. When the Bluetooth does not work, no Bluetooth device can be identified.

Note: If the line dtoverlay=pi3-miniuart-bt exists in the file /boot/config.txt, it should be commented out.

5) Connect to Bluetooth device

Input the following command to enter the Bluetooth control interface (you can input the command help to check the command list after entered the interface).

```
sudo bluetoothctl
agent on
```

After entered the interface, input the following lines (you can input the command help to check the command list after entered the interface).

```
agent on
default-agent
```

Following the scan on, you can see the physical address of the scanned Bluetooth device, similar to XX:XX:XX:XX:XX:XX.

```
pi@raspberrypi:~ $ sudo bluetootctl
sudo: bluetootctl: command not found
pi@raspberrypi:~ $ sudo bluetoothctl
[NEW] Controller B8:27:EB:2D:00:87 raspberrypi [default]
[bluetooth]# agent on
Agent registered
[bluetooth]# default-agent
Default agent request successful
[bluetooth]# scan on
Discovery started
[CHG] Controller B8:27:EB:2D:00:87 Discovering: yes
[NEW] Device 18:E2:9F:AC:E3:3C vivo X7
[NEW] Device A4:44:D1:E7:25:B2 A4-44-D1-E7-25-B2
[CHG] Device A4:44:D1:E7:25:B2 RSSI: -50
[CHG] Device A4:44:D1:E7:25:B2 Name: 魅蓝 Note5
[CHG] Device A4:44:D1:E7:25:B2 Alias: 魅蓝 Note5
```

For Bluetooth pairing, use the following command (In here, XX:XX:XX:XX:XX:XX can be replaced to your device address. For Android mobile phone, you can check the Bluetooth address by Setting-> About phone-> Status information)

```
pair XX:XX:XX:XX:XX:XX
```

```
[bluetooth]# pair A4:44:D1:E7:25:B2
Attempting to pair with A4:44:D1:E7:25:B2
[CHG] Device A4:44:D1:E7:25:B2 Connected: yes
```

```
[bluetooth]# pair 74:A5:28:F3:D0:31
Attempting to pair with 74:A5:28:F3:D0:31
[CHG] Device 74:A5:28:F3:D0:31 Connected: yes
Request confirmation
[agent] Confirm passkey 777190 (yes/no): yes
[CHG] Device 74:A5:28:F3:D0:31 Modalias: bluetooth:v000Fp1200d1436
[CHG] Device 74:A5:28:F3:D0:31 UUIDs:
        00001105-0000-1000-8000-00805f9b34fb
        0000110a-0000-1000-8000-00805f9b34fb
        0000110c-0000-1000-8000-00805f9b34fb
        0000110e-0000-1000-8000-00805f9b34fb
        00001112-0000-1000-8000-00805f9b34fb
        00001115-0000-1000-8000-00805f9b34fb
        00001116-0000-1000-8000-00805f9b34fb
        0000111f-0000-1000-8000-00805f9b34fb
        0000112f-0000-1000-8000-00805f9b34fb
        00001132-0000-1000-8000-00805f9b34fb
        00001200-0000-1000-8000-00805f9b34fb
        00001800-0000-1000-8000-00805f9b34fb
        00001801-0000-1000-8000-00805f9b34fb
[CHG] Device 74:A5:28:F3:D0:31 Paired: yes
Pairing successful
```

When pairing is successful, add the device to the trust list.

```
trust XX:XX:XX:XX:XX:XX
```

```
[bluetooth]# trust A4:44:D1:E7:25:B2
[CHG] Device A4:44:D1:E7:25:B2 Trusted: yes
Changing A4:44:D1:E7:25:B2 trust succeeded
```

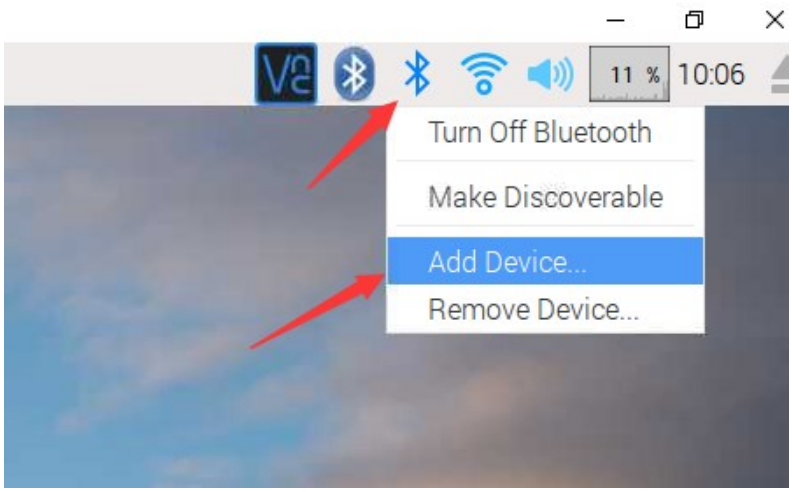
Next, connect to the device.

```
connect XX:XX:XX:XX:XX:XX
```

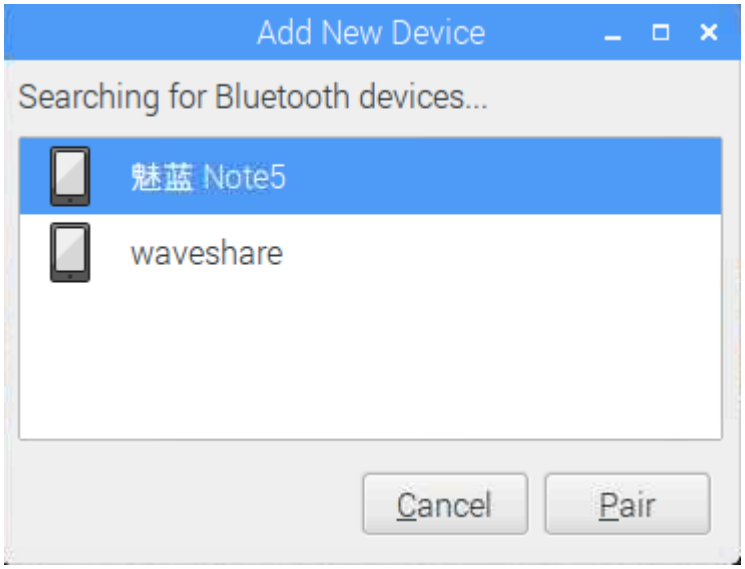
```
[bluetooth]# connect A4:44:D1:E7:25:B2
Attempting to connect to A4:44:D1:E7:25:B2
[CHG] Device A4:44:D1:E7:25:B2 Connected: yes
[CHG] Device A4:44:D1:E7:25:B2 Modalias: bluetooth:v000Fp1200d1436
[CHG] Device A4:44:D1:E7:25:B2 UUIDs:
        00001105-0000-1000-8000-00805f9b34fb
        0000110a-0000-1000-8000-00805f9b34fb
        0000110c-0000-1000-8000-00805f9b34fb
```

At last, enter the command quit to exit the interface. After the settings above, as the Bluetooth device is turned on, the Raspberry Pi will automatically connect to it.

Note: If you are unable to build up the connection with the command line, you can enter the graphic interface to make the connection.



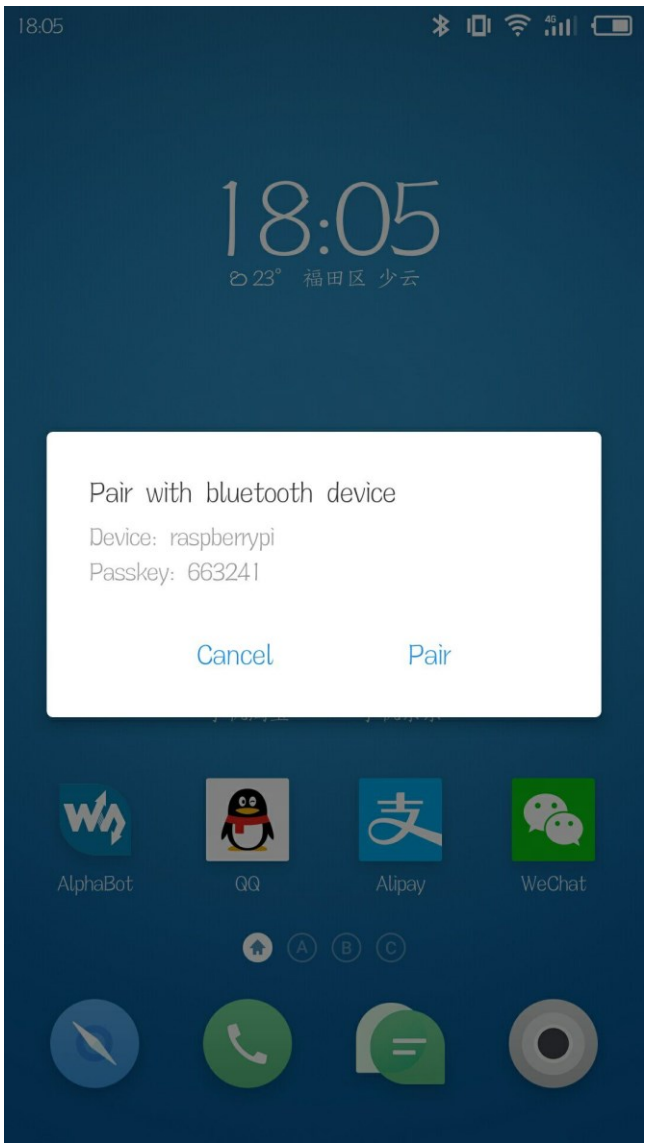
Click the Bluetooth icon and add new device.



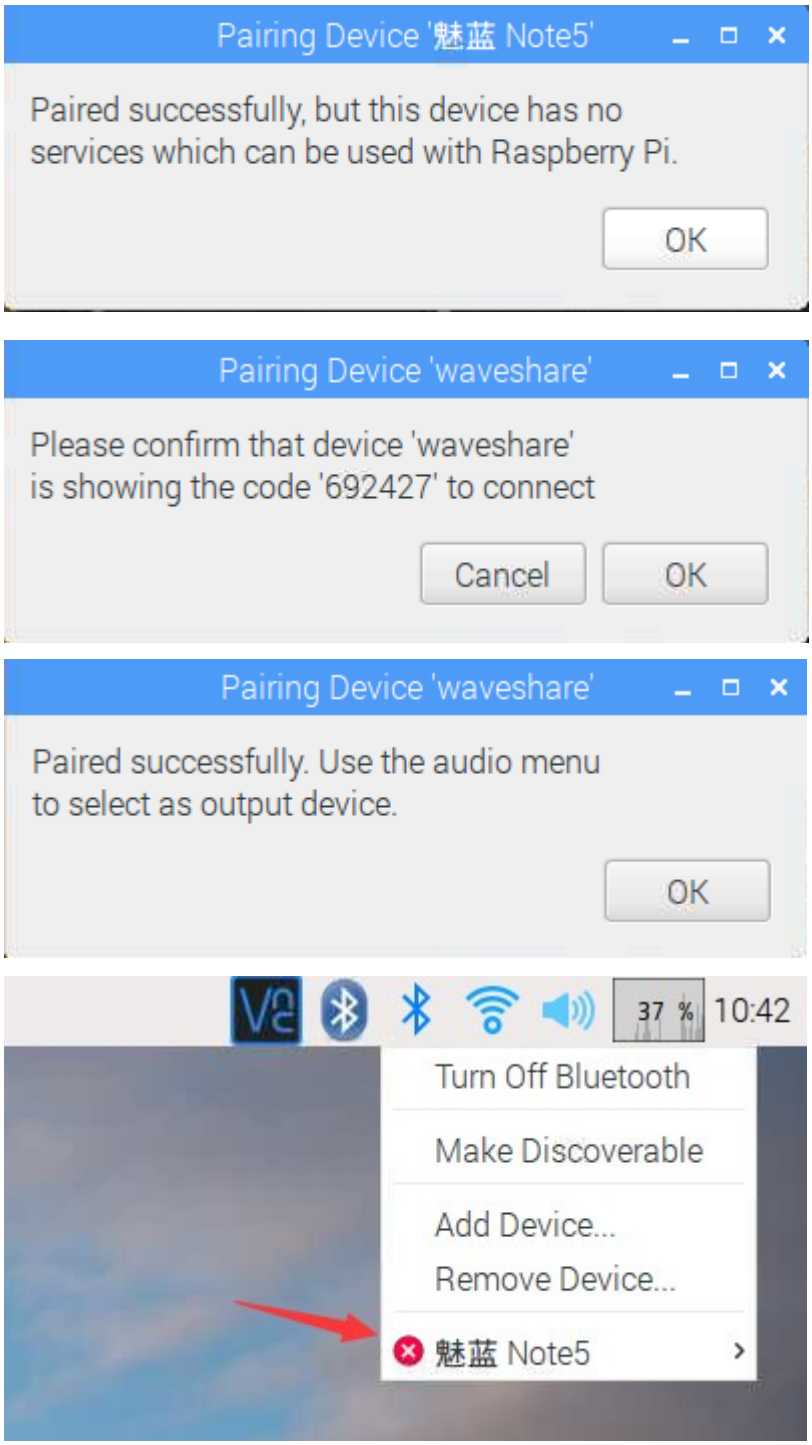
Select the corresponding Bluetooth device. Please make sure the Bluetooth on the mobile phone should be enable and set to discoverable.



On the RPi, select the option OK for pairing. And at the same time, on the mobile phone, click the option Pair.



Then, you may see the prompt saying that "Paired successfully, but this device has no services which can be used with Raspberry Pi."



Now, the connection has been built up.

Run the following commands to start the program:

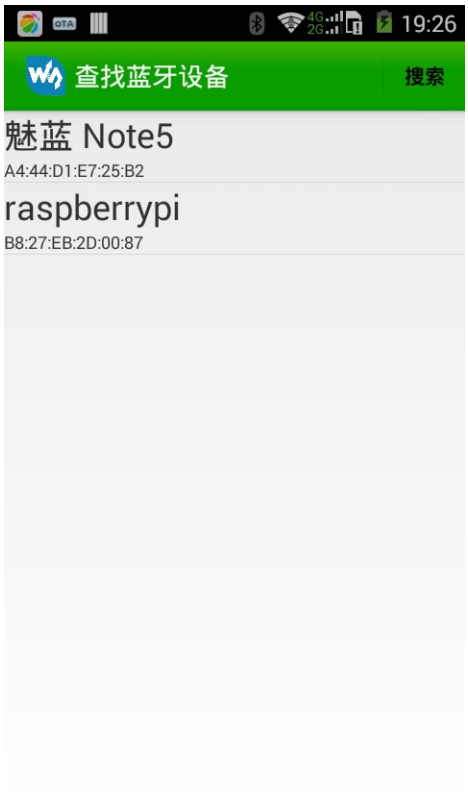
```
cd /AlphaBot2/Bluetooth-Control
```

```
sudo rfcomm watch hci0 1 python bluetooth.py
```

Then, scan the QR code below with your mobile phone, and download the relative APP. (This is the software for controlling the Dual-mode Bluetooth module. If you has installed this software in your Arduino mobile phone, you can skip this step)



Start the APP, and click the option Scan. (Note: please make sure the Bluetooth on your mobile phone is turned on) Normally, you can see the relative Bluetooth devices in the list. Then, select the option “raspberrypi”. Go to the next page, and select the option Remote control.





If the Bluetooth of the Raspberry PI cannot be searched, you can run the following lines to enable the Bluetooth and set it to discoverable.

```
pi@raspberrypi:~ $ sudo bluetoothctl
[NEW] Controller B8:27:EB:2D:00:87 raspberrypi [default]
[NEW] Device A4:44:D1:E7:25:B2 魅蓝 Note5
[NEW] Device 74:A5:28:F3:D0:31 PE-TL20
[NEW] Device F6:D0:10:0B:0E:2C waveshare
[bluetooth]# discoverable on
Changing discoverable on succeeded
[CHG] Controller B8:27:EB:2D:00:87 Discoverable: yes
[bluetooth]# quit
[DEL] Controller B8:27:EB:2D:00:87 raspberrypi [default]
```

FAQ

Question 1: Comparing with AlphaBot, is there any improvement on AlphaBot2?

Answer:

- AlphaBot2 has a smarter dimensions and more stable structure. Sensors are highly integrated in it.
- High-precision metal motor with low noise.
- TB6612FNG motor driver chip with high efficiency, smarter dimensions, and no heat produced, comparing with L298P.
- Increase more peripherals for debugging, such as keys, buzzer, RBG LED, USB converter and the likes.
- AlphaBot2-Ar adapter board adds OLED, and AlphaBot2-PiZero adapter board adds usb Hub.
- PCA9685 steer control chip, able to avoid jittering when using Raspberry Pi software to PWM control the steer.
- Provide much more programs. For Raspberry Pi, it has Andiron App video control and on-board Bluetooth remote control. For PC, it provide Qt software control.

Question 2: What kind of battery can be applied on Alphabot2 smart robot?

Answer: It uses 14500 type battery which is in the diameter of 14mm and length of 50mm. For a single battery, its rate voltage is 3.7V, full voltage is 4.2V， and its lowest voltage should not be lower than 2.75V, or else the battery may be

permanently damaged. This battery has a same dimensions with AA battery. But you should not use the AA battery to replace it, since the AA battery cannot provide enough voltage.

Question 3: Why the smart robot cannot perform infrared obstacle avoidance?

Answer: Firstly, you should check the whether the infrared detection module on the smart robot works properly. When there is no obstacle ahead of the robot, the green LEDs on the robot are off. When the obstacle is detected, the green LEDs will light up. In case that the LEDs are always off or always on, you can try to adjusted the potentiometers on the bottom of the robot to make the LEDs work properly.

Question 4: What can I do, if the motion of the smart robot is wrong?

Answer: In case that the direction of motion is wrong, you may need to change the pin settings in your program.

Question 5: The rotational range of the steer is abnormal.

Answer: The rotational range of the steer can reach 180 degree. In normal condition, the steer can turn to left at 90 degree, and turn to right at 90 degree as well. If there is a big difference between the both sides, you should reassemble the steer and make adjustment.

Question 6: How to know if the battery has power?

Answer: If there is low battery, the smart robot will move slowly. Normally, when the Raspberry Pi shuts down or become unable to connect, you should charge the battery. When the battery voltage is low, you should stop using the battery, or else it may be permanently damaged and cannot be applied any more.

Question 7: Can other MCUs control the base board of the smart robot?

Answer: Of course, they can. We have provided the schematic diagram and the dimension diagram of the smart robot for users to perform secondary development.

Safety Precautions

Notice

Please reserve the following information for future use.

Caution

To prevent AlphaBot2, a precision device, from breaking down or being damaged, please follow the requirement listed below.

- The product employs two series 14500 batteries for power supply with input voltage of 7.4V. When working with Arduino and Raspberry Pi at a same time, the external power supply should be applied. Any external power supply has to obey to the regulations and standards of power supply for your area.
- The product should be applied under a well-ventilated environment, to guarantee the heat dissipation of power supply and product performance.
- The disassembly chassis should be placed on the stable, flat and non-conducting surface, without touching any conductive materials.
- Installing the incompatible device to the chassis may cause damage and void the warranty.
- The product should not expose to water and moisture, or not be placed on conductive surface, in the course of any operations.
- AlphaBot2 should not touch any heat source, to make sure reliability service under normal room temperature environment

- Protect the printed circuit board and the components on it from mechanical or electrical damages, in the course of any operations.
- Avoid touching the energized printed circuit board in the course of any operations. Touching the edge of the board is allowed, which can reduce the risk electrostatic discharge.