AlphaBot

User Manual

Feb. 2017

V1.2

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. The figure below shows most the compatible accessories:

Package Contents		Products				
Item	Description	AlphaBot	AlphaBot-Ar-Basic	AlphaBot-Ar-Bluetooth	AlphaBot-Pi Acc Pack	AlphaBot-Pi
RPi3 B	Raspberry Pi 3 Model B					√
UNO PLUS	enhanced control board, Arduino compliant		√	√		
AlphaBot chassis kit	mainboard, wheels, drivers, etc.	√	√	√	√	√
Tracker Sensor	line tracking module	√	√	√	√	√
Photo Interrupter Sensor	speed measuring module (2pcs)	√	√	√	√	√
Infrared Proximity Sensor	obstacle avoidance module (2pcs)	√	√	√	√	√
IR remote controller	remotely control the robot	√	√	√	√	√
SG90	servo		√	√	√	√
Ultrasonic sensor	ultrasonic obstacle avoidance, distance measuring		√	√		
Accessory Shield	accessories add-on board, Arduino compliant			√		
Dual-mode Bluetooth	dual-mode Bluetooth module			√		
RPi Camera (B)	Raspberry Pi camera, adjustable focus				√	√
Micro SD Card 16GB	16GB Miro SD Card, class 10				√	√
5V 2.5A Power Adapter	RPi3 B requires 2.5A or above power supply				√	√

Note:

AlphaBot requires a control board, Arduino OR Raspberry Pi, if you don't have one in hand, please consider the all-in-one kits: AlphaBot-Ar-Basic, AlphaBot-Ar-Bluetooth, AlphaBot-Pi

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

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 roboteful 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 AlphaBot, 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.

Data website：www.waveshare.com/wiki/AlphaBot

Contents

Product description

Introduction

Mobile robot development platform, compatible with Raspberry Pi/Arduino

Functions

AlphaBot is a robotic development platform compatible with Raspberry Pi and Arduino. It consists of the AlphaBot mainboard, the mobile chassis, and everything required to get it moving.

Just connecting a controller board, Raspberry Pi or Arduino, and combined with our open source example code, now it's all ready to start your robotic exploration: line tracking, obstacle avoidance, video monitoring, WiFi/Bluetooth/ZigBee/Infrared remote control, etc.

AlphaBot can perceive its environment and perform relative response. It involves the following technologies:

Tracking line, obstacle avoidance, mobile phone/PC video monitoring, WIFI/Bluetooth/ZigBee/infared remote control and the likes.

Notes: This document is not for any specific product kits. Some of them may not have the component(s) described in the sections below. For more information about the product kit, please refer to the product page in Waveshare website.

Features

● Raspberry Pi/Arduino interfaces, works with either one separately, or both

- Arduino extend header, supports Arduino shields

- Modular design, plug-and-play modules like line tracking, obstacle avoidance, speed measuring, etc. eliminating the trouble of connecting mess wires.

- L298P motor driver with diode protection circuit, more safety

- LM2596 voltage regular, provides stable 5V power to the Raspberry Pi/Arduino

- TLC1543 AD acquisition chip, allows the Pi to use analog sensors

Audience

A lot of MCU enthusiasts may have a dream to design their smart robot. However, it is not easy when they get down to do it. Someone feel difficult maybe because they do not fully understand the smart robott or they do not know how to start. With the application kit provided by Waveshare, you can quickly study the smart robot, including the structural framework, the basic principle and the external modules.

In this document, we will take the example of Waveshare AlphaBot smart robot to present the working principle and the production process of the smart robot. Relative example programs are also provided, including tracking line, obstacle avoidance, Bluetooth remote control and wifi control. This document describes the smart robot development with the example programs. It is easy to understand, covering the knowledge of the structural framework from the min. system to the main control design of the robot, and the function design from the straight line movement to the multifunction implementation. We sincerely hope that the MCU hobbyists can have a thorough understand of the smart robot. Due to the limited knowledge and ability of the author, there is still much room for improvement in

this paper.

If you have any question, please don't hesitate to visit Waveshare site http://www.waveshare.com and leave your message.

On-board resource
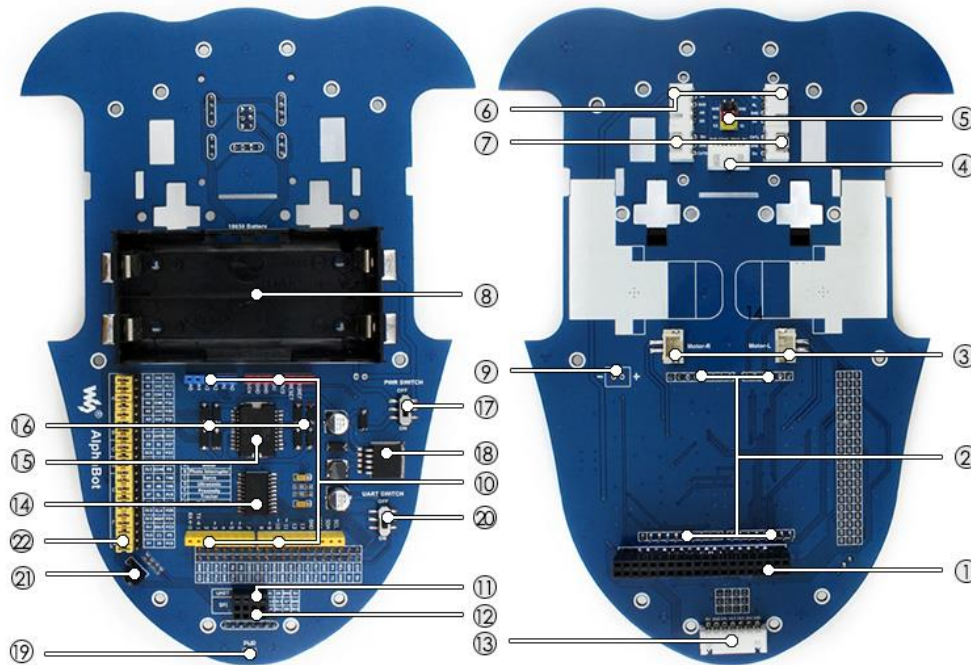
1. **Raspberry Pi interface**: for connecting Raspberry Pi
2. **Arduino interface**: for connecting Arduino
3. **Motor interface**
4. **Ultrasonic module interface**
5. **Servo module interface**
6. **Obstacle avoidance module interface**
7. **Speed measuring interface**
8. **Battery holder**: supports 18650 batteries
9. **Reserved power input (not soldered):** for connecting other external power supply
10. **Arduino expansion header**: for connecting Arduino shields
11. **UART interface**: for connecting Bluetooth module, to control the robot remotely via Bluetooth
12. **SPI interface**: for connecting NRF24L01 wirmoduleeless
13. **Line tracking module interface**
14. **TLC1543**: 10-bit AD acquisition chip, allows the Pi to use analog sensors
15. **L298P**: dual H bridge motor driver chip, up to 2A current
16. **Anti-reverse diode**
17. **Power switch**
18. **LM2596:** 5V regulator
19. **Power indicator**
20. **UART switch**: turn on to enable serial communication between Raspberry Pi and Arduino
21. **IR receiver**: control the robot remotely via infrared

22. **Raspberry Pi/Arduino selection**: select the Raspberry Pi or Arduino to control the robot peripherals

Module functions

Main control module

The main control module is the key part of the smart robot. AlphaBot provides

Arduino and Raspberry Pi interfaces. Configuration can be one of two options, or

both of them work together. By taking fully use of the hardware and software of

both boards, the smart robot can be applied to much more application scenarios.
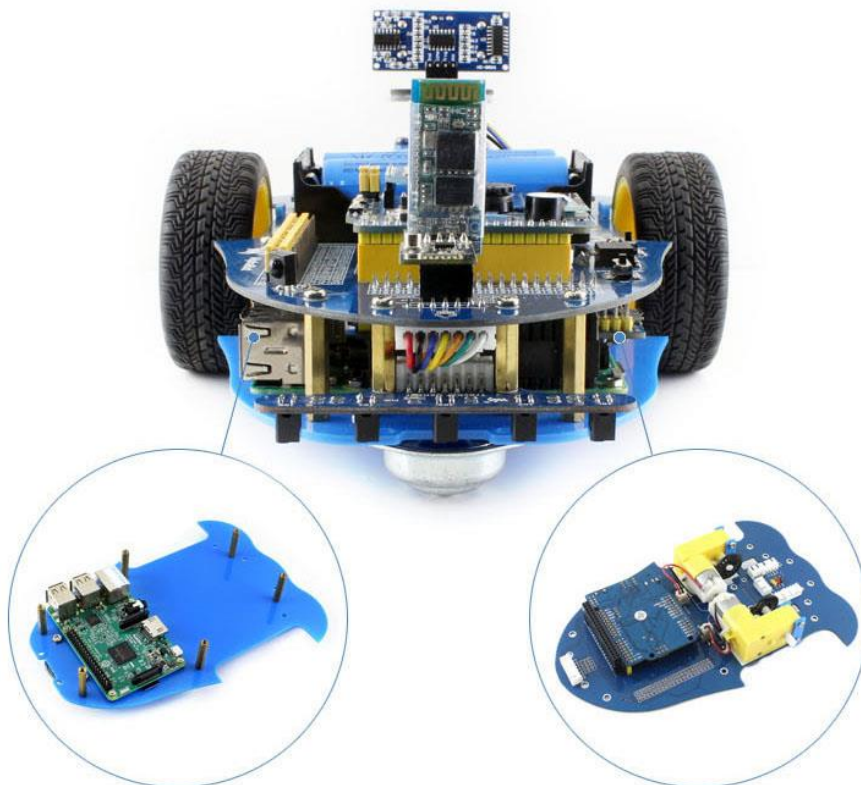
☺Working with Arduino or raspbeery Pi can be selected by jumpers.

Motor driver module

Moter driver module is one of the most important parts of the smart robot.

AlphaBot use the L298P driver chip from ST, which is a high voltage, big current

motor driver chip.
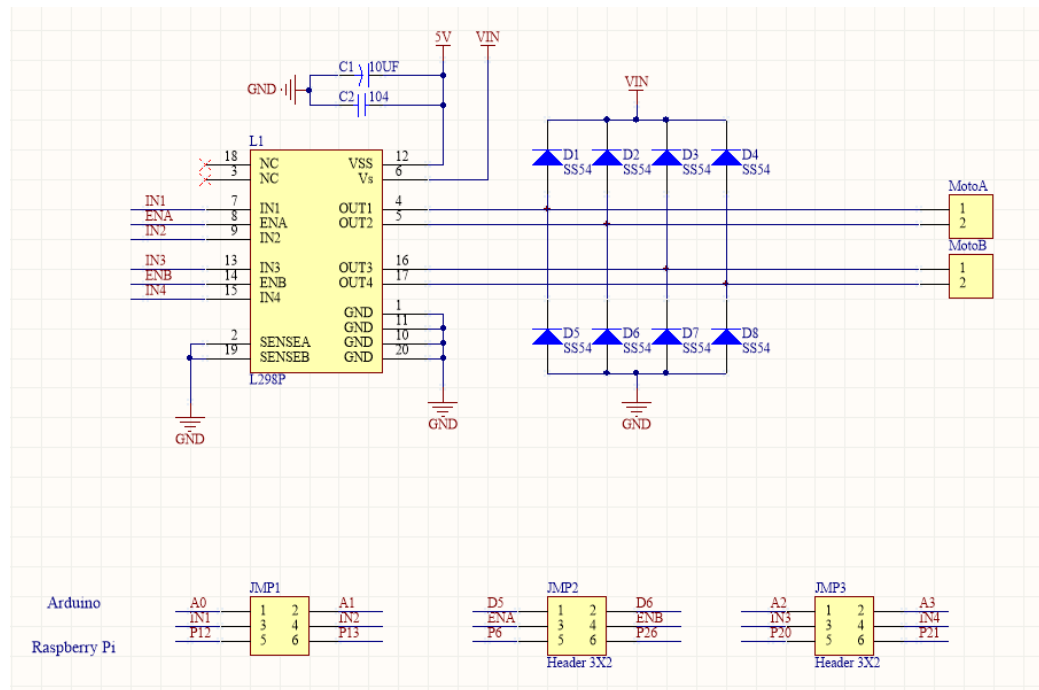
Interface definition of driver module:

Interfaces	Raspberry Pi	Arudino
IN1	P12	A0
IN2	P13	A1
ENA	P6	D5
IN3	P20	A2
IN4	P21	A3
ENB	P26	D6

IN1 and IN2 are connected to the left motor, while IN3 and IN4 are connected to the right motor.

ENA and ENB are output enable pins, active high enable. When they are driven to High level, the PWM pulse will be outputted from IN1, IN2, IN3 and IN4, so as to control the speed of the motor robot.

Control theory :

| IN1	IN2	IN3	IN4	Descriptions
1	0	0	1	When the motors rotate forwards, the robot goes straight
0	1	1	0	When the motors rotate backwards, the robot draws back
0	0	0	1	When the left motor stops and right motor rotates forwards, the robot turns left
1	0	0	0	When the right motor stops and left motor rotates forwards, the robot turns right
0	0	0	0	When the motors stop, the robot stops

Power supply

The smart robot employs two series 18650 batteries for power supply with input voltage of 7.4V. The input voltage will be deal with the LM2596 regulator, and send out to Arduino, Raspberry Pi and sensors.
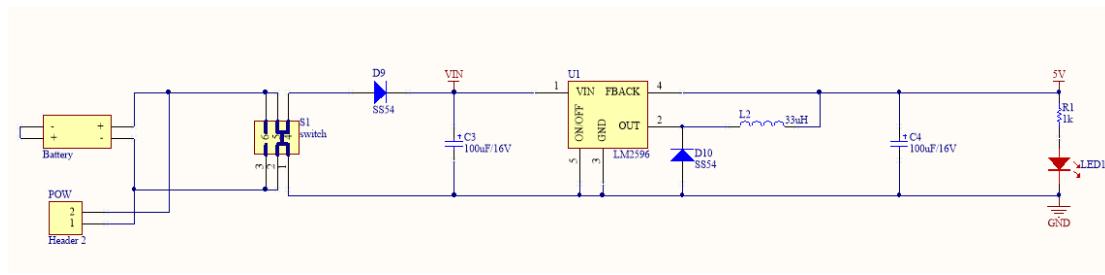
! For using external power supply, the input voltage should not beyond 12V.

AD sampling chip

Since the GPIO of raspberry Pi do not support AD function, AlphaBot smart robot has an on-board 10-bit of 11 channel AD conversion chip for tracking line application.。

Tracing module
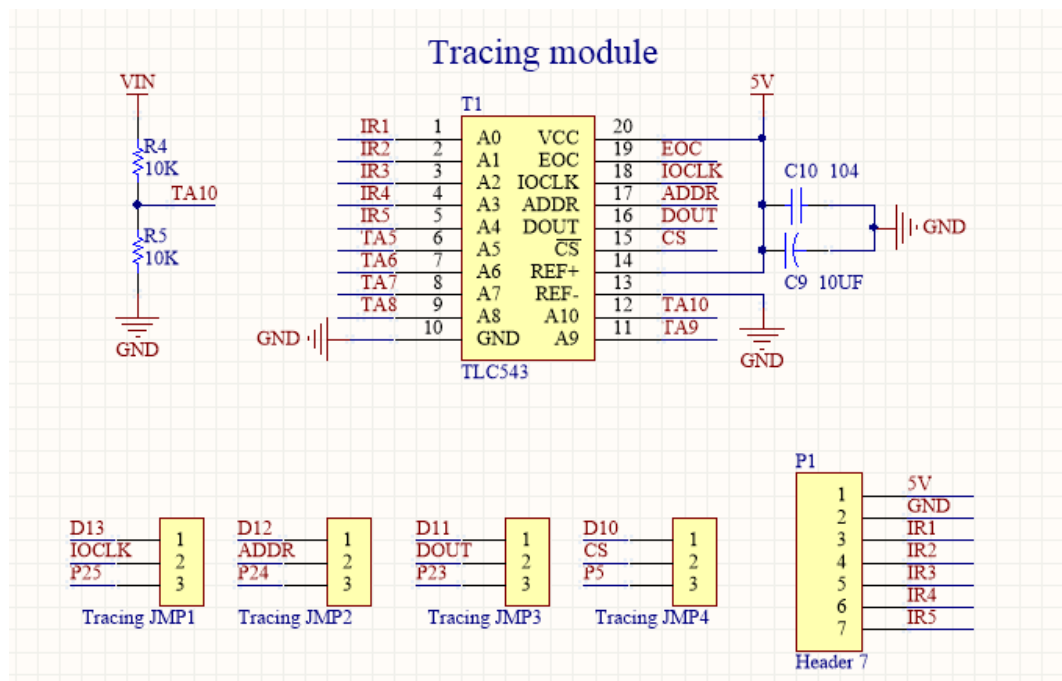
Obstacle avoidance module

Obstacle avoidance module consists of an infrared transceiver and a comparator. The infrared transmitter has an infrared LED array as a luminophor. When there is an obstacle (reflector) on the detection direction, the Infrared light will be reflected, and received by the infrared receiver, which is a semiconductor with a PN junction made of a special material as its core part. As the intensity of the infrared light enhances, more current can be generated and the analog signal increases. LM393 comparator receives and handles the analog signal, and then outputs the relative digital signal. At this point, the green LED will light up. The logical level of the DOUT can tell you whether there is obstacle in front of the sensor, and the output voltage of AOUT can tell you the distance from the obstacle if there is. The detection distance can be adjusted via the potentiometer knob.
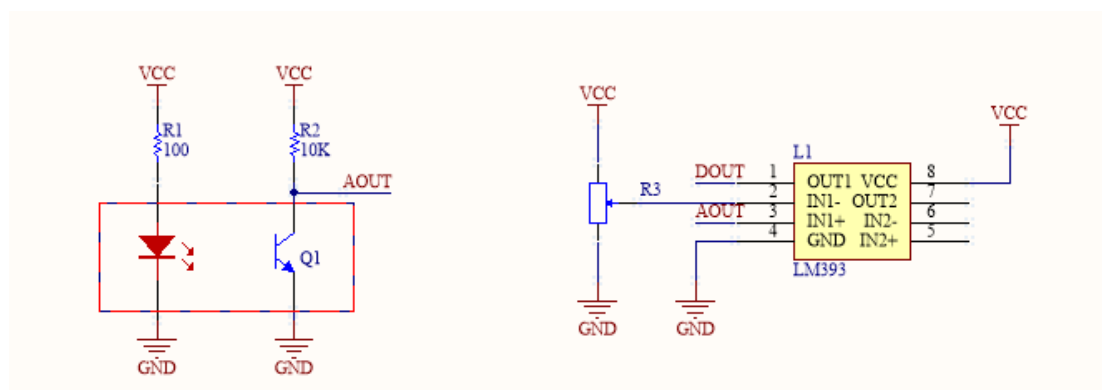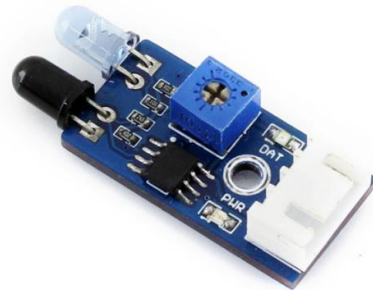
Speed testing module

The speed testing module contains a coded disc and a WYC-H206 photoelectric sensor. WYC-H206 photoelectric sensor has an infrared transmitter and an infrared receiver. When the infrared receiver is obscured, unable to receive infrared light, the sensor will output a high level voltage. The high level voltage passes the inverting schmitt trigger and becomes a low level voltage. At this point, the relative indicator lights up. When the coded disc runs, DOUT will output a series of high level pulses and low level pulses. By checking the number of the pluses in a cycle time, you can get the speed of the smart robot. Here, we use the schmitt trigger because it has a stable output signal, a clear waveform without any jitter.
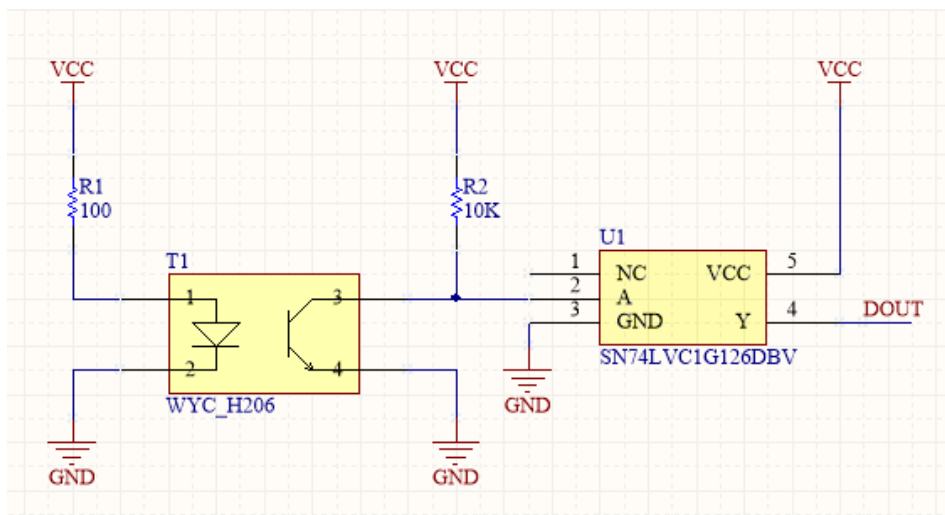
Infrared remote control

The smart robot applies LFN0038K receiver to receive infrared signal. The infrared remote controller provided with the application kit, complies with the standard NEC encoding protocol. When the infrared receiver receives the infrared signal, it will output the relative pulses to the main control chip. Then, the main control part decode the signal to the key code, so as to control the corresponding motor.

Infrared NEC protocol encoding is a kind of PWM serial code, in which the binary logical "0" is in the cycle of 1.125ms with the pulse width 0.565ms and the interval 0.56ms, and the binary logical "1" is in the cycle of 2.25ms with the pulse width 0.565ms and the interval 1.685ms.
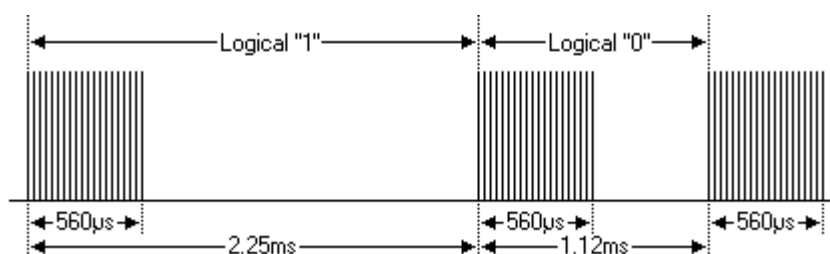
Infrared control protocol:

The 32-bit binary code made up of logical "0" and logical "1" should be secondary modulated with a 38kHz robotrier frequency, in order to enhance the transmitting efficiency and reduce the power consumption. The secondary modulated code will be transmitted in the form of infrared light by a infrared transmitter, as the figure shows below.
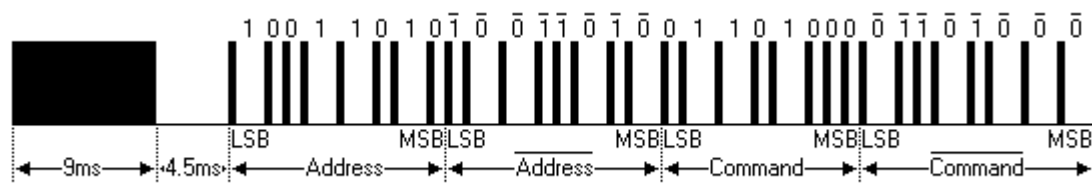

| Boot code | User ID | Radix-minus-one complement of user ID | Op code | Radix-minus-one complement of op code|

Firstly, a 9ms high level pulse is transmitted, and a 4.5ms low level pulse is followed. Later coming are a 8bit address code (LSB first) and its radix-minus-one complement (for checking). The last are a 8bit command code (LSB first) and its radix-minus-one complement.

Each command will only be transmitted once, even you keep pressing the key on the controller. But it will send out a duplication code every 110mS, until you release the key on the controller. The format of the duplication code is a 9mS of AGC pulse, a 2.25mS of interval and a 560uS of pulse.
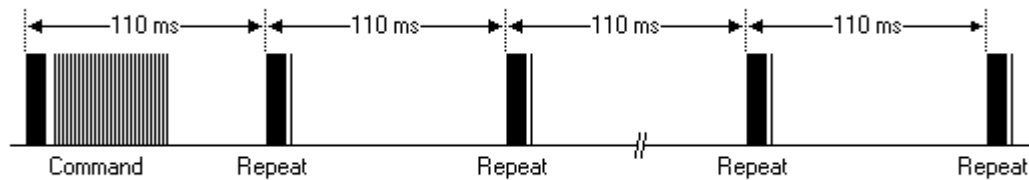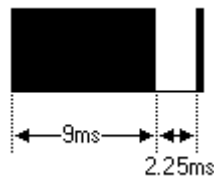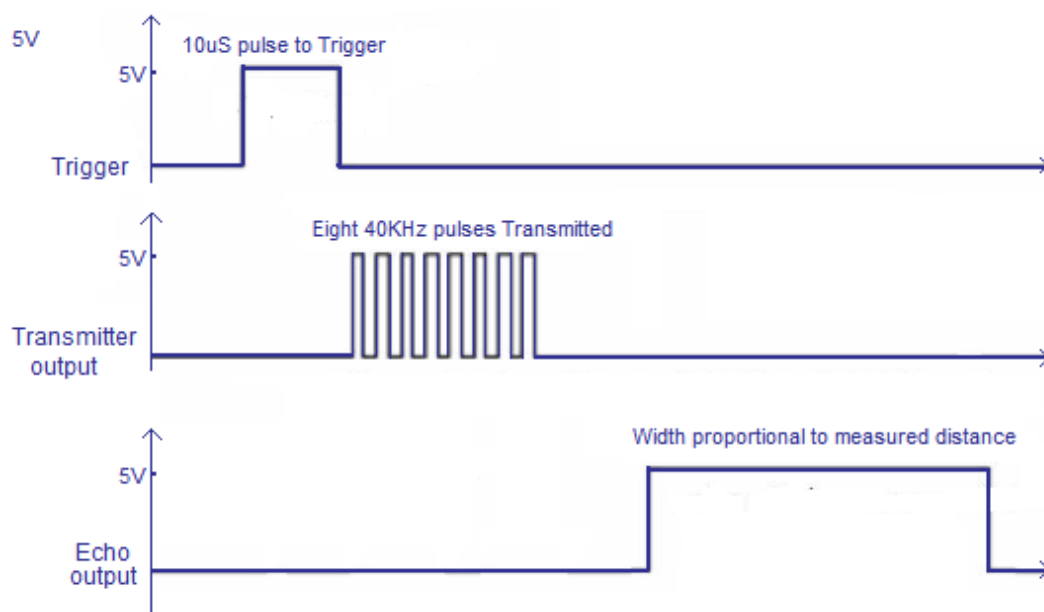
Ultrasonic distance measurement module

The ultrasonic distance measurement module has 4 pins, they are VCC, GND, TRIG

(transmitting pin) and ECHO

(receive pin).

Control theory :
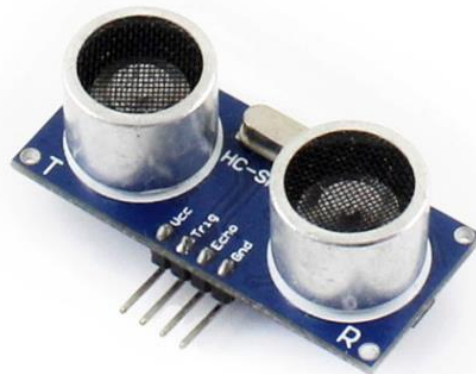
Here is the principle of ultrasonic

distance measurement. When the

ultrasonic wave meets a object, it will be reflected back and received by the receiver.

You can get the distance of the object from the sensor by measuring the interval

from transmitting signal to receiving the echo.

The timing diagram above shows the control principle of ultrasonic distance

measurement. When the module is working, it sends out a high level signal at least

for 10us to control the pin TRIG to trigger distance measurement. Then, the module

transmits 8 serial of 40kHz square wave automatically, to check whether there is

echo signal. If there is, the module outputs a high level voltage from the pin ECHO.

The time duration of the high level voltage is the time of ultrasonic from being

transmitted to reflected. According to the sound transmitting speed and time, we

can get that : measured distance= (measured time*sound speed) /2. The sound

speed is 340m/s in here.

Technical Parameters :

Parameters	Remark	Min	Typ	Max	Units
Operating voltage		3.0		5.5	V

5V operating current	Vcc=5V		2.8		mA
3.3V operating current	Vcc=3.3V		2.2		mA
5V minimum detection distance	Vcc=5V		2	3	cm
3.3V minimum detection distance	Vcc=3.3V		2	3	cm
5V maximum detection distance	Vcc=5V	400	450	600	cm
3.3V maximum detection distance	Vcc=3.3V	350	400	550	cm
Detection angle				15	°
Detection accuracy			1		%
Resolution			1		mm
Output mode			GPIO		
Working temperature		-20		80	℃

Servo

Servo is a auto-control system with a DC motor, a reduction gear set, a sensor and a control circuit. The servo can control the rotation angle of the output axis by transmitting control signal. It has 3 control lines, the red one is the positive power line (5V), the orange one is signal line (IO) and the brown one is power ground (GND).

☺The control signal will be sent to the signal modulating chip via the receiver, and generates the DC bias current. The servo has a reference circuit, which can generate the reference signal in the cycle of 20ms and the width of 1.5ms. The generated DC bias current is compared with the voltage of the potentiometer, and you get the voltage difference which will be outputted to the motor driver chip. The polarity of the voltage difference, positive or negative, can determine the rotation direction of the motor. When the motor is rotating in a stable speed, you can use the cascade reduction gear to drive the potentiometer to run, turning the voltage difference to 0, to stop the motor.

Generally, a 20ms of time based pulse is required in controlling the servo. And the high level should be last for at least 0.5ms-2.5ms. Taking the 180 degree angle servo

control as an example, the relationship between the pulse and the rotation angle is showed as the table below.

| Pulse width	Rotation angle
0.5ms	0 degree
1.0ms	45 degree
1.5ms	90 degree
2.0ms	135 degree
2.5ms	180 degree

Tracker module

The working principle of

the tracker module is

similar to the infrared

obstacle avoidance

module. The tracker

module has an

ITR20001/T infrared reflection sensor, of which the infrared transmitter can transmit

the infrared light all the time. When the infrared light is reflected back by the

obstacle, it will be received by the infrared receiver. And the sensor will output the

relative analog value. The outputted data are affected by the distance and the color of
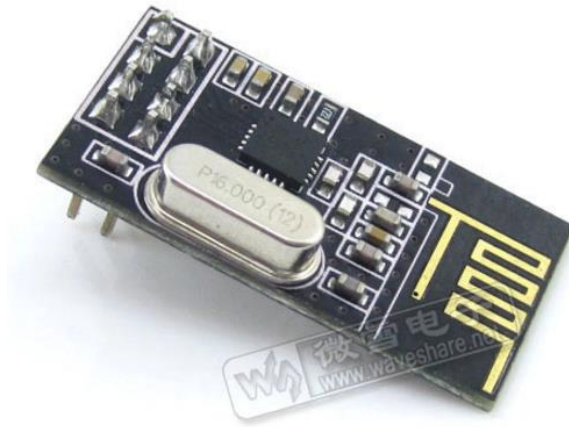
the detected object.

The tracker module has 5-channal of infrared sensors. By checking the outputs

from the 5-channel of infrared sensor, the module can judge the position of the

black line, so as to control the action of the smart robot.

☺For more detailed information about the control theory and the algorithm,

please refer to the Tracker Sensor User Manual.
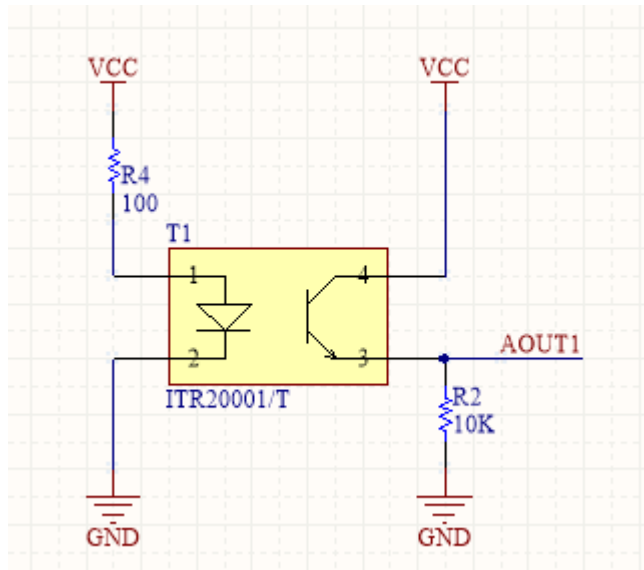
NRF24L01+wireless control

AlphaBot has a SPI interface which can connect with the NRF24L01 module, a new RF transceiver. The NRF24L01 has built-in frequency synthesizer, a power amplifier, a crystal oscillator and a modulator. With enhanced ShockBurst technology integrated, its address, output power and communication channel can be configured by program, suitable for multiple machine communication. The NRF24L01 has a ultra-low power consumption; when the transmitting power is within -6dBm, its working current is only 9mA, and the working current of its receiver is only 12.3mA. The NRF24L01 module also provides low power working modes, such as power down mode and idle mode.

When using SPI interface to configure the NRF24L01 module, you should set the module to Enhanced ShockBurstTM mode, enabling the module handle the RF protocol automatically. Finished the configuration, the module is ready to work. The switch between receive mode and transmission mode can be done by changing the lowest byte of the command when the module is running.

The settings of the main parameters: Data width, declares the number of bit occupied by the data in the RF data package, enabling the NRF24L01+ to make a distinction between the data and the CRC code in the data package; Address width,

declares the number of bit occupied by the address in the RF data package, enabling the NRF24L01+ to make a distinction between the data and the address; Receive channel, receive the address of data, the address from channel 0 to channel 5; CRC checking, NRF24L01+ can generate CRC code and perform decoding; Working frequency, configurable between 2.4GHz to 2.524GHz with the interval of 1MHz; Transmission power, affects the communication distance and the power consumption of the whole device; Communication rate, selectable of 1Mbps or 2Mbps.

Bluetooth control

AlphaBot has a UART interface, which can connect with a Bluetooth module 2.0 directly, or connect with dual Bluetooth module via the Accessory Shield module. Since the Bluetooth module is controlled via serial port, user do not need to know much about the Bluetooth protocol. When connected with the Bluetooth module , you can control your smart robot via your mobile phone.
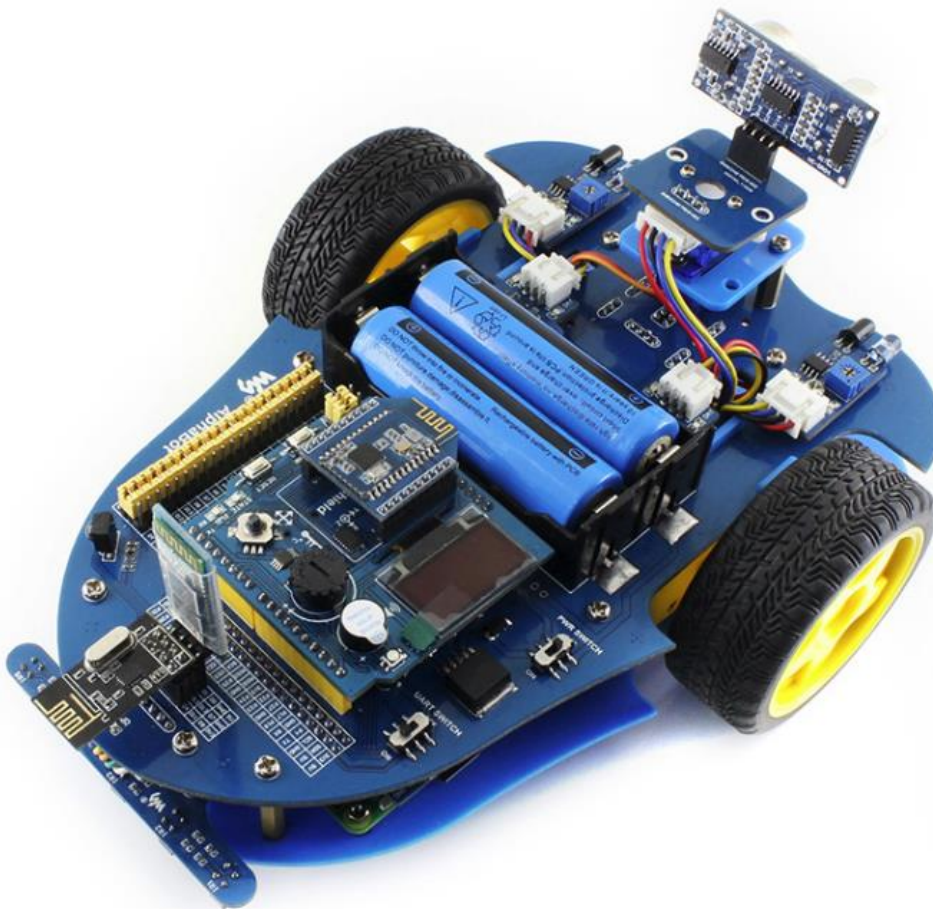

! In the figure above, we can see the robot use the dual Bluetooth module via Accessory Shield board, supporting Bluetooth 2.0 and Bluetooth 4.0. This is the Bluetooth configuration of our application. However, the Bluetooth 2.0 for UART
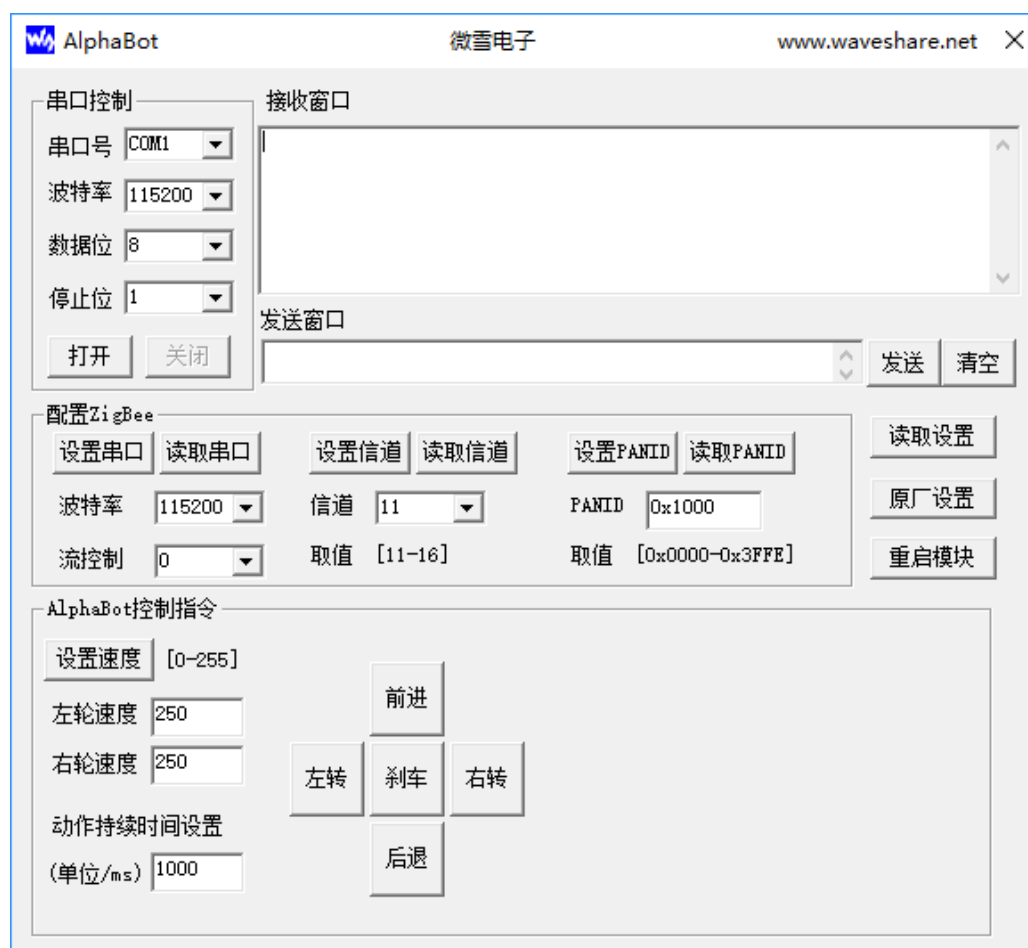
interface is not provide in our application kit.

ZigBee control

AlphaBot can connect with the Core2530 (B) module via Accessory Shield, to perform ZigBee control. In this configuration, the PC should be connected to the CC2530 Eval Kit (B) via a USB cable.
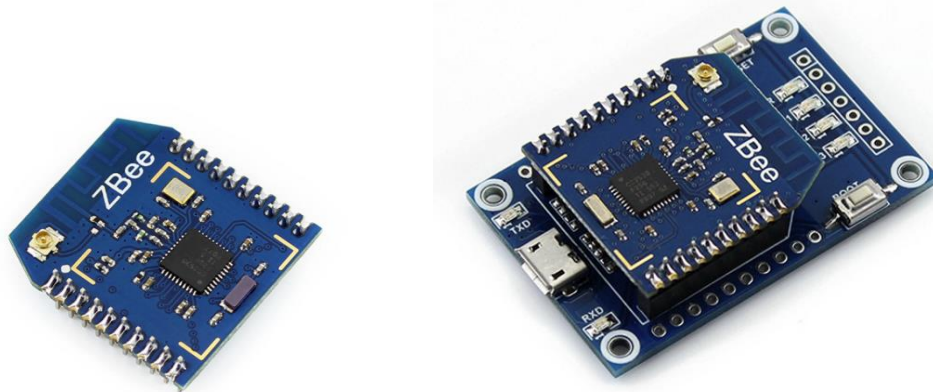
Here is the PC software for controlling the smart robot.

Wifi video monitoring

In AlphaBot application, when raspberry Pi works as the main control part, you can use your mobile phone or PC to perform wifi video monitoring via website control. The webiopi can help you to perform the remote control, and the mjpg-streamer software can realtime display the image captured by the camera.

Webiopi, a web framework orient to Internet of Things (IoT), can control the GPIOs of raspberry Pi. This project is hosted in Google, its source code can be downloaded form the website sourceforg. Webiopi supports REST Server and CoAP server, and provides relative python library and javascript library.

MJPG-streamer can collect images from webcam camera, and transmit them to the mobile device with browser in the form of stream via the ip based network. With the software mjpg-streamer, you can see the image captured by the camera displayed on your browser via the network.
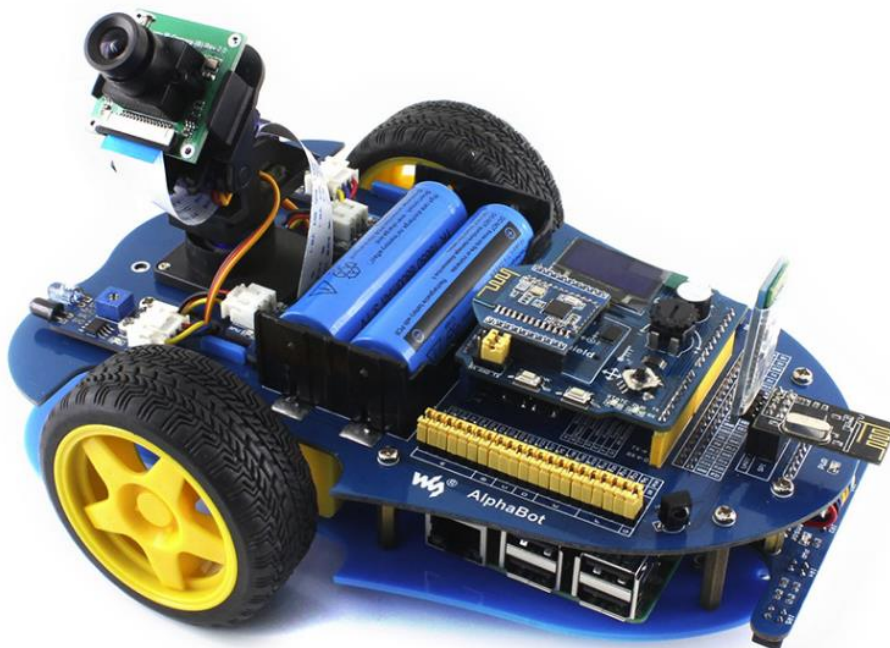
Example programs

We provide the control programs of Arduino and Raspberry Pi, enabling to implement tracking line, obstacle avoidance, remote control and video monitoring. The following example programs are available from Waveshare WIKI., Copy the library file under the directory of Arduino to the libraries folder under the installation directory of Arduino IDE. Then, reboot Ariduino IDE, and click File-> Example to check whether there are the options of AlphaBot, TRSensor and Servo. If there are, the library has been exported successfully. Extract the Raspberry Pi program from the package, and place it under the directory of /home/pi in the Raspbian.

Arduino example program

Smart robot testing program

Click File-> Example -> AlphaBot -> E01_Run_Test to open the project. Compile and download the program to the Arduino development board. Connect the Jumpers IN1, IN2, ENA, ENB, IN3 and IN4 in the A area to the A0, A1, D5, D6, A2 and A3, respectively. Turn on the power adapter, you can see that the smart robot run straight forward. If the wheels of the smart robot are not forward running, you can try to change the wiring of the motor, or modify the pin setting in the AlphaBot.c file.

Infrared obstacle avoidance program

Click File -> Example -> AlphaBot -> E02_Infrared_Obstacle_Avoidance to open the project. Compile and download the program to the Arduino development board. Install the Infrared Proximity Sensors to the left side and the right side of the smart robot. Connect the jumper of motor in A area to the Arduino, and the jumpers DL and DR of E area to D7 and D8, respectively. Turn on the power adapter, you can see that the smart robot can perform infrared obstacle avoidance. When the sensor detected the obstacle ahead of the robot, the green LED will light up. The detection distance can be adjusted by potentiometer. When the left sensor detects the obstacle, the smart robot will turn to right. When the right sensor detects the obstacle, the smart robot will turn to left.

Infrared tracking program

Click File -> Example -> AlphaBot -> E03_Infrared_Tracking_Objects to open the project. Compile and download the program to the Arduino development board. Install the Tracker Sensor to the smart robot. Connect the jumper of motor in A area to the Arduino, and the jumpers DL and DR of E area to D7 and D8, respectively. Turn on the power adapter, you can see that the smart robot can perform object tracking. If there is an object in front of the smart robot, the robot will run forward. If there is nothing in front of the robot, the smart robot will stand. The detection distance can be adjusted by potentiometer.

Infrared remote control program

Click File -> Example -> AlphaBot -> E04 Infrared_Remote_Control to open the project. Compile and download the program to the Arduino development board. Connect the jumper of motor in A area to the Arduino, and the jumper of the Infrared receiver IR in G area to the jumper D4 on Arduino.

Expectation result: When pressed the key on the Infrared remote controller, you can control the smart robot. The key 2 is for go forwards, 8 for go backwards, 4 for turn left, 6 for turn right, 5 for stop, - for speed down and + for speed up. (Notes: The key encoding may change with different Infrared remote controller. You can modify the program as required.)

Ultrasonic distance measurement program

Click File-> Example->AlphaBot-> E05_Ultrasonic_Ranging to open the project. Compile and download the program to the Arduino development board. Install the servo and Ultrasonic module to the smart robot. Connect the jumpers TRIG, ECHO of Ultrasonic unit in D area to the pins D11 and D12 on the Arduino. (The tracking line function will use these pins as well, so please remove the corresponding jumpers, avoiding interruption). Turn on the power adapter, the screen will show the distance measured by the Ultrasonic unit currently.

Ultrasonic obstacle avoidance program (without servo)

Click File-> Example -> AlphaBot -> E06_Ultrasonic_Obstacle_Avoidance1 to open the project. Compile and download the program to the Arduino development

board. Install the steering gear and Ultrasonic module to the smart robot. Connect

the jumpers TRIG, ECHO of Ultrasonic unit in D area to the pins D11 and D12 on the

Arduino.

Turn on the power adapter, the smart cat can perform ultrasonic obstacle

avoidance. When there is obstacle in front of the robot, it will move to the side that

far away from the obstacle.

Ultrasonic obstacle avoidance program (with servo)

Click File-> Example -> AlphaBot -> E07_Ultrasonic_Obstacle_Avoidance2 to open

the project. Compile and download the program to the Arduino development

board. Install the servo and Ultrasonic module to the smart robot. Connect the

jumpers TRIG, ECHO of Ultrasonic unit in D area to the pins D11 and D12 on the

Arduino. Connect the jumpers S1 and S2C of servo in C area to the pins D9 and D10

on the Arduino. (The tracking line function will use these pins as well, so please

remove the corresponding jumpers, avoiding interruption).

Turn on the power adapter, the smart cat can perform ultrasonic obstacle

avoidance. When there is obstacle in front of the robot, the Ultrasonic module will

measure the distance from the right side and the left side of the robot to the

obstacle, respectively. Then, it will move to the side that far away from the obstacle.

Infrared tracking line program

Click File -> Example -> AlphaBot -> E08_Infrared_Line_Tracking to open the

project. Compile and download the program to the Arduino development board. Install the Tracker Sensor to the smart robot. Connect the jumper of motor in A area to the Arduino, and the jumpers CLK, ADDR, DOUT and CS of F area to D13, D12, D11 and D10, respectively. (The servo in C area and the ultrasonic unit in D area will use these pins as well, so please remove the corresponding jumpers, avoiding interruption).

The tracking line program enable the smart robot run along the black line with 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. 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 smart robot. When the wheels of the robot begin to move, you can release the robot and it will run along with the black line.

For more detailed information about the control theory and the algorithm, please refer to the Tracker Sensor User Manual.

Bluetooth remote control program

Click File-> Example -> AlphaBot -> E09_Bluetooth_Control to open the project. Compile and download the program to the Arduino development board. Install the

Accessory Shield module to the smart robot via the Arduino interface, and the

Bluetooth module to the Accessory Shield module via the XBeeinterface. Turn on

the power adapter, and download and install the Bluetooth control software to your

mobile phone. Run the software and connect with the Bluetooth, then you can

control the motion of smart robot with the direction keys. OLED can display the

command string that you sent.

ZigBee remote control program

Click File -> Example -> AlphaBot -> E10_Zigbee_Control to open the project.

Compile and download the program to the Arduino development board. Install the

Accessory Shield module to the smart robot via the Arduino interface, and the

ZigBee module Core2530 (B) to the Accessory Shield module via the XBeeinterface.

Connect the CC2530 Eval Kit5 development kit to your PC with a USB cable.

Turn on the power adapter, and open the AlphaBot.exe on your PC, select the

corresponding serial port number. Then you can control the motion of smart robot

with the direction keys. OLED can display the command string that you sent.

Here is the PC software for controlling the smart robot.
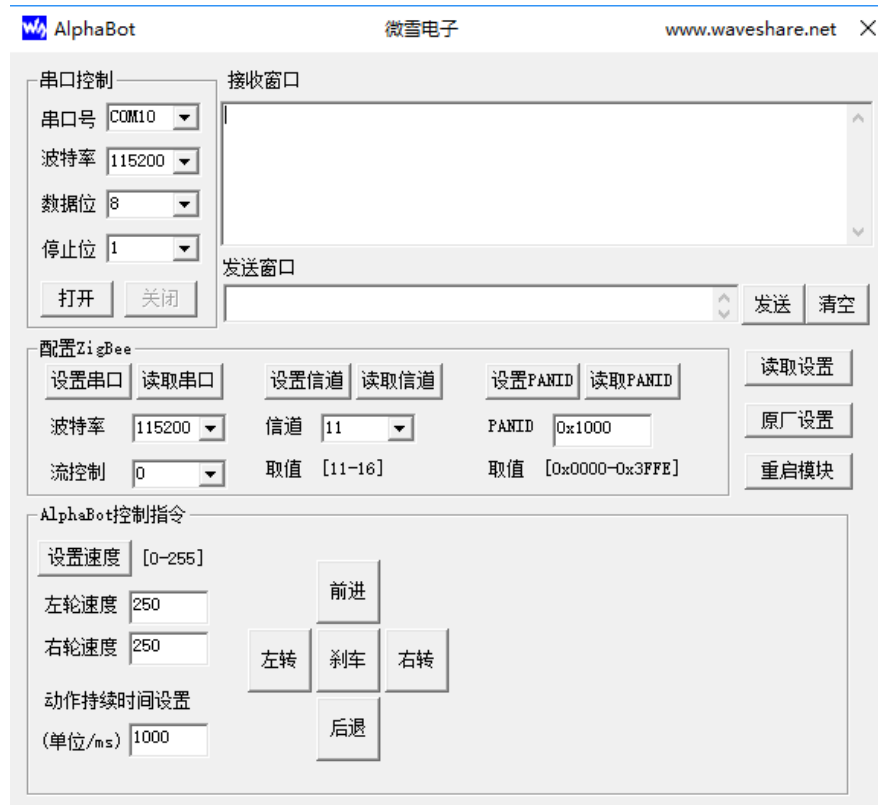
Raspberry Pi example program

Extract the AlphaBot.tar.gz, and place it under the directory of /home/pi in the raspbian.

Before using this extension board, we should install a python library to the Raspberry Pi. For more information about the Raspberry Pi library installation and configuration, please refer to the document *Install necessary libraries to 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.

Infrared obstacle program

Install the Infrared Proximity Sensors to the left side and the right side of the smart robot. Connect the jumpers IN1, IN2, ENA, ENB, IN3 and IN4 of motor in A area to the pins P12, P13, P6, P26, P20 and P21 of the Raspberry Pi, respectively. And connect the jumpers DL and DR of the infrared unit in E area to the pins P19 and P16.

Enter the Linux terminal, and input the following lines:

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

Expectation result: When the left sensor detects the obstacle, the smart robot will turn to right. When the right sensor detects the obstacle, the smart robot will turn to left.

Infrared tracking program

Install the Infrared Proximity Sensors to the left side and the right side of the smart robot. Connect the jumpers IN1, IN2, ENA, ENB, IN3 and IN4 of motor in A area to the pins P12, P13, P6, P26, P20 and P21 of the Raspberry Pi, respectively. And connect the jumpers DL and DR of the infrared unit in E area to the pins P19 and P16.Enter the Linux terminal, and input the following lines:

```
cd ~/AlphaBot/python
sudo python Infrared_Tracking_Objects.py
```

Expectation result: If there is an object in front of the smart robot, the robot will run forward. If there is nothing in front of the robot, the smart robot will stand. The detection distance can be adjusted by potentiometer.

Infrared remote control program

Connect the jumper of motor in A area to the Raspberry Pi, and the jumper of the

Infrared receiver IR in G area to the pin P18.

Enter the Linux terminal, and input the following lines:

```
cd ~/AlphaBot/python
sudo python Infrared_Remote_Control.py
```

Expectation result: When pressed the key on the Infrared remote controller, you can

control the smart robot. The key 2 is for go forwards, 8 for go backwards, 4 for turn

left, 6 for turn right, 5 for stop, - for speed down and + for speed up. (Notes: The

key encoding may change with different Infrared remote controller. You can modify

the program as required.)

Infrared tracking line program

Connect the jumpers of the motor in A area to the Raspberry Pi, and the pins CLK ,

ADDR, DOUT and CS of tracking line function in F area to the pins P25 ,P24, P23 and

P5.

Enter the Linux terminal, and input the following lines:

```
cd ~/AlphaBot/python
sudo python Infrared_Line_Tracking.py
```

Connect the jumpers TRIG, ECHO of Ultrasonic unit in D area to the pins D11 and

Expectation result: Turn on the power adapter, the smart cat can perform ultrasonic

obstacle avoidance. When there is obstacle in front of the robot, the Ultrasonic

module will measure the distance from the right side and the left side of the robot

to the obstacle, respectively. Then, it will move to the side that far away from the

obstacle.

Ultrasonic Ranging program

Install the steering gear and Ultrasonic module to the smart robot. Connect the jumpers TRIG, ECHO of Ultrasonic unit in D area to the pins P17 and P5 on the Raspberry Pi.

Enter the Linux terminal, and input the following lines:

```
cd ~/AlphaBot/python
sudo python Ultrasonic_Ranging.py
```

Expectation result: The screen will show the distance measured by the Ultrasonic unit currently.

Ultrasonic obstacle program

Install the servo and Ultrasonic module to the smart robot. Connect the jumpers TRIG, ECHO of Ultrasonic unit in D area to the pins P17 and P5 on the Raspberry Pi. Connect the jumpers S1 and S2C of servo in C area to the pins D9 and D10 on the Arduino. (The tracking line function will use these pins as well, so please remove the corresponding jumpers, avoiding interruption).

Enter the Linux terminal, and input the following lines:

```
cd ~/AlphaBot/python
sudo python Ultrasonic_Obstacle_Avoidance.py
```

Expectation result: The smart cat can perform ultrasonic obstacle avoidance. When there is obstacle in front of the robot, the Ultrasonic module will measure the distance from the right side and the left side of the robot to the obstacle,

respectively. Then, it will move to the side that far away from the obstacle.

WiFi control video program

This test demonstrates how to remote control the robot via webiopi, and real-time

display the image captured by the camera with the software mjpg-streamer. For

some browser may be unable to display the image correctly, we recommend you to

use the Chrome browser or the Firefox browser.

Step 1. Install webiopi

```
cd ~/AlphaBotmjpg-AlphaBot/WebIOPi-0.7.1-raspi2
sudo ./setup.sh
```

Check the installation: run the command webiopi –h. When the library is installed

successfully, you can see the following information as the figure shown below.

Enter the terminal, and input the line below:

```
sudo webiopi -d -c /etc/webiopi/config
```

Then, open the browser on your PC or cell phone, and enter the IP address of RPi

and the port number: 8000 into the address bar. For example, input

http://192.168.1.16:8000 (the address can be changeable according to your actual

condition). To login the website, you should enter your account and password. The

default account name is webiopi, and the original password is raspberry. When

finished the steps above, if you can enter the webpage WebIOPi Main Menu, it

means the environment is configured well.

WebIOPi Main Menu

GPIO Header

Control and Debug the Raspberry Pi GPIO with a display which looks like the physical header.

GPIO List

Control and Debug the Raspberry Pi GPIO ordered in a single column.

Serial Monitor

Use the browser to play with Serial interfaces configured in WebIOPi.

Devices Monitor

Control and Debug devices and circuits wired to your Pi and configured in WebIOPi.

Under the terminal, press the keys **Ctrl + C** to end the program.

Step 2. Install and use mjpg-streamer

This section describes the new function: camera, since the RPi can be connected

with a camera. If you application do not need this function, please jump to the next

section.

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

```
sudo raspi-config
```

Then, select the option **Enable Camera**.

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

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. (Please take a notice that the

letter l in the command bcm2835-v4l2 is the lower case of L.)

d) Install dependent libraries:

```
sudo apt-get install libv4l-dev libjpeg8-dev
sudo apt-get install subversion
```

e) Compile the example:

```
cd ~/AlphaBot/mjpg-AlphaBot/mjpg-streamer
make USE_LIBV4L2=true clear all
```

During the make command running, you may see a warning: make: *** No rule to

make target 'clear'. Stop. This warning can be ignored.

f) If there is any error occurred, you can try to modify the content of the

file mjpg-streamer/plugins/input_uvc/input_uvc.c,

changing V4L2_PIX_FMT_MJPEG to V4L2_PIX_FMT_YUYV

g) Start up mjpg-streamer:

```
sudo ./start.sh
```

Then, open the browser, and enter the IP address of RPi and the port number: 8080

into the address bar. (Notices: the port number here is 8080, other than 8000 what

we used before.) 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.
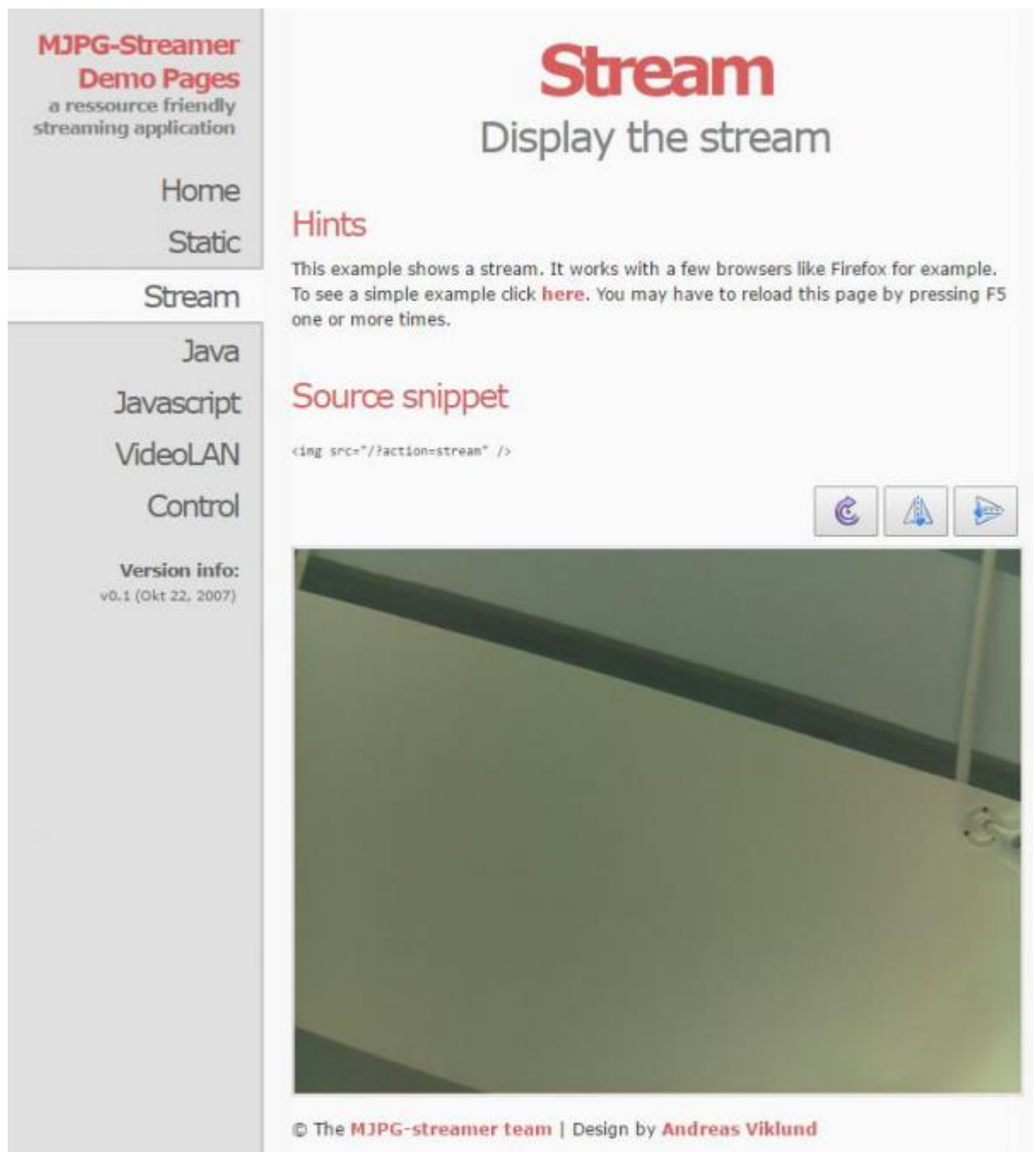
Under the terminal, pressing the keys Ctrl + C can end the program. However, it

should be kept running, since we still need it in the following operations.

Step 3. Run the robot program

Open another terminal; don't end the program in the step 2.

Enter the directory of magpi-cambot, which contains the source code for

controlling the robot.

```
cd ~/AlphaBot/mjpg-AlphaBot/mjpg-AlphaBot
```

Modify the file index.html:

```
sudo nano index.html
```

You should modify the html tag according to the IP of Raspberry Pi in used.

<img width="320" height="240" src="http://192.168.1.16:8080/?action=stream">

In here, "src" is followed by the IP address of RPi: 192.168.1.16 and the port

number: 8080 (This port is used for transmitting stream).

Start up the cambot program:

```
cd ~/AlphaBot/mjpg-AlphaBot/mjpg-AlphaBot
sudo webiopi -c config
```

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.)

The image captured by the camera will be shown in the website. Clicking the

direction icon on the website can control the action of the robot.
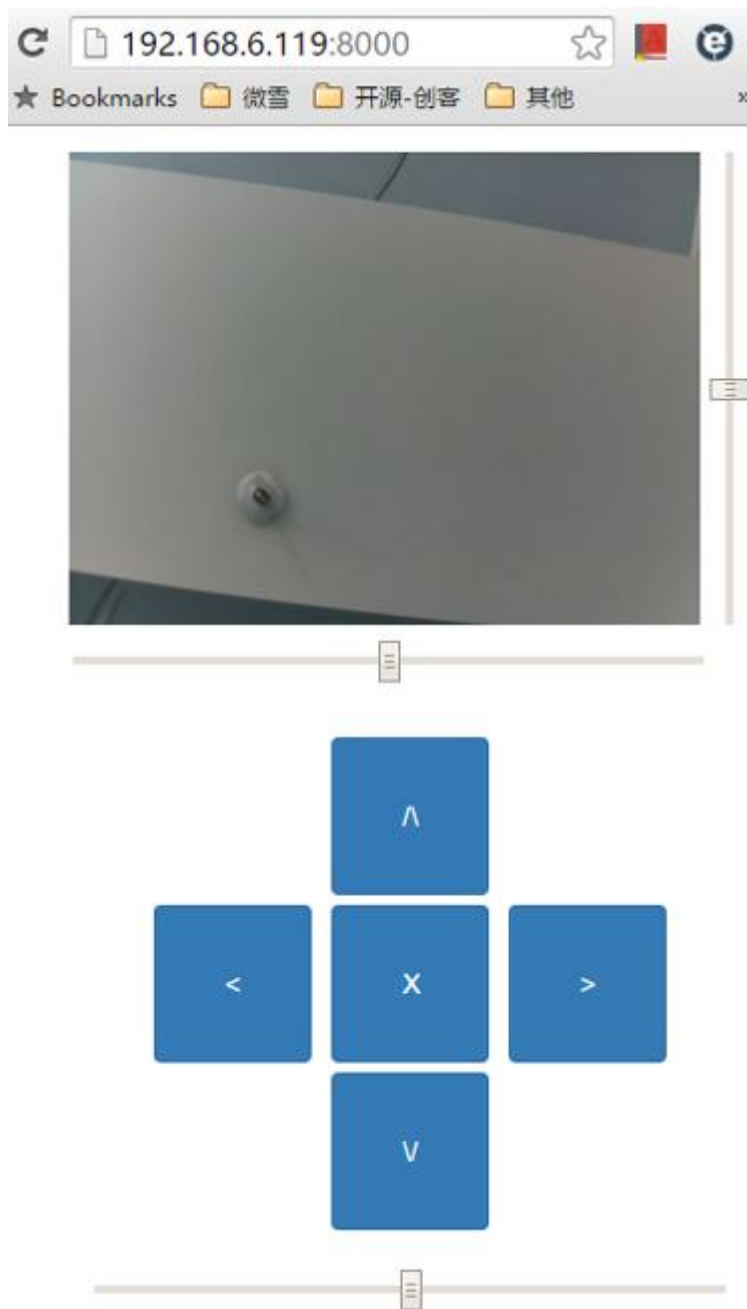
If you cannot enter this webpage, we recommend you to use the Chrome browser

or the Firefox browser. Furthermore, please make sure the current directory of

Raspberry Pi is ~/AlphaBot/mjpg-AlphaBot/mjpg-AlphaBot and there should be a

file index.html under this directory. And then, input the code

```
sudo webiopi -c config
```

to enter the index.html. Or else, you will go to the WebIOPi Main Menu webpage.

Automatically start settings

Replace the configuration file

```
cd ~/AlphaBot/mjpg-AlphaBot/mjpg-AlphaBot
sudo cp config /etc/webiopi/config
```

This starts the webiopi script when system boot up.

```
sudo update-rc.d webiopi defaults
```

Edit the /etc/local file:

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

Append the following lines after the comment lines and you must make sure the

"exit 0" line is the last statement. Then save and exit.

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

Connect the Motor jumpers IN1, IN2, ENA, ENB, IN3, IN4 in A area to the P12, P13,

P6, P26, P20, P21 pin on Raspberry Pi. Connect the jumpers S1 and S2 of the servo

in C area to the pins P27 and P22. Reboot your Pi and enter the ip in the browser

with port number 8000, then you can control the Robot.

Arduino and raspberry Pi combined control

The examples presented above are using the Raspberry Pi to control the servo and

the smart robot. In this case, the robot speed adjustment is controlled by the analog PWM, which may occupy CPU resource. And the output of the PWM is not stable. To have a better result, we recommends using Arduino and Raspberry Pi together to control the smart robot. In this way, Arduino controls the motor and servo, and Raspberry Pi handles the video transmission and the website control. Arduino and Raspberry Pi apply serial communication.

1. Disable the shell serial debugging function of the Raspberry Pi, to allow the serial port to work independently.

Replace the file config.

```
cd ~/AlphaBot/mjpg-AlphaBot/ARPI-AlphaBot
sudo cp config /etc/webiopi/config
```

Select AdvancedOptions-> Serial -><No> to disable the serial port debugging function.

Open the file /boot/config.txt, and find out the following configuration line to enable the serial port. If you can not find it, please add the line at the end of the file.

```
enable_uart=1
```

2. Download program to Arduino

Open Arduino IDE , click File-> Example -> AlphaBot -> E11_mjpg-AlphaBot to open the project.Compile and download the program to the Arduino development board.

Install the Arduino and the Raspberry Pi to the smart robot. Connect the jumpers IN1, IN2, ENA, ENB, IN3 and IN4 of the motor in A area to the pins A0, A1, D5, D6, A2 and A3 of Arduino, respectively. Connect the jumpers S1 and S2 of the servo in C area to the pins D9 and D10. Switch the UART SWITCH to ON, then reboot the Raspberry Pi. Input the ip address of the Raspberry Pi and the port number 8000 in

the browser bar to control the smart robot.

❗ In assembling, Arduino and Raspberry Pi should not touch each other.

Safety Precautions

Product name: Smart robot extension development kit, contains AlphaBot base board, and smart robot base board. Support Arduino and Raspberry Pi development boards.

Notice
Please reserve the following information for future use.

Caution

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

● The product employs two series 18650 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.

● The chassis can be connected to either Raspberry Pi or Arduino, or connected to both of them. Arduino and Raspberry Pi should not touch each other, in case of working together.

- 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.

- AlphaBot 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.

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