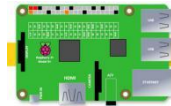
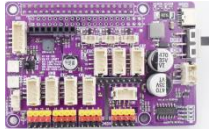



Lesson 19 Record with a Microphone

19.1 Overview

In this lesson, we will guide beginners to deeply learn how to connect an external microphone device to a Raspberry Pi and achieve audio recording and playback. Through the explanation of practical operation steps, everyone will truly master the entire process of using the Raspberry Pi to control the microphone for recording and playing back the recorded audio for verification, so as to become familiar with the way the Raspberry Pi controls audio devices.

19.2 Required Components

Components	Quantity	Picture
Raspberry Pi	1	
Adeept Robot HAT V3.1	1	
Microphone Module	1	

19.3 Principle Introduction

The Raspberry Pi itself has no built - in microphone interface and requires an external USB microphone or an expansion board with audio input functionality. The microphone converts sound signals into electrical signals, and these analog electrical signals are transmitted to the Raspberry Pi through the interface. The audio processing module of the Raspberry Pi samples the analog signals, converting the continuous analog signals into discrete digital samples at a

certain frequency. Then, these digital samples are quantized, mapping the sample values to a finite number of discrete values, and finally encoded into audio file formats that can be stored and processed by a computer, such as WAV.

19.4 Demonstration

1. Insert the USB recording device into any USB port of the Raspberry Pi. Then power on the Raspberry Pi and log in to the Raspberry Pi terminal remotely.
2. Enter the following command to check the list of USB devices and confirm that the sound card is listed:

```
lsusb
```

```
pi@raspberrypi:~/adeept_picar-b2/examples $ lsusb
Bus 004 Device 001: ID 1d6b:0003 Linux Foundation 3.0 root hub
Bus 003 Device 002: ID 08bb:2902 Texas Instruments PCM2902 Audio Codec
Bus 003 Device 001: ID 1d6b:0002 Linux Foundation 2.0 root hub
Bus 002 Device 001: ID 1d6b:0003 Linux Foundation 3.0 root hub
Bus 001 Device 001: ID 1d6b:0002 Linux Foundation 2.0 root hub
```

3. Enter the following command to view the recording devices (confirm the name and number of the USB sound card, such as card 2, device 0):

```
arecord -l
```

```
pi@raspberrypi:~/adeept_picar-b2/examples $ arecord -l
**** List of CAPTURE Hardware Devices ****
card 2: Device [USB PnP Sound Device], device 0: USB Audio [USB Audio]
  Subdevices: 1/1
  Subdevice #0: subdevice #0
```

4. Enter the following command to view the playback devices (such as card 3, device 0, optional, used to verify the recording playback):

Note: Audio playback devices need to be prepared by yourself.

```
aplay -l
```

```
pi@raspberrypi:~ $ aplay -l
**** List of PLAYBACK Hardware Devices ****
card 0: vc4hdmi0 [vc4-hdmi-0], device 0: MAI PCM i2s-hifi-0 [MAI PCM i2s-hifi-0]
  Subdevices: 1/1
  Subdevice #0: subdevice #0
card 1: vc4hdmi1 [vc4-hdmi-1], device 0: MAI PCM i2s-hifi-0 [MAI PCM i2s-hifi-0]
  Subdevices: 1/1
  Subdevice #0: subdevice #0
card 3: Device [USB2.0 Device], device 0: USB Audio [USB Audio]
  Subdevices: 0/1
  Subdevice #0: subdevice #0
```

5. Enter the following commands to install the relevant audio libraries.

```
sudo apt-get update
```

```
sudo apt-get upgrade
```

```
sudo apt-get install alsa-utils pulseaudio
```

6. Enter the following command to start recording audio.

Note: The parameters of the following command need to be adjusted according to the actual situation.

-D: Specify the device (adjust according to the card and device numbers displayed by `arecord -l`).

-f: Audio format (S16_LE represents 16-bit little-endian format).

-r: Sampling rate (16000Hz is suitable for speech recognition).

-d: Recording duration (in seconds).

In the example, a USB recording device is connected, and the sequence number of the sound card is 2.

```
arecord -D "plughw:2,0" -f S16_LE -r 16000 -d 5 -c 1 test.wav
```

```
pi@raspberrypi:~ $ arecord -D "plughw:2,0" -f S16_LE -r 16000 -d 5 -c 1 test.wav
Recording WAVE 'test.wav' : Signed 16 bit Little Endian, Rate 16000 Hz, Mono
```

```
ls
```

```
pi@raspberrypi:~ $ ls
Adeept_DarkPaw  Bookshelf  Desktop    Downloads  Pictures  startup.sh  test.wav
adeept_picar-b2 create_ap  Documents  Music       Public    Templates  Videos
```

7. Now that the recording is complete, an audio file named test.wav has been generated in the current folder. Execute the following command, and you will be able to hear the sound that was just recorded.

Specify the USB sound card for playback.

-D: Specify the device (adjust according to the card and device numbers displayed by `arecord -l`).

In the example, a USB playback device is connected, and the sequence number of the sound card is 3.

```
aplay -D "plughw:3,0" test.wav
```

```
pi@raspberrypi:~ $ aplay -D "plughw:3,0" test.wav
Playing WAVE 'test.wav' : Signed 16 bit Little Endian, Rate 16000 Hz, Mono
pi@raspberrypi:~ $
```