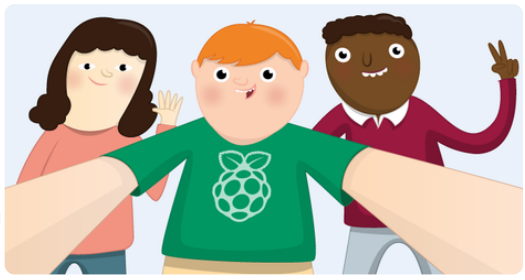
Projects

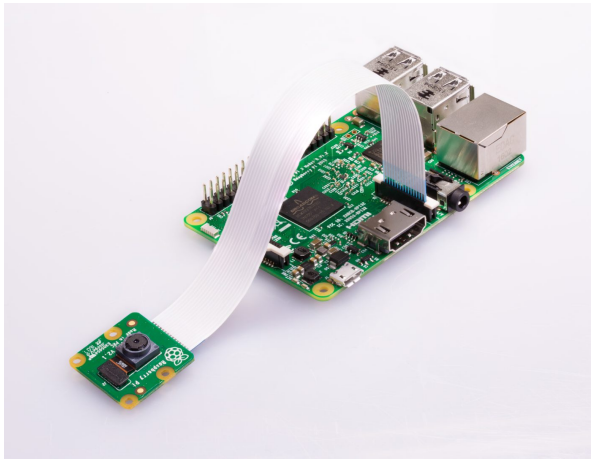
Getting started with the Camera Module

Take pictures and video with the Raspberry Pi Camera Module and Python



Step 1 Introduction

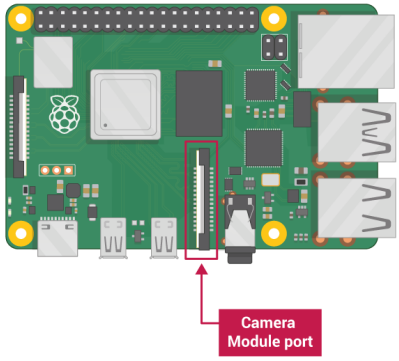
Learn how to connect the Raspberry Pi Camera Module to your Raspberry Pi and take pictures, record video, and apply image effects.



Step 2 What you will need

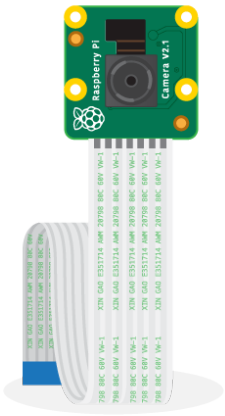
Raspberry Pi computer with a Camera Module port

All current models of Raspberry Pi have a port for connecting the Camera Module.



Note: If you want to use a Raspberry Pi Zero, you need a Camera Module ribbon cable that fits the Raspberry Pi Zero's smaller Camera Module port.

Raspberry Pi Camera Module



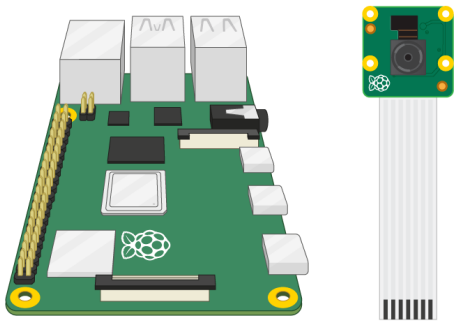
There are two versions of the Camera Module:

- **The standard version** (https://www.raspberrypi.org/products/camera-module-v2/), which is designed to take pictures in normal light
- **The NoIR version** (https://www.raspberrypi.org/products/pi-noir-camera-v2/), which doesn't have an infrared filter, so you can use it together with an infrared light source to take pictures in the dark

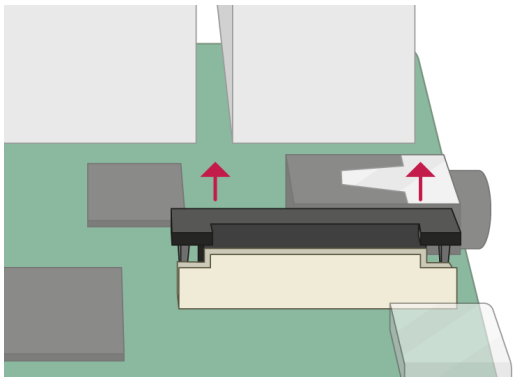
Step 3 Connect the Camera Module

Ensure your Raspberry Pi is turned off.

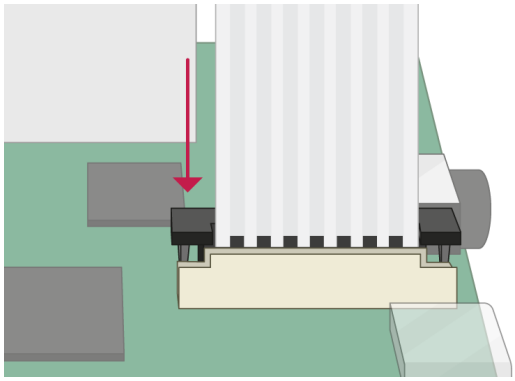
1. Locate the Camera Module port.



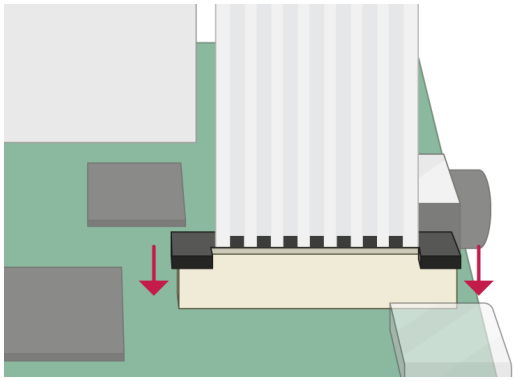
1. Gently pull up on the edges of the port's plastic clip.

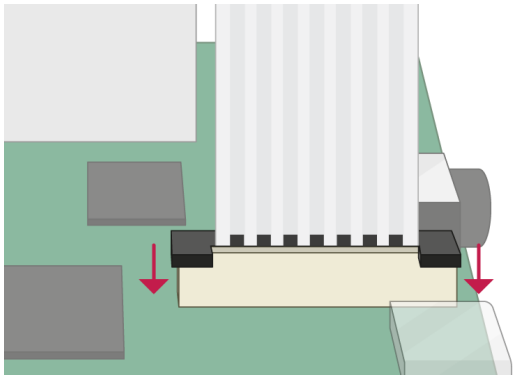


1. Insert the Camera Module ribbon cable; make sure the cable is the right way round.

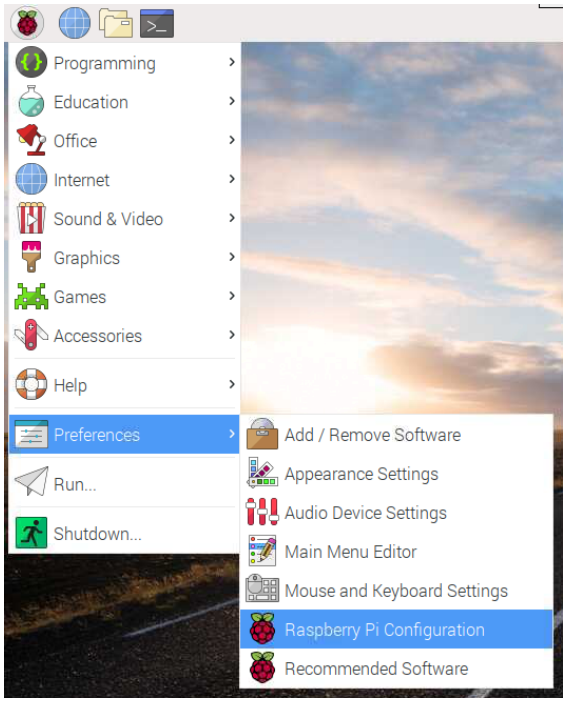


1. Push the plastic clip back into place.

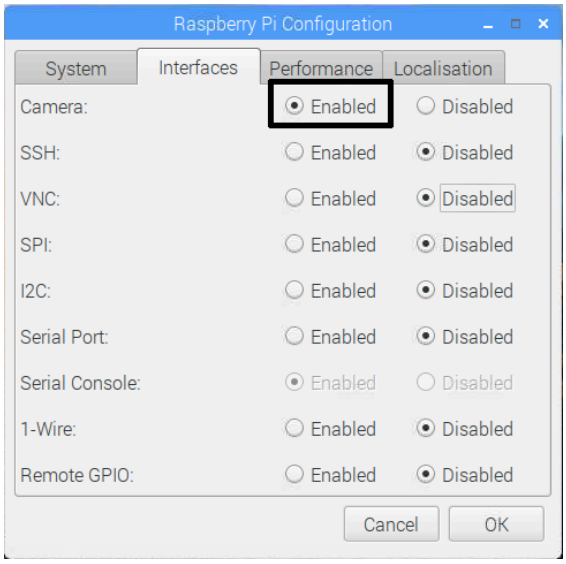




- Start up your Raspberry Pi.
- Go to the main menu and open the **Raspberry Pi Configuration** tool.



- Select the **Interfaces** tab and ensure that the camera is **enabled**:



- Reboot your Raspberry Pi.

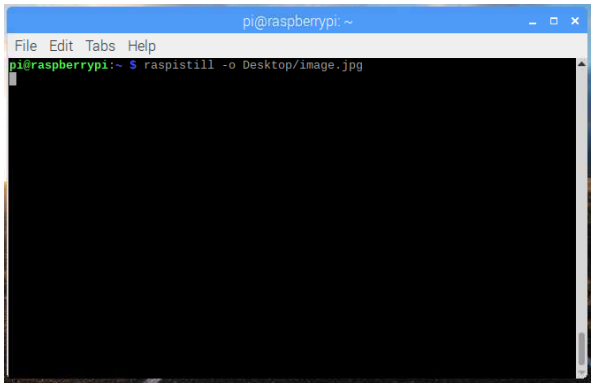
Step 4 How to control the Camera Module via the command line

Now your Camera Module is connected and the software is enabled, try out the command line tools `raspistill` and `raspivid`.

- Open a terminal window by clicking the black monitor icon in the taskbar:

- Type in the following command to take a still picture and save it to the Desktop:

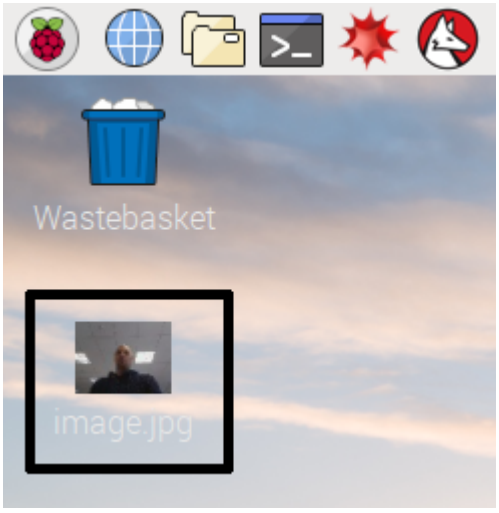
```
raspistill -o Desktop/image.jpg
```



- Press `Enter` to run the command.

When the command runs, you can see the camera preview open for five seconds before a still picture is taken.

- Look for the picture file icon on the Desktop, and double-click the file icon to open the picture.



By adding different options, you can set the size and look of the image the `raspistill` command takes.

- For example, add `-h` and `-w` to change the height and width of the image:

```
raspistill -o Desktop/image-small.jpg -w 640 -h 480
```

- Now record a video with the Camera Module by using the following `raspivid` command:

```
raspivid -o Desktop/video.h264
```

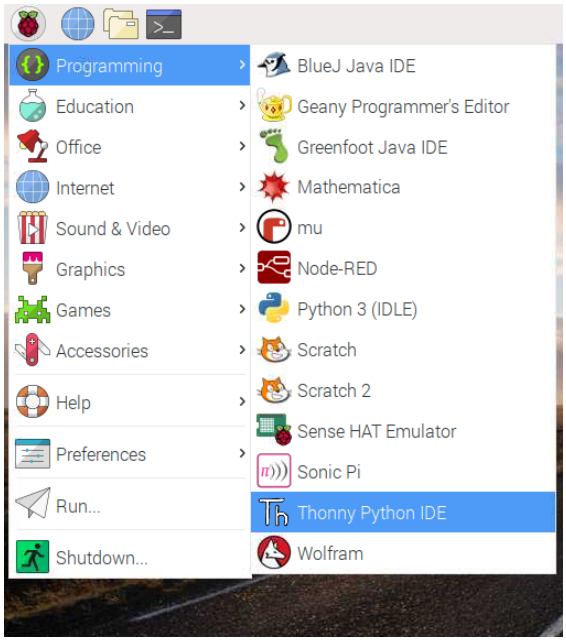
- In order to play the video file, double-click the `video.h264` file icon on the Desktop to open it in VLC Media Player.

For more information and other options you can use with these commands, read the **documentation for raspistill** (https://www.raspberrypi.org/documentation/usage/camera/raspicam/raspistill.md) and the **documentation for raspivid** ([path](https://www.raspberrypi.org/documentation/usage/camera/raspicam/raspivid.md)).

Step 5 How to control the Camera Module with Python code

The Python `picamera` library allows you to control your Camera Module and create amazing projects.

- Open a Python 3 editor, such as **Thonny Python IDE**:



- Open a new file and save it as `camera.py`.

  Note: it's important that you **never save the file as** `picamera.py`.

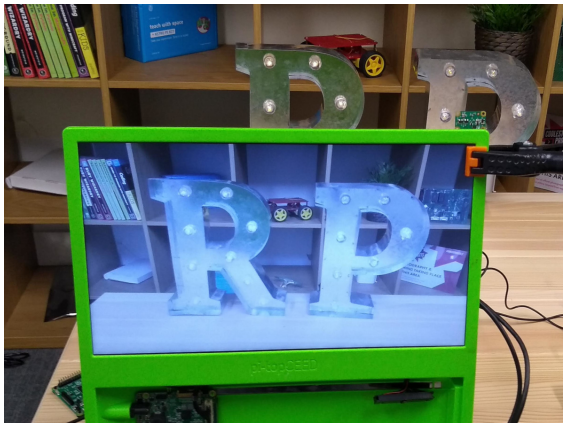
- Enter the following code:

```
from picamera import PiCamera
from time import sleep

camera = PiCamera()

camera.start_preview()
sleep(5)
camera.stop_preview()
```

- Save and run your program. The camera preview should be shown for five seconds and then close again.



Note: the camera preview only works when a monitor is connected to your Raspberry Pi. If you are using remote access (such as SSH or VNC), you won't' see the camera preview.

- If your preview is upside-down, you can rotate it by 180 degrees with the following code:

```
camera = PiCamera()
camera.rotation = 180
```

You can rotate the image by `90`, `180`, or `270` degrees. To reset the image, set `rotation` to `0` degrees.

It's best to make the preview slightly see-through so you can see whether errors occur in your program while the preview is on.

- Make the camera preview see-through by setting an `alpha` level:

```
camera.start_preview(alpha=200)
```

The `alpha` value can be any number between `0` and `255`.

Step 6 Take still pictures with Python code

Now use the Camera Module and Python to take some still pictures.

- Amend your code to add a `camera.capture()` line:

```
camera.start_preview()
sleep(5)
camera.capture('/home/pi/Desktop/image.jpg')
camera.stop_preview()
```

Note: it's important to `sleep` for at least two seconds before capturing an image, because this gives the camera's sensor time to sense the light levels.

- Run the code.

You should see the camera preview open for five seconds, and then a still picture should be captured. As the picture is being taken, you can see the preview briefly adjust to a different resolution.

Your new image should be saved to the Desktop.

- Now add a loop to take five pictures in a row:

```
camera.start_preview()
for i in range(5):
    sleep(5)
    camera.capture('/home/pi/Desktop/image%s.jpg' % i)
camera.stop_preview()
```

The variable `i` counts how many times the loop has run, from `0` to `4`. Therefore, the images get saved as `image0.jpg`, `image1.jpg`, and so on.

- Run the code again and hold the Camera Module in position.

The camera should take one picture every five seconds. Once the fifth picture is taken, the preview closes.

- Look at your Desktop to find the five new pictures.

Step 7 Recording video with Python code

Now record a video!

- Amend your code to remove `capture()` and instead add `start_recording()` and `stop_recording()`

  Your code should look like this now:

```
camera.start_preview()
camera.start_recording('/home/pi/Desktop/video.h264')
sleep(5)
camera.stop_recording()
camera.stop_preview()
```

- Run the code.

Your Raspberry Pi should open a preview, record 5 seconds of video, and then close the preview.

Step 8 How to change the image settings and add image effects

The Python `picamera` software provides a number of effects and configurations to change how your images look.

Note: some settings only affect the preview and not the captured image, some affect only the captured image, and many others affect both.

Set the image resolution

You can change the `resolution` of the image that the Camera Module takes.

By default, the image resolution is set to the resolution of your monitor. The maximum resolution is 2592×1944 for still photos, and 1920×1080 for video recording.

- Use the following code to set the `resolution` to maximum and take a picture.

  Note: you also need to set the frame rate to `15` to enable this maximum resolution.

```
camera.resolution = (2592, 1944)
camera.framerate = 15
camera.start_preview()
sleep(5)
camera.capture('/home/pi/Desktop/max.jpg')
camera.stop_preview()
```

The minimum resolution is 64×64.

- Try taking a picture with the minimum resolution.

Add text to your image

You can add text to your image using the command `annotate_text`.

- Run this code to try it:

```
camera.start_preview()
camera.annotate_text = "Hello world!"
sleep(5)
camera.capture('/home/pi/Desktop/text.jpg')
camera.stop_preview()
```

Change the look of the added text

- Set the text size with the following code:

```
camera.annotate_text_size = 50
```

  You can set the text size to anything between `6` to `160`. The default size is `32`.

It's also possible to change the text colour.

- First of all, add `Color` to your `import` line at the top of the program:

```
from picamera import PiCamera, Color
```

- Then below the `import` line, amend the rest of your code so it looks like this:

```
camera.start_preview()
camera.annotate_background = Color('blue')
camera.annotate_foreground = Color('yellow')
camera.annotate_text = " Hello world "
sleep(5)
camera.stop_preview()
```

Change the brightness of the preview

You can change how bright the preview appears. The default brightness is `50`, and you can set it to any value between `0` and `100`.

- Run the following code to try this out:

```
camera.start_preview()
camera.brightness = 70
sleep(5)
camera.capture('/home/pi/Desktop/bright.jpg')
camera.stop_preview()
```

- The following loop adjusts the brightness and also adds text to display the current brightness level:

```
camera.start_preview()
for i in range(100):
    camera.annotate_text = "Brightness: %s" % i
    camera.brightness = i
    sleep(0.1)
camera.stop_preview()
```

Change the contrast of the preview

Similarly to the preview brightness, you can change the contrast of the preview.

- Run the following code to try this out:

```
camera.start_preview()
for i in range(100):
    camera.annotate_text = "Contrast: %s" % i
    camera.contrast = i
    sleep(0.1)
camera.stop_preview()
```

Add cool image effects

You can use `camera.image_effect` to apply a particular image effect.

The image effect options are:

- `none`
- `negative`
- `solarize`
- `sketch`
- `denoise`
- `emboss`
- `oilpaint`
- `hatch`

- `gpen`
- `pastel`
- `watercolor`
- `film`
- `blur`
- `saturation`
- `colorswap`
- `washedout`
- `posterise`
- `colorpoint`
- `colorbalance`
- `cartoon`
- `deinterlace1`
- `deinterlace2`

The default effect is `none`.

- Pick an image effect and try it out:

```
camera.start_preview()
camera.image_effect = 'colorswap'
sleep(5)
camera.capture('/home/pi/Desktop/colorswap.jpg')
camera.stop_preview()
```

- Run this code to loop over **all** the image effects with `camera.IMAGE_EFFECTS`:

```
camera.start_preview()
for effect in camera.IMAGE_EFFECTS:
    camera.image_effect = effect
    camera.annotate_text = "Effect: %s" % effect
    sleep(5)
camera.stop_preview()
```

Set the image exposure mode

You can use `camera.exposure_mode` to set the exposure to a particular mode.

The exposure mode options are:

- `off`
- `auto`
- `night`
- `nightpreview`
- `backlight`
- `spotlight`

- `sports`
- `snow`
- `beach`
- `verylong`
- `fixedfps`
- `antishake`
- `fireworks`

The default mode is `auto`.

- Pick an exposure mode and try it out:

```
camera.start_preview()
camera.exposure_mode = 'beach'
sleep(5)
camera.capture('/home/pi/Desktop/beach.jpg')
camera.stop_preview()
```

- You can loop over all the exposure modes with `camera.EXPOSURE_MODES`, like you did for the image effects.

Change the image white balance

You can use `camera.awb_mode` to set the auto white balance to a preset mode.

The available auto white balance modes are:

- `off`
- `auto`
- `sunlight`
- `cloudy`
- `shade`
- `tungsten`
- `fluorescent`
- `incandescent`
- `flash`
- `horizon`

The default is `auto`.

- Pick an auto white balance mode and try it out:

```
camera.start_preview()
camera.awb_mode = 'sunlight'
sleep(5)
camera.capture('/home/pi/Desktop/sunlight.jpg')
camera.stop_preview()
```

- You can loop over all the auto white balance modes with `camera.AWB_MODES`, like you did for the image effects.

Step 9 What next?

Now you know how to use your Camera Module, you could for example:

- Add buttons to control the camera with the help of **GPIO Zero** (https://gpiozero.readthedocs.org/) Python code
- Integrate the camera with Minecraft Pi
- Post the camera's pictures to Twitter automatically

Try these Camera Module projects to learn more:

- Create a **push button stop-motion** (https://projects.raspberrypi.org/en/projects/push-button-stop-motion/) film
- Make a **Minecraft photobooth** (https://projects.raspberrypi.org/en/projects/minecraft-photobooth/)
- Get **Babbage bear to tweet pictures** (https://projects.raspberrypi.org/en/projects/tweeting-babbage/)
- Build a **parent detector** (https://projects.raspberrypi.org/en/projects/parent-detector/)
- Use the NoIR Camera Module to create an **infrared bird box** (https://projects.raspberrypi.org/en/projects/infrared-bird-box/)

For more information about writing Python code to control the Camera Module, see the extensive **picamera documentation** (https://picamera.readthedocs.org/).
