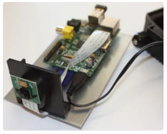
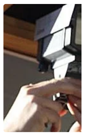
Raspberry Pi As Low-cost HD Surveillance Camera

By scavix in Circuits > Raspberry Pi 2,588,652 2,783 430 Featured Winner





This instructable describes how to build a surveillance cam based on a Raspberry Pi micro-computer which records HD video when something moves in the monitored area. Live picture can be viewed from any web browser, even from your mobile while you're on the road.

What you will get:

- See live stream in any web browser from anywhere
- Record any motion into video file

Usually, such a cam will cost you around US$1.000, but with the result from this instructable, you will get such a cam for only about US$120.

Step 1: Background

Have you ever heard of Raspberry Pi? It's a low-cost micro-computer that is able to run Linux and has endless extension possibilities. It cost only about US$35 and opens up endless possibilities of what you can build with it. The official website can be found at http://www.raspberrypi.org/

Step 2: Hardware Components

We need some hardware for this project. This is a list of the major things we need:

- Raspberry Pi Model B: This is the larger model of the Raspberry computer system with 700MHz and 512MB Ram. It supports HD video. You can easily order it from i.e. here. Cost: about **US$40**. You could also use the Raspberry Pi Model A which is slightly cheaper and consumes less energy. Stefan Knight has written an excellent article on how to run this whole project on a model A.
- Raspberry Pi Camera Module: This module was specially build for the Raspberry micro-computer. It has a connector to be plugged directly into the Raspberry board and supports HD video up to 1080p. The website http://www.rs-components.com/raspberrypi will show you where you could order it from your country. I.e. http://www.alliedelec.com/lp/130513rasocameramodule/ ships this camera in the US for only **US$29**.
  There will be an infrared camera module for the Raspberry Pi soon (http://www.raspberrypi.org/archives/5089). We've not yet had the chance to test it, but it should work for this surveillance camera as well.
- A housing for the camera: you don't need to buy a high-price-housing for your Raspberry. There are loads of very cheap fake security cameras available which perfectly fit our needs here. Search the web for "surveillance camera dummy" and you will find loads of housings for your new camera for only a few dollars. I.e. this one will do the job: http://amzn.to/15XLaAj for only **US$9**. We have ordered this camera housing for about 20€ in Germany that had enough space for all the components:http://amzn.to/19CTEaN. You can use any camera housing, but only be careful about the size of the housing so that the Rasperry board will fit in there. The dimensions of the Raspberry board are 85.6 x 53.98 x 17 mm (approx 3.37 x 2.13 x 0.67 in).
- Power supply: The Raspberry computer does not come with any power supply, you have to get one on our own. Any power supply with a micro-USB plug can do the job as long as it supplies at least 1A of power. We have ordered such a power supply which already has a micro-USB plug for about **US$10**
- SD card: as the Raspberry Pi does not have any storage on board, you need to add some so that you can install and run the operating system for this device. Any SD or microSDHC should do the job, but we recommend using a Class 10 SD card. It's only around **US$7**

- To connect this cam to your network, you also need some kind of network connection. One possibility is to use a LAN connection, but you would need to put LAN cable to the point where you want to mount the camera. A better alternative is such a WiFi USB adapter for only about **US$10**

That's all: for about **US$120** we have all the hardware we need to build this HD surveillance cam.

Step 3: Install Raspbian

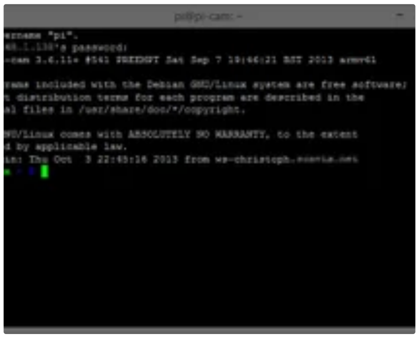
At first, you should install the OS and software to the Raspberry Pi before mounting it all together. An OS is the basic operating system software that tells the Raspberry hardware what to do. Linux is perfect for this. We have chosen Raspbian, as it's one of the most advanced OS for the Raspberry with loads of help and tutorials on the internet.
You need to prepare the SD card to be able to run Raspbian on the Raspberry: this excellent tutorial from Adafruit will explain the necessary steps.
Now temporarily connect your Raspberry Pi board to LAN cable, a monitor (HDMI TV works out of the box, but a HDMI-to-DVI cable like this will do the job as well) and a USB keyboard for the basic setup.
Insert the prepared SD card with the Raspbian installer on it and attach the power supply. The Raspberry should boot up and guide you through the setup process as explained in this Adafruit tutorial. After this, you should have a basic Raspbian OS running.
Be sure to enable SSH in Raspbian so that you are able to control the Raspberry device also when there is no monitor and keyboard attached. And you should also enable the camera from the Raspbian setup menu so that we can use it for motion detection.
Now make sure your RPI is up to date:

```
sudo apt-get install rpi-update
sudo rpi-update
```

And also update all packages:

```
sudo apt-get update
sudo apt-get upgrade
```

Step 4: Connect Via SSH



```
ername "pi".
68.1.130's password:
-cam 3.6.11+ #541 PREEMPT Sat Sep 7 19:46:21 BST 2013 armv6l

rams included with the Debian GNU/Linux system are free software;
t distribution terms for each program are described in the
al files in /usr/share/doc/*/copyright.

NU/Linux comes with ABSOLUTELY NO WARRANTY, to the extent
d by applicable law.
in: Thu Oct  3 22:45:16 2013 from ws-christoph.
```

Now that the basic setup is done, you should connect to your Raspberry device from your computer. You can connect to Linux console from any computer in your local network and control it like you where sitting directly in front of it. This is very important as once mounted far away from your desktop, you need to be able to make updates and change the configuration of this camera any time later without the need to detaching it from the wall and bringing it back to your desk.

Remember that this cam is not just a dump cam device but a very powerful computer with Linux OS running on it. It's not limited to what we explain in this article now; it will follow any development in software so that you will be able to install updated software and more modules any time later.

First, you need a software to connect to the Linux console on the Raspberry. For Windows, you will need the extra (free) software PuTTY. Download it from the PuTTY website, install it and connect to your Raspberry Pi device:

From now on, you don't need any monitor and keyboard attached to the Raspberry anymore.

Step 5: Enable WiFi

If you want to run this camera with a WiFi USB dongle (like we've suggested in step 2), you will need to do some quick additional steps to make WiFi work on the Raspberry:
From the console (PuTTY window), edit the network properties of the Raspberry:

```
sudo nano /etc/network/interfaces
```

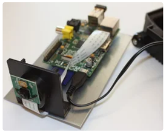
Now add these lines at the end of the file (or change existing lines to match these):

```
allow-hotplug wlan0
iface wlan0 inet dhcp
wpa-ssid "YOUR NETWORK SSID"
wpa-psk "WIFI PASSWORD"
```

(Fill in the SSID and password for your WiFi network)
Reboot the Raspberry with this command and see if it correctly connects to your WiFi network:

```
sudo reboot
```

Step 6: Put the Hardware Together



Now it's time to assemble all the hardware components together into the housing. Depending on the housing, this should not be a too complicated job. Be sure to mount the Raspberry board safely so that it doesn't tumble around in the housing.
As our housing had a very large glass window at the front, we have closed it with a black paper with a hole in it. This has the advantage that the "tech" of the camera is not visible anymore. If you like the camera recording led to be visible, don't cover it. Whenever the camera is detecting any motion or is recording, the led light will glow in a very bright red.
You can also turn off the camera red LED by adding this line to /boot/config.txt:

```
disable_camera_led=1
```

Step 7: Installing the Motion Detection Software

A very good (and free open-source) motion detection/surveillance software with many configuration options is motion.
We now need to install it using the command line (log in to your raspberry as user "pi"):

```
sudo apt-get install motion
```

Some packages will be installed in the installation process; just type "y" to proceed with the installation.
As the current version of motion does not (yet) support the Raspberry camera module, we need to download and install a special build with support for this camera module.

```
cd /tmp
sudo apt-get install -y libjpeg62 libjpeg62-dev libavformat53 libavformat-dev libavcodec53 libavcodec-dev libavutil51 libavutil-dev libc6-
wget https://www.dropbox.com/s/xdfcxm5hu71s97d/motion-mmal.tar.gz
```

And now you need to unpack the downloaded file to the /tmp directory:

```
tar zxvf motion-mmal.tar.gz
```

After this unzipping, you now need to update your installed motion with the downloaded build:

```
sudo mv motion /usr/bin/motion
sudo mv motion-mmalcam.conf /etc/motion.conf
```

You also need to enable the motion daemon so that motion will always run:

```
sudo nano /etc/default/motion
```

and change the line to:

```
start_motion_daemon=yes
```

We're pretty sure that the official build of motion will shortly also support the Raspberry camera module as well.
A very important command to edit the motion configuration file is

```
sudo nano /etc/motion.conf
```

Note: in the standard motion installation, the motion.conf is in /etc/motion/, but in the special motion-mmal build from dropbox-url (see above) it's in /etc/. If you follow this tutorial with all steps, this is no problem at all.
Be sure to have the file permissions correct: when you install motion via ssh while being logged in as user "pi", you need to make sure to give the user "motion" the permissions to run motion as service after reboot:

```
sudo chmod 664 /etc/motion.conf
sudo chmod 755 /usr/bin/motion
sudo touch /tmp/motion.log
sudo chmod 775 /tmp/motion.log
```

We've made some changes to the motion.conf file to fit our needs. Our current motion.conf file can be downloaded here. Just download, unzip and copy the containing motion.conf to /etc/motion.conf if you would like to use the exact config options we describe below.
Some of the main changes are:
Make sure that motion is always running as a daemon in the background:

```
daemon on
```

We want to store the logfile in /tmp instead (otherwise autostart user won't be able to acces it in /home/pi/ folder):

```
logfile /tmp/motion.log
```

As we want to use a high quality surveillance video, we've set the resolution to 1280x720:

```
width 1280
height 720
```

We don't need real-time video, 2 pictures per second are totally ok for our needs:

```
framerate 2
```

This is a very handy feature of the motion software: record some (2 in our configuration) frames before and after the motion in the image was detected:

```
pre_capture 2
post_capture 2
```

We don't want endless movies. Instead, we want to have max. 10 minutes slices of the motion videos. This config option was renamed from max_movie_time to max_mpeg_time in motion. If you use the motion-mmal build, this one will work. If you get an error 'Unknown config option "max_mpeg_time"' either change this one to max_movie_time or make sure to really use the motion-mmal build as shown above.

```
max_mpeg_time 600
```

As some media players like VLC are unable to play the recorded movies, we've changed the codec to msmpeg4. Then, the movies play correctly in all players:

```
ffmpeg_video_codec msmpeg4
```

Enable access to the live stream from anywhere. Otherwise only localhost (= the Raspberry device) would be allowed to access the live stream:

```
stream_localhost off
```

If you want to protect the live stream with a username and password, you should enable this:

```
stream_auth_method 2
stream_authentication SOMEUSERNAME:SOMEPASSWORD
```

All configuration parameters are explained in detail in the motion config documentation.

After your changes to the motion.conf, reboot the Raspberry:

```
sudo reboot
```

After the reboot, the red light of the camera module should be turned on, which shows that motion currently is using the camera to detect any movement.

Step 8: Save Videos on Windows Shared Folder

As the SD card of the Raspberry Pi is a pretty limited resource, we've decided to let the Raspberry cam store the videos on one of our Windows Servers. This is pretty easy:
First share a folder from some Windows machine. Just follow some guides on the internet if you've never shared a folder from a Windows machine before.
Then open the fstab configuration on your Raspberry from a PuTTY console or directly from the device:

```
sudo nano /etc/fstab
```

Now add an extra line with the configuration of your Windows network shared folder:

```
//YOURSERVERNAME/YOURSHAREDFOLDERNAME /mnt/camshare cifs username=YOURSHAREDFOLDERUSERNAME,password=YOURSHAREDFOLDERPASSWORD,iocharset=utf
```

Be sure that the user has the correct permissions to save files to that shared folder.
After a reboot, the Raspberry should have an extra folder /mnt/camshare mounted to the Windows shared folder. You should now set in your motion.conf:

```
target_dir /mnt/camshare
```

so that motion saves all movies to the shared folder on the Windows machine.

Step 9: Fix Motion Autostart

We had some trouble that motion was not automatically started on a reboot of the Raspberry. We've found out that this was because the mounted folder of the Windows machine was not yet ready when motion tried to access it.
A very quick fix solved our problem:
Just edit the motion file with

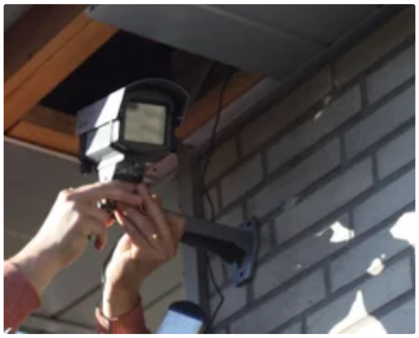
```
sudo nano /etc/init.d/motion
```

and add the line

```
sleep 30
```

to the start-sequence.
Our changed /etc/init.d/motion script can be downloaded from here.

Step 10: Mounting the Camera



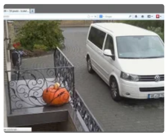
After all these steps, you can finally mount the surveillance camera to the destination point.
Some helpful hints:

- Be sure to place the power supply in a dry and safe place
- Keep an eye on the WiFi signal: if you mount the camera out of range of the WiFi, it won't be able to send any live video nor save any motion videos

Step 11: Accessing the Live Stream

Now you can access the live stream from the camera from any browser via the url http://IPADDRESSOFRASPBERRY:8080
Where 8080 is the port that we've configured for our stream in the motion.conf file. See your own configuration setting "stream_port" in motion.conf for the port.
We've found out that Google Chrome 30 (not even on iOS) wasn't able to play this stream directly due to a bug in the underlying Chromium project.
A workaround for this is to create a simple html file that contains one large image with the stream-url of the camera. See the file cam.html from raspberry_surveillance_cam_scavix.zip. This way, Chrome can show the live stream as well. Let's hope that Chrome will fix this issue in their browser.
But other browsers like FireFox, Safari and even VLC media player was able to show the live stream of the camera.
We were not able to make the live stream work in Internet Explorer as it doesn't support Motion JPEG. Kenneth Lavrsen (the maker of motion) has described workaround for live stream in Internet Explorer here.

Step 12: Access Live Stream From Anywhere



To make the live stream accessible from anywhere, you will need to enable some kind of dynamic domain services to your local network. This will enable you to always be able to connect to your local IP address from the outside even if your local IP address changes (over here in Germany, every private DSL ip address changes every 24 hours).
Such a (free) service enables you to access your Raspberry from anywhere even if your ip address changes. A very good service we're using for some years now is dyn.com. They have some free services and are integrated in many routers.
Once you have set up the dynamic ip url, you can access the camera stream from anywhere in your browser (i.e. http://YOURDYNAMICDOMAIN:8080).
And this also works from the browser on your mobile device.

Step 13: Next Steps

There are a thousand things you can do with such a surveillance cam basic setup now. How about sending Growl notifications when some motion was detected? This guide explains how to add this functionality easily.

Or you could easily add a temperature-sensor to the cam. It's only a few bucks and can be integrated very easily.
We're currently working on integrating the live stream into MediaPortal server so that we can switch to a TV channel to see the live stream from the cam in our office.

If you want extra security, you could also add a battery pack to the camera. Be sure to buy one that is able to charge simultaneously while powering the Raspberry. This would enable you to detect if some bad guy cuts the power strips of your camera and send some alert messages to you (i.e. SMS or email) including the video of the disturber.

What are you going to add? Let us know!