

Thymio, Raspberry, and Python

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1 Thymio, Raspberry, and Python

This is what you need to follow this manual:

- Thymio II with cable
- Raspberry Pi 2
- External battery with cable
- Empty Micro SD
- Dongle WI-FI or Ethernet Cable



Figure 1: Requested object

2 Connect Thymio to a computer

This wiki page aggregates the configurations needed to use Raspberry 2 to control Thymio II robot. First of all you need to install Raspberry Pi Operating System [1]. Remember the default login username and password:

username: pi

password: raspberry

3 Initial Configuration

After that, launch raspberry configuration tool using `sudo raspi-config` (in case it is the first boot of the OS, the configuration tool will be shown automatically) and make the following configurations:

- Expand filesystem
- Internationalization Options
 - Locale `en_US.UTF-8 UTF-8`
 - Time zone: Europe > Amsterdam
 - Keyboard Layout: choose Generic 105-keys (intl) PC>Other> *choose your keyboard language*
- Advanced Options
 - Set the desired hostname (*testthymio* in our case)
 - Enable SSH server
 - Disable the login shell accessibility over serial (by other words, select option "No" on the serial menu)
- enable the camera

Then Reboot Raspberry Pi:

```
$ sudo reboot .
```

and delete unnecessary files:

```
$ cd ~ && rm -rf python_games
```

4 SSH server Configuration

On file `/etc/ssh/sshd.config` make the following changes (using an editor like nano or vim. Do not forget to edit as super user - using sudo):

- Uncomment line regarding the use of public keys (`AuthorizedKeysFile %h/.ssh/authorized_keys`)
- Uncomment line regarding GSSAPI Authentication (`GSSAPIAuthentication no`) in order to remove lag from ssh login
- Add `"UseDNS no"` on the end of the file

5 Network Configuration

Disable IPv6 (Run `sudo -i` command first or you won't be able to run the following commands successfully. Run exit command in the end):

```
$ echo "blacklist_ipv6" >> /etc/modprobe.d/raspi-blacklist.conf
$ sed -i "s%^#%" /etc/hosts
```

You can test if IPv6 is enabled by running this command after reboot.

```
$ netstat -tunlp | grep p6 | wc -l
```

If the output is other than 0, then IPv6 is enabled. (0 is the right output)

Now you can connect your Raspberry to Internet (VU University Network) or to RobotLab Private Wireless Network. My suggestion is follow both section and save both configuration in two different files. When you need one configuration just rename the file and use it.

If Raspberry Pi doesn't have the WI-FI dongle, put it now.

5.1 Connect Raspberry to VU University Network

Configure network interfaces by putting the following content in `/etc/network/interfaces` file if you want to connect Raspberry with VU University WI-FI (replacing the existent content):

```
auto lo
iface lo inet loopback
iface eth0 inet dhcp
allow-hotplug wlan0
iface wlan0 inet manual
wpa-roam /etc/wpa_supplicant/wpa_supplicant.conf
iface default inet dhcp
```

And put the following content in `/etc/wpa_supplicant/wpa_supplicant.conf`

```
ctrl_interface=DIR=/var/run/wpa_supplicant GROUP=netdev
update_config=1
network={
identity="xxx@vu.nl"
password="xxxxxxxx"
eap=TTLS
phase2="auth=PAP"
priority=999
disabled=0
ssid="eduroam"
scan_ssid=0
mode=0
auth_alg=OPEN
proto=WPA2
pairwise=CCMP TKIP
key_mgmt=WPA-EAP
proactive_key_caching=1
}
```

5.2 Connect Raspberry to Private Wireless Network

If you want to connect Raspberry in a private WI-FI network (with a static IP address) put the following content in `/etc/network/interfaces`.

```
auto wlan0
auto lo
iface lo inet loopback
iface eth0 inet dhcp
allow-hotplug wlan0
iface wlan0 inet static
address 192.168.xxx.xxx
netmask 255.255.255.0
gateway 192.168.yyy.yyy
wpa-conf /etc/wpa_supplicant/wpa_supplicant.conf
iface default inet dhcp
```

and this in `/etc/wpa_supplicant/wpa_supplicant.conf`

```
ctrl_interface=DIR=/var/run/wpa_supplicant GROUP=netdev
update_config=1
network={
ssid="ThymioNet"
psk="172luckytulip75B"
proto=RSN
key_mgmt=WPA-PSK
pairwise=CCMP
auth_alg=OPEN
}
```

Then replace the content of `/etc/hosts` with the following:

```
$ 127.0.0.1          localhost
$ 182.168.xxx.xxx    testthymio
```

Add the server name's IP to `/etc/resolv.conf` file

```
$ nameserver 192.168.yyy.yyy
```

5.3 Connect Raspberry using Ethernet Cable

To connect Raspberry to your computer using an Ethernet Cable you need only to modify one *txt* file:

1. Ensure the Raspberry Pi is powered off, and remove the SD-Card.
2. Insert the SD-Card into a card reader and plug it into your laptop.
3. Find the drive and you should find several files on the Card (note it a lot smaller than youd expect since it is only the boot section of the Card (the rest is hidden)).
4. Edit `cmdline.txt` and add the IP address in the end (be sure you dont add any extra lines).

```
$ ip=192.168.xxx.xxx
```

Ensure you take note of this IP address (you will need it every time you want to directly connect to the Raspberry Pi).

5. Return the card to the Raspberry Pi. Attach the network cable attached to both the computer and Raspberry Pi and power up.
6. Set in your computer the right IP address inside Wired connection settings
\$ 192.168.yyy.yyy
7. You will need to wait for your computer to finish detecting the network settings (you may see a small networking icon flashing in your system tray while it does, or open up the network settings to see when it has finished and has an IP address) it can take around 1/2 minute. Your computer may report the connection as limited or no connection when connected to the Raspberry Pi in this way, this is normal as indicates it is a direct computer to computer connection rather than a standard network.

6 Passwordless SSH Access

It is possible to configure your Pi to allow your computer to access it without providing a password each time you try to connect. To do this, you need to follow this page [2].

If you get an error saying *-bash: /home/pi/.ssh/authorized_keys: No such file or directory* this is because you do not have a ssh folder. Simply run:

```
$ mkdir ~/.ssh
```

7 Installing Thymio's control program

First of all Update and Upgrade everything present inside the Raspberry:

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

In order to install D-Bus run the following command:

```
$ sudo apt-get install dbus-*dev
```

Download Aseba program (check online for the latest version), by running the following command:

```
$ wget https://aseba.wikidot.com/local--files/en:linuxinstall/
aseba_1.3.3_armhf.deb
```

Install Aseba with the command:

```
$ sudo dpkg -i aseba_1.3.3_armhf.deb
```

Some packages may be missing, they have to be installed with the following command:

```
$ sudo apt-get -f install
```

8 Controlling Thymio II robot

At this point, you should be able to control the thymio through raspberry. In order to be able to start D-Bus on raspberry with X11 you have to access the Raspberry with the following command (this works for Linux and Mac OS; on Windows you need to download and install Xming [3]):

```
$ ssh -X pi@PI_ADDRESS
```

To start aseba in order to communicate with the thymio II you need to run the command:

```
$ asebamedulla "ser:name=Thymio-II"
```

or

```
$ (asebamedulla "ser:name=Thymio-II" &)
```

Transfer the code that you want to run to the Raspberry and run it. The example needs to install also *gobject* library:

```
$ sudo apt-get install python-gobject
```

Now you can run the example:

```
$ python test.py
```

8.1 Control the camera with Python

It is also possible control the camera installed on Raspberry with Python. This code takes a picture and saves it in the Raspberry memory:

```
import picamera

camera = picamera.PiCamera()

camera.start_preview()
time.sleep(2)
camera.capture('image.jpg')
```

If you press "f" after runs *test.py* [4] the camera will take a picture.

9 Install OpenCV and Python

You can follow this tutorial [5] to install OpenCV.

9.1 Installing Picamera

We can install by utilizing pip:

```
pip "picamera[array]"
```

IMPORTANT: Notice how I specified *picamera[array]* and not just *picamera*.

Why is this so important?

While the standard module provides methods to interface with the camera, we need the (optional) sub-module so that we can utilize OpenCV. Remember, when using Python bindings, OpenCV

represents images as NumPy arrays and the sub-module allows us to obtain NumPy arrays from the Raspberry Pi camera module.

Assuming that your install finished without error, you now have the module (with NumPy array support) installed.

9.2 Accessing a single image of your Raspberry Pi using Python and OpenCV

Open up a new file, name it , and insert the following code:

```
# import the necessary packages
from picamera.array import PiRGBArray
from picamera import PiCamera
import time
import cv2

# initialize the camera and grab a reference to the raw camera
# capture
camera = PiCamera()
rawCapture = PiRGBArray(camera)

# allow the camera to warmup
time.sleep(0.1)

# grab an image from the camera
camera.capture(rawCapture, format="bgr")
image = rawCapture.array

# display the image on screen and wait for a keypress
cv2.imshow("Image", image)
cv2.waitKey(0)
```

10 Run script on RaspberryPi boot

To run a script after the boot of the Raspberry Pi you have to add this line at the end of the /etc/profile file.

```
. /home/pi/ #name of the file.sh that you want to run
automatically after the boot
```

In our case file.sh will contain the instruction to run asebamedulla and the python script.

```
#!/bin/sh
sleep 5
if ps aux | grep "[a]sebamedulla" > /dev/null
then
echo "asebamedulla is already running"
else
(asebamedulla "ser:device=/dev/ttyACM0" &)
python *****your python script*****
fi
```

11 Question & Answers

In [6] is possible find useful information about use Raspberry with Thymio

References

- [1] Raspberry Pi Operating System download page, <https://www.raspberrypi.org/documentation/installation/installing-images/README.md>
- [2] Passwordless SSH Access, <https://www.raspberrypi.org/documentation/remote-access/ssh/passwordless.md>
- [3] XMING download page, <http://sourceforge.net/projects/xming/d>
- [4] Alessandro Zonta, *Thymio and Python*.
- [5] OpenCV installation page, *CdricVerstraeten.pdf*
- [6] Nicolas Question & Answers, <http://piratepad.net/nikopi2>