

Introduction to Raspberry Pi

Ville Klar Doctoral Candidate Machine Design

What is Raspberry Pi?

- Arguably the most popular single board computer (SBC)
 - Easy to get started with because basically every problem is documented
- Add a computer with a OS to practically anything
 - NOTE: Do not expect it to perform as well as your laptop
- Support for a vast array of peripherals (thanks to the Linux kernel)
 - USB devices, networking, displays, cameras, audio etc.



What can you do with a Pi? (not so cool)



https://www.raspberrypi.org/magpi/magic-mirror/



http://mymediaexperience.com/raspberry-pi-xbmc-with-raspbmc/

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https://learn.adafruit.com/pigrrl-2/overview

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https://vadelmapii.com/blogi/yllapida-omaa-dropbox-kloonia-raspberry-pilla-kayttaen-owncloudia

https://github.com/foosel/OctoPrint



What can you do with a Pi? (cool)



https://hackaday.io/project/1279-ramanpi-raman-spectrometer





https://www.raspberrypi.org/blog/real-time-depth-perception-with-the-compute-module/





http://www.zdnet.com/article/build-your-own-supercomputer-out-



https://hackaday.io/project/1269-mashberry-beer-brewing-with-raspberry-pi

https://www.raspberrypi.org/magpi/fabscan-pi-project-3d-scanning-for-al



Raspberry Pi models





Raspberry Pi advantages and disadvantages

- Cheap (price per performance)
- Well documented
- Availability
 - Also in terms of add-ons (HATs)
- Versatile
- Compact (especially Zero)

- Scary linux (learning required)
- Not real time*
- No ADC (easy to add though)
- **PWM possible but limited frequency**

* It is possible to install a RTOS on the Pi



Getting started

Install OS
 Configure OS
 Connect peripherals
 Write software
 Profit (?)









Installation process

- Get SD card (micro on newer Pi's)
- Format to FAT32 (for example with <u>SD card formatter</u>)

Using NOOBS:

- Download NOOBS (sd-cards with pre-installed NOOBS can purchased)
- Unzip and copy all contents to SD card (takes a while)
- Boot

Using a disk image writer:

- Download the disk image (.img)
- Write the disk image on the SD card ("hard drive")
 - Windows: <u>Win32 disk image writer</u> or <u>Etcher</u>
 - <u>MacOSX / Linux</u>: Use dd (or image writer with GUI such as <u>Etcher</u>)
- Boot



Connections





On first boot...

- NOOBS installer has GUI (Raspbian recommended)
- Boots into raspi-config (you can run it with "sudo raspi-config")
- Expand file system, change password and change keyboard layout, enable ssh etc.

Setup Options	berry Pi Software Configuration Tool (raspi-config)				
1 Expand Filesystem	Ensures that all of the SD card storage is available to the OS				
2 Change User Password 2 Enable Root to Deskton/Scratch	Change password for the default user (pi) Change whether to best into a desktop environment. Scratch, or the command	line			
4 Internationalisation Options	Set up language and regional settings to match your location				
5 Enable Camera	Enable this Pi to work with the Raspberry Pi Camera				
6 Add to Rastrack	6 Add to Rastrack Add this Pi to the online Raspberry Pi Map (Rastrack)				
7 Overclock 8 Advanced Options	Configure overclocking for your Pi				
9 About raspi-config	Information about this configuration tool				
	_				
<	Select> <finish></finish>				





Terminal or Pixel

• There are two options when booting: shell or Pixel desktop (graphical session)





Connect to WLAN

In GUI:

Choose WiFi network and connect



Without GUI :

- sudo iwlist wlan0 scan
- sudo nano /etc/wpa_supplicant/wpa_supplicant.conf
- Add this to the bottom of the file

```
network={
ssid="aalto open"
proto=RSN
key_mgmt=NONE
```



// scan for networks
// open wpa_supplicant configuration

SSH

- Secure shell = Easy way to remotely access a Pi
- After connecting to a WLAN we need to find out the Pi's ip address
 - Type 'ip a' in a terminal output is something like this
- If you don't have a monitor connected you can try to nmap the ip
- If the Pi connects to the same router between boots, DHCP should give it the same ip
 - You can also configure a static IP







When you have obtained the ip-address you can access the Pi with e.g. Putty

Reputry Configuration	?	If you can't be both	nered with IP addresses
Category: Session Logging Terminal Features Window Appearance Behaviour Translation Selection Colours Connection Data Proxy Teinet Rlogin SSH Serial	Basic options for your PuTTY session Specify the destination you want to connect to Host Name (or IP address) P pi@10.100.52.174 2 Connection type: Raw O Raw Telnet Rlogin Saved Sessions Default Settings	TY Security Alert The server's host key is not cached in the registry. You have no guarantee that the server is the computer you think it is. The server's rsa2 key fingerprint is: ssh-rsa 2048 02:33:d0:0a:a6:b9:b5:e5:f7:31:e8:88:4f:d7:d8:46 If you trust this host, hit Yes to add the key to PuTTY's cache and carry on connecting. If you want to carry on connecting. If you want to carry on connecting. If you do not trust this host, hit Cancel to abandon the	<pre>istnames istnames istname</pre>
About He	Always Never Only on clean	Yes No Cancel Help	he 'pi' user has not been changed. 'pi' user and type 'passwd' to set



CLI / Shell commands

Command	Description
ls	List contents of current directory (folder)
cd	Change directory
mkdir	Creates a new directory (make directory)
sudo	Execute as super user ("admin" / root privileges)
ср	Copy (syntax is cp src dest)
mv	Move (syntax is mv src dest)
rm	Remove
./	Dot-slash means execute
nano	Launch nano text editor
apt-get update	Update repository list (update list of links to software downloads)
apt-get install	Install a package
reboot	Reboots the system (run with sudo)
poweroff	Turns the Raspberry Pi off (run with sudo)



CLI/ Shell tips

- Use tab to make the terminal autocomplete
- Up and down keys to browse command history
- Ctrl+c to kill a process, Ctrl+z to stop a process
- Ctrl+r to search command history
- Use 'exit' to close a terminal window
- Type 'man' before the command to see it's manual
- Github repositories can be cloned (copied) with 'git clone'

• You can also open an sftp connection to the Pi to view and edit files & folders



Programming language options

- Almost everything
 - C, C++, Python2/3, Javascript (node), Ruby, Lisp, Rust...
- Most projects are either C or Python



GPIO Libraries

- WiringPi (C and Python)
 - Blink example : <u>http://wiringpi.com/examples/blink/</u>
- RPIO (python2/3)
 - PWM via DMA (up to 1µs resolution)
- Bcm2835.h (C)
- Pigpio (javascript / python/ C)



Demo 1: Video streaming

- Installation instructions: <u>https://github.com/jacksonliam/mjpg-streamer</u>
 - Already installed in these Pi's
- Connect the Raspicam, make sure it is working with raspistill -o cam.jpg
- Run mjpeg-streamer with (first cd into ~/Software/mjpg-streamer/mjpg-streamer-experimental) : export LD_LIBRARY_PATH=.

./mjpg_streamer -o "output_http.so -w ./www" -i "input_raspicam.so"

- View the stream at http://elP-address-of-Pi>:8080 or with another computer (on the same network) at :8080">http://elP-address-of-Pi>:8080
- You can also use usb web cameras with mjpeg-streamer
- There are many other options for streaming: clvc, gstreamer,
- Use ctrl+c to kill the stream



Demo 2: WiringPi

- Open terminal
- cd into ~/Software/WiringPi_Blink
- Connect LED to gpio 29 and short lead to ground
 - We should put a current limiting LED but we can break the rules
- Run blink with sudo ./blink
- Try changing the pin to 28 (in the code) and run make to compile

Raspberry Pi GPIO Header

BCM	WiringPi	Name	Phy	sical	Name	WiringPi	BCM
		3.3v	1	2	5v		
2	8	SDA.1	3	4	5V		
3	9	SCL.1	5	6	0v		
4	7	1-Wire	7	8	TxD	15	14
		0v	9	10	RxD	16	15
17	0	GPIO. 0	11	12	GPIO. 1	1	18
27	2	GPIO. 2	13	14	0v		
22	3	GPIO. 3	15	16	GPIO. 4	4	23
		3.3v	17	18	GPIO. 5	5	24
10	12	MOSI	19	20	0v		
9	13	MISO	21	22	GPIO. 6	6	25
11	14	SCLK	23	24	CE0	10	8
		0v	25	26	CE1	11	7
0	30	SDA.0	27	28	SCL.0	31	1
5	21	GPIO.21	29	30	0v		
6	22	GPIO.22	31	32	GPIO.26	26	12
13	23	GPIO.23	33	34	0v		
19	24	GPIO.24	35	36	GPIO.27	27	16
26	25	GPIO.25	37	38	GPIO.28	28	20
		0v	39	40	GPIO.29	29	21
BCM	WiringPi	Name	Phy	sical	Name	WiringPi	BCM

Demo 3: Servo

Open terminal	
-	
	Open terminal

- cd into ~/Software/Python_Servo
- Connect servo to gnd, 5V and GPIO 4
- Run sudo pigpiod to start the gpio daemon
- Run the python script with python servo_demo.py
- You can give another pin as an argument to the script e.g. python servo_demo.py 18
- Try changing the speed of the servo

Raspberry Pi GPIO Header

BCM	WiringPi	Name	Phy	sical	Name	WiringPi	BCM
		3.3v	1	2	5v		
2	8	SDA.1	3	4	5V		
3	9	SCL.1	5	6	0v		
4	7	1-Wire	7	8	TxD	15	14
		0 v	9	10	RxD	16	15
17	0	GPIO. 0	11	12	GPIO. 1	1	18
27	2	GPIO. 2	13	14	0v		
22	3	GPIO. 3	15	16	GPIO. 4	4	23
		3.3v	17	18	GPIO. 5	5	24
10	12	MOSI	19	20	0v		
9	13	MISO	21	22	GPIO. 6	6	25
11	14	SCLK	23	24	CE0	10	8
		0 v	25	26	CE1	11	7
0	30	SDA.0	27	28	SCL.0	31	1
5	21	GPIO.21	29	30	0v		
6	22	GPIO.22	31	32	GPIO.26	26	12
13	23	GPIO.23	33	34	0v		
19	24	GPIO.24	35	36	GPIO.27	27	16
26	25	GPIO.25	37	38	GPIO.28	28	20
		0 v	39	40	GPIO.29	29	21
BCM	WiringPi	Name	Phy	sical	Name	WiringPi	BCM





- For (prototype) web servers: <u>Python Flask</u>
- For GUIs: <u>Tkinter (Python)</u> or <u>Qt (C++)</u> or Node.js+Express.js
- If you need e.g. read analog voltages and control motors → consider combining an Arduino with a Raspberry Pi

(Raspberry Pi commands Arduino board via serial (USB))





- Help videos (getting started)
- Embedded Linux Wiki
- <u>Raspberry Pi Forums</u>
- Hackaday.io Raspberry Pi projects
- <u>Adafruit learning guides</u>
- <u>Raspberry Pi subreddit</u>

