CSC270

Circuits & Systems

CSC270 Unit #6
Introduction to the Raspberry Pi

Smith College
Computer Science

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The Raspberry Pi 3 B+
• The Computer
  • History
  • Features
  • Explore!
  • Raspbian?
  • How Fast?
  • Internet Address
  • Remote Connection
  • Mini-Lab
History
History

• First prototype: 2006

• Created by Eben Upton in the UK

• Revealed online in 2011

• 600,000+ views on YouTube in 2 days

• Upton, Director of studies at the University of Cambridge: "Designed to rekindle the curiosity about computing in a generation immersed in technology but indifferent to how it worked."

https://www.techrepublic.com/pictures/how-the-raspberry-pi-was-created-a-visual-history-of-the-35-board/
History

# Features

<table>
<thead>
<tr>
<th>Feature</th>
<th>Raspberry Pi 3 Model B</th>
<th>Raspberry Pi Zero</th>
<th>Raspberry Pi 2 Model B</th>
<th>Raspberry Pi Model B+</th>
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<td>11/25/2015</td>
<td>2/2/2015</td>
<td>7/14/2014</td>
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<td>BCM2835</td>
<td>BCM2836</td>
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<td><strong>CPU</strong></td>
<td>Quad Cortex A53 @ 1.2GHz</td>
<td>ARM11 @ 1GHz</td>
<td>Quad Cortex A7 @ 900MHz</td>
<td>ARM11 @ 700MHz</td>
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<td><strong>Instruction set</strong></td>
<td>ARMv8-A</td>
<td>ARMv6</td>
<td>ARMv7-A</td>
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<tr>
<td><strong>GPU</strong></td>
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<td>250MHz VideoCore IV</td>
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<td>1GB SDRAM</td>
<td>512MB SDRAM</td>
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<td>micro-SD</td>
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<td>HDMI / Composite</td>
<td>HDMI / Composite</td>
<td>HDMI / Composite</td>
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<tr>
<td><strong>Audio Output</strong></td>
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<td>HDMI</td>
<td>HDMI / Headphone</td>
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<td><strong>Price</strong></td>
<td>$35</td>
<td>$5</td>
<td>$35</td>
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</table>

[https://hackaday.com/2016/02/28/introducing-the-raspberry-pi-3/](https://hackaday.com/2016/02/28/introducing-the-raspberry-pi-3/)
Features

Raspberry Pi 3B+

- **Quad Core 1.2GHz** Broadcom BCM2837 64bit CPU
- **1GB RAM**
- **BCM43438 wireless LAN (2.4GHz) and Bluetooth**
- **100 Base Ethernet**
- **40-pin extended GPIO**
- **4 USB 2 ports**
- Stereo output and composite video port
- **Full size HDMI**
- **CSI camera** port for connecting a Raspberry Pi camera
- **DSI display port** for connecting a Raspberry Pi touchscreen display
- **Micro SD** port for Linux OS and for storing data
- Upgraded switched **Micro USB power** source up to 2.5 A

https://www.raspberrypi.org/products/raspberry-pi-3-model-b/
<table>
<thead>
<tr>
<th>Features</th>
<th>Raspberry Pi 4</th>
<th>Raspberry Pi 3 B+</th>
</tr>
</thead>
</table>
| **CPU**  | Broadcom BCM2711  
Quad core Cortex-A72 @ 1.5GHz | Broadcom BCM2837B0  
Quad core Cortex-A53 @ 1.4GHz |
| **GPU**  | VideoCore VI @ 500Mhz | VideoCore IV @ 250-400MHz |
| **RAM**  | 1GB, 2GB or 4GB LPDDR4-2400 SDRAM | 1GB LPDDR2 SDRAM |
| **USB**  | 2x USB-a 2.0, 2x USB-A 3.0, 1x USB-C | 4x USB-A 2.0 ports |
| **Display ports** | 2x microHDMI | Single Full-size HDMI |
| **Connectivity** | 802.11ac Wi-Fi, Gigabit Ethernet, Bluetooth 5.0 | 802.11ac Wi-Fi, 300Mbps Ethernet, Bluetooth 4.0 |
| **Misc.** | 40-pin GPIO header, 3.5mm audio port, camera module support, composite video | 40-pin GPIO header, 3.5mm audio port, camera module support, composite video |
ARM Processor

- **Quad Core** processor
- **1.2 GHz** speed
- **Floating-Point** Processor
- Supports **virtualization** in hardware
- **31** general purpose **registers**
- Hardware-assisted **cryptography**
http://doc.xdevs.com/doc/RPi/
• The Computer
  • History
  • Features
    • Unboxing (see separate video)
    • Raspbian?
    • How Fast?
  • Internet Address
  • Remote Connection
  • Programming the GPIO
Turning off the Raspberry Pi

**DO NOT STOP THE PI BY CUTTING OFF POWER**
Turning Off the Pi

Option 1

Option 2

pi@270a:~ $ sudo halt -p
2.4 RASPBIAN’S DESKTOP ENVIRONMENT

Raspbian’s desktop is similar to Microsoft Windows and many of the ways that you use it are the same.
To interact with icons and buttons, click them with the mouse. If you right-click an icon, Raspbian displays a context menu. The options in a context menu only apply to the item that you clicked.
The desktop takes up most of the screen. This is where your programs will appear when you start them. And if you save files to the /home/pi/Desktop directory then you can see links to these files appear on the desktop.

When Raspbian’s graphical desktop is running, you can access the raspi-config tool at any time by clicking LXTerminal on your desktop. Then type the following command and press Enter:
sudo raspi-config

In the top left of the screen, you can find: the Raspbian menu, the Application Launcher, and the Wastebasket.
What's Raspbian?

- Operating System
- Free

- Rasp <-> Raspberry Pi       bian <-> Debian

- Based on Debian, Linux Kernel, optimized for RPi
- over 35,000 packages available for download (avail since 2012)
- Not affiliated with Raspberry Pi Foundation
- https://www.raspbian.org/
How Do We Get Raspbian?


2. Unzip the file downloaded (7-zip, Unarchiver, unzip)

2. Write disk image to microSD card (Win32 Disk Imager, dd)

3. Put microSD in Raspberry Pi, and go!

https://thepi.io/how-to-install-raspbian-on-the-raspberry-pi/
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Good References

• The Debian Administrator's Handbook: https://debian-handbook.info/browse/stable/

  • apt-get: Section 6.2
  • Configuring for a different language: Chapter 8
  • Managing Users: Section 8.4
  • Remote login: remote desktop (vnc), ssh: Chapter 9
  • Web server: Section 11.2
Good References (2)

Time for a coffee break!
Continuing our Exploration...
[13:38:49] ~$: ssh -Y pi@270a.is-a-geek.net
pi@270a.is-a-geek.net's password:
Linux 270a.is-a-geek 4.19.97-v7+ #1294 SMP Thu Jan 30 13:15:58 GMT 20
20 armv7l

The programs included with the Debian GNU/Linux system are free softw
are;
the exact distribution terms for each program are described in the
individual files in /usr/share/doc/*/copyright.

Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, to the extent
permitted by applicable law.
Last login: Sat Apr 11 12:21:30 2020 from 192.168.1.120
pi@270a:~ $
How Fast?

```
pi@270a:~ $ mkdir 270
pi@270a:~ $ cd 270
pi@270a:~/270 $ wget http://www.science.smith.edu/~dthiebaut/classes/112/queensdemo.c
Resolving www.science.smith.edu (www.science.smith.edu)... 131.229.72.71
Connecting to www.science.smith.edu (www.science.smith.edu)[131.229.72.71]:80... connected.
HTTP request sent, awaiting response... 200 OK
Length: 4307 (4.2K) [text/x-csrc]
Saving to: 'queensdemo.c'

queensdemo.c      100%[====================================> 4.21K -.-KB/s in 0s

2020-04-11 12:47:11 (8.53 MB/s) - 'queensdemo.c' saved [4307/4307]

pi@270a:~/270 $ gcc -o queensdemo queensdemo.c
pi@270a:~/270 $ ./queensdemo 15
solution  0: 0 2 4 1 9 11 13 3 12 8 5 14 6 10 7
N=15 solution found!
15x15  4 ms
pi@270a:~/270 $ 
```
How Fast?
Using wget

wget http://www.science.smith.edu/~dthiebaut/classes/112/queensdemo.c

or copy/paste from your browser
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pi@270a:~/270 $ for i in 15 16 17 18 19 20 21 22 23 24 ; do
> . ./queensdemo $i
> done
solution  0:  0  2  4  1  9  11  13  3  12  8  5  14  6  10  7
N=15 solution found!
  15x15 4 ms
solution  0:  0  2  4  1  12  8  13  11  14  5  15  6  3  10  7  9
N=16 solution found!
  16x16 26 ms
solution  0:  0  2  4  1  7  10  14  6  15  13  16  3  5  8  11  9  12
N=17 solution found!
  17x17 15 ms
solution  0:  0  2  4  1  7  14  11  15  12  16  5  17  6  3  10  8  13  9
N=18 solution found!
  18x18 115 ms
solution  0:  0  2  4  1  3  8  12  14  16  18  6  15  17  10  5  7  9  11  13
N=19 solution found!
  19x19 8 ms
solution  0:  0  2  4  1  3  12  14  11  17  19  16  8  15  18  7  9  6  13  5  10
N=20 solution found!
  20x20 600 ms
solution  0:  0  2  4  1  3  8  10  14  20  17  19  16  18  6  11  9  7  5  13  15  12
N=21 solution found!
  21x21 28 ms
^C
pi@270a:~/270 $ for i in 15 16 17 18 19 20 21 22 23 24 ; do . ./queensdemo $i; done^C
pi@270a:~/270 $
• The Computer
  • History
  • Features
• Unboxing!
• Keyboard, Display, Mouse Connection
• Explore!
• Raspbian?
• How Fast?
• Internet Address
• Remote Connection
• Programming the GPIO
RPI Internet Address

- *In terminal:* `/sbin/ifconfig`

- *dyndns address:* `270x.is-a-geek.net`
Remote Connection to the RPi

- **VNC Viewer** *(virtual network computing)*
- **SSH/Putty** *(secure shell/Putty)*
Turn On VNC Server on RPi

- In Terminal:

```bash
sudo raspi-config
```
Mini-Lab Time!
Mini-Lab Time!

Download the VNC viewer!