Raspberry Pi 好好玩
- 軟硬整合篇

台灣樹莓派 <sosorry@raspberrypi.com.tw>

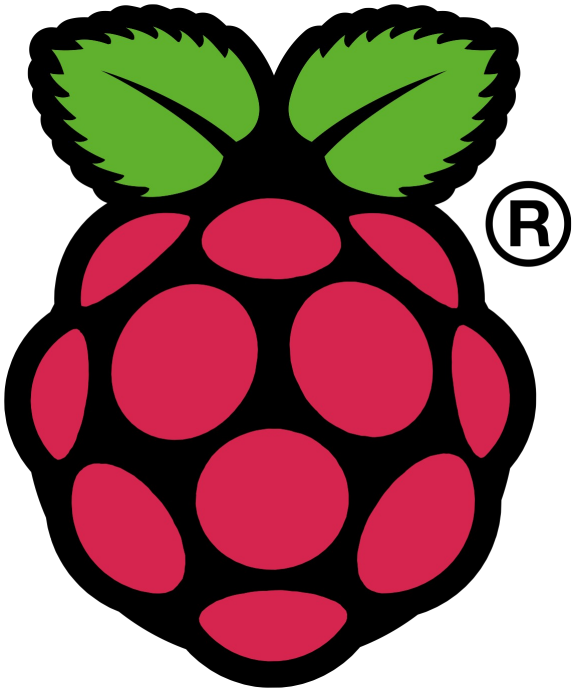
Mar 17, 2014/NTU

about 台灣樹莓派

- Element14 指定台灣獨家經銷 Raspberry Pi
- 專注於 Raspberry Pi 應用與推廣
- 舉辦台灣 Raspberry Pi 社群聚會

今日大綱

- Raspberry Pi 應用介紹
- Raspberry Pi 的軟硬整合



Raspberry Pi 應用介紹

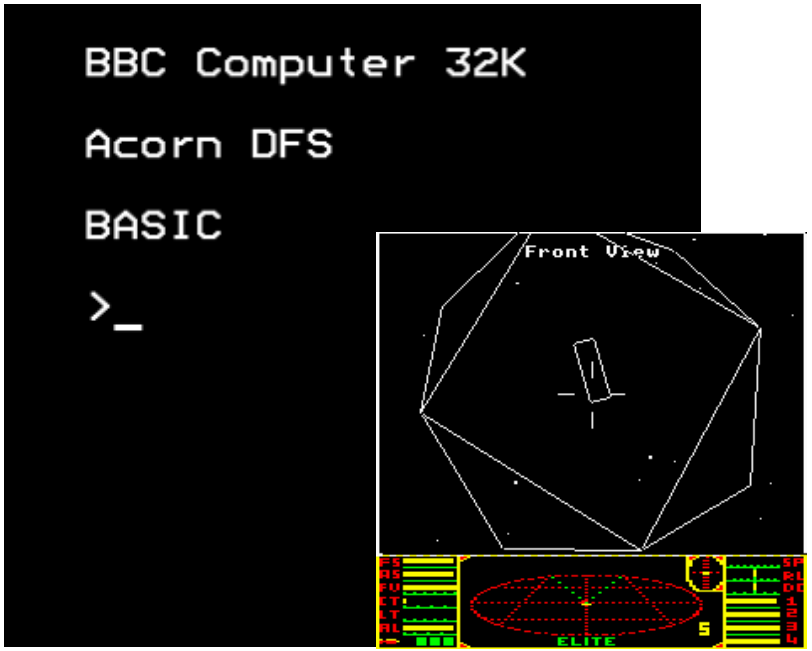
以前的電腦

PDP-8

Xerox Alto

Power Macintosh

BBC Micro



http://goo.gl/iU5f9w
http://goo.gl/U1aq9E

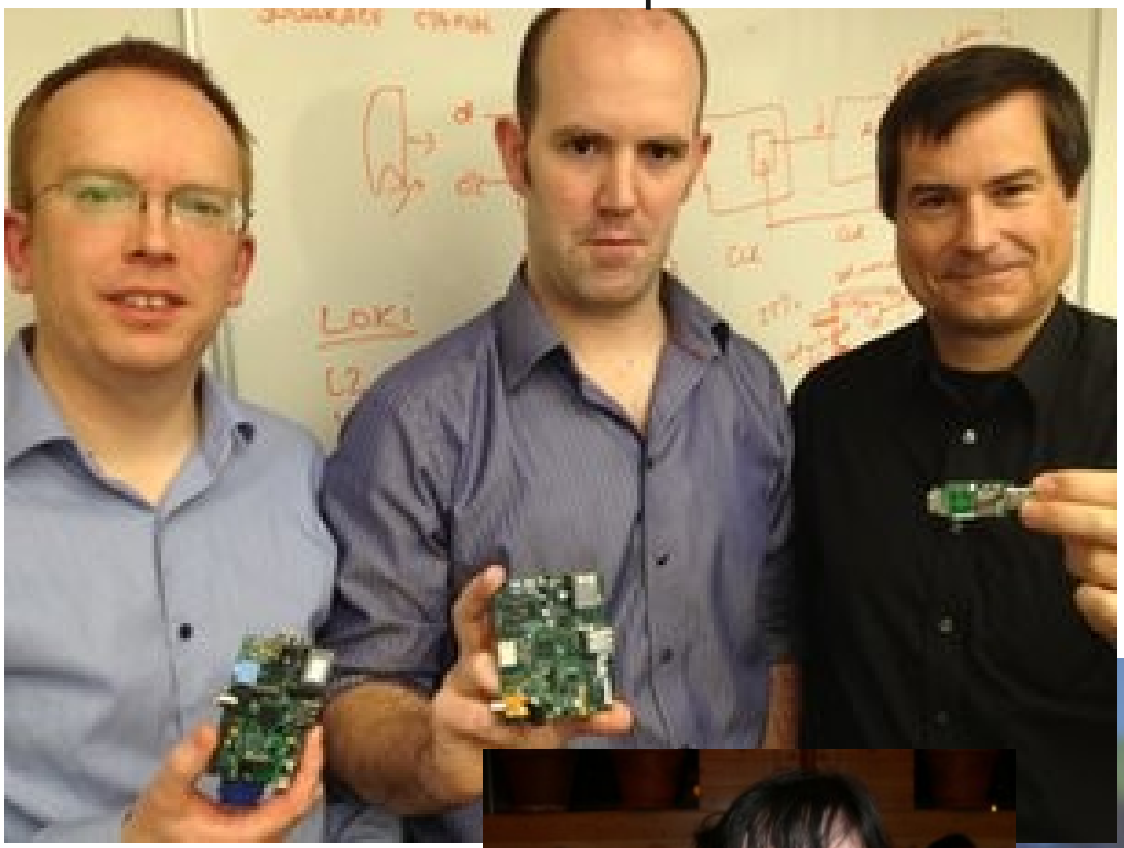
現在的電腦

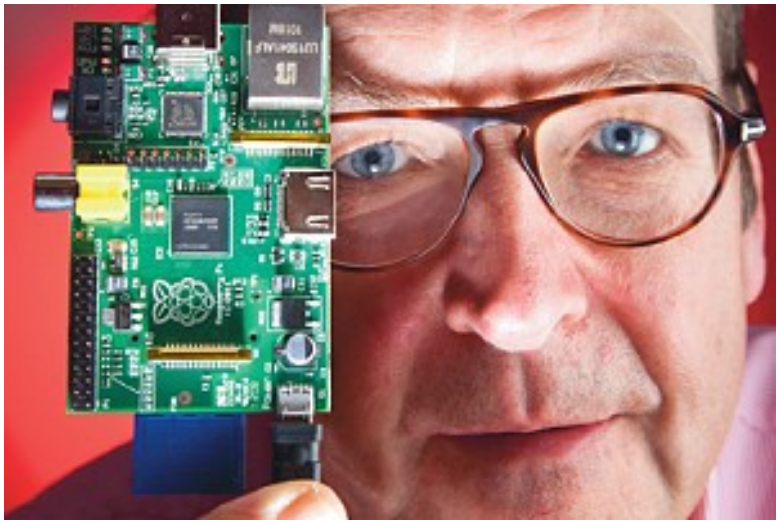
iphone 10 ?

裝置越來越聰明
人卻越來越糊塗

資訊科學系的學生不懂電腦？

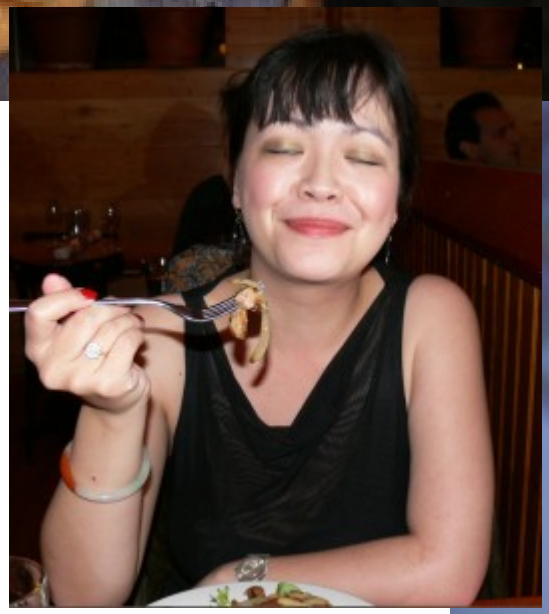
Robert Mullins Eben Upton David Braben





Jack Lang

Alan Mycroft



Liz

A criação do Raspberry Pi - com Pete Lomas - Palco Principal - Campus Party Brasil - 01/02/2013 - Foto: Flávia de Quadros/indicefoto

Pete Lomas

Raspberry Pi 是什麼？

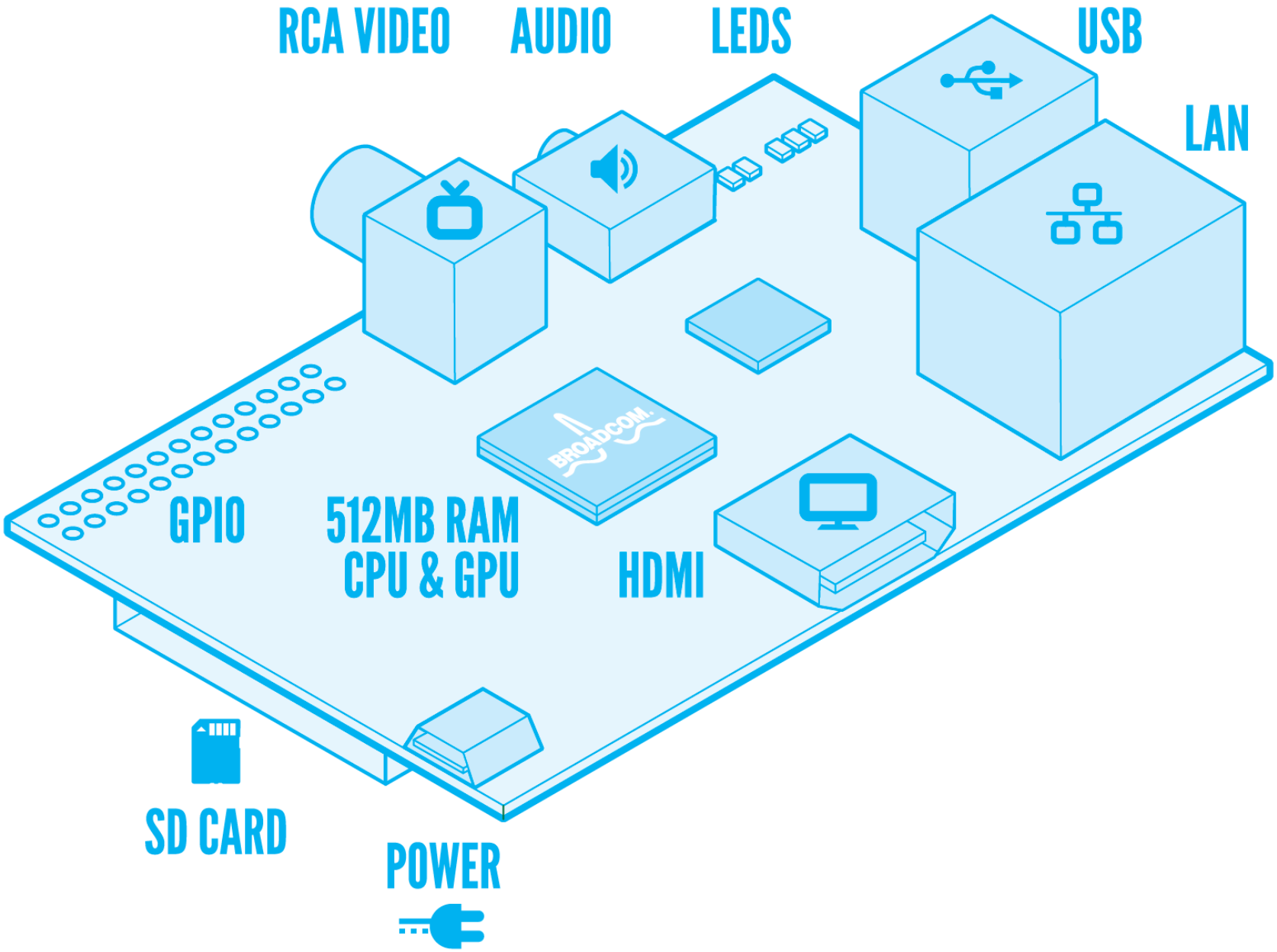
- 信用卡大小般的電腦

http://www.flickr.com/photos/fotero/7697063016/

Raspberry Pi 是 ...

- Raspberrypi.org 基金會所設計開發
- 以低價硬體 & 自由軟體刺激電腦科學教育
- 公開的 datasheet & 線路圖 & 原始碼
- 由 element14 / RS Components / Egoman 生產製造

RASPBERRY PI MODEL B



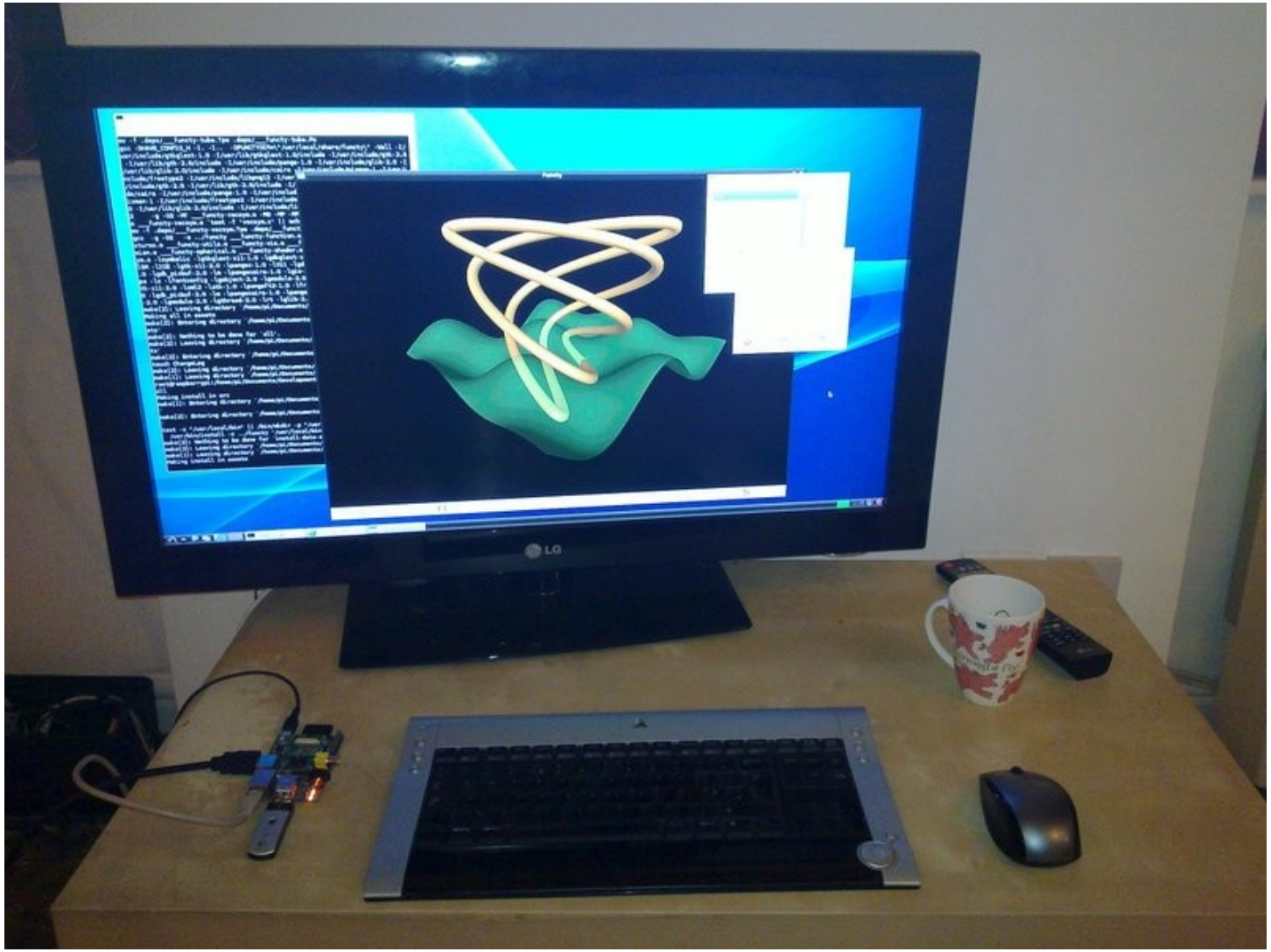
Raspberry Pi 怎麼玩？

很小，很省電的電腦

連接週邊 + OS

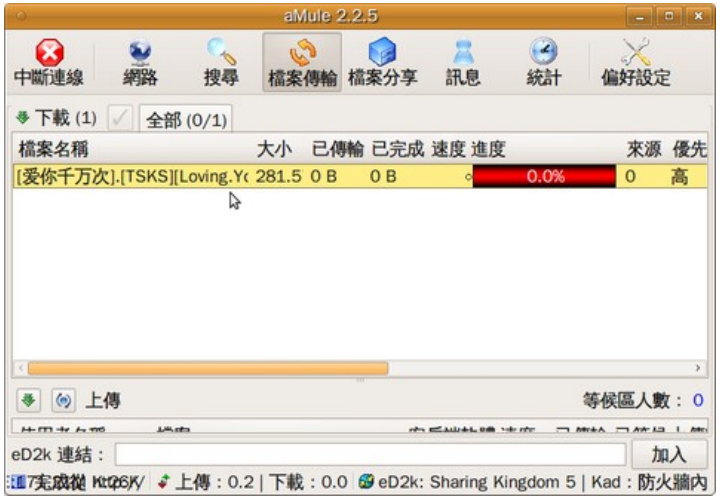
http://www.raspberrypi-tutorials.co.uk/starting-up-your-raspberry-pi-device/set-raspberry-pi/

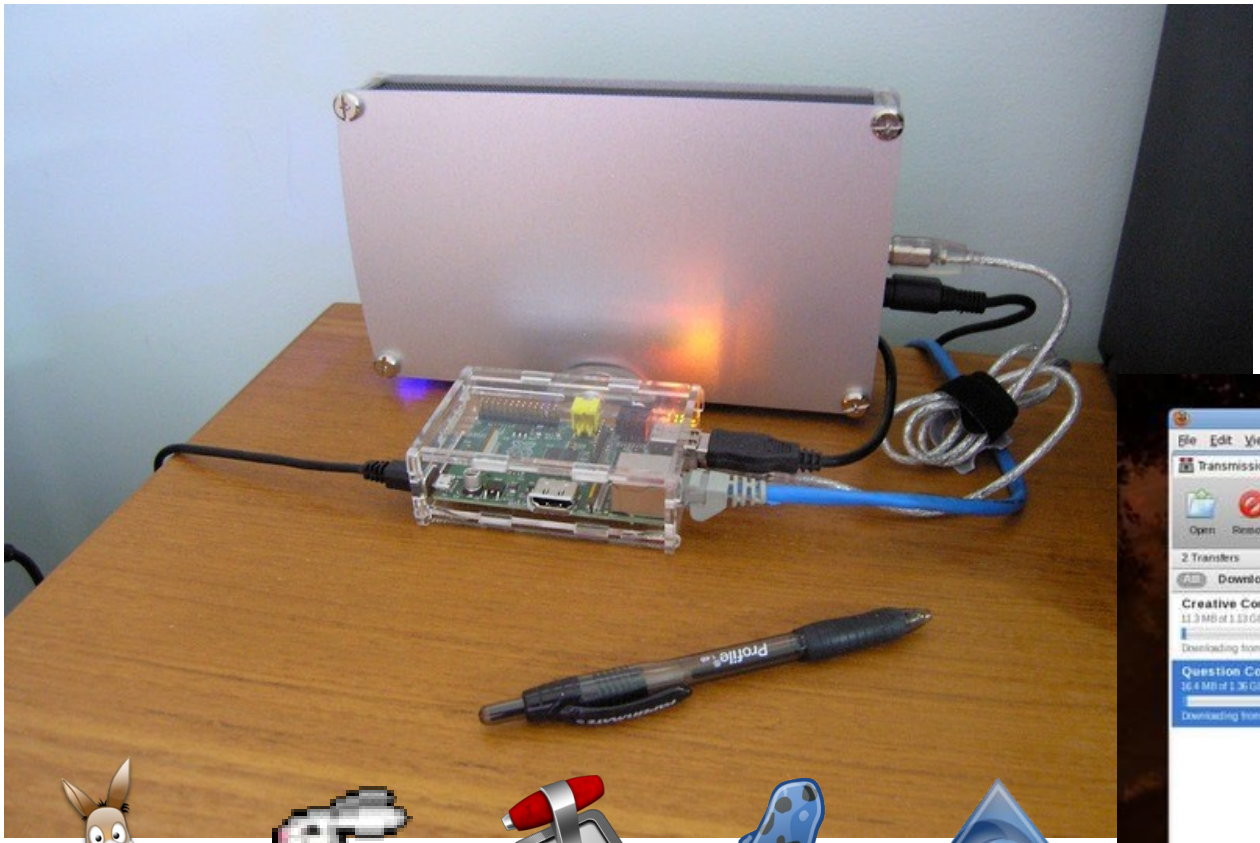
文書處理上網機

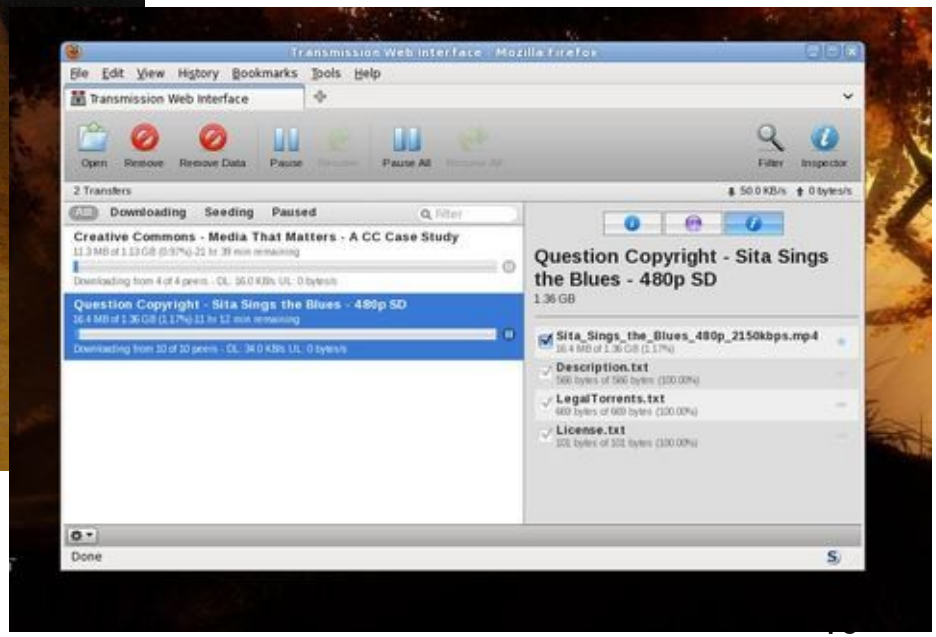


http://functy.sourceforge.net/?p=328

P2P 動物下載機



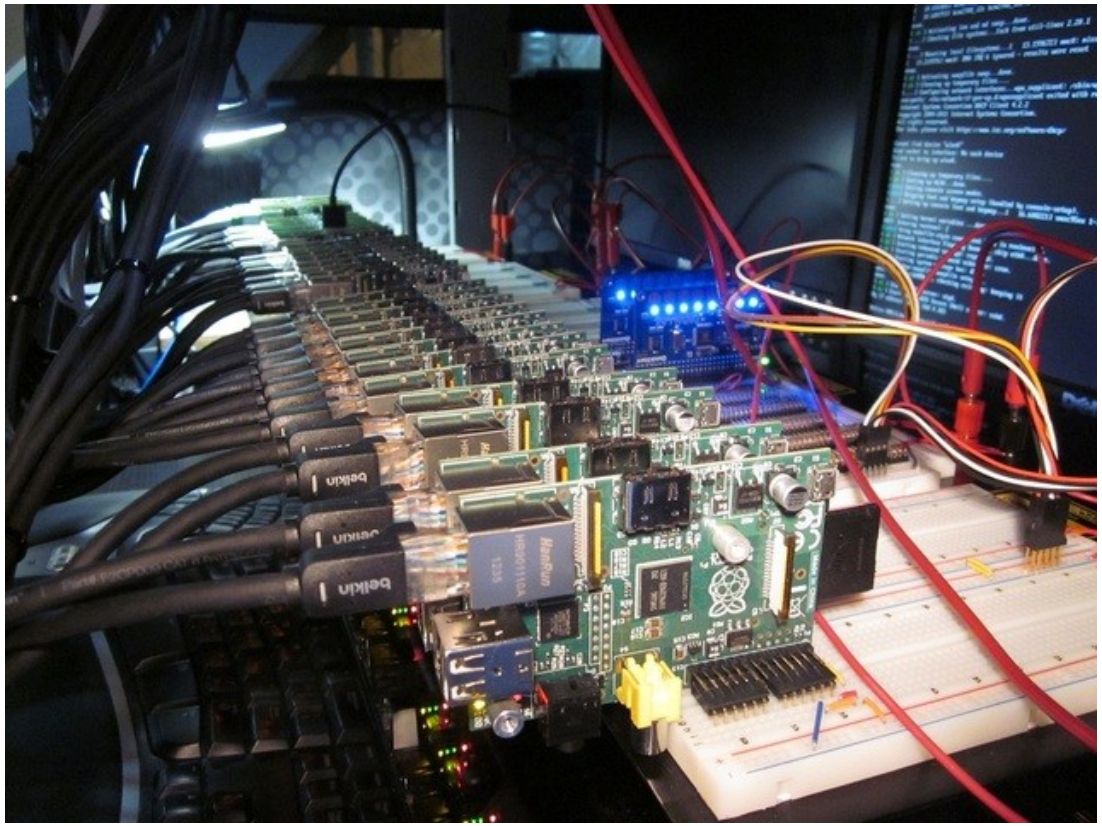




http://lcorg.blogspot.tw/2012/10/my-raspberry-pi-adventure.html

節能省電伺服器

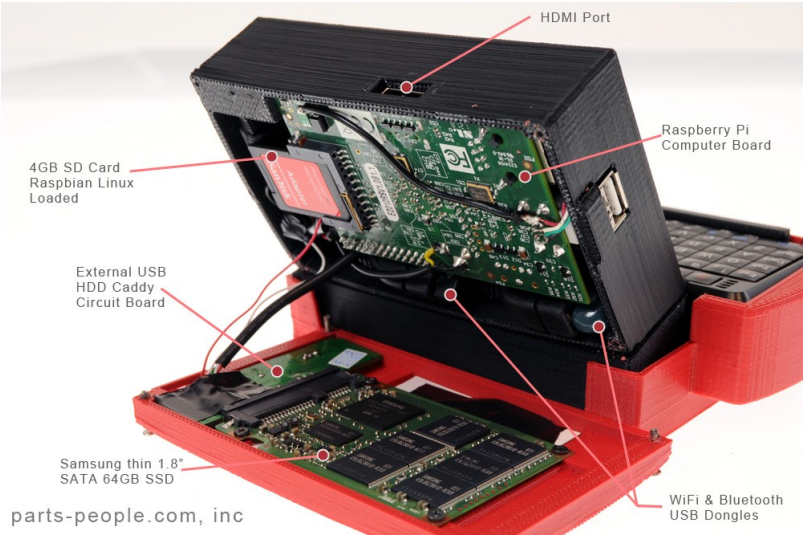
- Web Server
- Mail Server
- FTP Server
- File Server
- VPN Server
- Printer Server
- Git Server



http://eclipsejpa.blogspot.tw/2012/11/java-7-se-parallel-processing-cluster.html

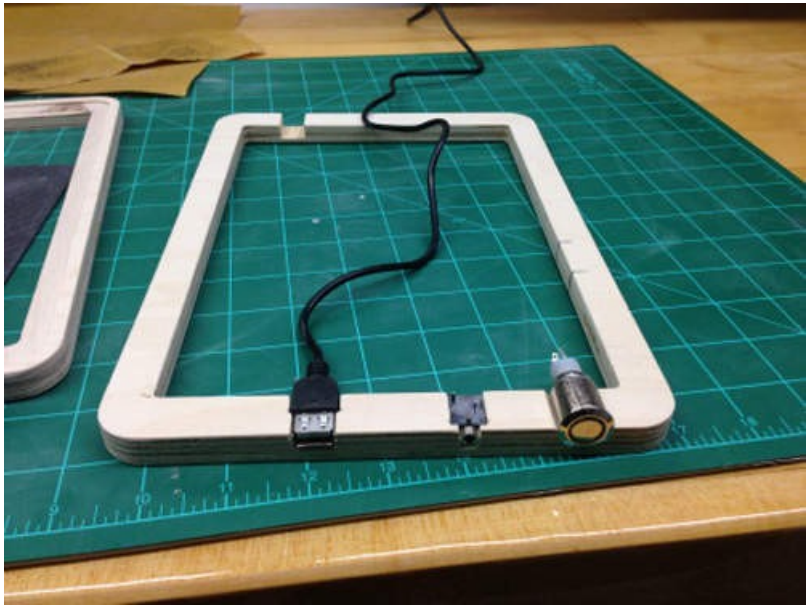
移動性

阿宅攜帶式電腦



http://blog.parts-people.com/2012/12/20/mobile-raspberry-pi-computer-build-your-own-portable-rpi-to-go/

超潮樹莓派平板



http://makezine.com/2014/01/07/how-i-built-a-raspberry-pi-tablet/

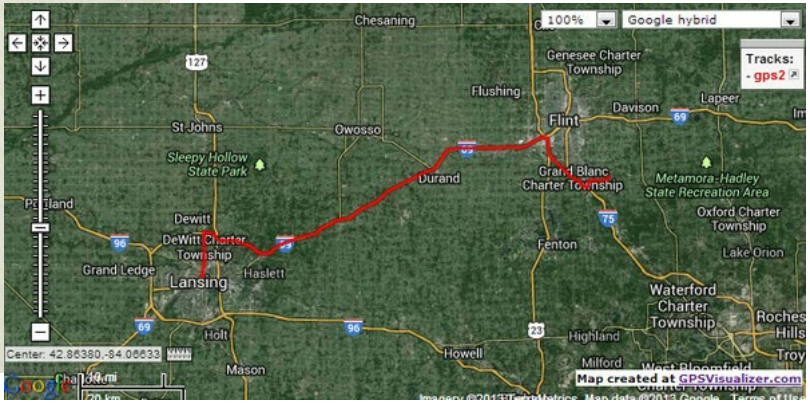
行動無線路由器

http://draalin.com/raspberry-pi-projects

無人自動監視器

http://www.flickr.com/photos/wolfpaulus/8024332721/

衛星導航系統 PiPiGo

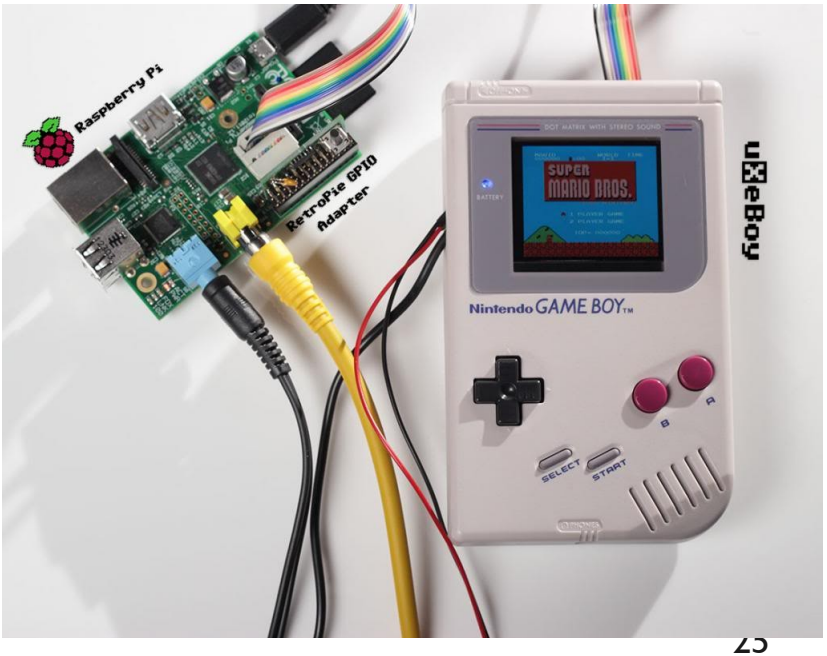


http://www.milos.ivanovic.co.nz/blog/252

娛樂性

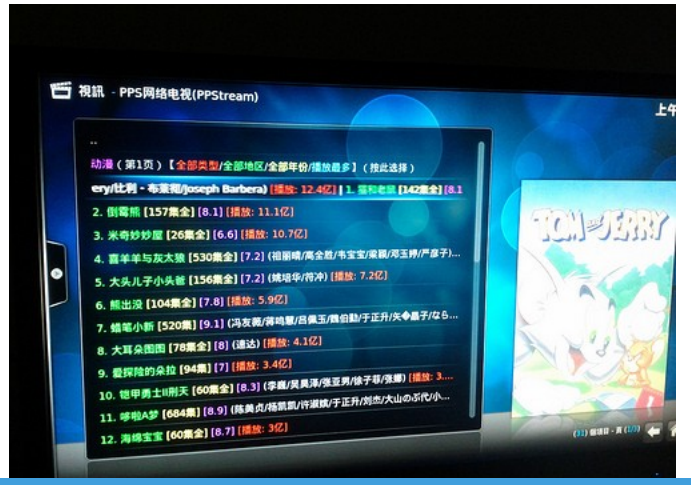
回味古早遊戲機

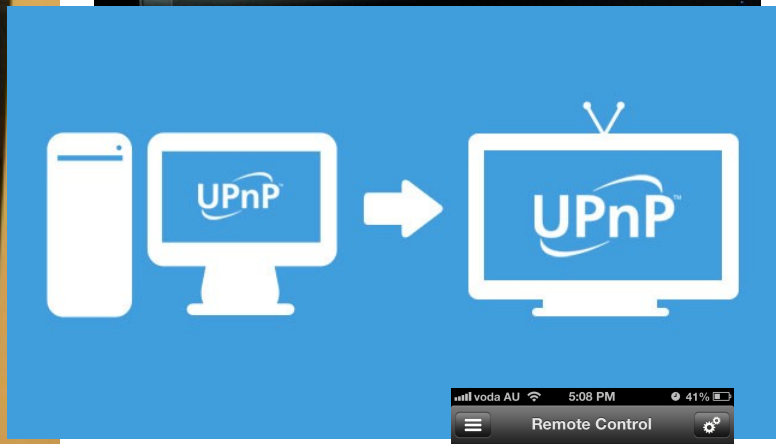
Games Not Included (Yet



http://bit.ly/1e1xaF7
http://blog.sheasilverman.com/2013/08/friday-post-my-book-raspberry-pi-gaming-now-available-for-pre-order/

多媒體娛樂中心

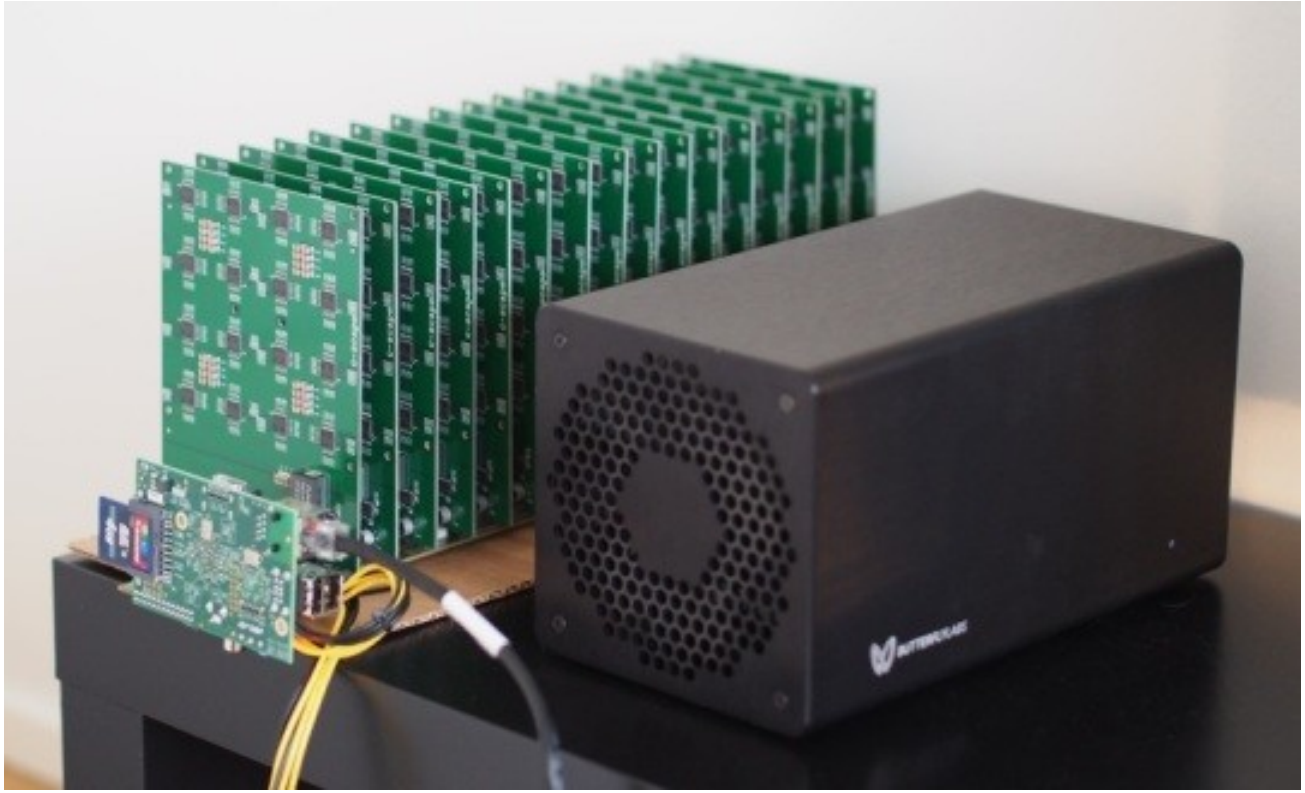




http://blog.changyy.org/2013/07/raspberry-pi-raspbmc-ppstream.html
http://geekify.me/turn-your-raspberry-pi-into-a-full-fledged-media-centre-with-xbmc/

擴充性

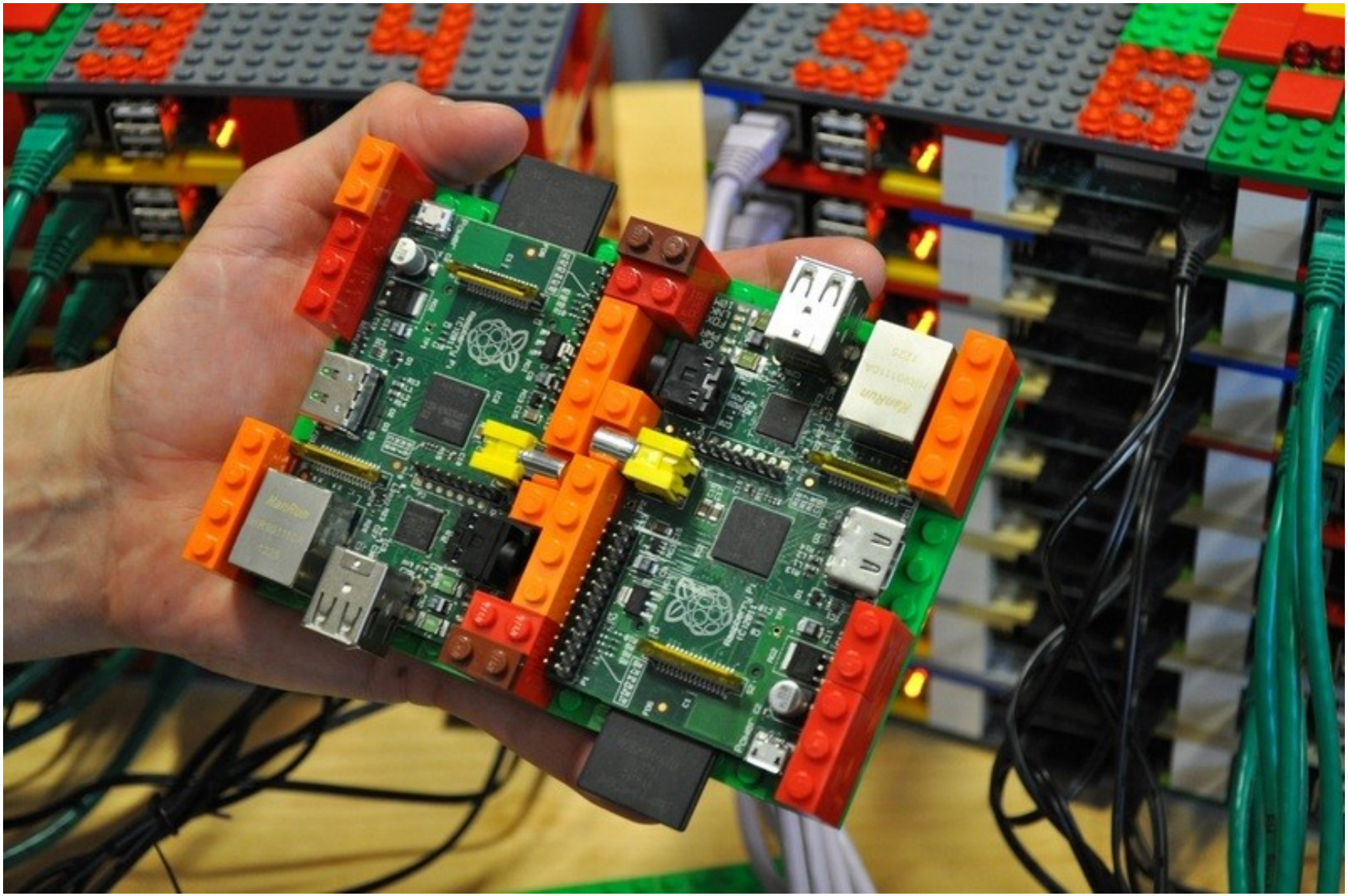
Bitcoin 採礦機



Company	Product	Cost (BTC)	Cost (USD)	Cost (EUR)	Speed (GHash/sec)	Power (Watts)
ASICMiner	Block Erupter USB	0.18	26	19	0.3	3
ASICMiner	Block Erupter Blade (overclock)	4.00	583	432	10.7	75
Avalon	Batch 3	75.00	10,935	8,100	65.0	620
Bitfury (EU)	Starter Kit (EU October Delivery)	9.26	1,350	1,000	25.0	40
Bitfury (EU)	Full Kit (EU August Delivery)	138.89	20,250	15,000	400.0	380
Bitfury (EU)	Full Kit (EU October Delivery)	69.44	10,125	7,500	400.0	380
Bitfury (US)	Starter Kit (October Delivery)	8.92	1,300	963	25.0	40
Bitfury (US)	Full Kit (August Delivery)	132.03	19,250	14,259	400.0	380
Bitfury (US)	Full Kit (October Delivery)	54.87	8,000	5,926	400.0	380

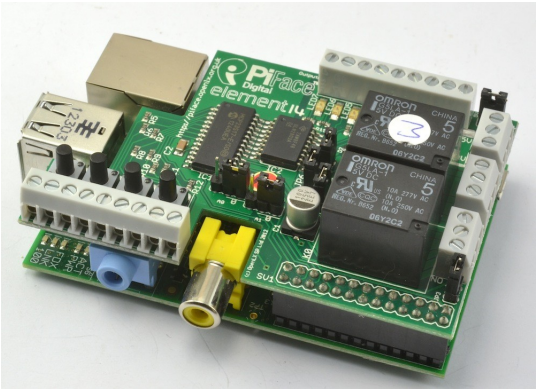
http://thegenesisblock.com/bitfury-begins-shipping-to-customers/

平行處理運算叢集

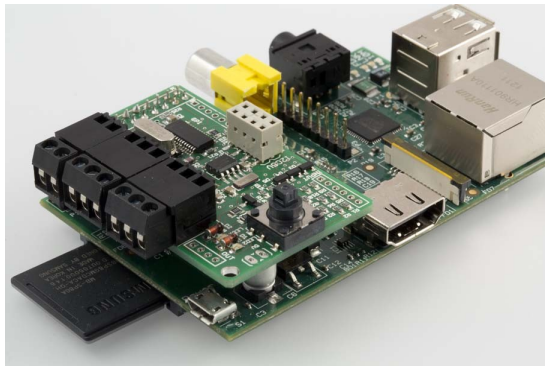


http://arstechnica.com/information-technology/2012/09/university-builds-cheap-supercomputer-with-raspberry-pi-and-legos/

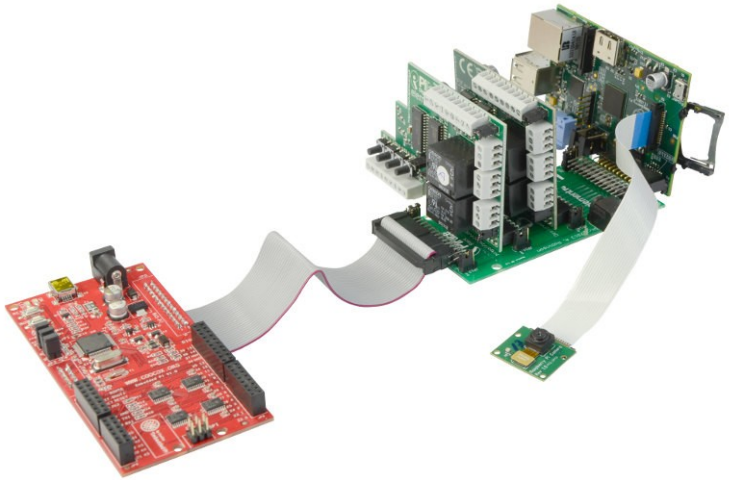
各式擴充板



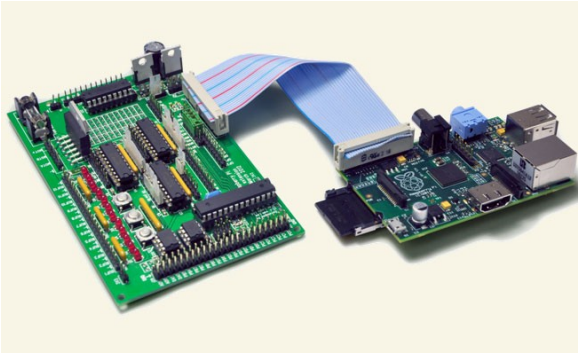
PiFace



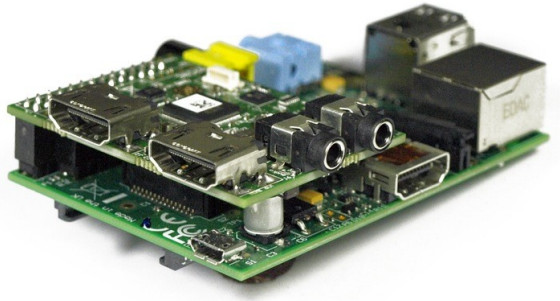
raspicomm



Pi Rack + Embedded Pi

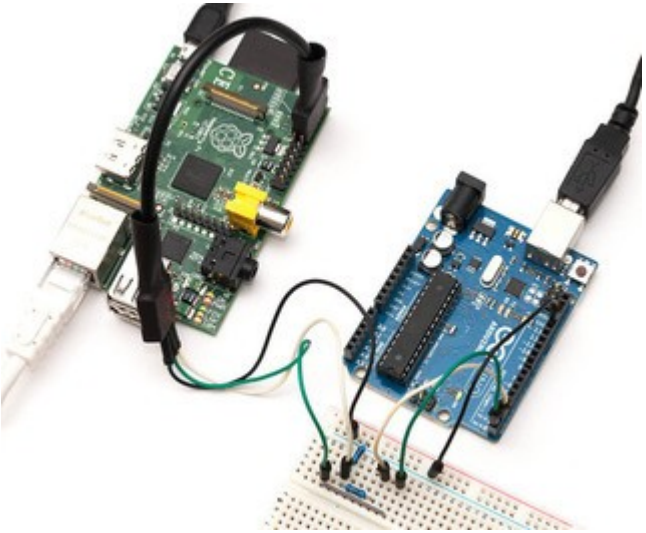


Gertboard



Wolfson Audio Card

cooking-hacks



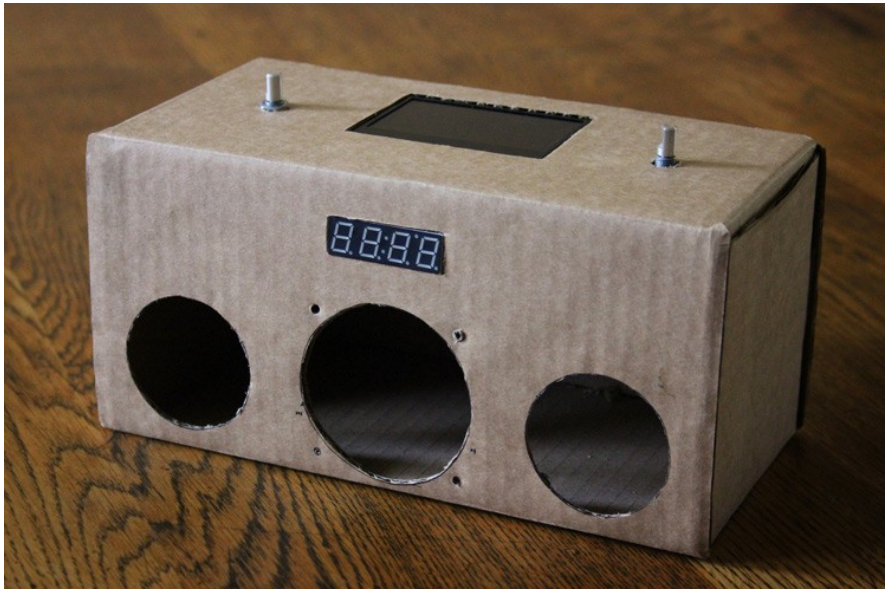
Arduino

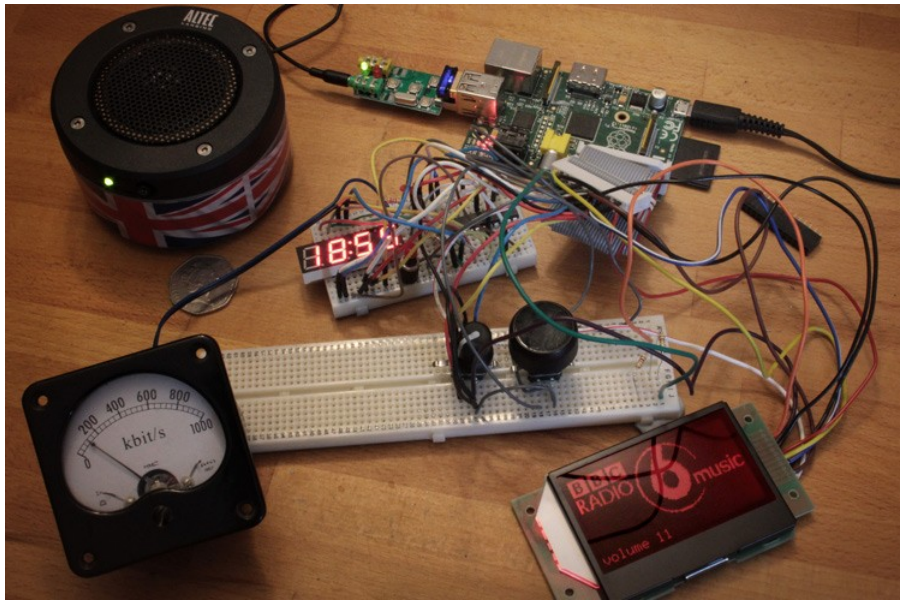
AlaMode

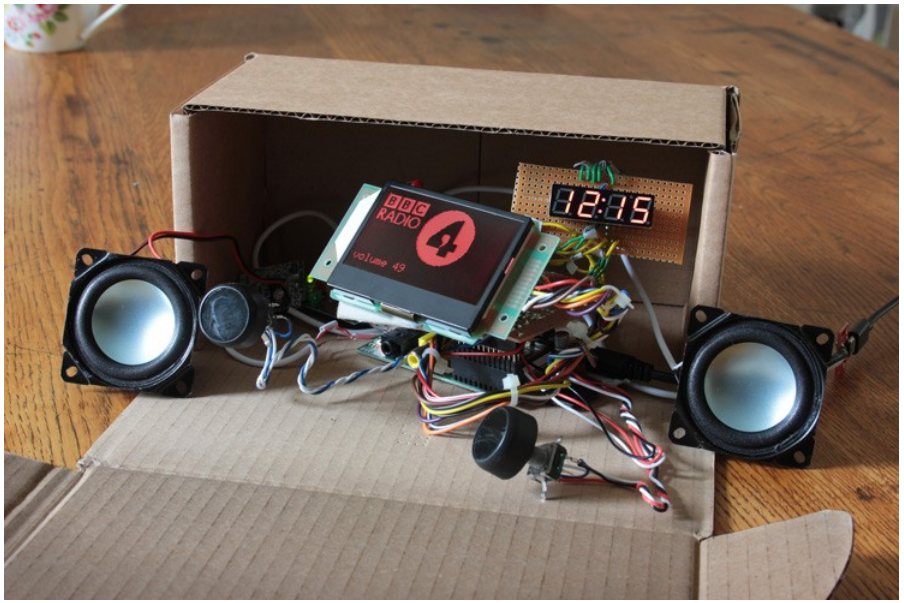
Raspberry Pi 還可以怎麼玩？

Raspberry Pi 還可以怎麼玩？
玩他的 GPIO - 跟周遭的硬體互動吧

無線網路收音機

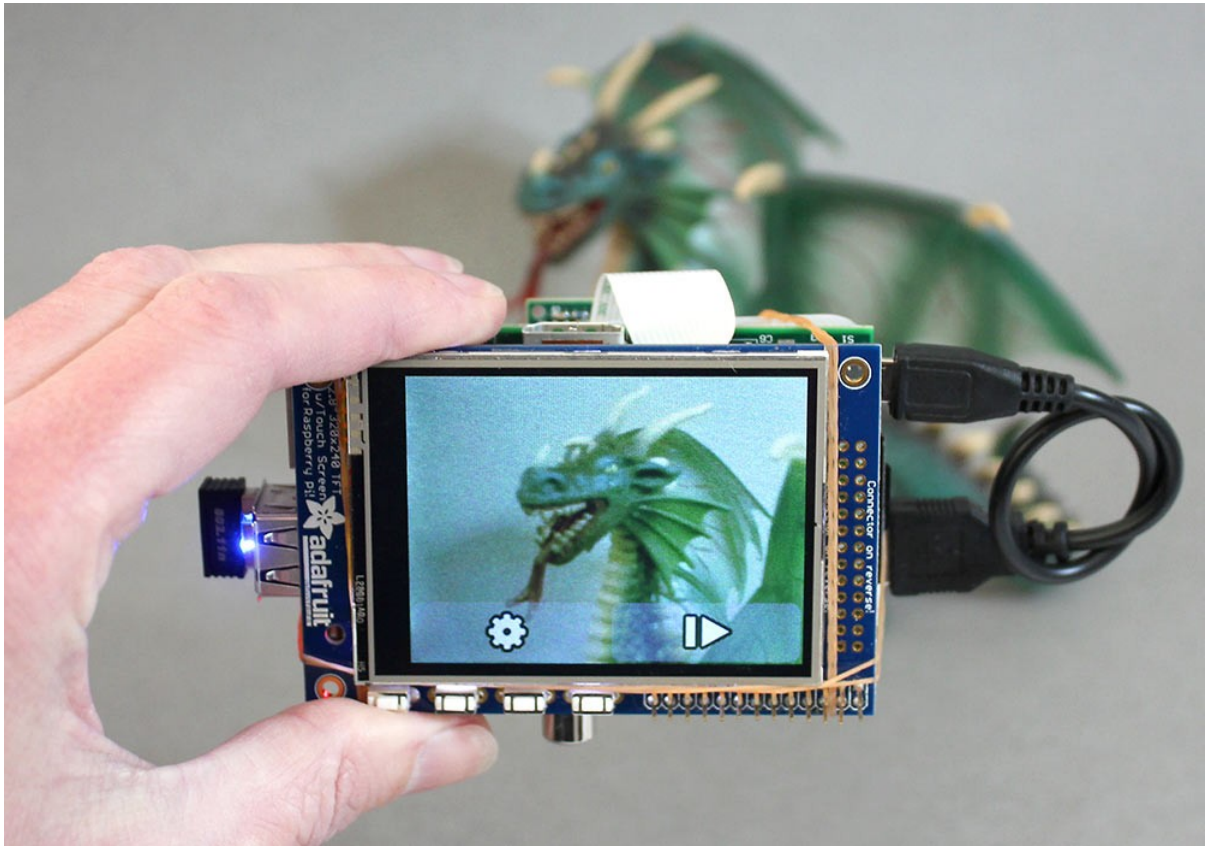


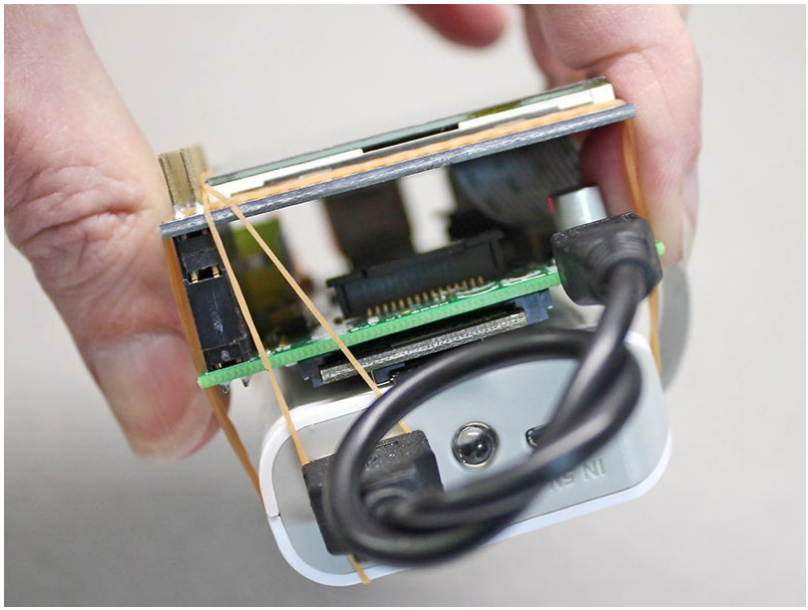




http://www.plingboot.com/2013/08/cardboard-raspberry-pi-wifi-internet-radio/

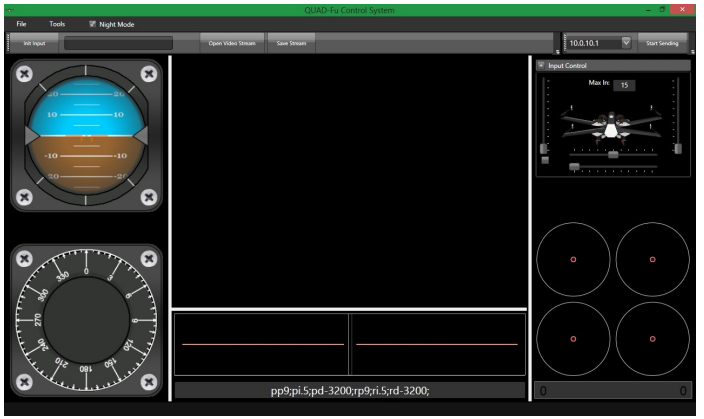
Pi 相機

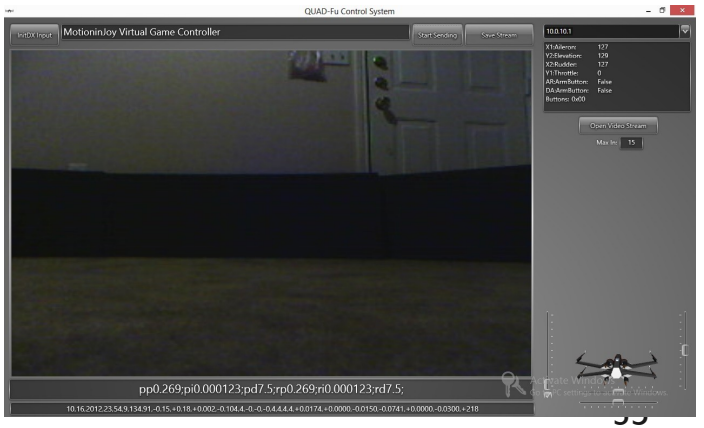




http://learn.adafruit.com/diy-wifi-raspberry-pi-touch-cam

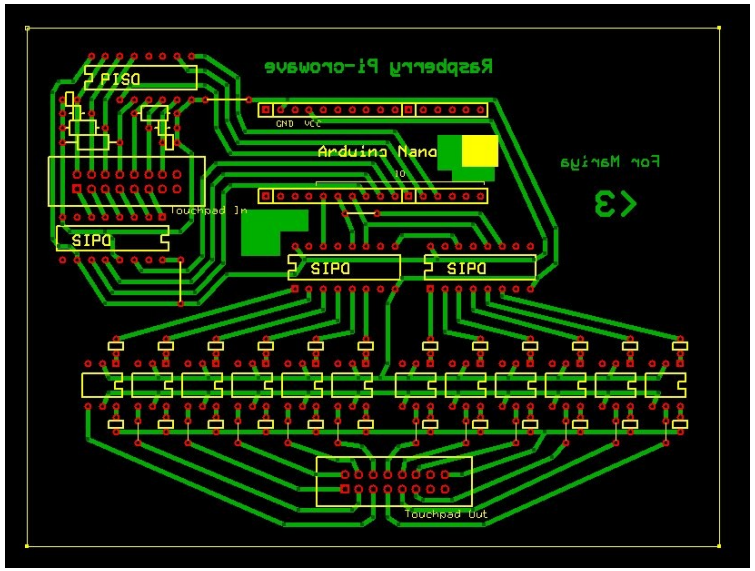
四軸飛行器

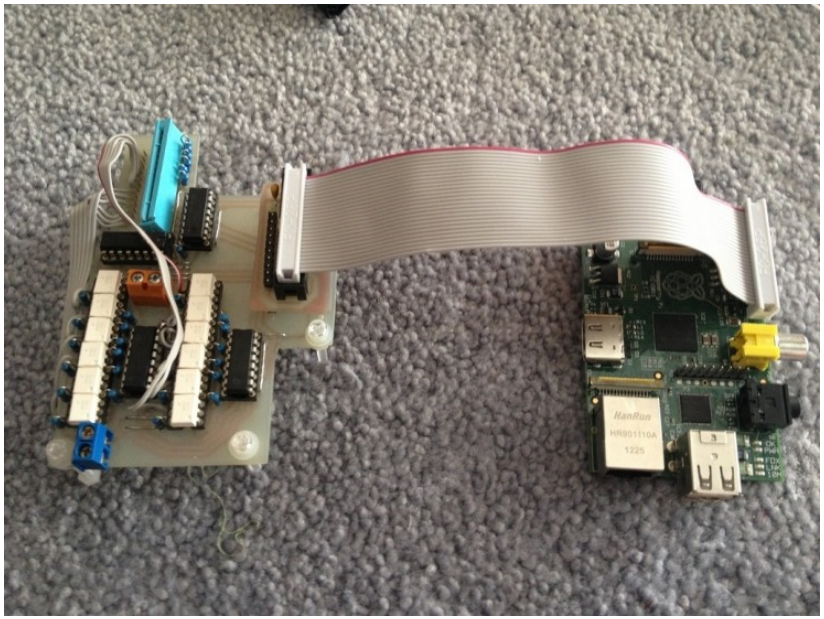


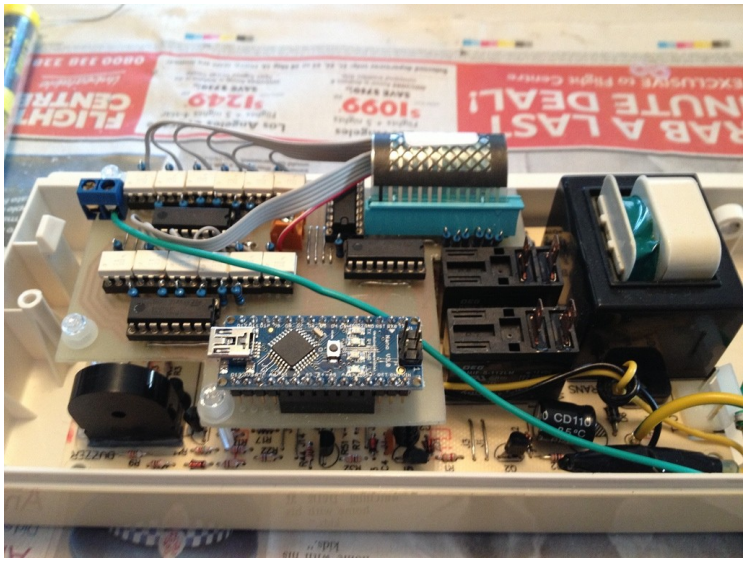


http://diydrones.com/forum/topics/the-raspberry-pi-quad-fu-project

語音輸入微波爐

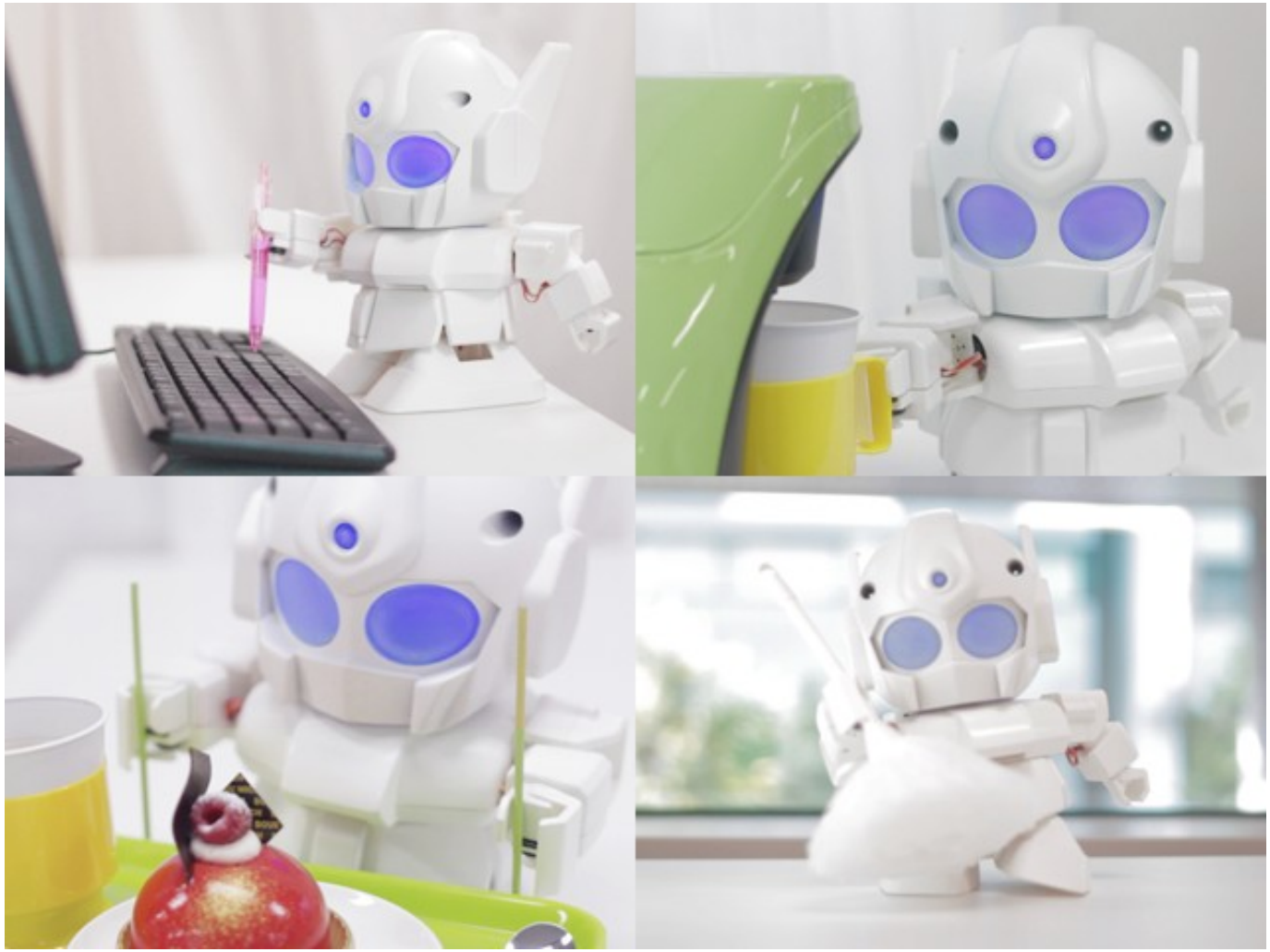






http://madebynathan.com/2013/07/10/raspberry-pi-powered-microwave/

鍵盤打掃機器人



402
backers

£75,099
pledged of £20,000 goal

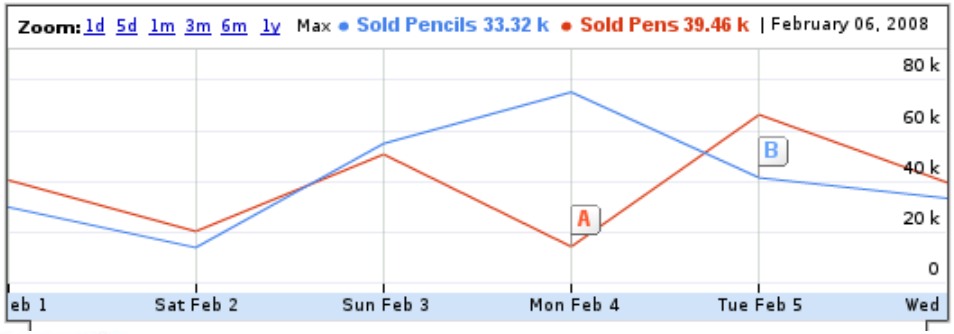
0
seconds to go

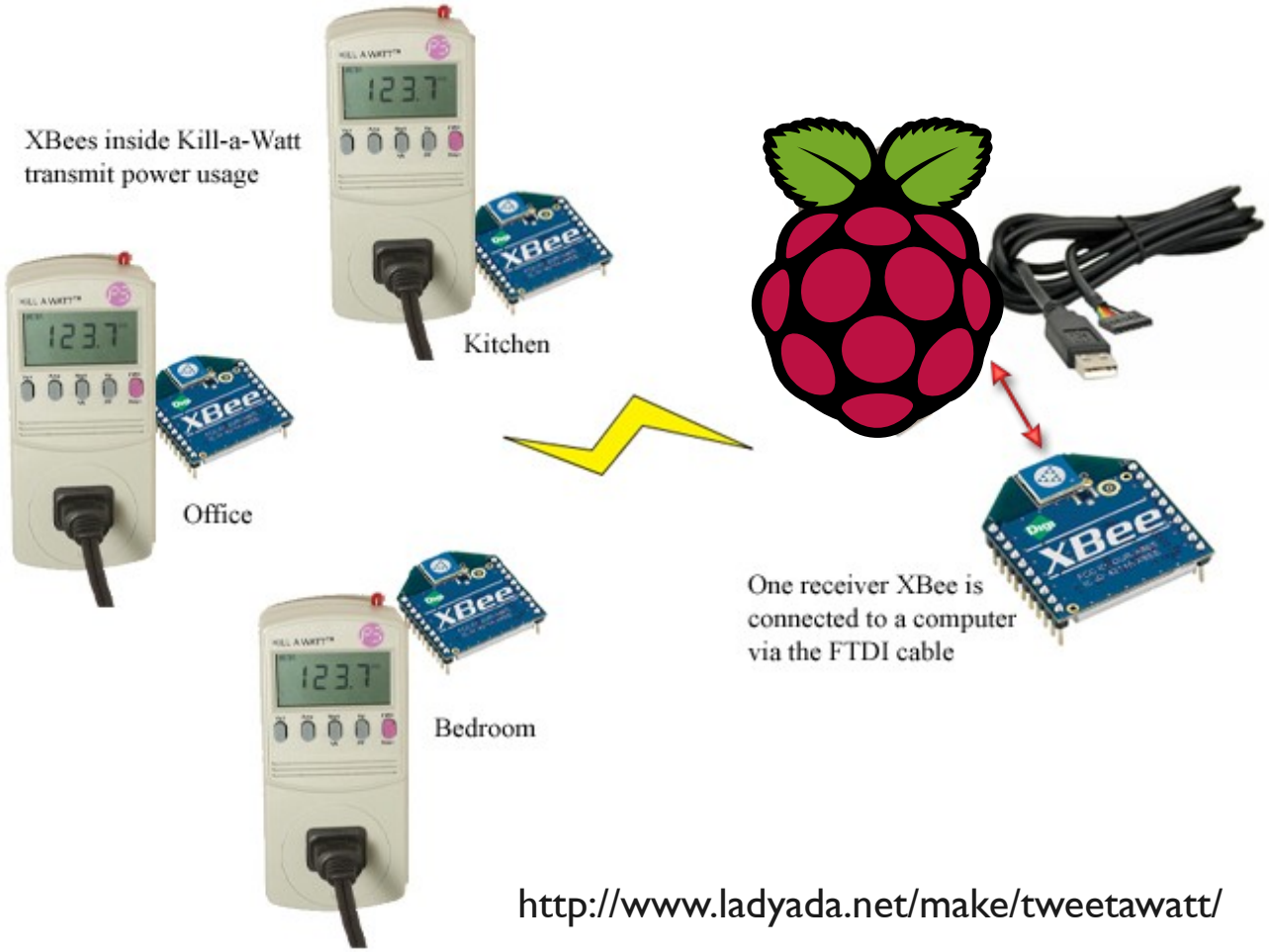
Funding period
Jun 20, 2013 - Aug 19, 2013 (60 days)

Project by
Shota Ishiwatari
Tokyo, Japan
Contact me

http://www.kickstarter.com/projects/shota/rapiro-the-humanoid-robot-kit-for-your-raspberry-p

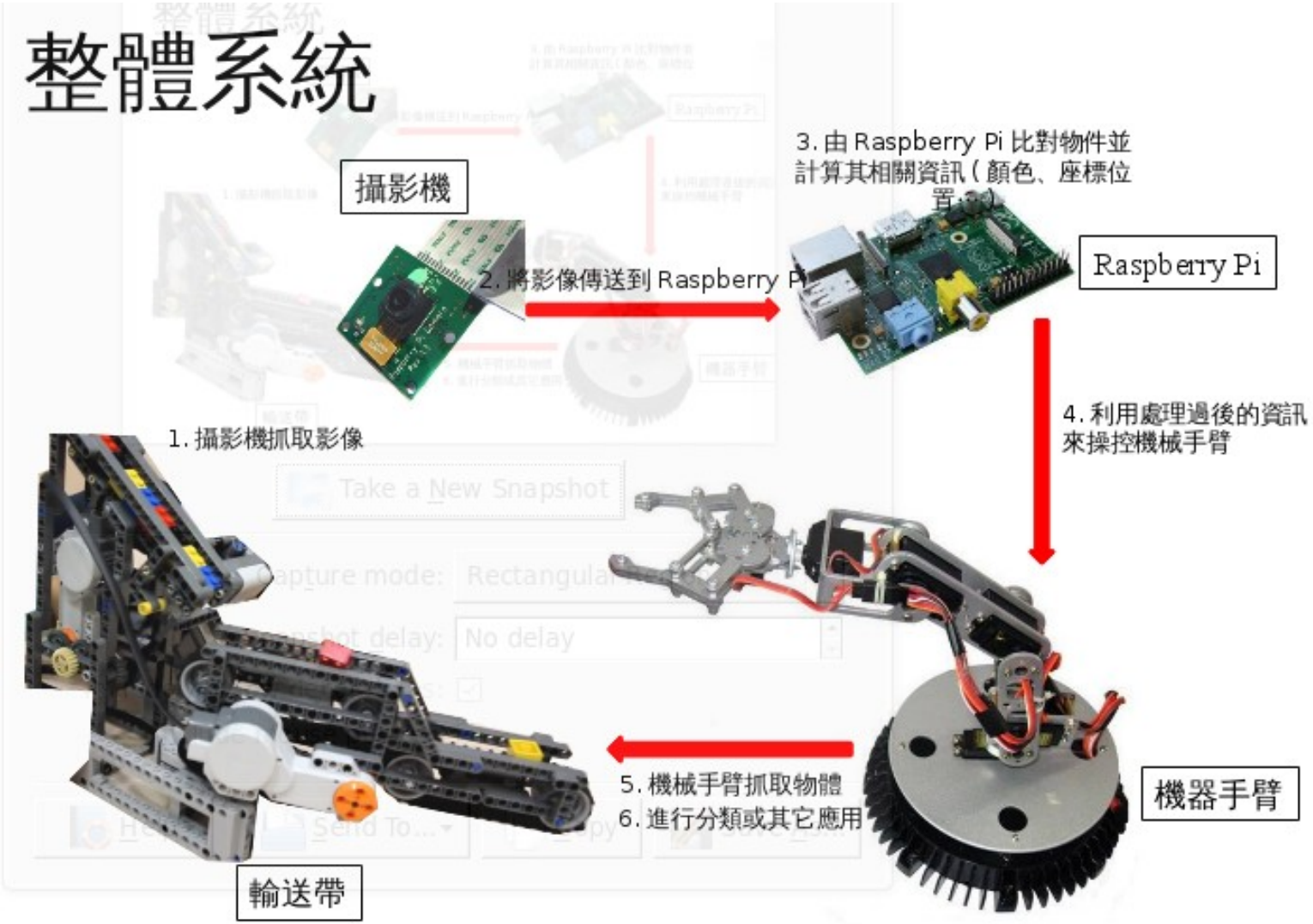
智慧節能家電控制





http://www.ladyada.net/make/tweetawatt/

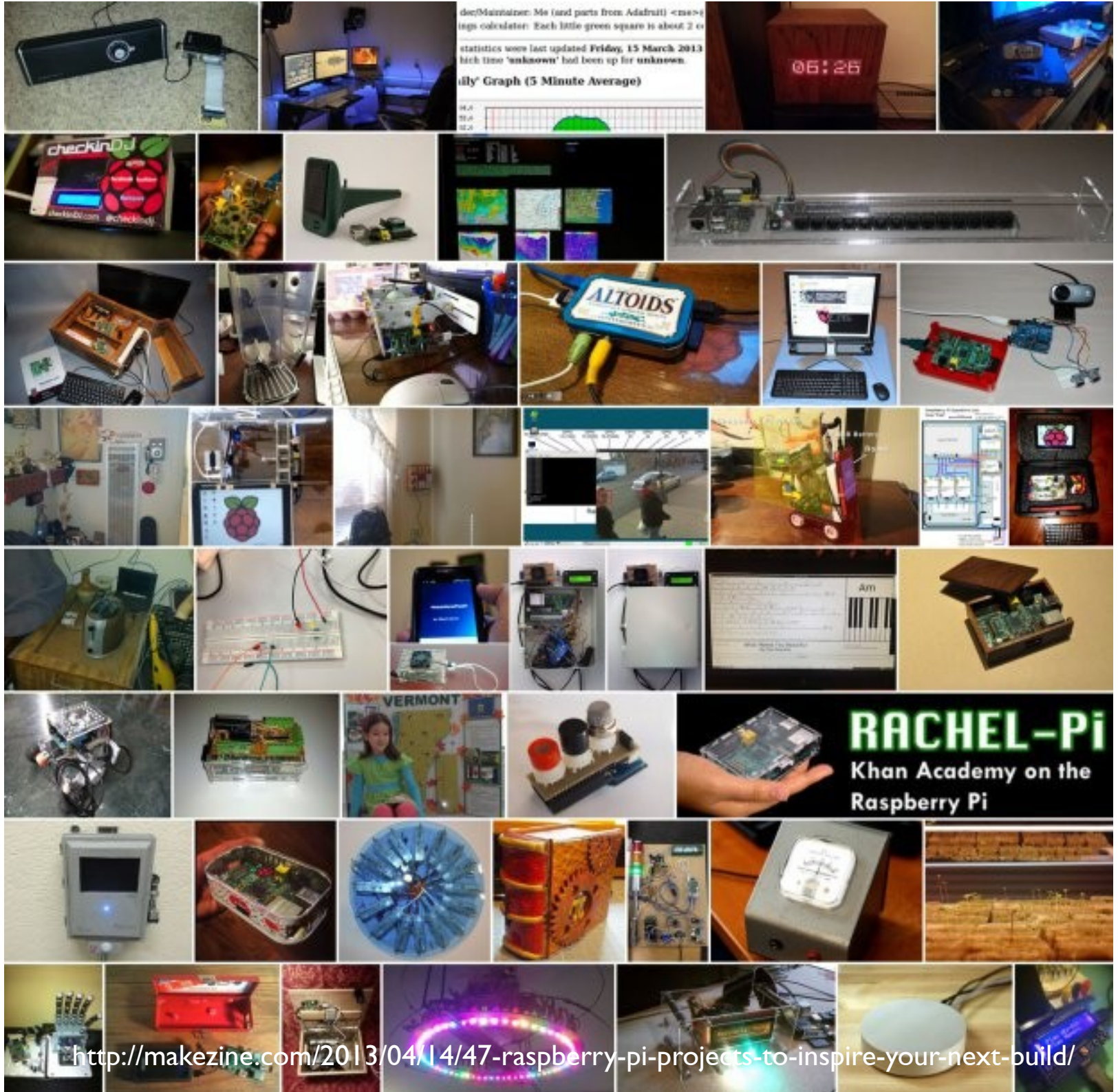
成大資工期末專題



進階嵌入式系統開發與實作 - 影像伺服系統 (Visual Servo System)

http://wiki.csie.ncku.edu.tw/embedded/team2013-3

更多應用 ...



http://makezine.com/2013/04/14/47-raspberry-pi-projects-to-inspire-your-next-build/

DEMO

我們可以從 Raspberry Pi 學到什麼？

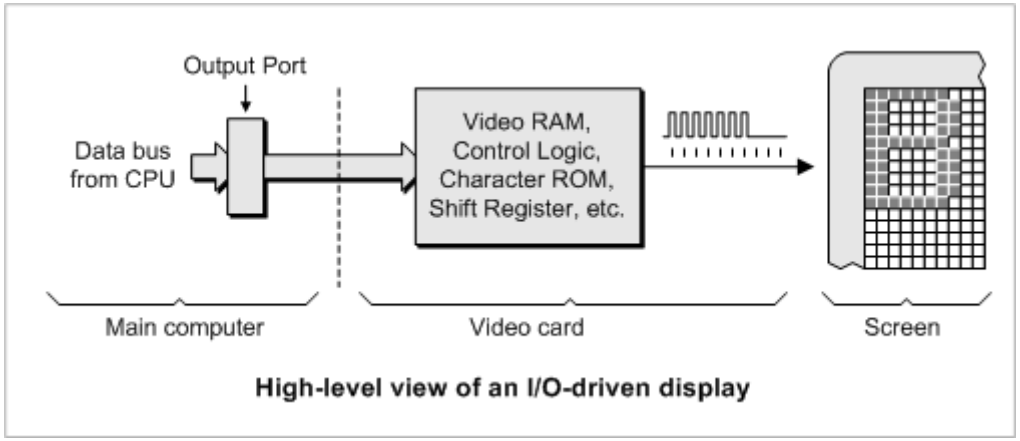
軟體 + 硬體的整合

軟體 + 硬體的整合
一個讓 LCD 亮起來的例子

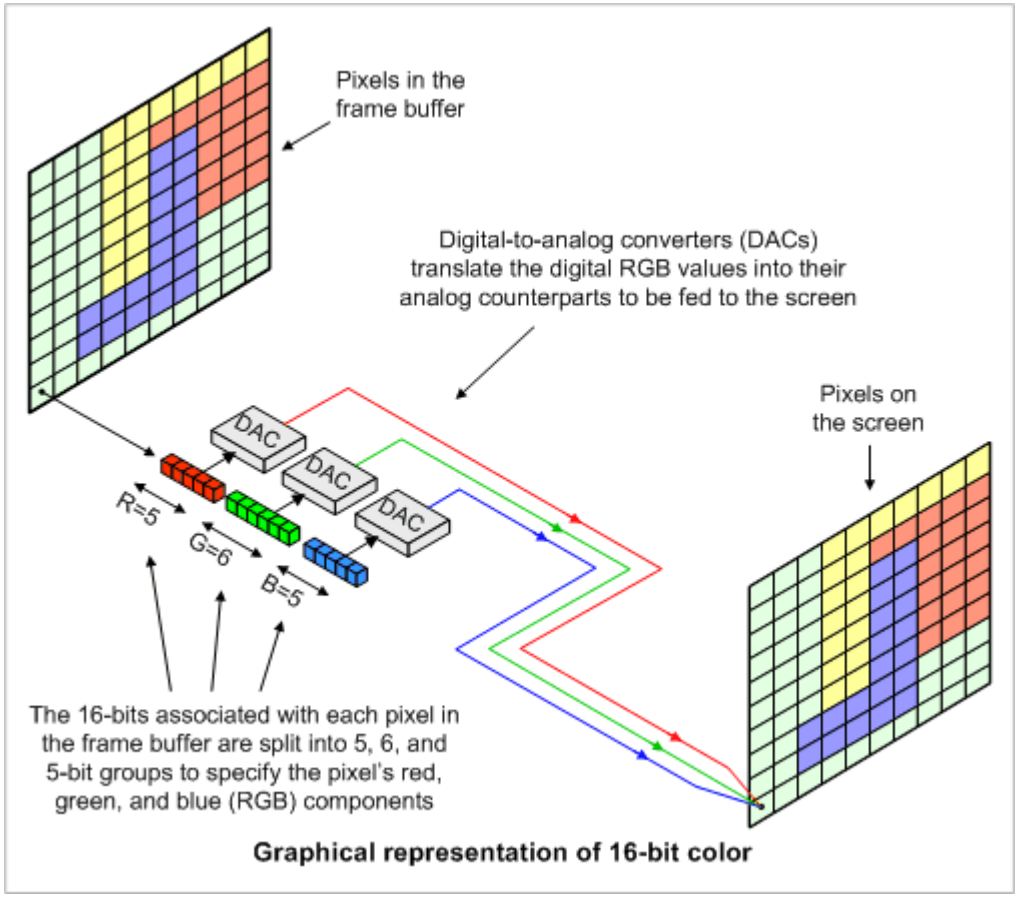
OCR
OCR Resources
IDLE
Scratch
Pi Store
Midori
Debian Reference
10:33
3231

先從硬體架構講起

LCD 和 Framebuffer 的關係



High-level view of an I/O-driven display



Graphical representation of 16-bit color

http://www.kickstarter.com/projects/shota/rapiro-the-humanoid-robot-kit-for-your-raspberry-p

16-bit = 16 pin

現實是：沒有這麼多腳位可以用

4094 - 序列轉並列

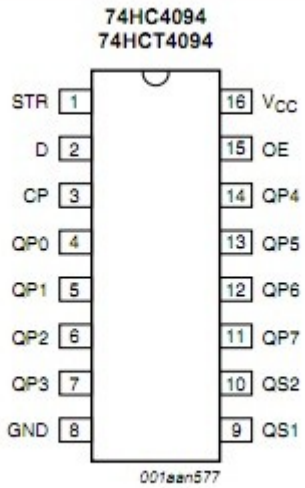


Fig 5. Pin configuration DIP16 and SO16

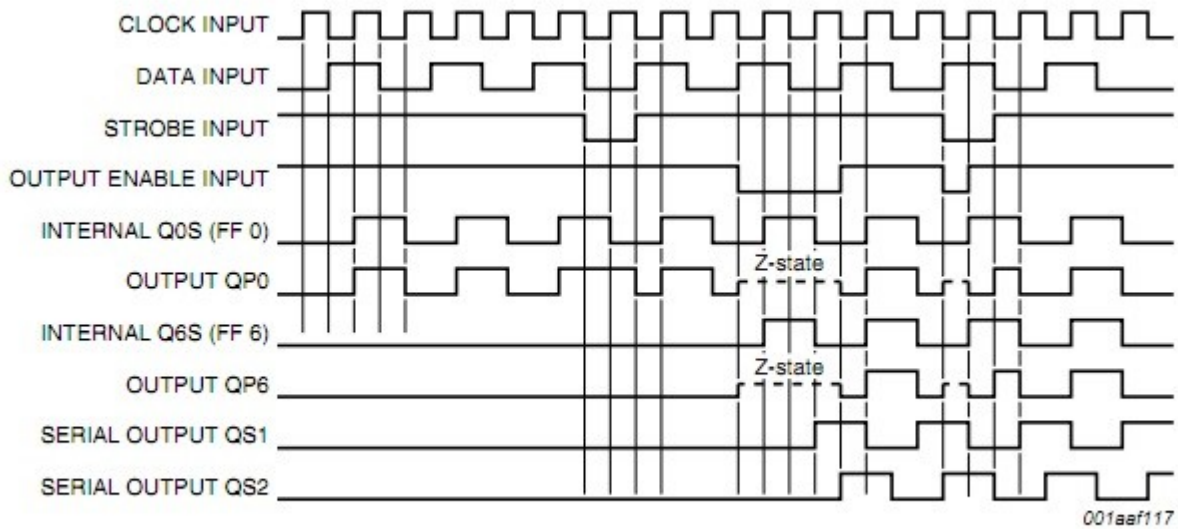
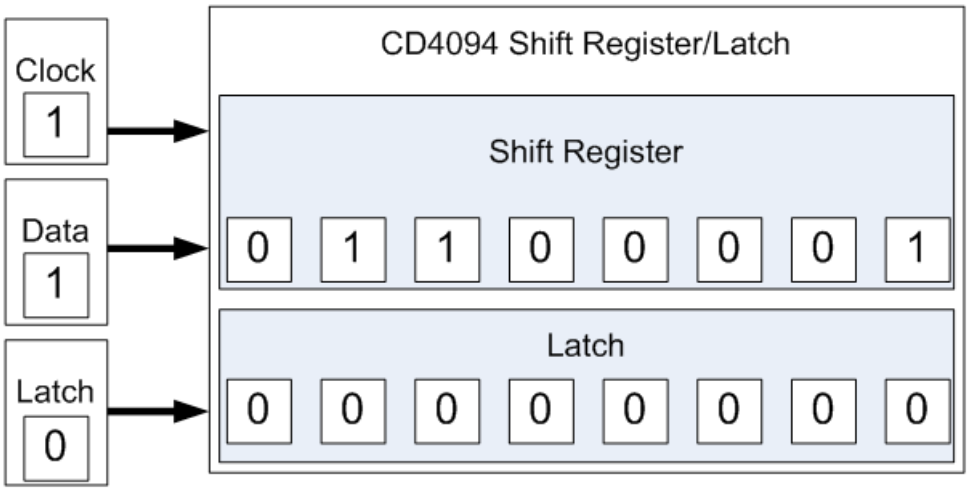


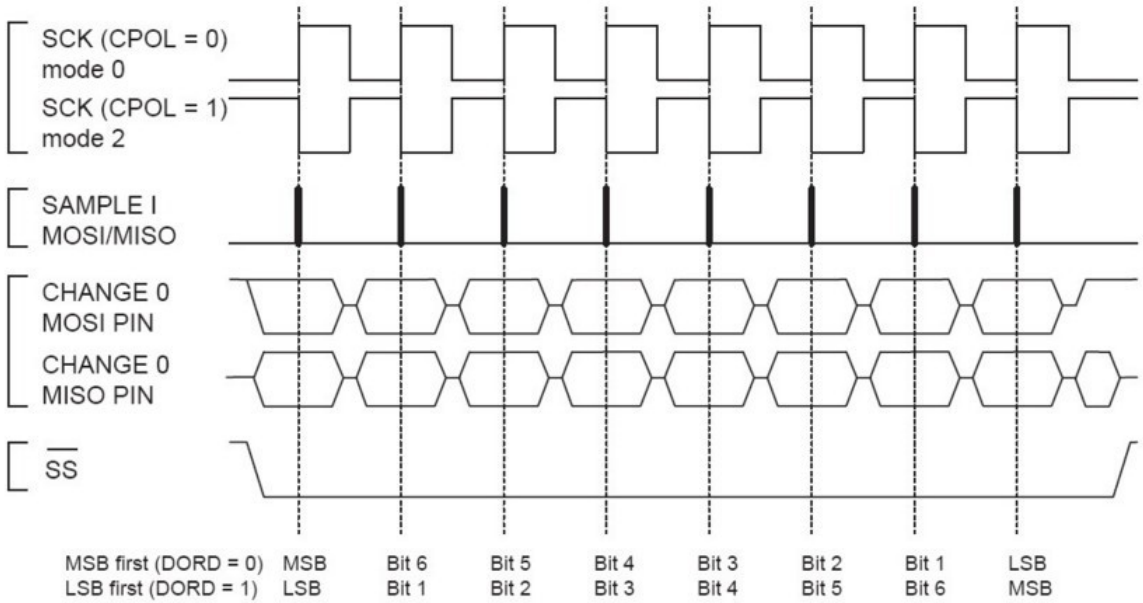
Fig 7. Timing diagram

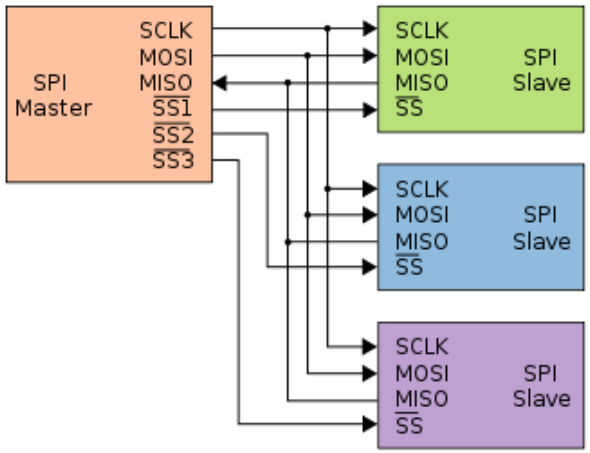


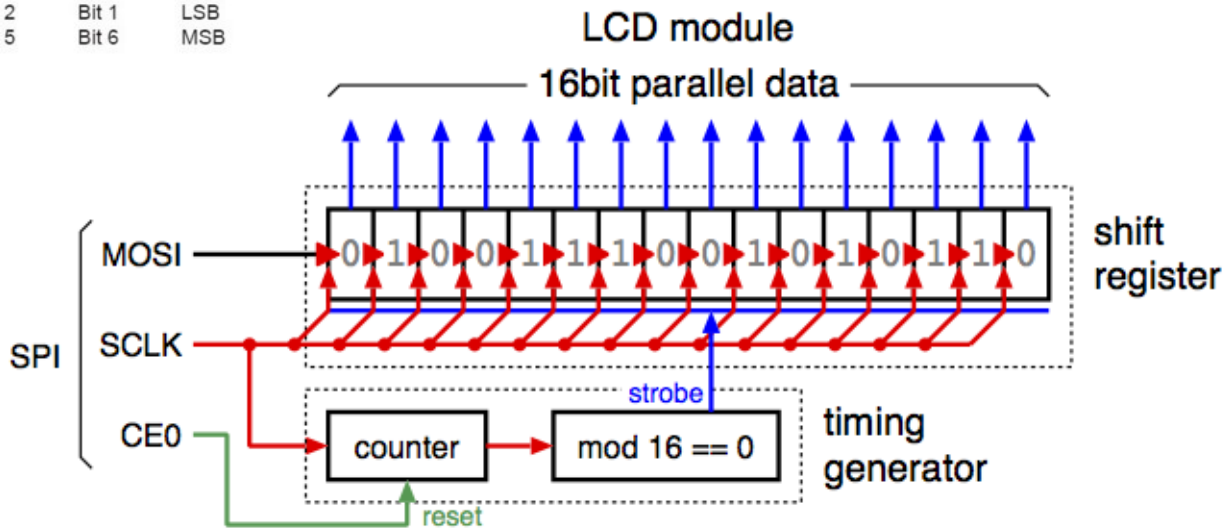
http://www.channel9.msdn.com
http://www.xuan.idv.tw/wordpress/?p=1181

SPI Protocol - 和 LCD 訊號同步

Figure 62. SPI Transfer Format with CPHA = 0

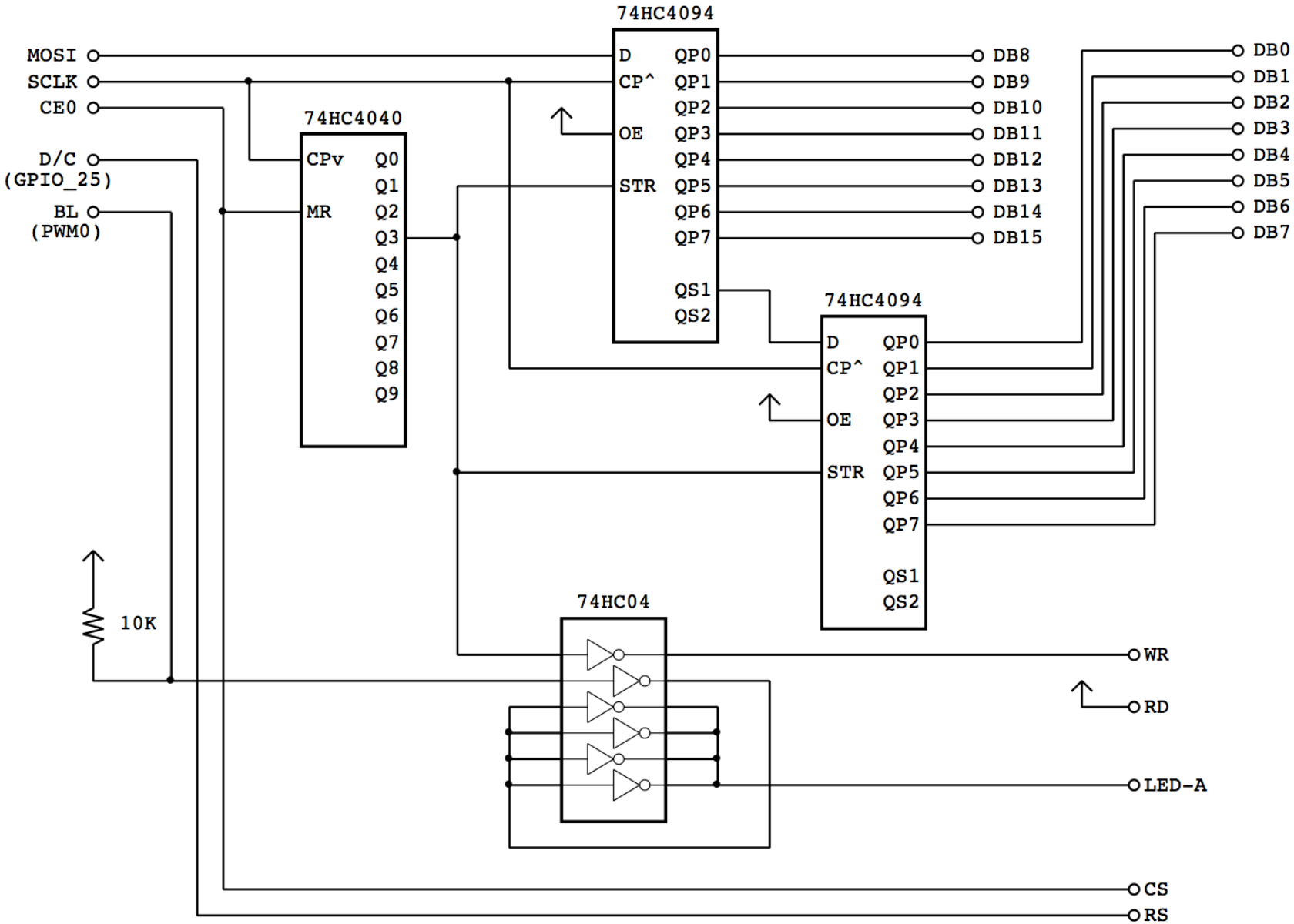






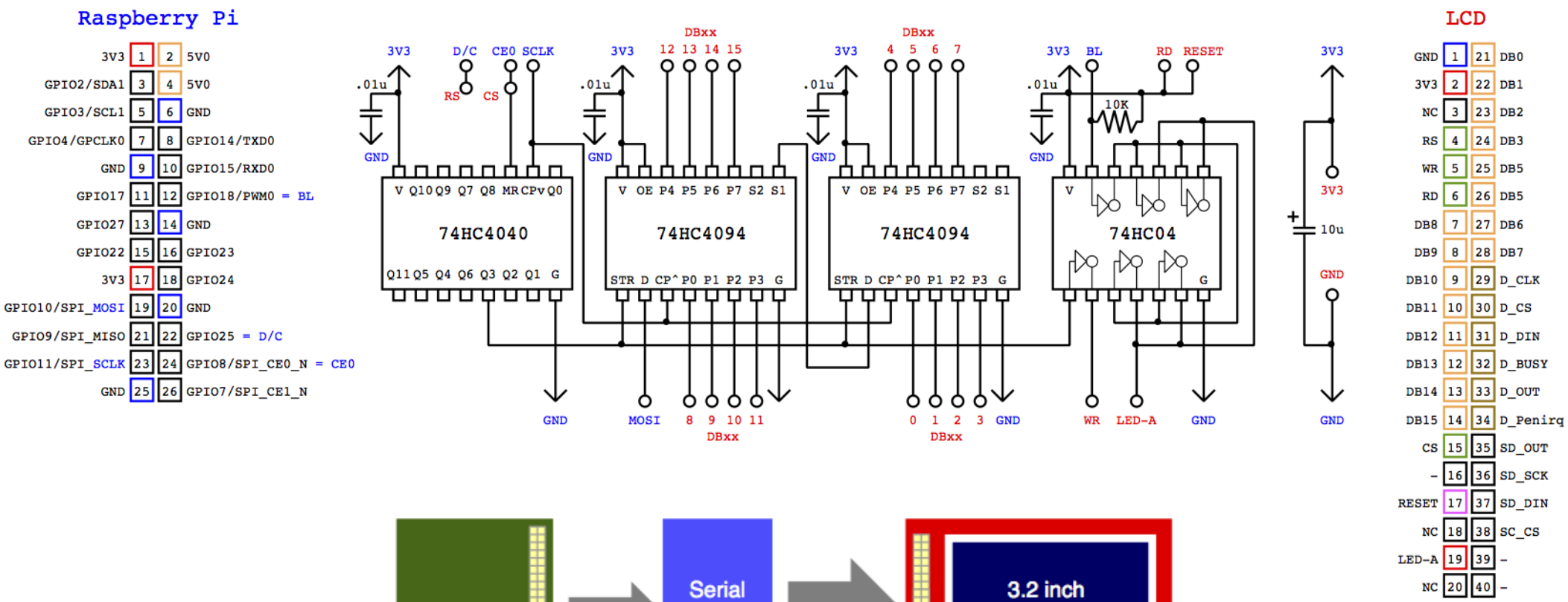
http://avrhelp.mcselec.com/index.html?using_the_spi_protocol.htm

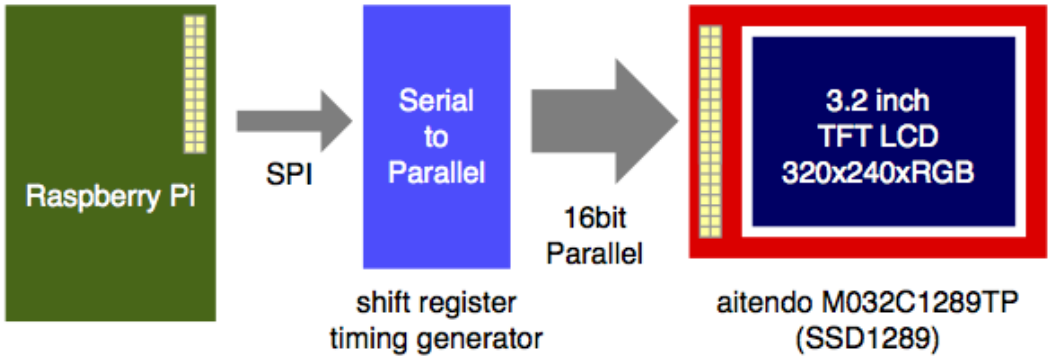
電路圖



http://www.myu.ac.jp/~xkozima/lab/raspTutorial3.html

Pi – 轉換電路 - LCD



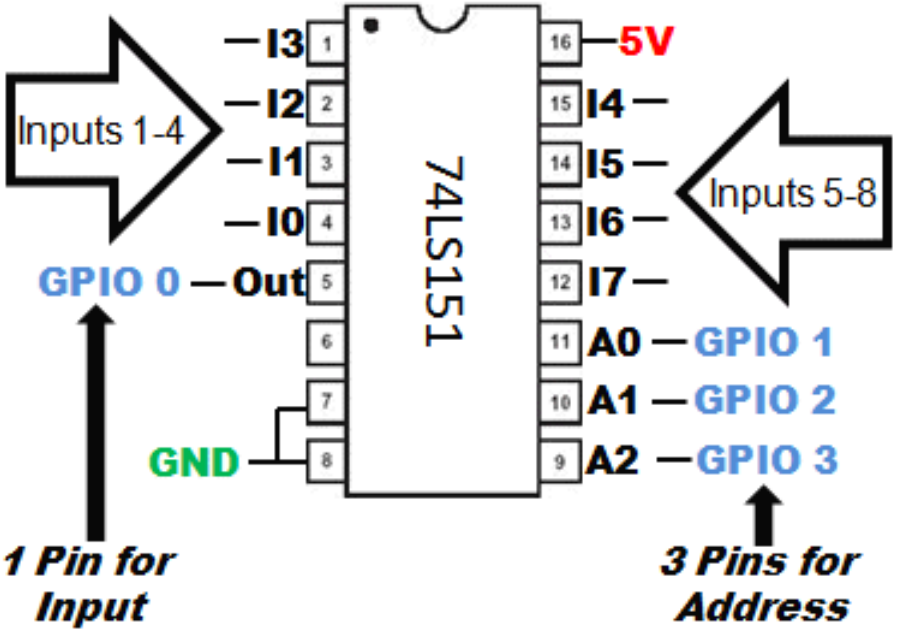


http://www.myu.ac.jp/~xkozima/lab/raspTutorial3.html

再講講軟體

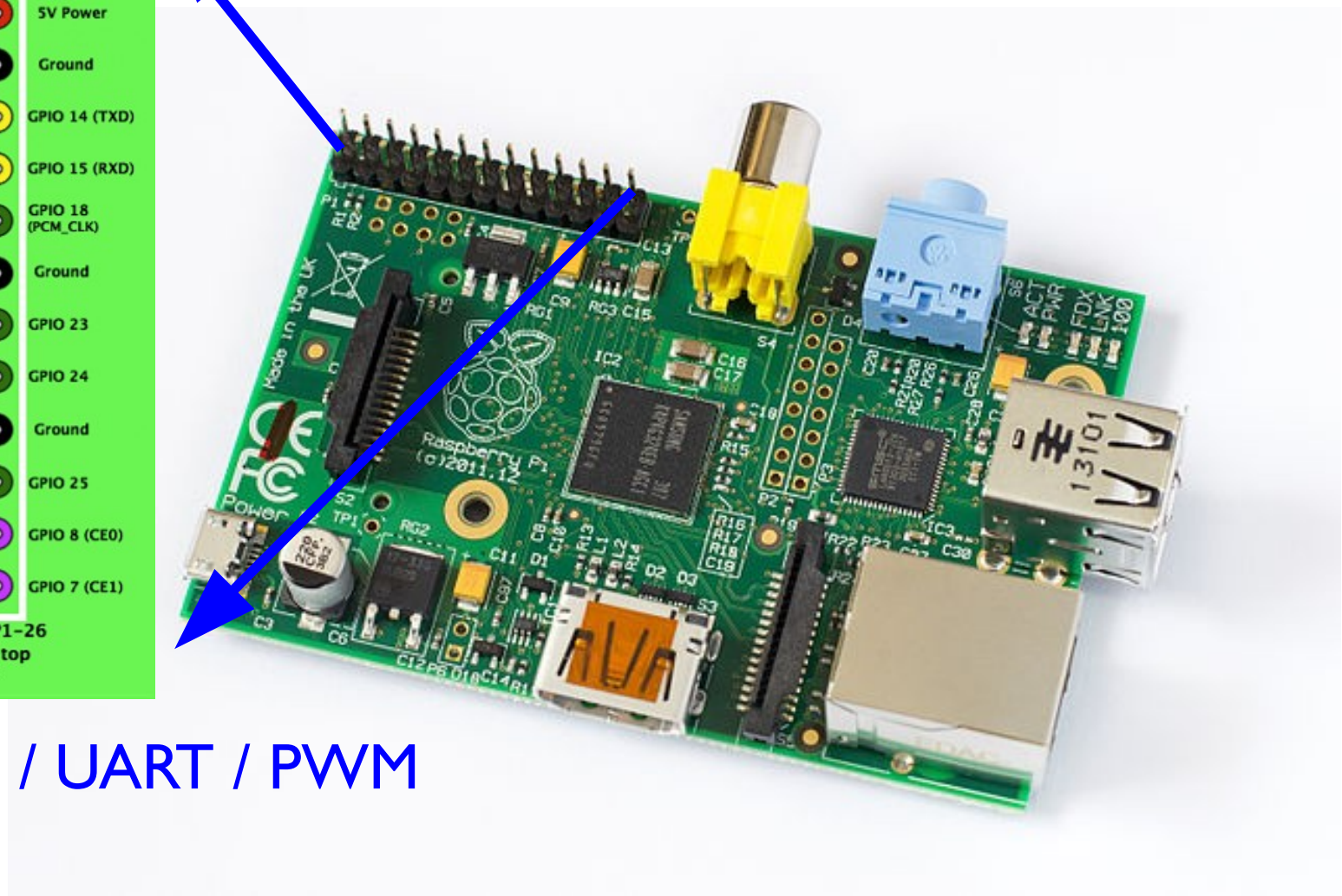
GPIO 的控制

- A generic pin on an IC



http://raspberrypihobbyist.blogspot.tw/2012/09/so-many-inputs-so-few-gpio-pins.html

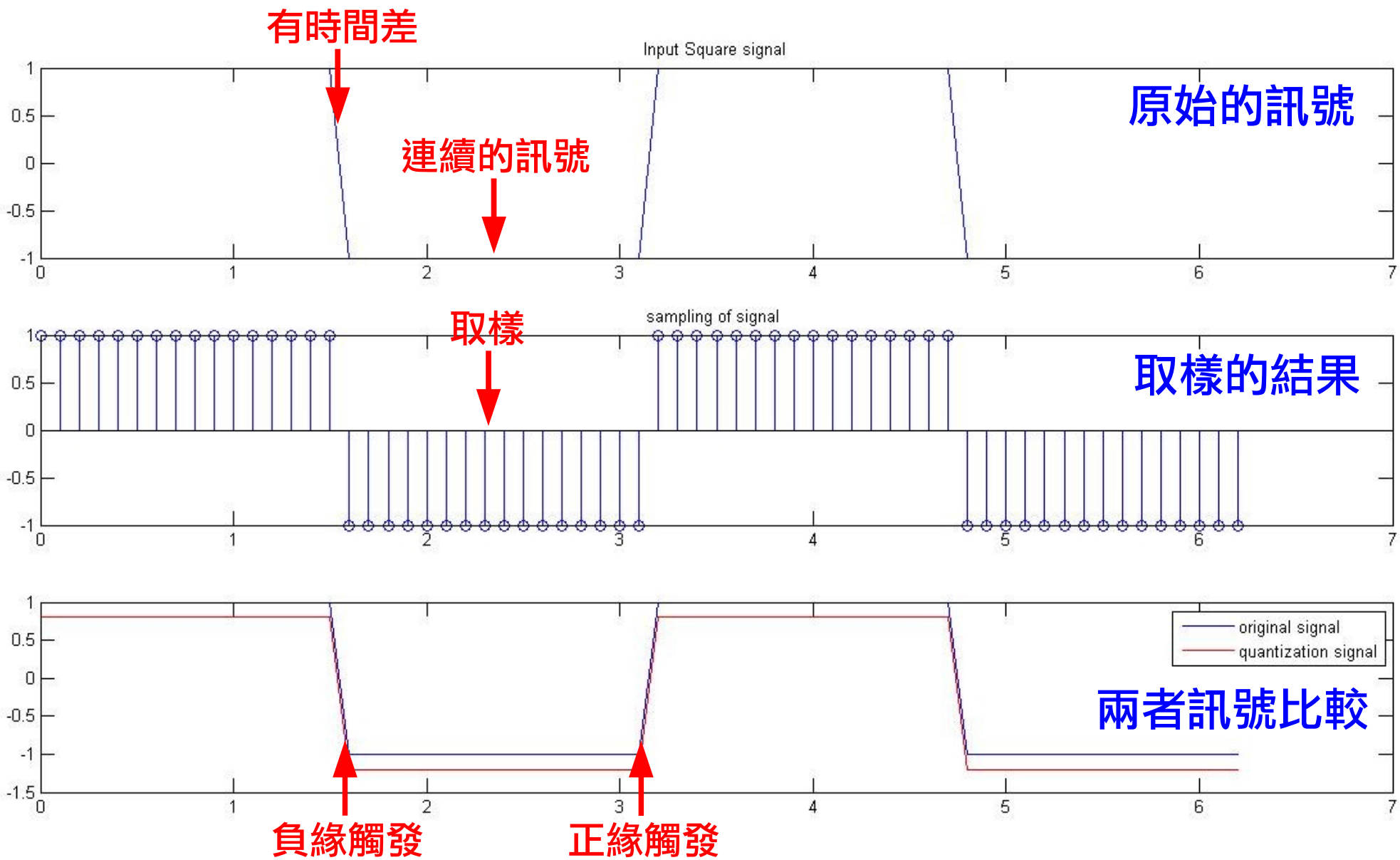
GPIO
(General Purpose Input/Output)



SPI / I^{2}C / UART / PWM

http://www.raspberrypi.org/phpBB3/viewtopic.php?t=4277

真實的電流輸入



http://goo.gl/IzwE0K

GPIO 量測與除錯

那軟體做什麼？ 控制硬體

- 開啟或關閉 GPIO
- 決定是 0 激活還是 1 要激活
- 決定是輸入還是輸出
- 寫值到某根腳位
- 從某根腳位讀值
- 決定是正緣觸發還是負緣觸發
- 等待中斷 (interrupt) 的發生

控制硬體的方法

- 直接修改 register 的值
- 透過 driver 進行操作

三言以蔽之

1. 看 datasheet
2. 查 register
3. 填對應的值

看 datasheet

BCM2835 ARM Peripherals

BROADCOM®

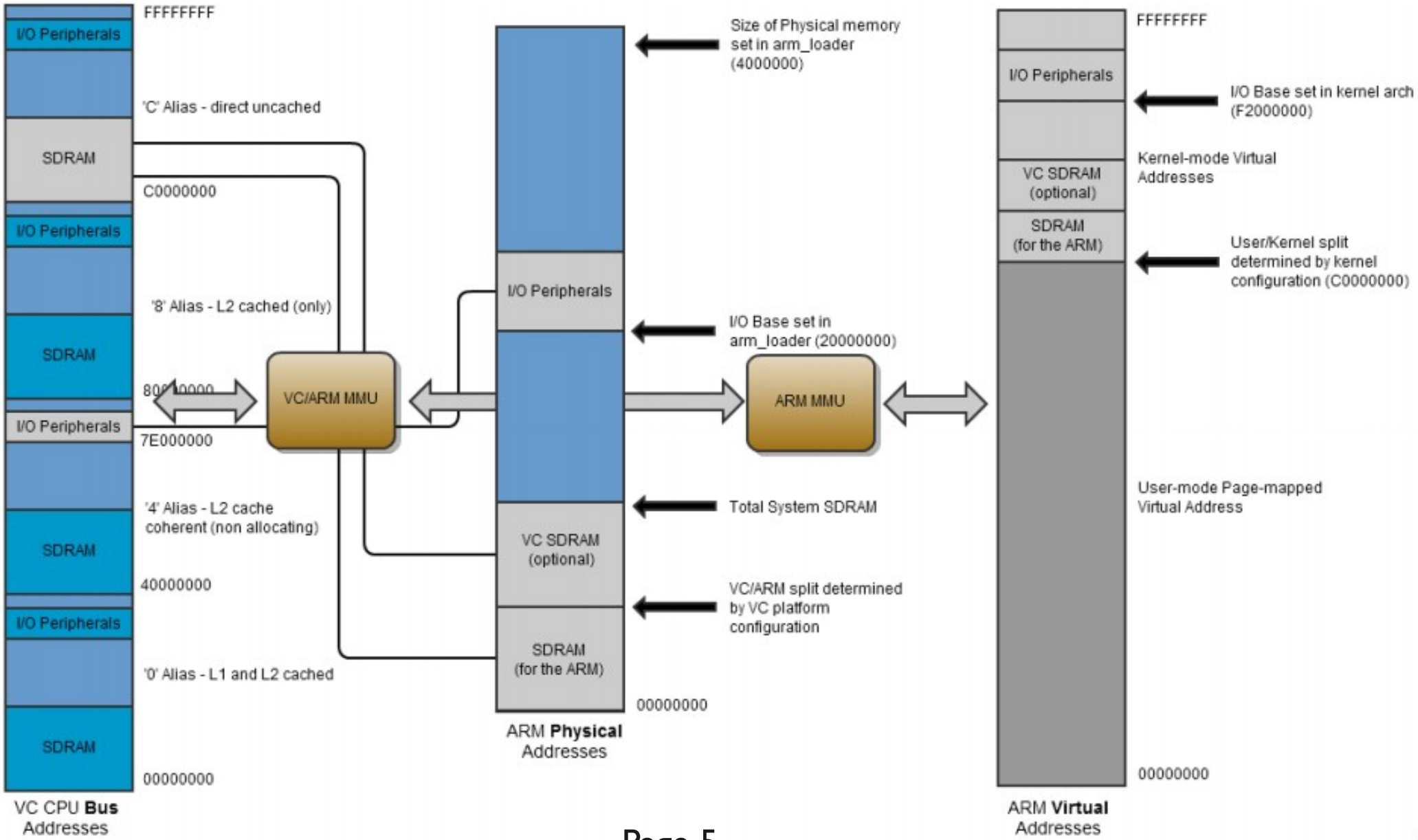
BCM2835 ARM Peripherals

http://www.raspberrypi.org/wp-content/uploads/2012/02/BCM2835-ARM-Peripherals.pdf

共 205 頁

查 register

BCM2835 ARM Peripherals



存取 register = 在記憶體位置讀寫值

先定義週邊成一個 structure

```
// RPI.h
struct bcm2835_peripheral {
        unsigned long addr_p;           //  指到實體記憶體位址
        int mem_fd;                     //  開啟 /dev/mem 的 fd
        void *map;                      // memory map 的回傳
        volatile unsigned int *addr;    //  指到 register 的位址
};

// RPI.c
struct bcm2835_peripheral gpio = {GPIO_BASE};
```

1. 開啟記憶體裝置
2. 映射到實體記憶體空間

```
// RPI.c
fd = open("/dev/mem", O_RDWR|O_SYNC);
mmap(NULL,
        BLOCK_SIZE,
        PROT_READ,
        MAP_SHARED,
        mem_fd,
        addr_p);
```

在顯示器上畫畫面 = 寫 Framebuffer

開啟 Framebuffer 裝置

```
void fb_init (int *fb_width, int *fb_height)
{
    fb_fd = open("/dev/fb0", O_RDWR);
    fb_mem = (unsigned char *)
        mmap(NULL, fb_size, PROT_READ | PROT_WRITE,
MAP_SHARED, fb_fd, 0);
}

unsigned char *fb_get ()
{
    return (unsigned char *) fb_mem;
}
```

將畫面寫到 Framebuffer

```
void main ()
{
    int width, height;
    fb_init(&width, &height);
    lcd_init(IMAGE_SIZE);

    while (1)
    {
        lcd_send(fb_get());
    }
}
```

啟動時就執行

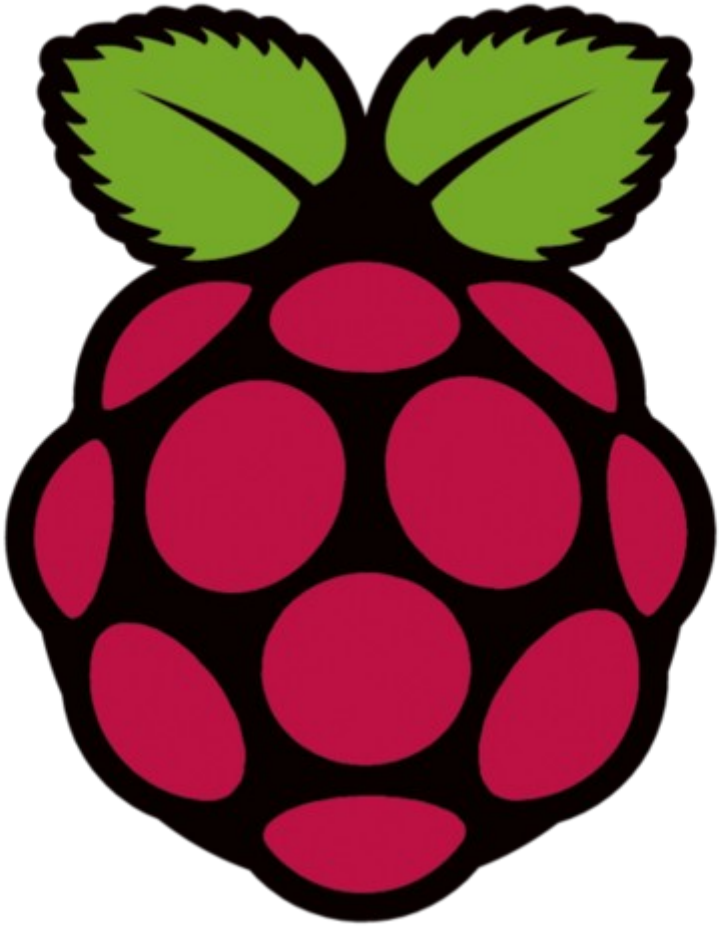
```
pi@raspberrypi:~$ sudo vi /etc/init.d/bootmisc.sh
...
do_start () {
        ...
        # fb2lcd (FrameBuffer to LCD)
        if [ -f /usr/local/bin/fb2lcd ]; then
                /usr/local/bin/fb2lcd &
        fi
}
...
```

DEMO

参考資料

- Raspberry Pi 応用編
  - http://www.myu.ac.jp/~xkozima/lab/raspTutorial3.html
- Low Level Programming of the Raspberry Pi in C
  - http://www.pieter-jan.com/node/15

Raspberry Pi Rocks the World



Thanks