

嵌入式试验1:认识树莓派

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一、实验目的

1. 了解嵌入式卡一半情况；
2. 熟悉raspberrypi的供电等接线方式；
3. 复习Linux启动过程（操作系统课）；
4. 复习通过Linux获得硬件数据（操作系统课）；
5. 熟练掌握串口在PC上的使用；
6. 熟练掌握Linux的以太网和WiFi配置；
7. 熟练掌握Linux的SSH配置；
8. 熟练掌握PC上的SSH软件。

二、实验器材

硬件

1. 实验主板一块；
2. 5V/1A电源一个；
3. microUSB线一根；
4. USB-TTL串口线一根；
5. 路由器一个；

软件

1. PC上usb串口匹配驱动程序；
2. PC上串口终端软件:minicon

三、实验步骤

1. 安装usb串口驱动程序

在http://www.prolific.com.tw/US/ShowProduct.aspx?p_id=229&pcid=41下载最新usb驱动程序，可直接安装用正版驱动；



PL2303 Mac OS X Driver Download

Download File: [md_PL2303_MacOSX-10.6-10.10_v1.5.1.zip](#)

Mac OS X Universal Binary Driver v1.5.1 (PKG file format)

- For Mac OS X 10.10 Yosemite (64-bit)
- For Mac OS X 10.9 Mavericks (64-bit)
- For Mac OS X 10.8 Mountain Lion (64-bit)
- For Mac OS X 10.7 Lion (32-bit and 64-bit kernel)
- For Mac OS X 10.6 Snow Leopard (32-bit and 64-bit kernel)
- For PL2303 H/HX/HXD/EA/RA/SA/TA/TB chip versions
- For Prolific USB VID_067B&PID_2303 Only
- Includes Driver Installation Manual

2. 下载树莓派iso；

名称	修改日期	大小
 2015-02-16-raspbian-wheezy.img	2015年2月16日 下午3:09	3.28 GB
 2015-02-16-raspbian-wheezy.zip	2015年3月21日 上午9:55	1.02 GB

3. 将sd卡插入电脑插槽，运行df -h获得硬件接口信息，通过sudo diskutil unmount先将sd卡卸载，一便使用dd命令安装系统镜像， sudo dd bs=1m if=2015-02-16-raspbian-wheezy.img of=/dev/rdisk2；

```
eledeMacBook-Pro:~ ele$ df -h
Filesystem      Size   Used  Avail Capacity  iused   ifree %iused
/dev/disk1      233Gi  40Gi  192Gi    18% 10647223 50334023   17%
devfs           187Ki  187Ki   0Bi   100%     647         0  100%
map -hosts       0Bi    0Bi   0Bi   100%         0         0  100%
map auto_home    0Bi    0Bi   0Bi   100%         0         0  100%
/dev/disk2s1     56Mi   14Mi   42Mi    26%     512         0  100%
t
/dev/disk3s4     15Gi   5.0Gi   9.6Gi    35%         0         0  100%
REME
eledeMacBook-Pro:~ ele$
```

3. 安装brew，运行命令如下；



```
Install Homebrew

ruby -e "$(curl -fsSL https://raw.githubusercontent.com/Homebrew/install/master/inst
```

4. 安装minicom，运行 brew install minicom；

5. 配置minicom，选择合适的serial device，同时关闭硬件流控制；

```
+-----[configuration]-----+
| Filenames and paths          |
| File transfer protocols      |
| Serial port setup            |
| Modem and dialing            |
| Screen and keyboard          |
| Save setup as dfl             |
| Save setup as..              |
| Exit                          |
| Exit from Minicom            |
+-----+-----+
|
```

```
+-----+-----+
| A - Serial Device            : /dev/tty.usbserial |
| B - Lockfile Location        : /usr/local/Cellar/minicom/2.7/var |
| C - Callin Program           :                     |
| D - Callout Program          :                     |
| E - Bps/Par/Bits             : 115200 8N1         |
| F - Hardware Flow Control    : No                  |
| G - Software Flow Control    : No                  |
|                               |
| Change which setting? [ ] |
+-----+-----+
|
```

5. 按照要求，将usb串口线与树莓派相连；



6. 运行minicom，使用账号pi和密码raspberryl登陆树莓派linux系统；

```
Raspberrypi login: pi
Password:
Last login: Mon Feb 16 14:25:43 UTC 2015 on ttyAMA0
Linux raspberrypi 3.18.7+ #755 PREEMPT Thu Feb 12 17:14:31 GMT 2015 armv6l

The programs included with the Debian GNU/Linux system are free software;
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.

NOTICE: the software on this Raspberry Pi has not been fully configured. Please'
pi@raspberrypi:~$ sudo apt-get install vim
```

7. 连接路由器后，运行ifconfig，获得当前ip；

```
pi@raspberrypi:~$ ifconfig
eth0      Link encap:Ethernet  HWaddr b8:27:eb:0c:02:91
          inet addr:192.168.1.104  Bcast:255.255.255.255  Mask:255.255.255.0
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:3953 errors:0 dropped:0 overruns:0 frame:0
          TX packets:2208 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:5494420 (5.2 MiB)  TX bytes:176830 (172.6 KiB)

lo        Link encap:Local Loopback
          inet addr:127.0.0.1  Mask:255.0.0.0
          UP LOOPBACK RUNNING  MTU:65536  Metric:1
          RX packets:0 errors:0 dropped:0 overruns:0 frame:0
          TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:0
          RX bytes:0 (0.0 B)  TX bytes:0 (0.0 B)
```

8. 安装ssh，执行sudo apt-get install ssh，确认已安装ssh；

```
pi@raspberrypi:~$ sudo apt-get install ssh
Reading package lists... Done
Building dependency tree
Reading state information... Done
ssh is already the newest version.
0 upgraded, 0 newly installed, 0 to remove and 0 not upgraded.
```

9. 开启另一个终端，通过ssh登陆树莓派系统，ssh pi@192.168.1.104；

```
eledeMacBook-Pro:~ ele$ ssh pi@192.168.1.104
pi@192.168.1.104's password:
Linux raspberrypi 3.18.7+ #755 PREEMPT Thu Feb 12 17:14:31 GMT 2015 armv6l

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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: Wed Apr 1 12:23:20 2015

NOTICE: the software on this Raspberry Pi has not been fully configured. Please
run 'sudo raspi-config'

pi@raspberrypi ~ $
```

10. 多个ssh登陆时的装款；

```
pi@raspberrypi ~ $ ps -ef|grep ssh
root      2100      1   0 12:22 ?        00:00:00 /usr/sbin/sshd
root      2646    2100   0 12:56 ?        00:00:00 sshd: pi [priv]
pi        2650    2646   0 12:56 ?        00:00:00 sshd: pi@pts/0
root      2672    2100   1 12:59 ?        00:00:00 sshd: pi [priv]
pi        2676    2672   0 12:59 ?        00:00:00 sshd: pi@pts/1
pi        2694    2677   0 12:59 pts/1    00:00:00 grep --color=auto ssh

pi@raspberrypi ~ $
pi@raspberrypi ~ $ ps -ef |grep ssh
root      2100      1   0 12:22 ?        00:00:00 /usr/sbin/sshd
root      2646    2100   0 12:56 ?        00:00:00 sshd: pi [priv]
pi        2650    2646   0 12:56 ?        00:00:00 sshd: pi@pts/0
pi        2671    2651   0 12:59 pts/0    00:00:00 grep --color=auto ssh

pi@raspberrypi ~ $
```

11. 通过/etc/ssh/ssh_config查看、修改ssh_config文件；

```
pi@raspberrypi ~ $ vim /etc/ssh/ssh_config
```

12. 给树莓派安装vim；

```
pi@raspberrypi:~$ sudo apt-get install vim
Reading package lists... Done
Building dependency tree
Reading state information... Done
The following extra packages will be installed:
  vim-runtime
Suggested packages:
  ctags vim-doc vim-scripts
The following NEW packages will be installed:
  vim vim-runtime
0 upgraded, 2 newly installed, 0 to remove and 0 not upgraded.
Need to get 5,281 kB of archives.
After this operation, 24.5 MB of additional disk space will be used.
```

四、 启动文件解析

Uncompressing Linux...Uncompressing Linux... done, booting the kernel.

boot

[0.000000] Booting Linux on physical CPU 0x0

#initialize cgroup(control group) cpu

[0.000000] Initializing cgroup subsys cpu

[0.000000] Initializing cgroup subsys cpuacct

#linux version 3.18.7+ gcc version 4.8.3

[0.000000] Linux version 3.18.7+ (dc4@dc4-XPS13-9333) (gcc version 4.8.3 205

#cpu ARMv6 Raspberry PI Model B

[0.000000] CPU: ARMv6-compatible processor [410fb767] revision 7 (ARMv7), cd

[0.000000] CPU: PIPT / VIPT nonaliasing data cache, VIPT nonaliasing instrue

[0.000000] Machine model: Raspberry Pi Model B

cam : continuous memory allocator

[0.000000] cma: Reserved 8 MiB at 0x1b800000

#memory policy : writeback

[0.000000] Memory policy: Data cache writeback

[0.000000] Built 1 zonelists in Zone order, mobility grouping on. Total pa2

dma chans(Direct Memory Access)

[0.000000] Kernel command line: dma.dmachans=0x7f35 bcm2708_fb.fbwidth=656 t

#PID hash table entry and number

[0.000000] PID hash table entries: 2048 (order: 1, 8192 bytes)

#Dentry cache hash table entry and number

[0.000000] Dentry cache hash table entries: 65536 (order: 6, 262144 bytes)

#Inode-cache hash table entry and number

[0.000000] Inode-cache hash table entries: 32768 (order: 5, 131072 bytes)

#size of memory

[0.000000] Memory: 437208K/458752K available (5926K kernel code, 358K rwdat)

#Virtual kernel memory layout

[0.000000] Virtual kernel memory layout:

[0.000000] vector : 0xffff0000 - 0xffff1000 (4 kB)

[0.000000] fixmap : 0xffc00000 - 0xffe00000 (2048 kB)

#virtual memory allocation

[0.000000] vmalloc : 0xdc800000 - 0xff000000 (552 MB)

#low memory

[0.000000] lowmem : 0xc0000000 - 0xdc000000 (448 MB)

[0.000000] modules : 0xbf000000 - 0xc0000000 (16 MB)

[0.000000] .text : 0xc0008000 - 0xc07a6ad8 (7803 kB)

[0.000000] .init : 0xc07a7000 - 0xc07fc000 (340 kB)

[0.000000] .data : 0xc07fc000 - 0xc085588c (359 kB)

[0.000000] .bss : 0xc085588c - 0xc090d128 (735 kB)

```
[ 0.000000] SLUB: HWalign=32, Order=0-3, MinObjects=0, CPUs=1, Nodes=1
[ 0.000000] Preemptible hierarchical RCU implementation.
[ 0.000000] NR_IRQS:522
[ 0.000023] sched_clock: 32 bits at 1000kHz, resolution 1000ns, wraps every s
[ 0.000074] Switching to timer-based delay loop, resolution 1000ns
[ 0.000356] Console: colour dummy device 80x30
```

tty1 enabled

```
[ 0.001413] console [tty1] enabled
```

calibrating delay loop

```
[ 0.001459] Calibrating delay loop (skipped), value calculated using timer f)
```

#max and minimum of pid

```
[ 0.001533] pid_max: default: 32768 minimum: 301
```

#Mount-cache table entries

```
[ 0.001913] Mount-cache hash table entries: 1024 (order: 0, 4096 bytes)
```

#Mountpoint-cache hash table entries

```
[ 0.001979] Mountpoint-cache hash table entries: 1024 (order: 0, 4096 bytes)
```

#initializing cpu and other divices

```
[ 0.002987] Initializing cgroup subsys memory
```

```
[ 0.003079] Initializing cgroup subsys devices
```

```
[ 0.003138] Initializing cgroup subsys freezer
```

```
[ 0.003193] Initializing cgroup subsys net_cls
```

```
[ 0.003244] Initializing cgroup subsys blkio
```

#testing write through cpu

```
[ 0.003368] CPU: Testing write buffer coherency: ok
```

```
[ 0.003481] ftrace: allocating 19479 entries in 58 pages
```

```
[ 0.111490] Setting up static identity map for 0x55d058 - 0x55d0b4
```

```
[ 0.114307] devtmpfs: initialized
```

```
[ 0.131739] VFP support v0.3: implementor 41 architecture 1 part 20 variant 5
```

```
[ 0.134927] pinctrl core: initialized pinctrl subsystem
```

```
[ 0.137592] NET: Registered protocol family 16
```

```
[ 0.143085] DMA: preallocated 4096 KiB pool for atomic coherent allocations
```

```
[ 0.171259] cpuidle: using governor ladder
```

```
[ 0.201323] cpuidle: using governor menu
```

```
[ 0.201830] bcm2708_uart_clock = 3000000
```

```
[ 0.204925] No ATAGs?
```

```
[ 0.204992] hw-breakpoint: found 6 breakpoint and 1 watchpoint registers.
```

```
[ 0.205055] hw-breakpoint: maximum watchpoint size is 4 bytes.
```

```
[ 0.205122] mailbox: Broadcom VideoCore Mailbox driver
```

```
[ 0.205283] bcm2708_vcio: mailbox at f200b880
```

```
[ 0.205753] bcm_power: Broadcom power driver
```

```
[ 0.205810] bcm_power_open() -> 0
```

```
[ 0.205841] bcm_power_request(0, 8)
```

```
[ 0.706582] bcm_mailbox_read -> 00000080, 0
```

```
[ 0.706627] bcm_power_request -> 0
```

#serial initializing

```
[ 0.706825] Serial: AMBA PL011 UART driver
```

```
[ 0.707059] dev:f1: ttyAMA0 at MMIO 0x20201000 (irq = 83, base_baud = 0) is 3
```

#enable tty

[1.096473] console [ttyAMA0] enabled

#SCSI intializing

[1.169531] SCSI subsystem initialized

#usb

[1.173663] usbcore: registered new interface driver usbfs

[1.179463] usbcore: registered new interface driver hub

[1.184983] usbcore: registered new device driver usb

[1.192170] Switched to clocksource stc

[1.226553] FS-Cache: Loaded

[1.229870] CacheFiles: Loaded

#tcp/ip

[1.250041] NET: Registered protocol family 2

[1.255999] TCP established hash table entries: 4096 (order: 2, 16384 bytes)

[1.263415] TCP bind hash table entries: 4096 (order: 2, 16384 bytes)

[1.269975] TCP: Hash tables configured (established 4096 bind 4096)

[1.276487] TCP: reno registered

[1.279762] UDP hash table entries: 256 (order: 0, 4096 bytes)

[1.285688] UDP-Lite hash table entries: 256 (order: 0, 4096 bytes)

[1.292439] NET: Registered protocol family 1

#rpc

[1.297444] RPC: Registered named UNIX socket transport module.

[1.303530] RPC: Registered udp transport module.

[1.308260] RPC: Registered tcp transport module.

[1.313026] RPC: Registered tcp NFSv4.1 backchannel transport module.

[1.320696] bcm2708_dma: DMA manager at f2007000

[1.325724] vc-mem: phys_addr:0x00000000 mem_base=0x1ec00000 mem_size:0x2000)

[1.335595] futex hash table entries: 256 (order: -1, 3072 bytes)

[1.341865] audit: initializing netlink subsys (disabled)

[1.347589] audit: type=2000 audit(1.100:1): initialized

[1.368453] VFS: Disk quotas dquot_6.5.2

[1.372954] Dquot-cache hash table entries: 1024 (order 0, 4096 bytes)

[1.382436] FS-Cache: Netfs 'nfs' registered for caching

[1.389550] NFS: Registering the id_resolver key type

[1.394866] Key type id_resolver registered

[1.399080] Key type id_legacy registered

[1.404624] msgmni has been set to 869

[1.410921] Block layer SCSI generic (bsg) driver version 0.4 loaded (major)

[1.418938] io scheduler noop registered

[1.423084] io scheduler deadline registered (default)

[1.428643] io scheduler cfq registered

[1.435214] BCM2708FB: allocated DMA memory 5bc00000

[1.440279] BCM2708FB: allocated DMA channel 0 @ f2007000

[1.451731] Console: switching to colour frame buffer device 82x26

[1.464034] bcm2708-dmaengine bcm2708-dmaengine: Load BCM2835 DMA engine drir

[1.473660] uart-pl011 dev:f1: no DMA platform data

[1.481077] vc-cma: Videocore CMA driver

[1.486833] vc-cma: vc_cma_base = 0x00000000

[1.493250] vc-cma: vc_cma_size = 0x00000000 (0 MiB)

[1.500226] vc-cma: vc_cma_initial = 0x00000000 (0 MiB)

[1.520812] brd: module loaded


```
[ 1.532818] loop: module loaded
[ 1.538006] vchiq: vchiq_init_state: slot_zero = 0xdb800000, is_master = 0
[ 1.547661] Loading iSCSI transport class v2.0-870.
[ 1.555947] usbcore: registered new interface driver smsc95xx
[ 1.563613] dwc_otg: version 3.00a 10-AUG-2012 (platform bus)
[ 1.771216] Core Release: 2.80a
[ 1.776061] Setting default values for core params
[ 1.782429] Finished setting default values for core params
[ 1.989701] Using Buffer DMA mode
[ 1.994608] Periodic Transfer Interrupt Enhancement - disabled
[ 2.002008] Multiprocessor Interrupt Enhancement - disabled
[ 2.009189] OTG VER PARAM: 0, OTG VER FLAG: 0
[ 2.015171] Dedicated Tx FIFOs mode
[ 2.020685] WARN::dwc_otg_hcd_init:1047: FIQ DMA bounce buffers: virt = 0xdb4
[ 2.033753] FIQ FSM acceleration enabled for :
[ 2.033753] Non-periodic Split Transactions
[ 2.033753] Periodic Split Transactions
[ 2.033753] High-Speed Isochronous Endpoints
[ 2.056926] WARN::hcd_init_fiq:412: FIQ on core 0 at 0xc040116c
[ 2.064513] WARN::hcd_init_fiq:413: FIQ ASM at 0xc0401444 length 36
[ 2.072451] WARN::hcd_init_fiq:438: MPHI regs_base at 0xdc806000
[ 2.080166] dwc_otg bcm2708_usb: DWC OTG Controller
[ 2.086769] dwc_otg bcm2708_usb: new USB bus registered, assigned bus number1
[ 2.095761] dwc_otg bcm2708_usb: irq 32, io mem 0x00000000
[ 2.102961] Init: Port Power? op_state=1
[ 2.108463] Init: Power Port (0)
```

#new usb driver

```
[ 2.113688] usb usb1: New USB device found, idVendor=1d6b, idProduct=0002
[ 2.122133] usb usb1: New USB device strings: Mfr=3, Product=2, SerialNumber1
[ 2.131027] usb usb1: Product: DWC OTG Controller
[ 2.137375] usb usb1: Manufacturer: Linux 3.18.7+ dwc_otg_hcd
[ 2.144749] usb usb1: SerialNumber: bcm2708_usb
[ 2.151999] hub 1-0:1.0: USB hub found
[ 2.157603] hub 1-0:1.0: 1 port detected
[ 2.164504] usbcore: registered new interface driver usb-storage
[ 2.172729] mousedev: PS/2 mouse device common for all mice
[ 2.180739] bcm2835-cpufreq: min=700000 max=700000
[ 2.187640] sdhci: Secure Digital Host Controller Interface driver
[ 2.195560] sdhci: Copyright(c) Pierre Ossman
[ 2.201790] DMA channels allocated for the MMC driver
[ 2.242251] Load BCM2835 MMC driver
[ 2.249299] sdhci-pltfm: SDHCI platform and OF driver helper
[ 2.261818] ledtrig-cpu: registered to indicate activity on CPUs
[ 2.272298] hidraw: raw HID events driver (C) Jiri Kosina
[ 2.279732] usbcore: registered new interface driver usbhid
[ 2.287074] usbhid: USB HID core driver
[ 2.296164] TCP: cubic registered
[ 2.302271] Initializing XFRM netlink socket
[ 2.310271] NET: Registered protocol family 17
[ 2.317899] Key type dns_resolver registered
[ 2.327934] registered taskstats version 1
[ 2.333989] vc-sm: Videocore shared memory driver
[ 2.340241] [vc_sm_connected_init]: start
[ 2.347182] [vc_sm_connected_init]: end - returning 0
[ 2.355787] Waiting for root device /dev/mmcblk0p2...
```



```
[ 2.362921] Indeed it is in host mode hprt0 = 00021501
[ 2.377294] mmc0: host does not support reading read-only switch, assuming we
[ 2.404343] mmc0: new high speed SDHC card at address b368
[ 2.422285] mmcblk0: mmc0:b368 SDC 7.51 GiB
[ 2.433647] mmcblk0: p1 p2
[ 2.485838] EXT4-fs (mmcblk0p2): INFO: recovery required on readonly filesystem
[ 2.495073] EXT4-fs (mmcblk0p2): write access will be enabled during recovery
[ 2.572445] usb 1-1: new high-speed USB device number 2 using dwc_otg
[ 2.580839] Indeed it is in host mode hprt0 = 00001101
[ 2.782770] usb 1-1: New USB device found, idVendor=0424, idProduct=9512
[ 2.791255] usb 1-1: New USB device strings: Mfr=0, Product=0, SerialNumber=0
[ 2.801440] hub 1-1:1.0: USB hub found
[ 2.807248] hub 1-1:1.0: 3 ports detected
[ 3.092438] usb 1-1.1: new high-speed USB device number 3 using dwc_otg
[ 3.212664] usb 1-1.1: New USB device found, idVendor=0424, idProduct=ec00
[ 3.221364] usb 1-1.1: New USB device strings: Mfr=0, Product=0, SerialNumber=0
[ 3.233706] smsc95xx v1.0.4
[ 3.296876] smsc95xx 1-1.1:1.0 eth0: register 'smc95xx' at usb-bcm2708_usb-1
[ 5.358238] EXT4-fs (mmcblk0p2): recovery complete
[ 5.728451] EXT4-fs (mmcblk0p2): mounted filesystem with ordered data mode. )
[ 5.740353] VFS: Mounted root (ext4 filesystem) readonly on device 179:2.
[ 5.750497] devtmpfs: mounted
[ 5.756540] Freeing unused kernel memory: 340K (c07a7000 - c07fc000)
[ 7.336375] udevd[159]: starting version 175
[ 13.210689] EXT4-fs (mmcblk0p2): re-mounted. Opts: (null)
[ 14.335463] EXT4-fs (mmcblk0p2): re-mounted. Opts: (null)
[ 14.532026] random: nonblocking pool is initialized
??
```

#login raspbian linux

Raspbian GNU/Linux 7 raspberrypi ttyAMA0

raspberrypi login: