An Introduction to Raspberry Pi
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Splat Space
http://splatspace.org

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Outline

- What is a Raspberry Pi?
  - History and charter
  - Description
- Resources
- The Raspberry Pi Workstation
- Open Computer Vision and Stepper Motors
- Q&A
Tonight vs Saturday

- Tonight:
  - Presentations/demos

- Saturday (Splat Space):
  - Installfest
  - Show and Tells
  - Educator discussion led by Elliot Hauser
    eah13@mac.com
  - Troubleshooting, customization
What is Raspberry Pi?

• A single board, very flexible, four watt computer in $35 (model B) and $25 (model A) flavors designed and made in the UK

• A mostly-open educational platform. (Some chip firmware not open)

• A standalone Linux, BSD, RISC OS, or Plan 9 system with a lot of I/O

• A powerful programming environment
The Short History

- Around 2005 Eben Upton was Director of Studies in Computer Science at Cambridge.
- Incoming students had relatively few programming and/or hardware skills vs “the old days”, creating vision of “something like the BBC Computer, but running a modern language like Python.” The name “Raspberry Pi” is a combination of “a fruit name” and a play on “Python”.
- Between 2006-2011 the vision turned into a highly capable single board computer design.
Raspberry Pi Proto

- Getting past the idea that “Python is enough”
History (2)

- Interest in RPi exploded as production plans became more and more enthusiastic, reaching the initial run of 10k boards by a partnership with Element14 and RS Components in the UK.

- The day sales began 100k orders were chasing the first 10k boards.

- Support hardware and software development have been proportionate to the estimated 1M boards shipped.

- But this is all really just STEP ONE.
Why was Raspberry Pi Made?

- Education!
- Original measure of success: more CS students
- But education-related efforts are rapidly spreading downward, aiming toward young children.
Two Models, Two HW Versions

- Model B, version 1
  - Original $35 board (almost everybody's is this one)
  - 1/4gb RAM, all peripheral support
- Model B, version 2 (starting late last year)
  - 1/2gb RAM, other tweaks mentioned later
- Model A (started shipping late last year)
  - $25
  - No ethernet jack: networking via USB add-on
  - 1/4gb RAM
Processor and Memory

- Broadcom 2835 System On Chip
  - 32 bit ARM RISC CPU core (not x86 compatible)
  - Videocore IV GPU
  - Gadzooks of additional I/O
- Arm11 hardware, Arm6 architecture (-1 from current “hot” cellphone chips)
- Default clock speed is 700mhz
- Second and third chips for ½ (model B) or ¼ (model A) gb RAM and ethernet/USB
The RPi Mass Storage: SD Card

- Any SD card, but if you don't have a very recent RPi, check class 10 list at elinux.org/RPi_Hub
- Kernel boots from SD card, period.
- Easy to have root FS on other device
Video

- HDMI or (digital) DVI via cheap adaptor/cable
- Composite NTSC/PAL via RCA
- Wide range of resolutions
- NO VGA without an add-on, nontrivial converter (Adafruit)
Audio

- Via HDMI or from stereo jack
- Output only
- Support maturity appears to be lagging
Networking

- 10/100mbps via RJ45 on model B
- Wireless via USB add-on supported
USB

- Dual USB sockets on RPi model B, single on model A
- Expandable via regular or powered hubs
Speaking of Power

- Primary power via microUSB plug: a one amp cell charger works well, but you'll need two amps with a USB hard drive
- Model A about a quarter amp less
- PC USB port does not work
More on Power

- Most existing Rpi boards have a current limiting fuse in the USB socket path
- This means high-power peripherals like hard drives **MUST** use a powered USB hub
- Fixed in rev 2 boards
General Purpose I/O

- 3.3 volt logic via 26 pin header (NOT 5 volt or short tolerant)
- Parallel I/O pins
- UART (Linux console support)
- I2C, SPI for peripherals
Even more I/O

- DSI LCD panel support
- CSI camera support
- JTAG
- Additional GPIO via other headers
More Version 2 Hardware Details

- Doubled RAM
- Removed current limiting fuse from USB socket path
- Rearranged, added GPIO, including reset
- Added two mounting holes
Software

- Many OS ports in progress
- Debian Linux best supported with two flavors of Wheezy (rev 7):
  - Current (mid-December), hardware FP
  - Earlier, software FP rev required by Oracle Java
- Initial install by pre-installed SD card or copied disk image
- Beginner's starting point:
  
  http://raspberryypi.org/downloads
Resources: Web sites

- http://raspberrypi.org
  - Foundation web site
  - Most folks should start here, but plan on going to:
- http://elinux.org/RPi_Hub
  - Primary reference repository. Your first 99 questions are answered here.
  - Where to buy list is http://elinux.org/Buying_RPi
Resources: Pubs and Communities

• Magpi magazine
  http://www.themagpi.com/

• Raspberry Pi Educational Manual
  • http://tinyurl.com/RPi -edu
  • This manual is being updated: revisit periodically

• Communities and Forums
  • Via http://elinux.org/RPi_Hub#Community
  • Via http://raspberrypi.org
Resources: Books

• **Raspberry Pi: A Quick Start Guide** by Schmidt
• **Raspberry Pi User Guide**, Upton and Halfacre
• Search Amazon, Barnes and Noble: bags of bunches of RPi books
2b Connect display
If *not* using HDMI, plug in your analogue TV or display

3 Connect input
Plug in a USB keyboard and mouse

4 Connect network
Connect to your wired network [optional]

Raspberry Pi
Quick start

5 Power up
Plug in the micro USB power supply

2a Connect display
Plug in your digital TV or monitor

Insert SD card
See page 3 for how to prepare the SD card
Alan Dipert, Splat Space Board President
Clinton Dreisbach, Web Developer
The Raspberry Pi Workstation

- Scratch http://scratch.mit.edu
- Clojure http://clojure.org
- Berryacam https://github.com/alandipert/berrycam
- Clinton's software stack http://prompt.sh/articles/raspberry-pi-fun/
Open Computer Vision (CV) and Stepper Motors

Peter Reintjes, Museum of Life and Science

- Can Raspberry Pi perform significant image processing and do something useful with some motors?
The other chip you need

ULN2001A-ULN2002A
ULN2003A-ULN2004A

SEVEN DARLINGTON ARRAYS

- SEVEN DARLINGTONS PER PACKAGE
- OUTPUT CURRENT 500mA PER DRIVER (600mA PEAK)
- OUTPUT VOLTAGE 50V
- INTEGRATED SUPPRESSION DIODES FOR INDUCTIVE LOADS
- OUTPUTS CAN BE PARALLELED FOR HIGHER CURRENT
- TTL/CMOS/PMOS/DTL COMPATIBLE INPUTS
- INPUTS PINNED OPPOSITE OUTPUTS TO SIMPLIFY LAYOUT

DESCRIPTION
The ULN2001A, ULN2002A, ULN2003 and ULN2004A are high voltage, high current darlington arrays each containing seven open collector darlington pairs with common emitters. Each channel rated at 500mA and can withstand peak currents of 600mA.
Transistor Amplifier

10 - 12 Volts DC

0-5 Volts @ 10 mA

11-1 Volts @ 200mA
Skynet Project #100010010010

- People have the right to defend themselves
- Corporations are People
- Autonomous Systems can run Corporations
- Autonomous Systems have the right ...

- If it has a face, shoot it.
Additional Software

- OpenCV - Camera capture/processing
  - Includes Face Detection example program
- RPi GPIO Python interface to GPIO pins
Problems

• Many scrambled file systems later...
  Bohdi Linux, Arch-Linux, eventually returning to Raspbian. Finding the commands to Sync and power down without removing power.

• Throughput problems doing image processing and finding enough cycles to update the tracking system (the stepper motors).
Read Only Filesystem

- Some people suggest R/0 filesystem to avoid problems with abrupt power-removal.
- But you can't make FS R/O before starting X
- So...
  - Start X and your application
  - F5 to get a terminal window
  - Alt-Cntl-SysRq-U to remount filesystem R/O
  - F7 to return to your X-session
Q & A

- Slides @ http://trilug.org
- Saturday the 12th workshop:
  - 9AM – 5PM
  - 331 W. Main St Durham
  - (919) 704-4250