Raspberry Pi Workshop

NOV 2014

About this workshop
-Summary
-This workshop will introduce you to the Raspberry Pi, an inexpensive single-board computer designed for educational and hobbyist use.
-The workshop is aimed at hobbyists, artists and makers who wish to incorporate the Pi into their projects.
-What you will learn
    -Blinking LEDs to incorporate into your artwork
    -Control motors
    -Read from various sensors

What comes in the kit
-Raspberry Pi Model B+
-Micro USB cable
-Micro SD card preloaded with Linux
-Resistors
-Servo
-Ultra-sonic range finder
-Pi breakout / protection board
-Hall-effect transistor
-MOSFETs
-LEDs
-Thermistor
-Photoresistor

Overview of the Raspberry Pi
-Created by the Raspberry PI foundation (registered charity in the UK)
-Designed as an educational tool for students, hackers, makers
-Similar to the Arduino in some respects, also much more capable (and lacking in other respects)
-Four versions to date (A, A+, B, B+) - all very similar
-Specs
    -Model B+ (other models available)
    -512 MB RAM
    -Broadcom system on a chip
    -ARM based processor (different than your desktop – Intel

x86)
-Broadcom chip 2708
-Photograph / diagram with labeled parts
-Boots OS from SD card (hard drive)
-4x USB ports
-On board Ethernet
-On board audio jack (or audio is delivered via HDMI cable)
-Power light shows when power is connected (not necessarily on!)
-Activity light – hard disk light
-General Purpose IO header (digital input+output pins, much like arduino) – 40 pins
-No analog input pins, only digital
-Linux install – Debian (distribution) Wheezy (version)

Warnings
-Be careful about 5v vs 3.3v
-Don't feed 5v into the board
-Be careful of stray wires (disconnect from the PI first, then from your breadboard)
-Power down your PI properly before disconnecting the supply
-Be careful not to eject the SD when handling your pi
-Avoid touching the pi while it is powered
-Be careful plugging / unplugging USB devices when powered up

Installation
-Your kit comes with linux pre-installed, updated and useful packages installed
-Installation is not covered here
-See http://www.raspberrypi.org/downloads/ for disk images and instructions

A brief tour of the Pi
-Booting
-Setup instructions (config utility)
-Starting X
-Some useful built-in features
-Playing video, music, web browser
-Intro to the command-line

-Running programs as root
-Brief mention of python
-Emphasis: the raspberry pi is a full computer, just smaller
-Connect to monitor / TV with HDMI
-Using an adapter connect with VGA or DVI (most computer displays)
-What if you don't have a spare monitor? Or a display with HDMI?

Config utility
-raspi-config (starts after a fresh install, run from command-line)
-Change host name
-Change audio (force HDMI or jack)

Connecting to the Pi remotely
-Advantages
    -Don't need a spare monitor
    -Very portable – can develop on the go with a Pi + laptop
    -Run the pi off your laptop supply, no need for extra power
    -Connect to Pi wireless (useful if the Pi is buried in your project – eg arcade cabinet)
-Connect via ssh or putty
-Shutdown with: sudo shutdown -h now

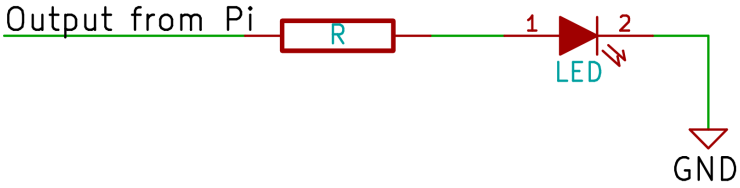
Finding your PI on the network
-Run a discovery protocol on your PI (uses mDNS protocol)
-Linux: avahi-browse –all
-Windows: Install Bonjour
-MacOS: ?? (http://hints.macworld.com/article.php?story=20051026183044858)

Introduction to GPIO and Python
-Blinking LED example
-Wiring to breadboard
-Resistor and LED in series
-Protection board
-Python code to drive led
-Blink faster, slower, change duty cycle

Breadboards
-Fast prototyping (wire without soldering)
-Columns are common, top and bottom rows are common
-Jumper wire makes wiring test circuits very easy

PI safety shield
-Protected IO pins prevent you feeding in too much voltage (somewhat)
-Also prevents you from drawing too much current from pins
-Current limiting resistor prevents too much current draw
-Zener diode (backwards) clamps input voltage to 3.3V

LED example
-Connect LED to PI output pin
-Be careful to pick the right resistor, or you will draw too much current and blow the LED / blow the PI
-RGB LED example



Hall-effect transistor
-Switches in the presence of a magnetic field
-Useful for creating a switch that doesn't need physical contact
-Very close proximity sensor

Range-finder example
-Power with 5v (be careful!), returns a 5v signal
-Ultra-sonic sensor
-Send a pulse, time how long it takes to come back
-Estimate distance based on the speed of sound
-Not very accurate, has problems with some materials not reflecting sound (multiple reflections?)

Servo example
-PWM signal determines angle of rotation
-Motor has feedback so it “knows” where it is in the rotation
-Use servos to create robots, interactive pieces with moving parts

MOSFET example
-Driving an LED, multiple LEDs
-You need to be very careful when handling MOSFETs, they are very sensitive to ESD (electro-static discharge)
-Mishandling them can damange or destroy them very quickly
-We use a zener diode to protect them from accidental ESD (same component on the protection board)

Using the onboard ATTINY for extra functionality
-Analog to digital converter

Photo resistor example
-Measure light levels
-Drive LED based on light levels

Thermistor
-Resistor that changes resistance based on temperature (similar to a photo resistor)

Images

-Diagram of a PI - OK
-Diagram of PI header - OK
-Schematic for safety board – OK
-Labeled circuit board (safety) – OK
-Hall effect circuit – OK
-LED circuit - OK
-Range finder circuit - OK
-Servo circuit – OK
-MOSFET LED – OK