An Introduction to Real World Design using the Raspberry Pi

University of Maryland Eastern Shore
Department of Technology

Etahe Johnson (Academic Support Specialist)
Joel Tomlinson (Instructor, Electrical Engineering Tech)
Cole Chesser (Student, Senior Electrical Engineering Tech)

UMES Programs

- Undergraduate Programs
  - Technology and Engineering Education
  - Electronics/Electrical Engineering Technology
  - Construction Management Technology
- Graduate Programs
  - Cybersecurity Engineering Technology
  - Career and Technology Education

MERIT Program

Home Automation with Raspberry Pi™

Omari Carter, Brandon Cartwright, Cole Chesser
Team Coordinator: Ms. Etahe Johnson
Team Sponsor: Dr. Derrek Dunn
Department of Engineering
University of Maryland Eastern Shore, Princess Anne, MD 21853

UNIVERSITY of MARYLAND EASTERN SHORE

MERIT
Maryland Elite Researchers in Training

INTRODUCTION

The Raspberry Pi is an ultra-low-cost, single-board, credit-card sized Linux computer which was conceived with the primary goal of teaching computer programming to elementary students. The gadget looks rather odd next to sleek modern offerings such as the iPad and appears to have more in common with the crystal radio sets of the 1950s. The machine is a fully-fledged computer and can be connected to a monitor, keyboard, mouse, speakers, and printers.

DESIGN AND FUNCTIONALITY

Omari, Brandon, and Cole built a scale model of an average household.

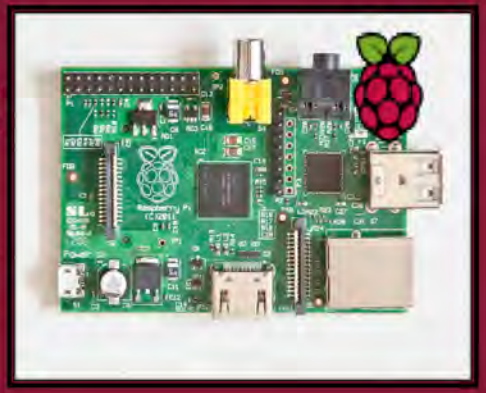
- Furniture was fabricated utilizing the MakerBot 3D printer
- Carpet and insulation were installed
- Three Raspberry Pi's were positioned throughout the model to provide automation
- Pi one supplied the power for the lights
- Pi two measured temperature and humidity factor of the air
- Pi three fed live video to a computer monitor
- Python coding was implemented for the Pi's functionality

ARRANGEMENT AND DISPLAY

Breakout wires attach to the Pi's GPIO (General Purpose Input Output) pins that feed voltage to the LEDs

How Does the Pi Work?

The Raspberry Pi comes with no pre-installed operating system; however, the purchaser of this product can install their most preferred operating system on an SD card for the Raspberry Pi. However, the Raspberry Pi primarily uses Linux kernel-based operating systems. There are two models of the Raspberry Pi that can be purchased, Model A, and Model B. Model A, is somewhat cheaper due to its lack of Ethernet and only one USB port. Model B, on the other hand, is a more expensive but also more functional model. This model has a 10/100 Ethernet port and also contains two USB ports rather than one as in the previous model. Model A can connect to a network, but with the aid of an external USB Ethernet adapter. Both models, A and B, have many aspects of a modern computer, such as the use of USB keyboards and mice, as well as a monitor and other computer accessories.



Online References

http://readwrite.com/2014/01/20/raspberry-pi-everything-you-need-to-know#awesm=~ox2cbxruKpD5z3

http://techcrunch.com/2012/10/21/getting-started-with-the-raspberry-pi-is-not-as-easy-as-pie/

http://www.quickanddirtytips.com/tech/computers/what-is-the-raspberry-pi

Raspberry Pi

- The Raspberry Pi is a micro-computer that is no bigger than most of our cell phones
- It has full functionality of a regular computer when set up
- It was first intended to teach children how to use a computer
- Very customizable

Photo Courtesy of px4 Development Guide

Pros and Cons

Pros

- This unit is very small and easy to set up
- Reduced Instruction Set Computing (RISC)
- It can be set up to the users preferences and is very customizable
- Has a variety of uses
  - Arcade Table
  - Print Server

Cons

- Accessories or add-ons constitute the majority of cost
  - Monitors, keyboards, mouse, etc.
- The unit cannot run X86 Operating Systems
- RISC processing is efficient but does not compare to standard desktops

History of the Pi

- Production began in 2006 when the engineers of this product realized that kids from the 2000's lacked computer programming skills
- The name
  - Raspberry Pi was based on a fruit, just like others of its time (Apple)
- Founded in 2009, the Raspberry Pi Foundation, was a charity with the goal of promoting the study of computer science at middle school level
- The first Pi went on sale in February 2012

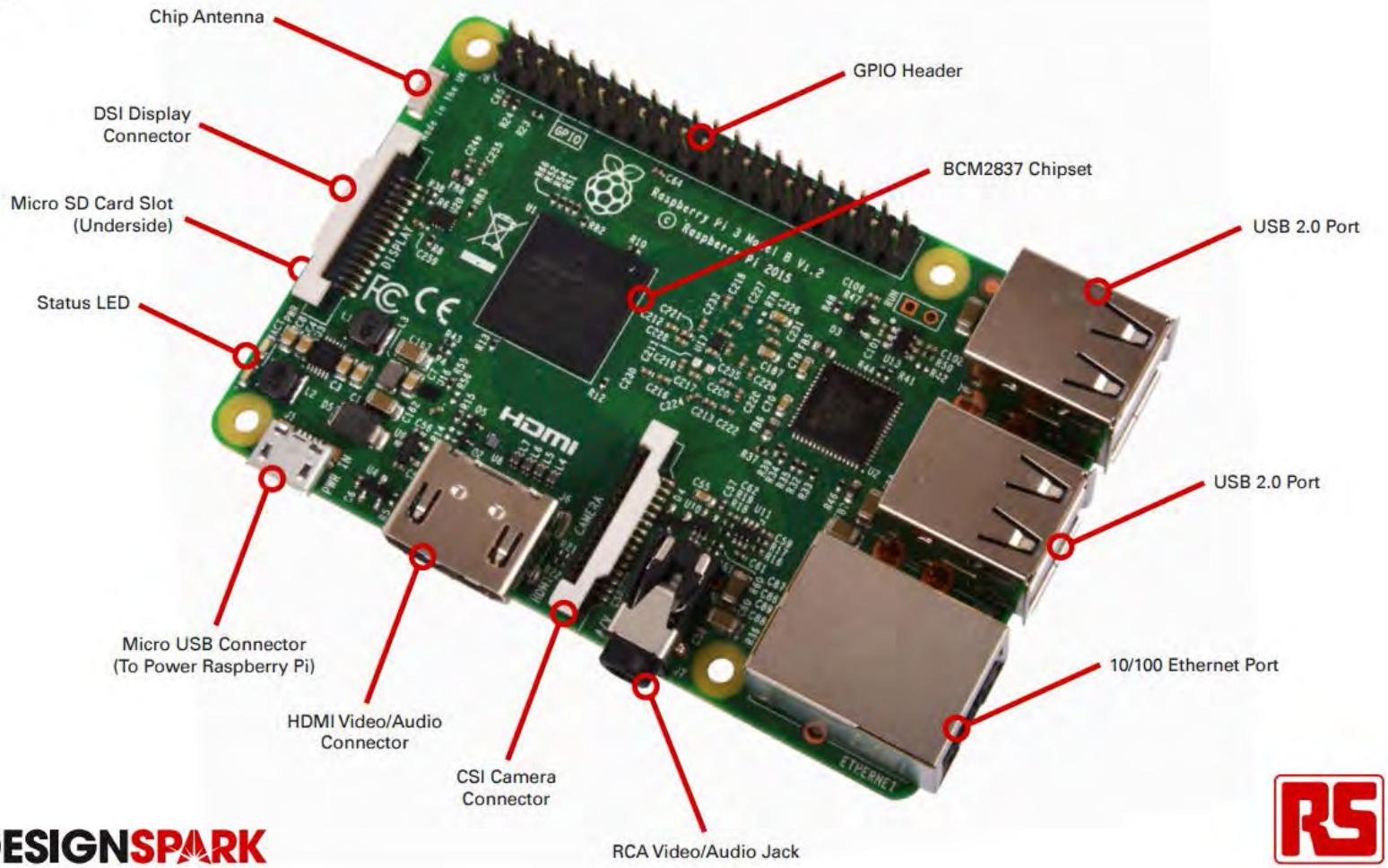
Current Uses

- Print Server
  - The Print server allows the user to print from the Raspberry Pi after teaching the Pi how to interact with the Printing device
- XMBC Media Center
  - A program that organizes movies, music and other media into a cloud based corral
- TV
  - Can attach the Pi to a TV through a video cable to have a fully functional computer using your TV as the monitor
- Powered Arcade Table
  - Pre installed software along with an arcade box can be used with the Pi to make a classic Arcade Table

How It Works

- A SD card is installed with a compatible Operating System(s) is inserted into the slot of the board
- The Pi becomes a fully functional computer once a mouse, keyboard, and monitor are attached; but without some of the processing power
- Has an Ethernet port for an internet connection
- The Raspberry Pi 3 includes Bluetooth and WiFi capabilities

Raspberry Pi 3 Model B

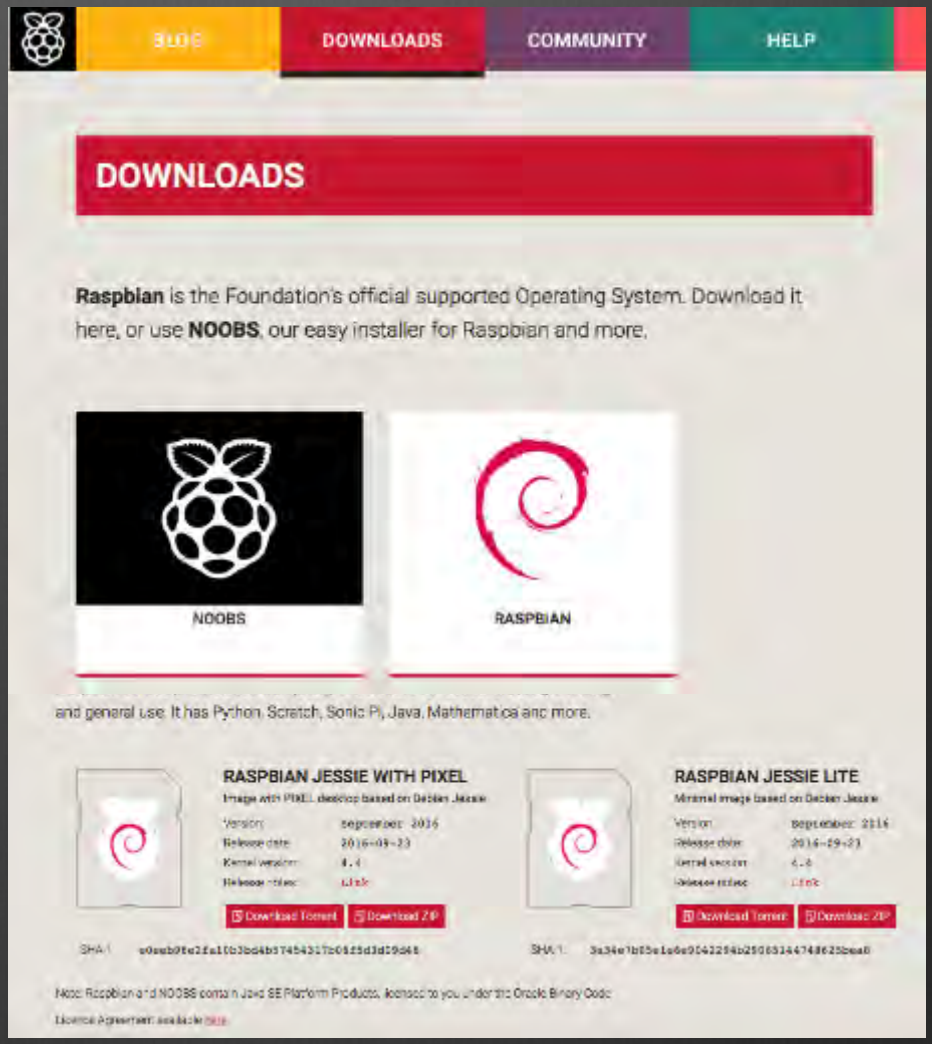


DESIGNSPARK

RS

Steps to Installation

- Begin by downloading SD card formatter to desktop or laptop (PC or MAC)
- Select and download operating system image from raspberrypi.org
- Using SD Card Formatter, place image on blank SD card.
- Install to SD card then check using the Pi.
  - Seeing if the Pi will boot or not



Raspberry Pi Desktop

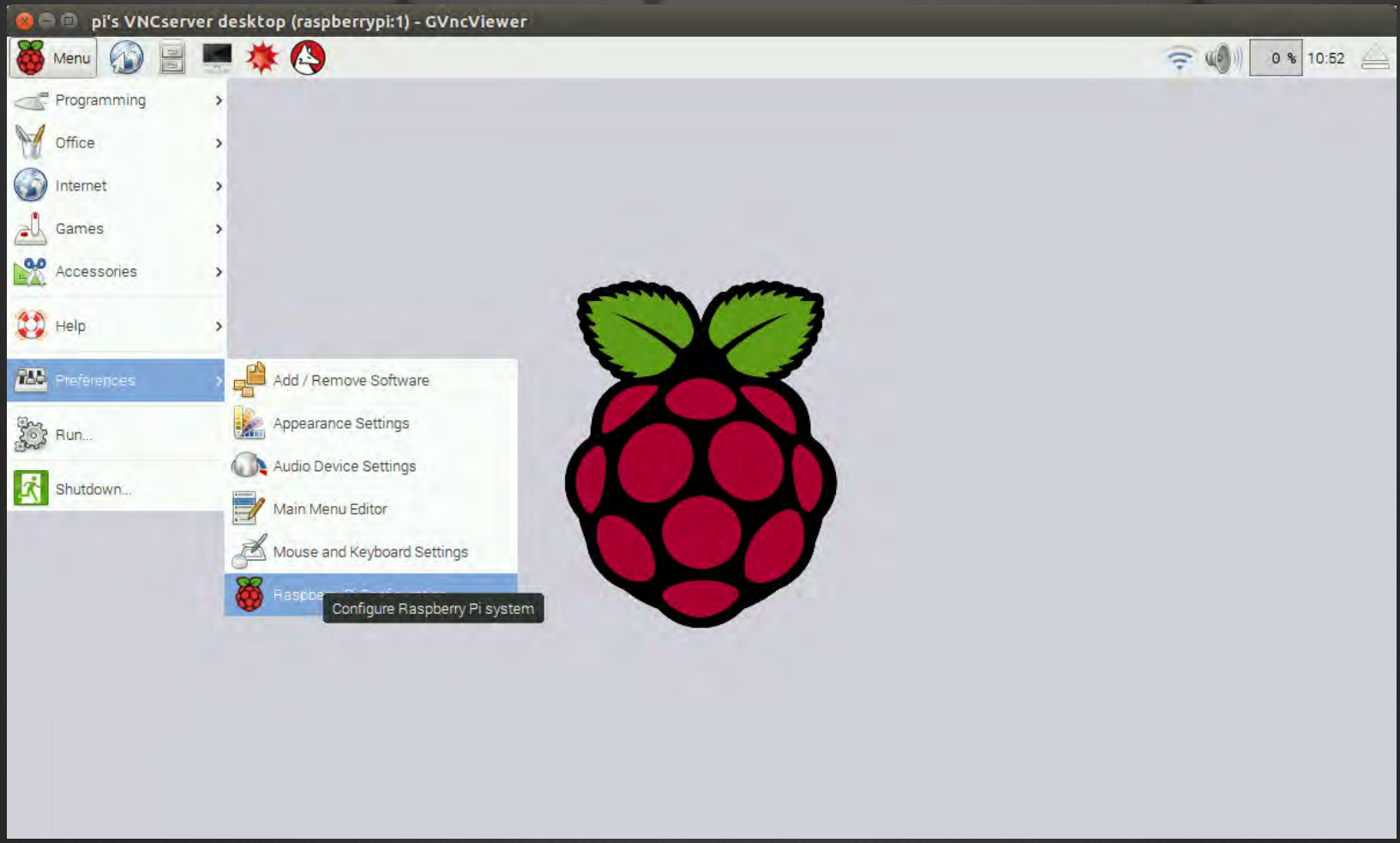
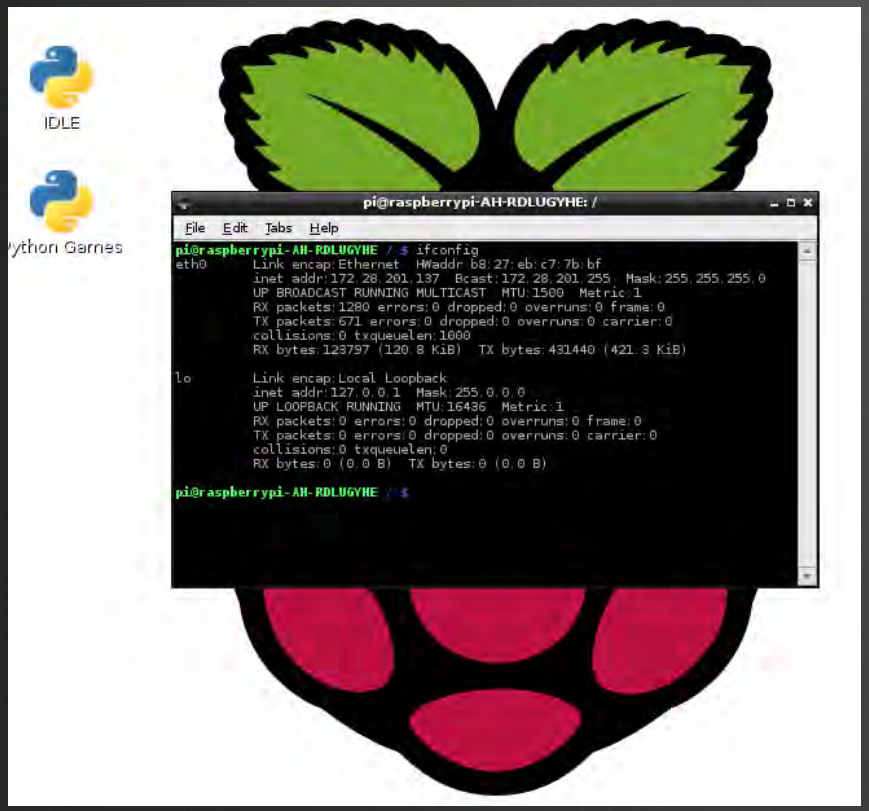
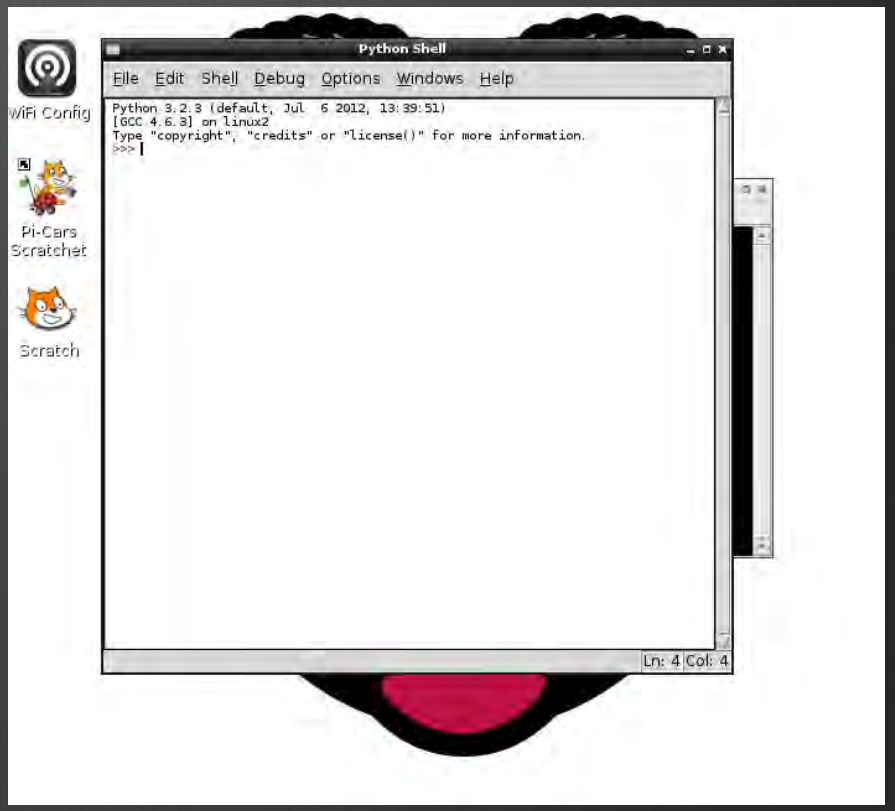


Image courtesy of everydaylinuxuser.com

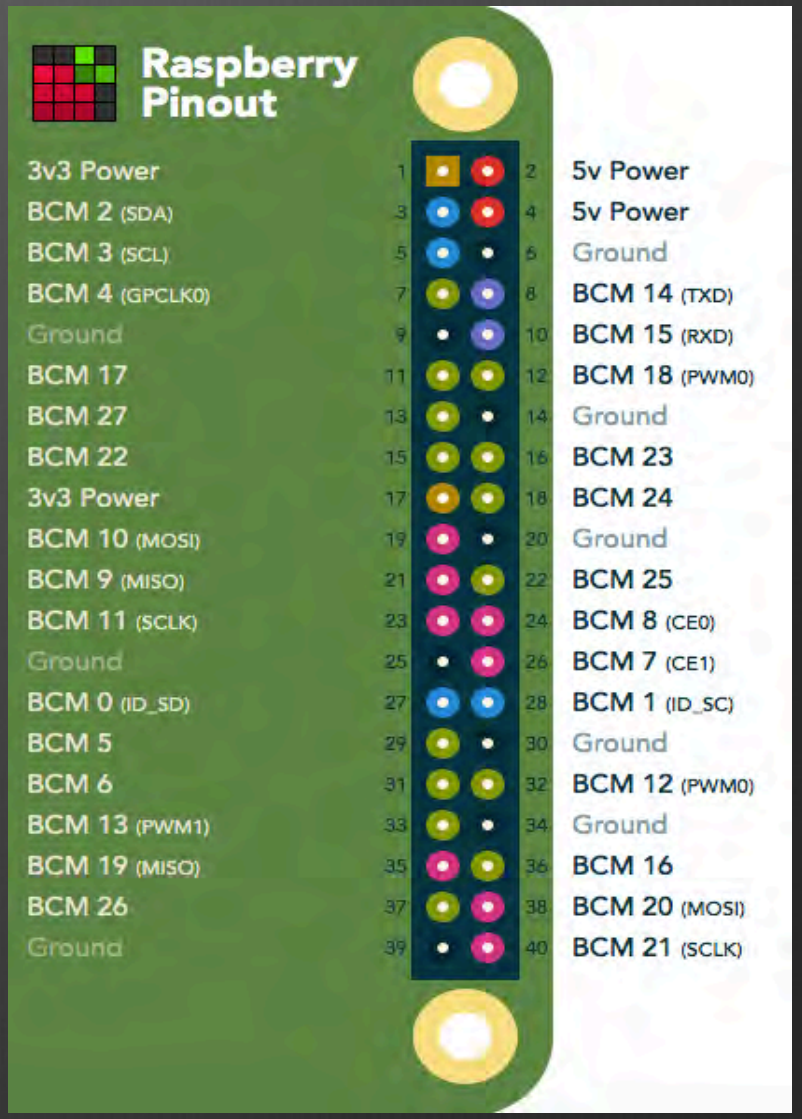
Terminal and Shell





BCM/BOARD

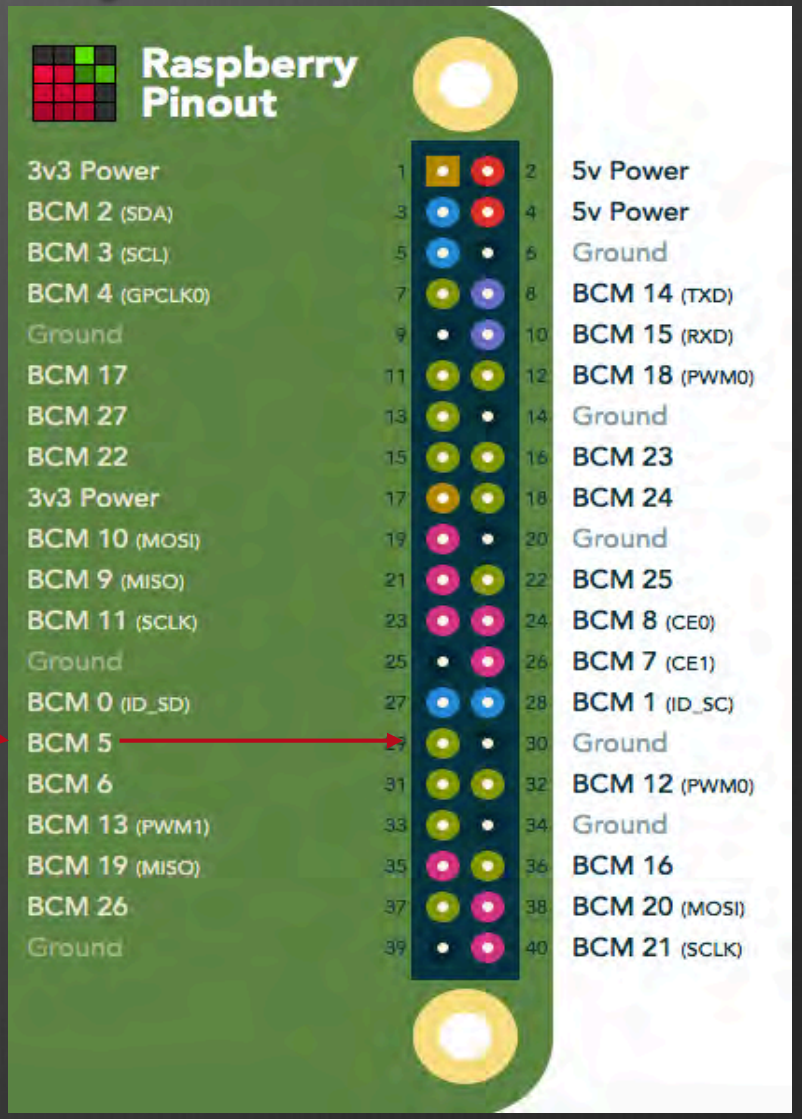
- Declares “HIGH” or +5V/3.3V or “LOW” >5V or >3.3V depending on which side of the GPIO the pin is on.
- Gives GPIO pin a labeled name (BCM 17) or (11)
- +3.3V is on left side
- +5V is on right side



BCM Layout

"GPIO.setmode(GPIO.BCM)"

- This GPIO.BCM command arranges Pi GPIO pins as seen in picture to right
- Notice how the pins are labeled BCM 2, BCM 3, etc.



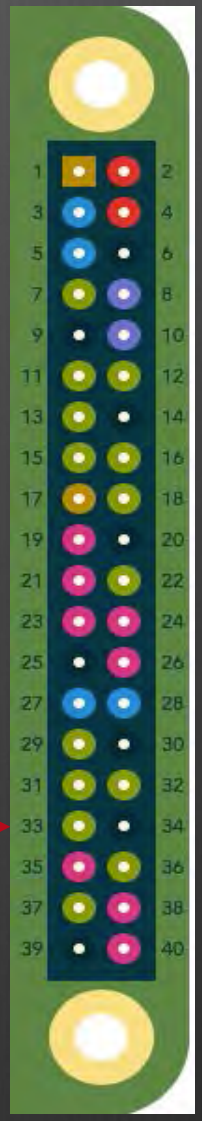
- Photo courtesy of pinout.xyz

Board Layout

GPIO.setmode(GPIO.BOARD)

- This GPIO.BOARD command arranges Pi GPIO pins as seen in picture to right
- This sets the pins up in a numerical order starting at one then having all odds on the left side and even on the right side

Pin Number 33



- Photo courtesy of pinout.xyz

Design Objective

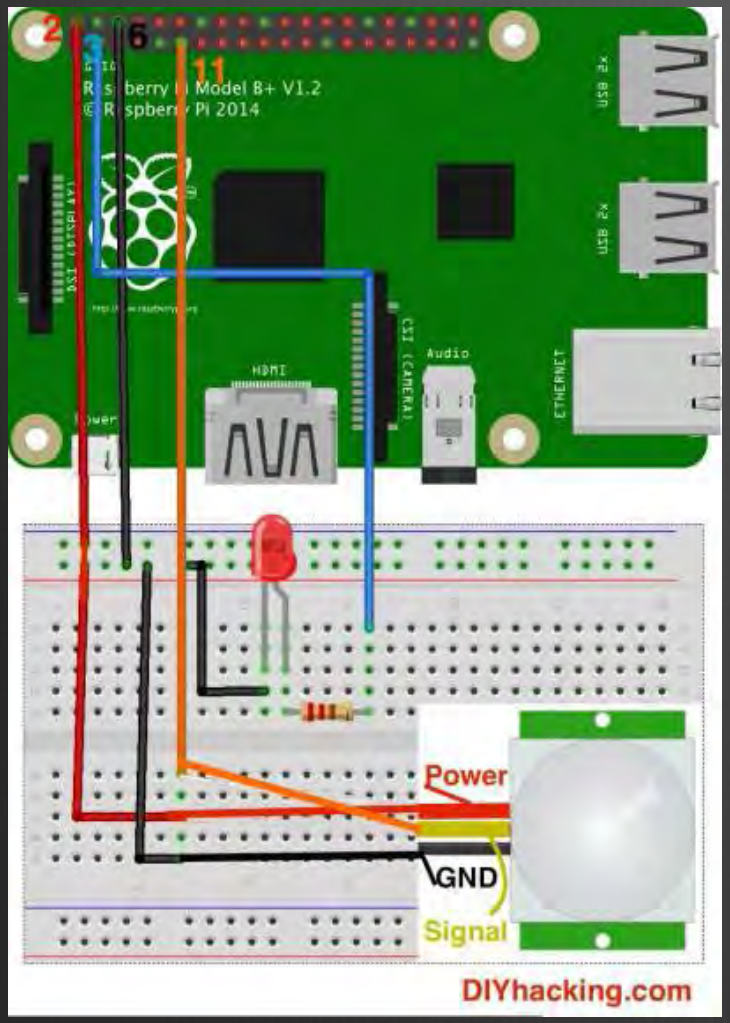
- Integrating computer programming with electronics to solve an engineering design problem.

  - Develop an alarm system that will:
    - A: Turn on Lights when motion is detected (primarily for security reasons such as an intruder, burglar, etc.)
    - B: Output to screen “Intruder Detected”

Parts List/Cost

Item	Vendor	Price
Raspberry Pi 3 Board	Amazon	$35.99
Power Cord	Amazon	$5.99
16 GB SD Card	Amazon	$6.99
Mouse/Keyboard Combo	Amazon	$14.95
HDMI Cable	Amazon	$4.99
Bread Board & Break Out Kit	Amazon	$13.95
PIR Sensor (5pack)	Amazon	$5.99
		Total: $88.85

Photo of Breadboard & Pi



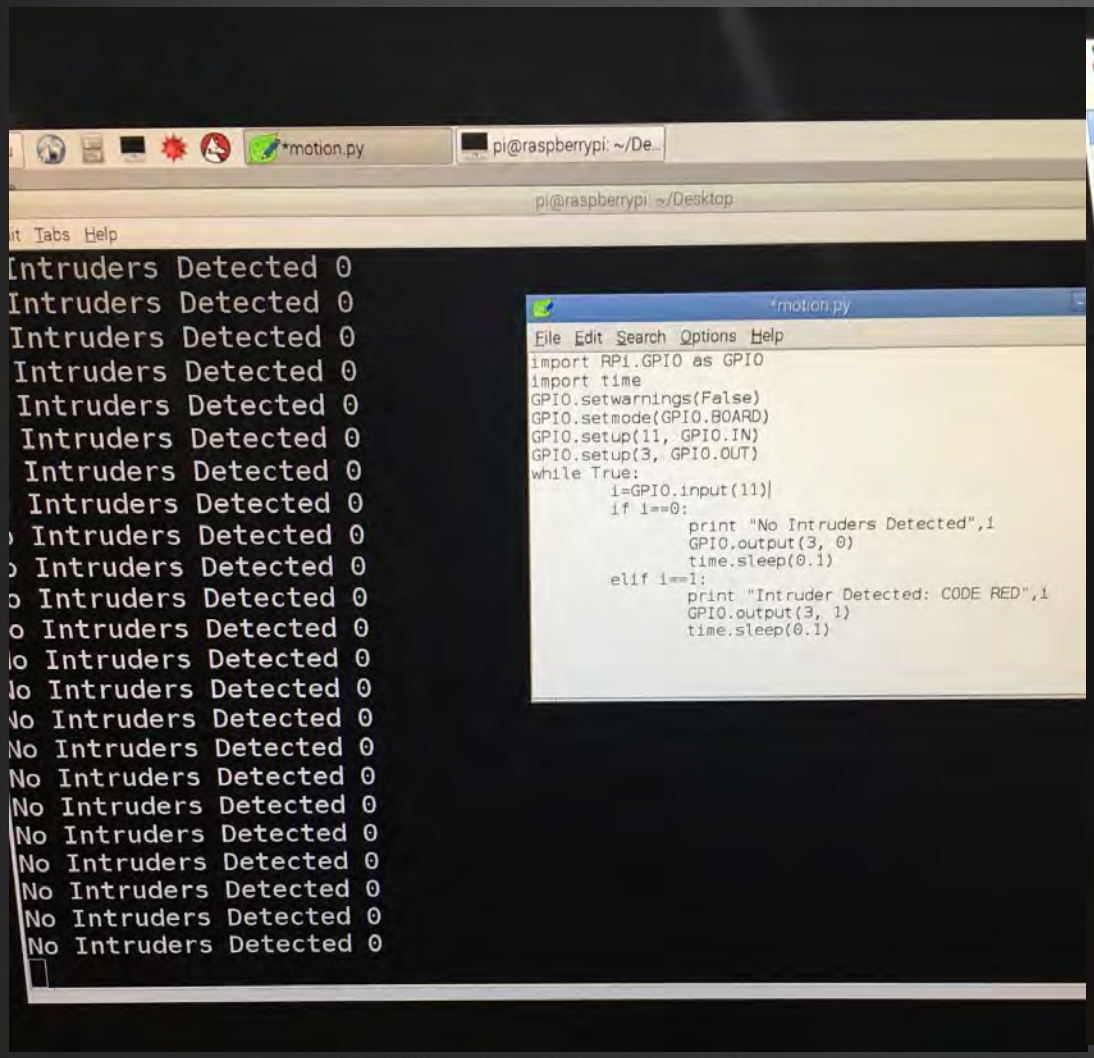
Using the PRI Motion Detector

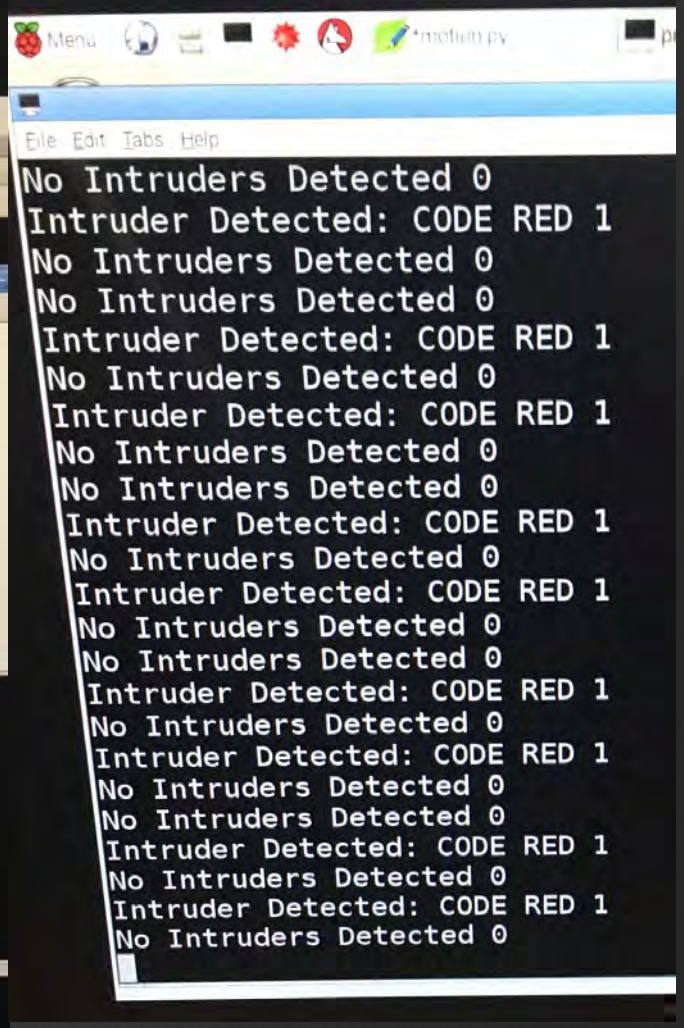
- Pi was coded to sense when/if signal was produced from PRI
- If motion/signal was produced, LED pin will be set to high and light will be turned on while printing to the screen "Intruder Detected"

Program for PIR Sensor

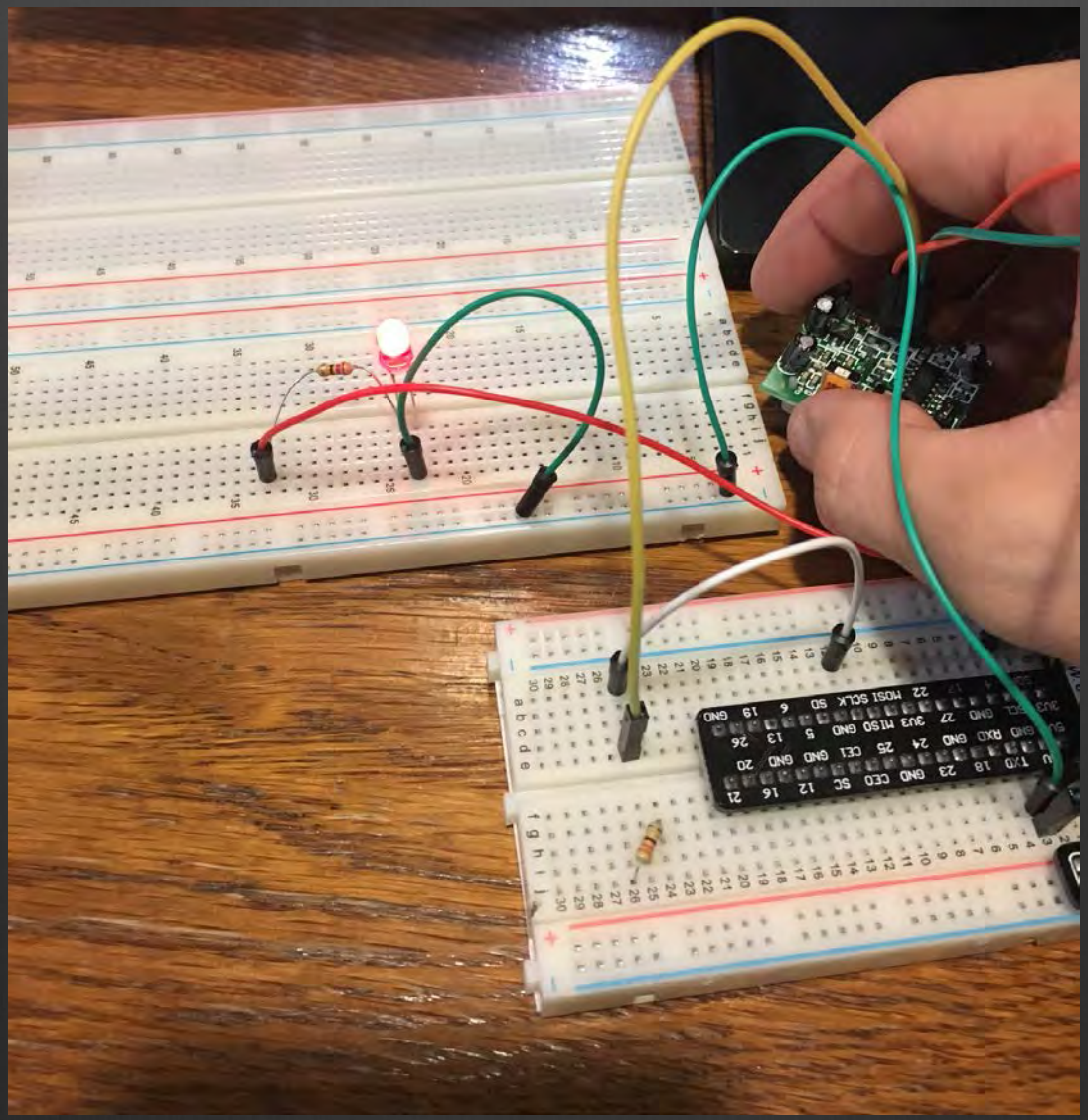
```
import RPi.GPIO as GPIO
import time
GPIO.setwarnings(False)
GPIO.setmode(GPIO.BOARD)
GPIO.setup(11, GPIO.IN)        #Read output from PIR motion sensor
GPIO.setup(3, GPIO.OUT)         #LED output pin
while True:
      i=GPIO.input(11)
      if i==0:                 #When output from motion sensor is LOW
            print "No intruders",i
            GPIO.output(3, 0)  #Turn OFF LED
            time.sleep(0.1)
      elif i==1:               #When output from motion sensor is HIGH
            print "Intruder detected",i
            GPIO.output(3, 1)  #Turn ON LED
            time.sleep(0.1)
```

Running the Program in terminal window





Picture of LED and Sensor



Raspberry Pi Community

- https://www.raspberrypi.org/
- https://www.adafruit.com/
- https://www.raspberrypi.org/magpi/

References

- Raspberry Pi GPIO with PIR motion sensor: Best tutorial. (2016). Retrieved October 19, 2016, from DIYhacking.com: https://diyhacking.com/raspberry-pi-gpio-control/
- Newell, Gary (2013). Raspberry Pi Terminal [Online Image]. (2013) Retrieved October19, 2016 from http://www.everydaylinuxuser.com/2016/01/how-to-connect-to-raspberry-pi-2-using.html
- Raspberry Pi Layout [Online Image]. (2016). Retrieved October 19, 2016 from https://diyhacking.com/raspberry-pi-gpio-control/
- Raspberry Pi Board Identifiers [Online Image]. (2016). Retrieved October 19, 2016 from http://www.rs-online.com/designspark/assets/ds-assets/uploads/images/573300ad87d442759a12186b0ab544b9pi_3_features.jpg
- Raspberry Pi Installation [Online Image]. (2016) Retrieved October 19, 2016 Retrieved from https://www.raspberrypi.org/documentation/installation/installing-images/

Questions?