SORT 2016

Automate All the Things

Use IoT to make life awesome

Jordan Spencer Cunningham

October 11, 2016

What is the Internet of Things?

- Connects the physical world to computers for control, monitoring, and automation of physical objects
- Consumer versions often referred to as “smart” things
- Part of the industrial world for decades (e.g., traffic signal systems, factory production lines, air traffic controllers, and so on)
- Consider IoT devices as APIs between software and the physical world

Everybody's Cashing in on Consumer IoT

- Nest: thermostat, smoke alarm, surveillance, doorbell
- GE: fridges, ovens, dishwashers, water heaters
- Amazon: Echo, Dash buttons
- Phillips: Hue lights
- Samsung SmartThings: lights, wall outlets/switches, proximity modules
- Google: Just announced their Google Home product
- Many, many, *many* more

Reasons to Take the DIY route

- Greater availability of components for a more customized experience
- Avoid commercial product lock-in
- Avoid unprecedented amounts of personal data being sent to people who want to sell you more garbage
- Sometimes you can get better security doing it yourself than relying on companies to be secure for you
- Typically DIY is less expensive than commercial products with fancy brand names and wannabe Apple design
- Be the coolest nerd in your cubicle block; score some major nerd credibility
- Even with a fully finished home, you can often replace existing hardware with automated upgrades
- Actually know what's going on under the hood and expand your horizons of knowledge and experience

Reasons Not to Take the DIY Route

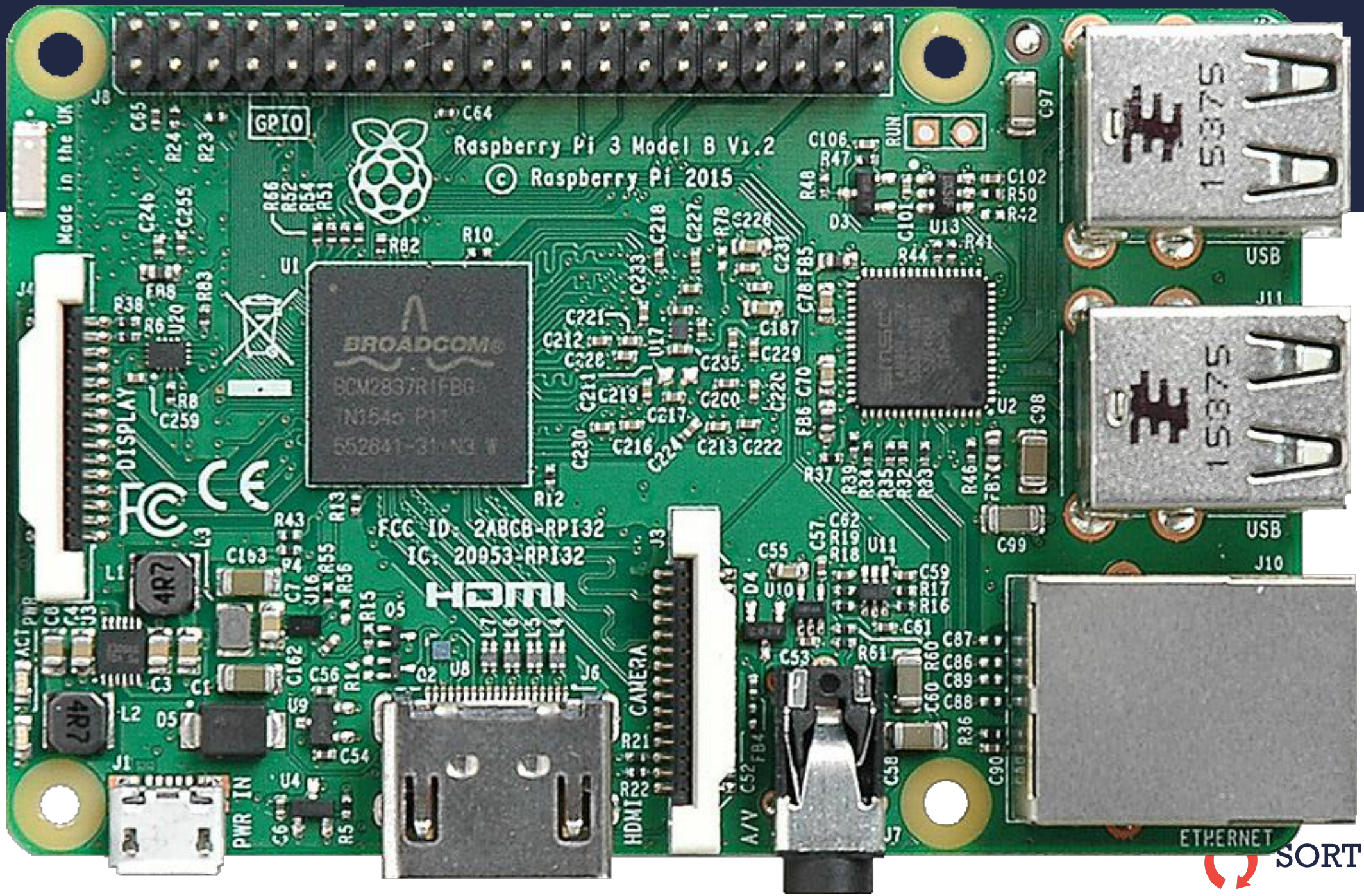
- Depending on the project, extensive experience or self-teaching is required, not to mention patience
- Consumes more time, often quite a bit of time
- If you're overconfident in your skills, you could at best damage your property, at worst cause yourself injury or death
- Difficult to add without cutting open walls for wired-only automation if house is fully finished

Security Considerations

- Everything has risk, even (sometimes especially) commercially available, non-DIY automation products
- If you open your automation system to the internet and don't have basic authentication and security measures set up, you're essentially inviting strangers to control your home
- **There is no substitute for multilayered security**: multifactor auth, encryption, VLAN isolation, obfuscation, obscurity, IPS/IDS/firewalls, input sanitization and other anti-XSS measures, and so on, using the most tested and secure technologies currently available, fully patched

Today's Focus: Raspberry Pi

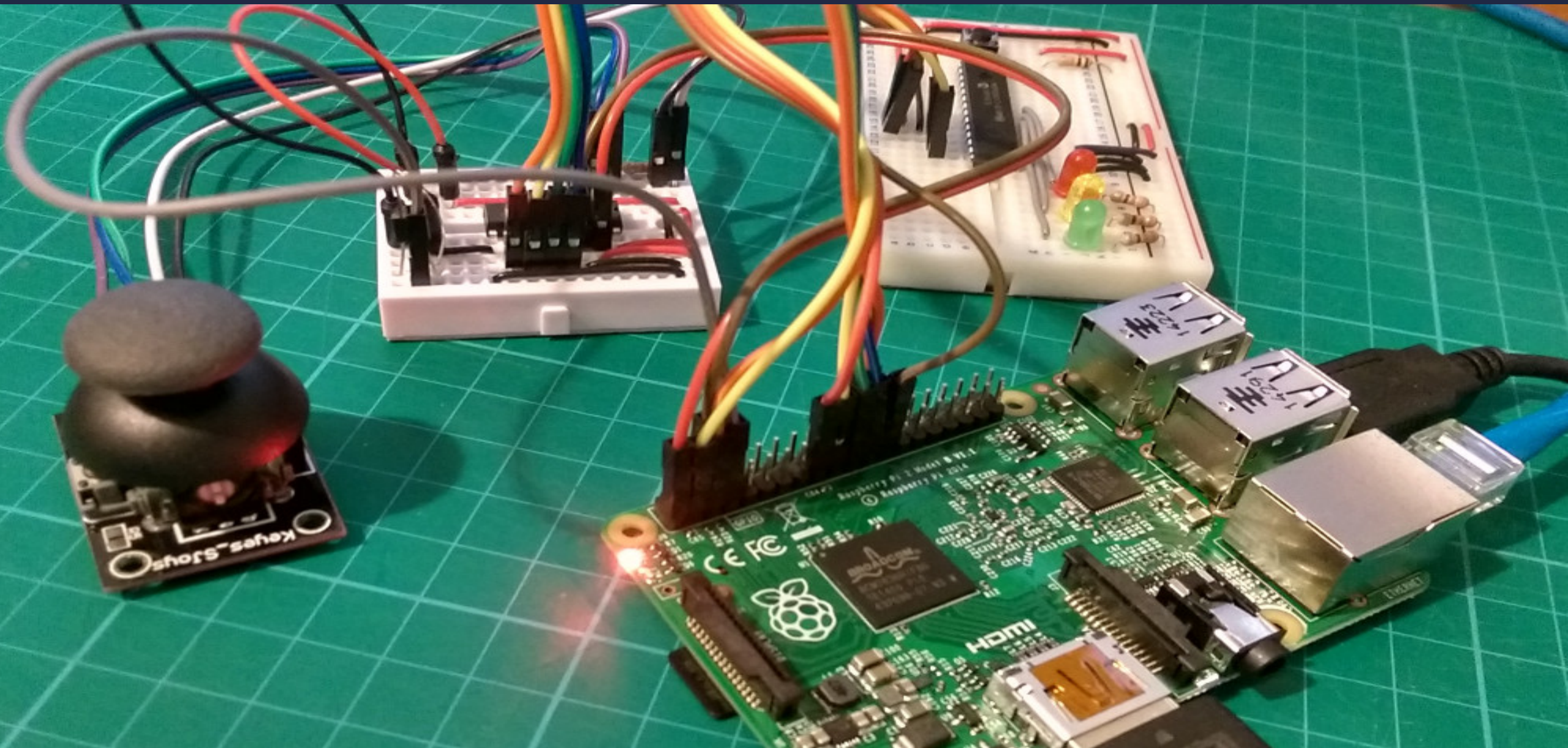
- Raspberry Pi is a full-fledged computer on a board about the size of a credit card
- One of the most popular automation/maker tools on the market for its versatility and low cost ($35)
- Comes in various models ranging from 32-bit 700Mhz single core CPU w/256MB RAM to 64-bit 1.2GHz quad w/1GB RAM and built-in WiFi, Bluetooth, Ethernet, USB
- Other popular choices offering similar capabilities: Arduino, C.H.I.P., Pine64, VoCore, Intel's Gallileo and Joule, and various other fruit- or math-inspired minicomputers


GPIO
Raspberry Pi 3 Model B V1.2
© Raspberry Pi 2015
Made in the UK
BROADCOM
FCC ID: 2ABCB-RPI32
IC: 20953-RPI32
HDMI
CAMERA
DISPLAY
USB
USB
ETHERNET
PWR IN
A/V
RUN

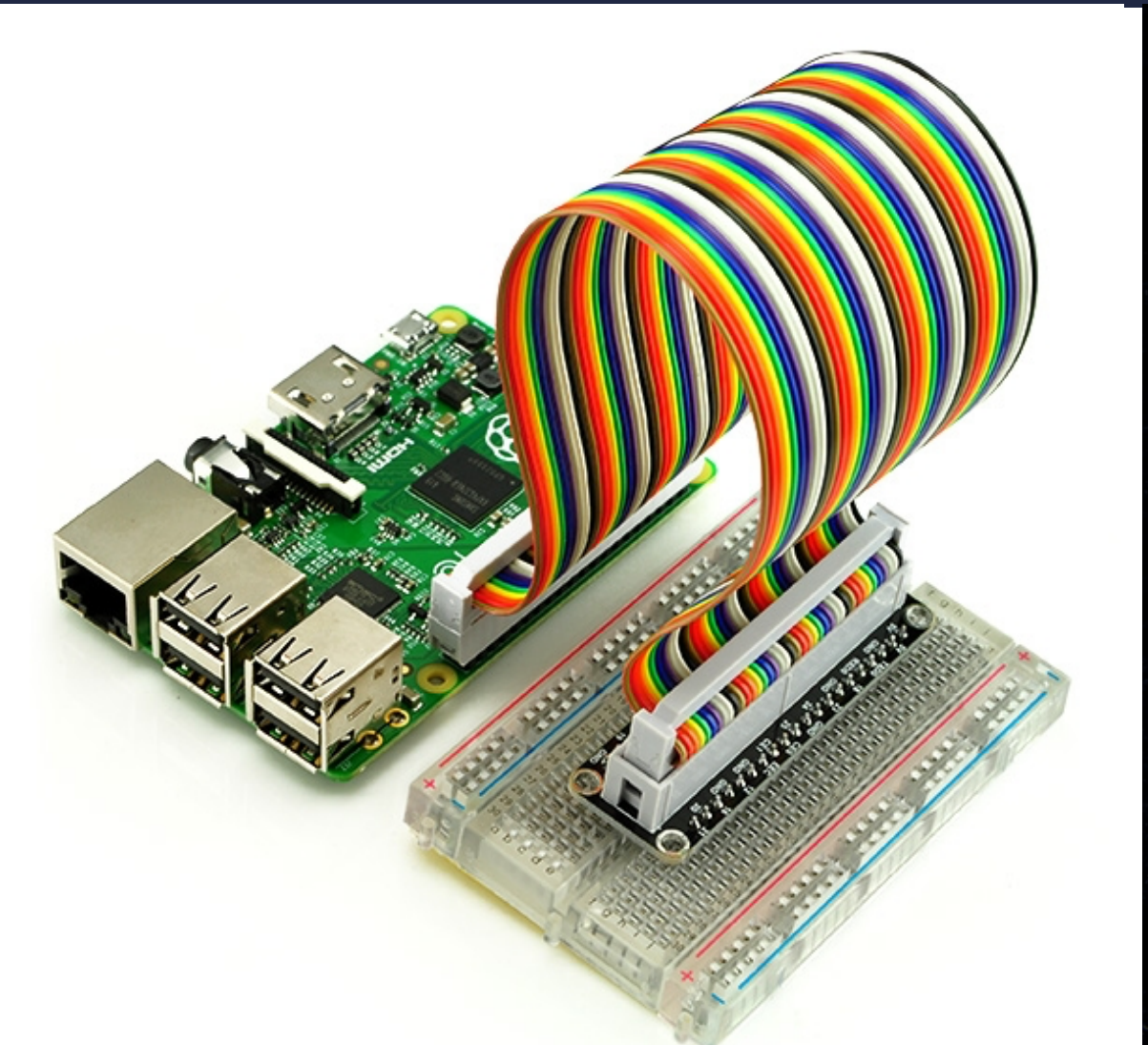
Linking Virtual and Physical Worlds: GPIO

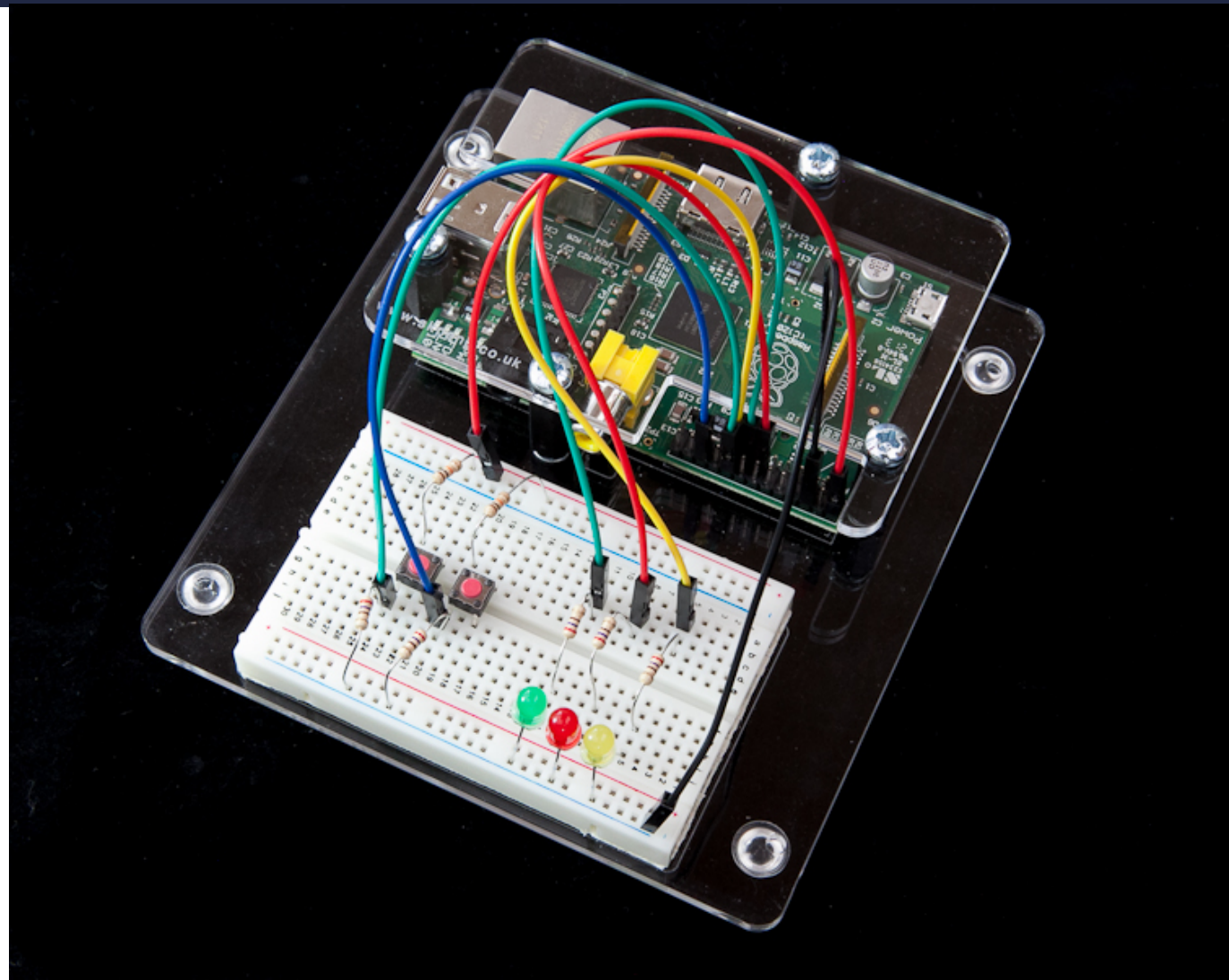
- General Purpose Input/Output
  - Output digital signals (on or off, binary) to other equipment
  - Receive digital signals from other equipment
  - Raspberry Pi's GPIO is only capable of digital signals out of the box; analog signals require an analog to digital converter (kits exist for this; you may only need a simple capacitor)
  - Arduino devices support analog signals out of the box

Linking Virtual and Physical Worlds: GPIO

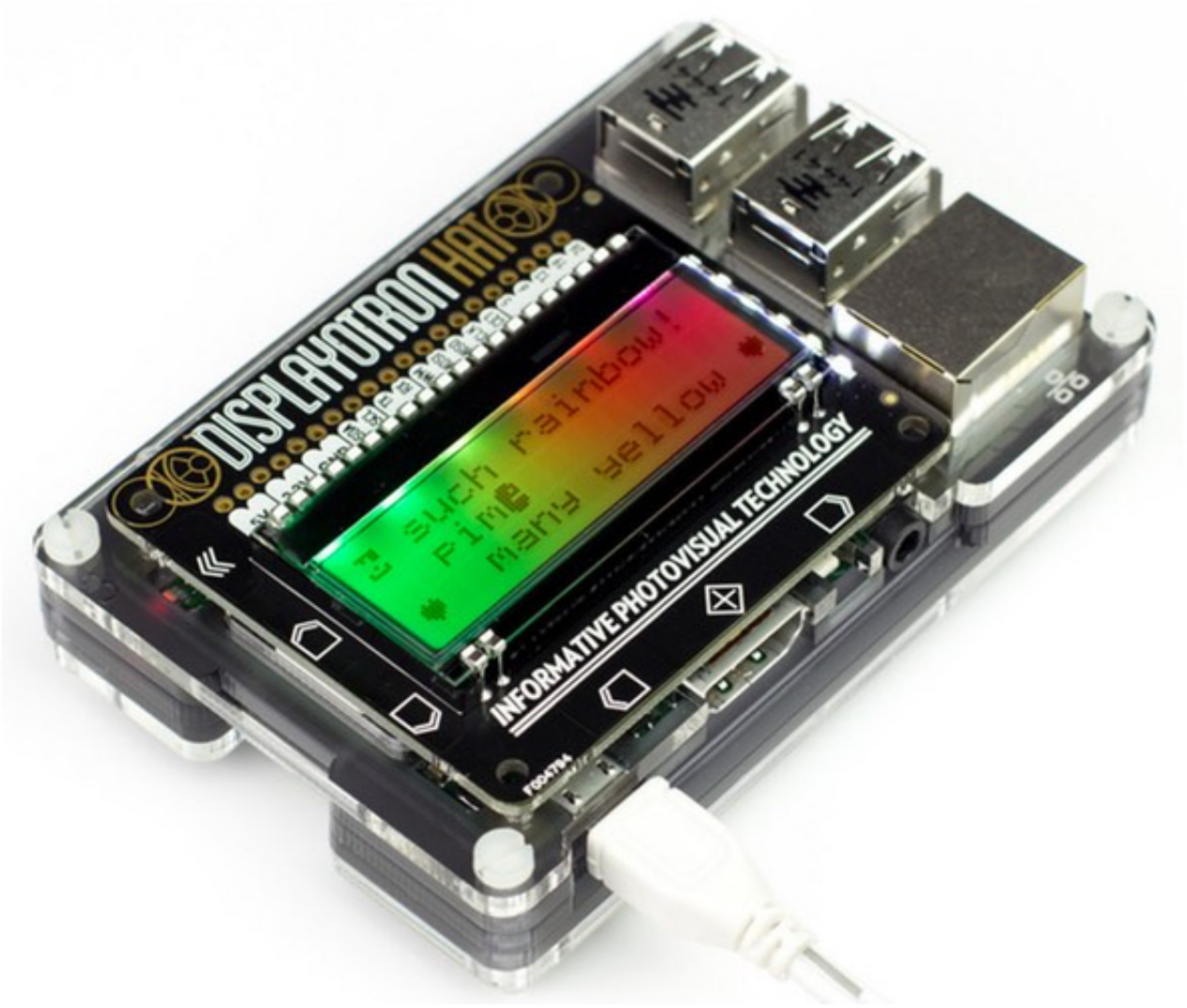


Linking Virtual and Physical Worlds: GPIO





Linking Virtual and Physical Worlds: GPIO



Controlling the Pi: Software

- Raspbian: Debian Linux specifically designed to run on Raspberry Pi hardware and comes pre-installed with various software packages
- Python: most commonly used scripting language on Raspberry Pi with tens of thousands of existing projects via sites like GitHub and limitless community support across various forums
- Bash can also be used to control GPIO pins
- Python and Bash are relatively easy to learn and are very useful outside the Pi
- Use a service such as ITTT to easily interconnect events from many sources to act as triggers

Example 1: Christmas Ambiance Controller

- Simple but effective example
- Control lights from phone, computer, anywhere in the world using web server
- Easily set up timers, motion sensors, or other triggers to control the setup and completely remove the human element
- Uses simple relay switches prefabricated specifically for Raspberry Pi to control 120v mains to lights and electric train
- Sends WOL packet to HTPC and then uses SSH to send remote control commands to computer

Example 2: Safe Combo Brute-Forcer

- Could have spent $40 to pay the safe company to send the factory code. I decided on something much more awesome
- Uses two prefabricated relay boards, some indicator LEDs with resistors, a breadboard, a lot of wire, and an alligator clip, not to mention about 400 lines of Python
- I was able to crack my 5-digit combination in around 14 hours

Example 2: Safe Combo Brute-Forcer

- Since this is a PDF now, here's a link to the video:

  https://www.youtube.com/watch?v=o2Y2ZDMJ_u4

Example 3: Home Automation

- Control lights or anything else electrical using relays and current sensors and still use physical switches for convenience using three-way switches
- Have your Pi open garage when your phone gets in range of your home's WiFi network; have a tone play or a stoplight turn on if your car gets too close to a proximity sensor
- For finished homes where you don't want to or can't run wires through the walls, make your Pi a controller of Z-Wave protocol devices (ZigBee is also popular)
- Add a relay to each circuit controlling each of your sprinkler valves; have Pi intelligently lengthen or cancel sprinkler time based on recent weather conditions or even based on moisture sensor data from each sprinkler zone

Example 3: Home Automation

- Add temperature and motion sensors on each floor or in each room and only run HVAC when an occupied room reaches certain threshold or when you leave your workplace
- Add number pads and/or RFID scanners by each outside door and install electric strikes and deadbolts to each door controlled by the Pi via relays; supply temporary codes to friends, family, or neighbors, or unlock doors remotely from anywhere in the world
- Extend your smoke/CO2 detector 9v COM line to power a 9v/12v relay. When triggered, the Pi sends you an urgent email or text message, or even calls the fire department for you

Example 3: Home Automation

- Reroute doorbell wiring through 24-volt relay, which will both ring doorbell and send a signal to Pi
- Using the LIRC software package, control TVs, sound systems, space heaters/coolers, and anything else with RFID receivers
- Add moisture sensors outside and relay-controlled valves to plumbing
- Add “away mode” button to trick would-be burglars into thinking you’re still at home

Example 3: Home Automation

- Many more possibilities
- These ideas mostly build off of the simplicity of the Christmas Controller proof-of-concept
- Add some smart algorithms and data tracking, and you can remove the human element completely when desired
- Several good full-fledged systems exist, both proprietary and open source, such as HomeGenie, OpenHab, and HomeAssistant

Example 4: Retro Arcade

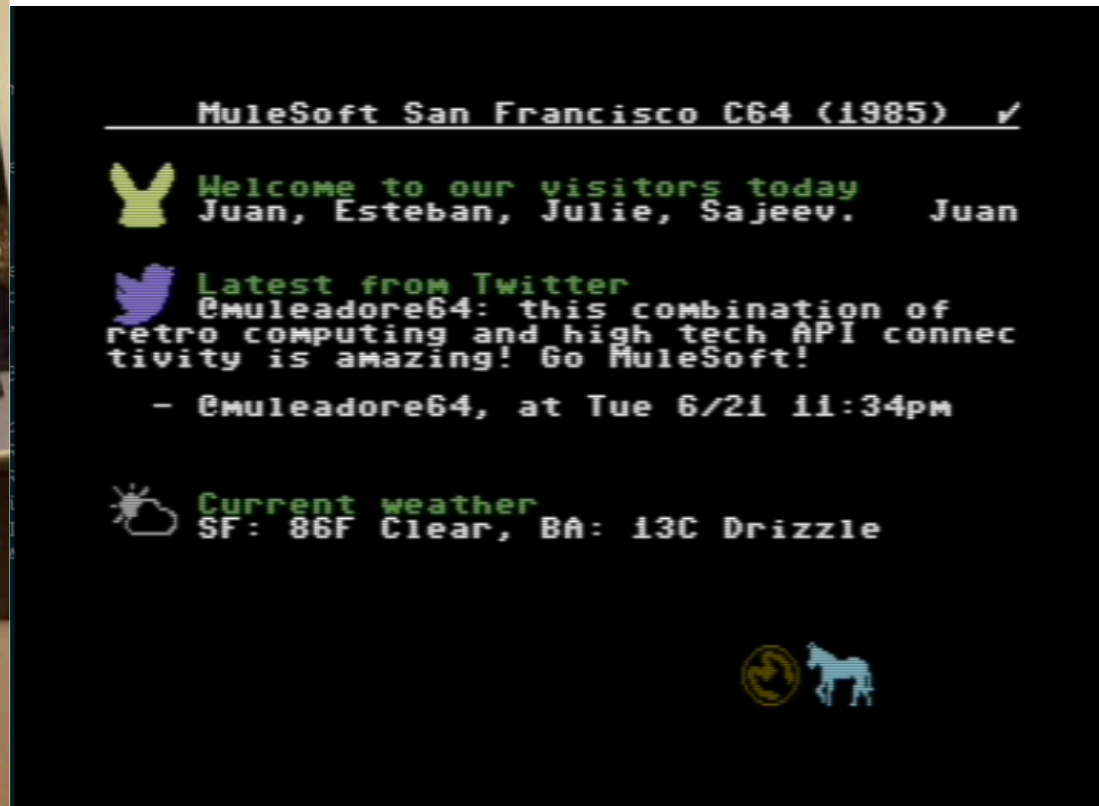
SORT 2016

Example 4: Retro Arcade

- Not so much automation, but it shows the nearly limitless things you can do with a Pi
- Run a classic games emulator within Raspbian (arcade, NES, SNES, Genesis, GB, &c.), build your own arcade cabinet or GameBoy-like enclosure, connect up all the buttons and joysticks, and enjoy
- Ultimarc sells all the parts you could ever need to build your own arcade

Example 5: Breathe New Life into Archaic Technology

- Mulesoft used a Raspberry Pi as an [interface between a Commodore 64](#) and Twitter, weather data, and some Phillips Hue lights



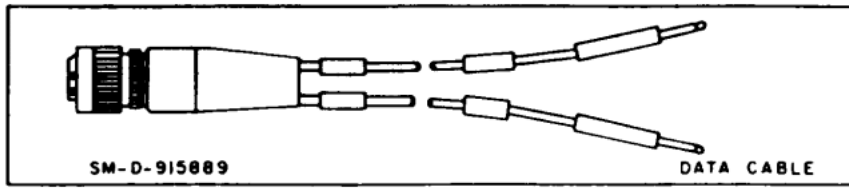
Example 5: Breathe New Life into Archaic Technology

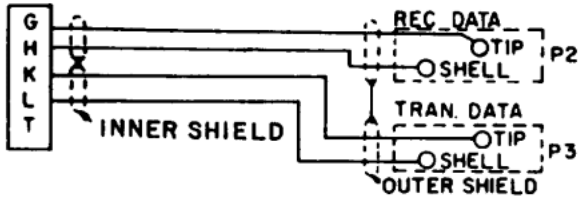
- I built this Modern Telegraphy Interface Apparatus to send and receive telegraph signals across the internet with a Pi

Example 5: Breathe Life into Archaic Technology

- Use teletype as a terminal to Unix/Linux systems or send messages across networks to any other device
- Concept that's not quite finished but is still quite possible

DATA CABLE





- **Data cable provides interface capability between equipments having phon connectors, and the transmit and receive lines of AN/UGC-74B(V)3 or AN/UGC-74C(V)3.**
- **Used in conjunction with TS-3378/G and SG-1054/G during testing.**

Long story short…

- If you can imagine it, you can probably do it with a Raspberry Pi

Many more examples we don't have time to admire today

- Have a physical counter displaying actual website hits
- Control a Roomba (or an iRobot Create 2)
- Detect and alert for smoke or gas leaks
- Build a surveillance, doorbell, or nature camera
- Build an Enigma machine emulator
- Build a Bombe (Enigma-cracking) computer emulator
- Build a rotary or push-button phone interface and have it play secret messages when the correct number sequence is entered or connect to another device
- Have your USB rocket launcher automatically shoot the dev who broke the latest build or simply shoot when the Pi detects motion in different zones
- Start your Jeep remotely via your phone or computer
- Install your own inexpensive IPS on your home network
- Train your dog to simply bark so he or she can open the door to go outside
- Be the coolest nerd on the block while whipping out your touchscreen smartphone
- Build your own RAID NAS
- Build your own Raspberry Pi supercluster for cheap parallel computing
- Turn your Pi into a simple FM transmitter
- Turn your Pi into a numbers station controller(ask me about this)