In the day and age of “IoT” I’ve frequently found myself thinking, “I could build that”. With a few Raspberry Pis (RPi) and Arduinos paired with a 3D printer I’ve found an innocent curiosity turn into what may now be an addiction (or so my wife tells me). I am going to walk through all the uses I’ve found for my army of Micro Computers/Controllers.

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Raspberry Pis

Pi-Hole & PiVpn (OpenVPN)
Using DNS to block ads

No one loves the never ending assault of advertisements when browsing the internet but with the help of Pi- Hole (PH) you can block advertisements from ever appearing. We all know that malware can spread through malicious advertisements via “malvertising” on a page which makes advertisements even worse. You can setup Pi-Hole to be a DNS server for your local network to block advertisements and also reduce the chances of falling victim to malvertising. For those who care about security (I think that’s all of us) you can set up PH to use DNS-Over-HTTPS (DOH) to protect against tampering.

Rather than re-write the steps for installing PH, here is a link to the docs.

Once up and running you can control Pi-Hole though the web interface and monitor the status.
Maybe you don’t like the percentage of ads being blocked, you can add lists to the blocklist to increase the blocking power. Here’s a few lists I found when searching which average me about 40-50% of total DNS queries blocked (apparently my wife hasn’t opened Facebook today putting me at only 33% blocked).

- https://raw.githubusercontent.com/StevenBlack/hosts/master/hosts
- https://mirror1.malwaredomains.com/files/justdomains
- http://sysctl.org/cameleon/hosts
- https://s3.amazonaws.com/lists.disconnect.me/simple_tracking.txt
- https://s3.amazonaws.com/lists.disconnect.me/simple_ad.txt
- https://hosts-file.net/ad_servers.txt
- https://adaway.org/hosts.txt
- https://pgl.yoyo.org/adservers/serverlist.php?hostformat=hosts&mimetype=plaintext&useip=0.0.0.0
- https://raw.githubusercontent.com/PolishFiltersTeam/KADhosts/master/KADhosts_without_controversies.txt
- https://raw.githubusercontent.com/FadeMind/hosts.extras/master/add.2o7Net/hosts
- https://someonewhocares.org/hosts/zero/hosts
- https://raw.githubusercontent.com/anudeepND/youtubeadsblacklist/master/domainlist.txt

You are also able to look at the query log to see what is happening on your network. You may find that some apps, not just mobile but for Amazon fire sticks, don’t work. Maybe you tried to open up an app (say CBS) on an Amazon fire stick and found it won’t load. Checking the query log, you can see that CBS was attempting to access a bunch of analytic servers that got blocked by PH. You could just white list those servers or temporarily disable DNS blocking OR..... you can setup a VPN (I use Private Internet Access [PIA]) on your fire stick and tunnel just that specific app’s traffic through PIA using the ‘app specific settings’ keeping all the ad blocking power intact for the rest of the network.

Great, now your local network is covered, but what if you want to block advertisements while on the go? Adding OpenVPN to your RPi gives you the same Ad blocking power anywhere. Even better, you now get the added protection from threats such as rogue access points (and base stations).

Maybe your ISP speeds don’t quite handle a full VPN with ease but you still want the ad blocking. Here are the steps to only route DNS queries though the VPN.

So you setup your PH and VPN but after a bit of time you find that your device can no longer connect to your VPN and then realize your ISP issued you a new public IP (or maybe you already knew this happens). Setting up a dynamic dns record allows you to always have access to your VPN instead of using hard coded IP addresses. You can pay for dynamic dns or use one of the many free services:

- https://docs.pi-hole.net/guides/vpn/dyndns/
- https://www.duckdns.org
- https://www.noip.com

ForiOS, OpenVPN Connect is great but doesn’t offer the ability to have “trusted networks”. Passepartout is a great alternative which will turn the VPN on and off automatically for your configured trusted networks. It also can manage other VPN services such as PIA giving you complete control of your VPNs in one app.
Network Attached Storage
NAS for all

Another great use for a pi is to make a network-attached storage solution or NAS, which to my wife’s disappointment is not the same as the stuff from Fast and Furious. I run mine on the same RPi 3b+ that runs my Pi-Hole and PiVpn. Sure there’s the obvious use case of file backups for those times you were “sure” you hit save. But if you setup some of the other projects covered later you can have your security cameras save the pictures and videos on the share.
https://magpi.raspberrypi.org/articles/build-a-raspberry-pi-nas

For a hard drive I used the Seagate Portable 5TB External Hard Drive HDD which is currently $116 on Amazon.

Why not make it a RAID NAS server…? I plan to pick up a couple more HDDs and beef up my current setup to a RAID-5, because well… why not?
https://www.ricmedia.com/build-raspberry-pi3-raid-nas-server/

I have cron jobs set to do various tasks such as copy files to the NAS or delete all files older than a specific number of days/months etc. If you do add more hard drives be sure to also use a powered usb hub to reduce the chance of damage to the RPi or HDDs.

RetroPie
Emulate old consoles for that kick of nostalgia

There are so many times where I really wanted to play an old NES (Nintendo Entertainment System or “The original Nintendo”) or GameBoy game. The problem is that I would need to buy an adapter to even connect my NES to the TV or hunch over a tiny un-lit screen to play my GameBoy. When I found RetroPie I can’t tell you how many nights I stayed up late playing Zelda just like when I was younger, except I was much more tired the next day. Here’s the RetroPie Docs to learn more about it. ** Please Read this about legal and ethical ways to play your favorite retro games. I recommend sticking with the Homebrew games or games that you currently own for a given system.

Why put your RPi in a boring old case when you can get something like the Retroflag NESPi Case off Amazon for about $25. If NES isn’t your thing you can find cases that look like other consoles or better yet if you have a 3D printer you can print your own.

I also strongly recommend picking up the 8Bitdo N30 Pro2 Wireless Bluetooth Controller off Amazon for about $40.

OctoPrint
Control and monitor your 3D printer remotely (or from anywhere with Pi-Vpn)
I got the Creality Ender-3 3D Printer last Christmas and have probably spent more time modifying it than I have actually printing. If you get the Ender-3, don’t pay more for the ‘pro’ when you can quickly print some parts and get a few mods off of Amazon making it better than the ‘pro’ for about the same price.

After about 3 prints I got too lazy to want to manually move files via an sdcard so I set up OctoPrint. This allowed me to remotely move files to the printer and start/stop prints. I could monitor the current print time, estimated remaining time, and temperatures but I wanted to be able to periodically watch the print without having to go stand in front of the printer. Adding a cheap USB camera solved that problem. Using an app such as OctoPod or OctoClient allowed me to do everything from my phone.

With the RPi connected and running and the printer turned off the LCD would remain partially lit and the hotend fan would slightly buzz. To fix this you can make your own USB cable and disconnect the 5v+ or do what I did at first and just put a thin strip of electrical tape covering the connector as described in this reddit post.

To get the BL-Touch to work you need to flash the firmware on your printer. While I could have Used an Arduino that I connected directly to the board I wanted to be able to easily flash the firmware from the pi already plugged into it. After a bit of research I found https://www.fission3d.com/post/flash-bootloader-and-install-firmware-with-raspberry-pi which worked.

I picked up a $25 Power Relay off Amazon which allowed me to remotely turn the 3D printer on and off as well as have it automatically turn off 5 min after a print completes.

After finding a plugin for OctoPrint called The Spaghetti Detective which “constantly watches your prints when you are not. It uses AI (Deep Learning) to analyze webcam images in the background and alerts you when you[‘re] print shows the signs of failing.” This is great, but my 3D printer has no access to the internet except when I grant it access solely for updates. I found the Nvidia Jetson Nano Dev Kit and got one with the intention of creating a something to the spaghetti detective that ran local to my network but got distracted running hashcat to see how well it worked cracking passwords (don’t ask why, I usually never know the answer to ‘why?’). Such as; ‘why is my Nintendo Switch running Linux and Android or why is the PS3 I got off CraigsList running Linux; it just is). If anyone has experience with AI/Machine Learning and wants to help with this let me know!

WiFi Range Extender
Not much more to say on this one

Sure, you could buy a WiFi range extender for about $20 but if you have an extra RPi laying around why not make your own. This tutorial walks through the steps to get it all set up and running.
I didn’t have much need for a WiFi repeater so instead I turned my RPi into a wireless router to be used as a guest network which I could control access, routing, and more.

**Security Cameras**

*Security you can ‘trust’*

I wanted to get some security cameras to have around the house but I never know what I can trust. Ring has had its share of headlines making me hesitant to use it. The cheap camera a friend got off Amazon that was regularly reaching out for an IP address in China is simply not happening. I also don’t want to pay a small fortune for a nice closed circuit setup. I decided to use a RPi and some USB cameras to make my own setup that was only accessible on my local network.

With a bit of research I found a project for pis called motion which had all the functionality I needed except a web server to view and access all the cameras. A little more digging and I found MotionEyeOs which was built on the motion project.

I needed a few cameras, so I got the Logitech c615 HD USB Camera which was $28… but due to the pandemic going on it’s now the low price of $90… I wanted a camera to see outside at night so I got this $41 Infrared USB Camera which works fairly good.

The cheaper USB cameras were great, but my wife wanted something that she could move to follow and watch the dogs during the day (yes, my security cameras are more to watch the dogs than for security). I found and bought this wireless camera off Amazon for $38 (found a refurbished one, no longer available) D-Link DCS-5030L Pan/Tilt/Zoom Wireless Security Camera.

I figured that the camera was littered with vulnerabilities and not even close to being secure in any sense so I setup some rules to allow it to only communicate with my RPi running MotionEyeOs. I scraped all the URIs from the camera’s web service to find that I could access the live camera feed as well as control the pan/tilt of the camera (super secure right…). To do this I fired up Kali and ran DirBuster which returned even more results than I expected to see. I grabbed the URIs I needed using the camera feed to add a network camera to MotionEyeOs and then plugged the URIs for panning and tilting into MotionEyeOs as action buttons. Now from the web page I could view the camera feed and move the camera in any direction which bought some major points until I bored my wife by explaining how I did it and lost all the points I just had.

Instead of having to check the cameras to see what has been happening or receiving emails I set up Signal-CLI to send me an alert when an action takes place along with a picture from the camera where the action was detected.

For just over $20 I got this 16 in 1 Smart Home Sensor Modules Kit for Arduino Raspberry Pi which I plan to add and use for Smoke, Combustable Gas, Carbon Monoxide, and Flame detection sensors which will trigger the buzzer alarm and send an alert via signal. You could also use 5v 2-channel relay to
make smart outlets or the infrared sensor to detect motion instead of the video motion detection which requires effort to tune ensuring motion is detected without excessive false positives.

‘Smart’ Garage door control/monitoring
This project is still #TODO

I haven’t gotten around to this one yet but plan to use a RPi to remotely control and monitor my garage door. There are a few different ways of going about this but the general idea is to use relays to connect directly to the garage door opener. Those would allow me to open and close the door but not know whether it was currently open or closed.

For that, I plan to also use a magnetic gap switch or two enabling the RPi to know if the door is currently opened or closed. Then I plan to add Signal-CLI to be sent alerts when the garage door state changes as well as sending commands to open and or close.

Mobile PenTesting Kit
Wireless Pentesting on the Go

Just for fun I built a RPi that I could take with my when I traveled for my last job and do some wireless pentesting (WiFi and BT).

I got this 7” Screen for $65 and a Case for the screen and RPi for $15. I then bought this Small Logitech Wireless Keyboard with Touch Track pad $25.

With two ALFA AWUS036NEH Long Range WIRELESS 802.11b/g/n Wi-Fi USBAdapter and a Sena UD100 Long Range USB BT Adapter I could fire up some rogue access points or throw some bluetooth exploits such as BlueBorne. A bit off topic but an example of the application of this kit: for fun I modified the BlueBorne exploit a bit, I used the connection part of the BlueBorne to make the unauthenticated connection and then sent over packets to establish an ethernet interface over the BT connection. From there issued a created and sent a few DHCP packets and was then able to re-direct a phones network traffic through my BT connection without any user interaction allowing my complete man in the middle access.

Pwnagotchi
Like a tamagotchi but better

This project I really have no answer for ‘why?’, which is a question I seem to get asked a lot. I’ll just provide the answer from the website and let you learn about it for yourself.

“But...why?
To give hackers an excuse to learn about reinforcement learning and WiFi networking—and have a reason to get out for more walks.

Also? It’s cute as f—.“

You can only change your networks password so many times before you get bored trying to refrain from going out in public with ‘Steve’ (my pwnagotchi’s name). I got a bit adventurous and went to the Greene Turtle (adding only their public wifi ap to the whitelist). After a bit of time running the hash through the Nvidia Jetson Nano Dev Kit I got to use for machine learning to monitor my 3D prints informed me that the passwords are ‘greeneturtle’ and ‘shell123’ (double the public wifi.. double the fun…). And sure, my wife was right, I could have just looked at the sign with the password but it was far more enjoyable to get the password myself.
Arduinos

Parking Sensor
Garage parking made easy

I always park in the garage but am always having to make sure I pulled my truck in far enough that the door can close but also make sure I don’t hit the wall. With an Arduino nano, an HC-SR04 ultrasonic range sensors, and some RGB LEDs and a little programming I now have an LED that changes from green to yellow to red as I pull in. There is a second red LED that comes on if I get too close to the wall.

![Image of Arduino setup with sensors and LEDs]

Digispark ATTiny 85

Rubber Ducky for under $5
Cheaper isn’t always better, except when it is

The Hak5 Rubber Ducky is pretty cool but not very cheap at $50. For about $15 on Amazon you can get the main parts to make 5 USB Rubber Duckies. If you have a 3D printer you can make your own case for it. Following this tutorial you can script out any sequence of keystrokes for it to perform.

![Image of Digispark and Raspberry Pi]

[Link to tutorial]
Automatic Password Typer
Typing passwords is a pain

My computers all have fairly long passwords to log in and they lock very quickly after inactivity. This means I have to enter my long passwords all the time and usually about 2 or 3 times before I get it without any mistakes.

Building off the concept of a cheap rubber ducky I could plug in the digispark and have it enter my password automatically, but that would mean anyone could plug it in and see my password. I don’t like the idea of that. If you notice, most keyboards will have a light for the caps, scroll, and num lock states. Since the computer sends a command to toggle the led my plan was to listen for the different lock states which would act as a simple password if toggled in the correct order it would enter the associated password. Great concept but hit a snag, I just couldn’t get it to work and it appears the Digikeyboard library doesn’t have the functionality I need. This project has been on hold for a bit but instead of using the various lock states I plan to solder on 3 or 4 buttons to be used in the same manner.