

Problem Set 3: HackRF One

Nick Jones, Phaelyn Kotuby

The purpose of this problem set was to work with the HackRF One to send and receive wireless signals and interact with signal encoding.

Problem 1: SDR Platform Setup

Problem 1 involved the setup process of the HackRF One and associated tools. Overall, this part was not very complicated. Other than some minor issues resolving dependencies, the installation process was relatively straight-forward.

To confirm that we had connected the HackRF One correctly, we ran `hackrf_info` which responded with information about the attached HackRF such as the serial number, ...

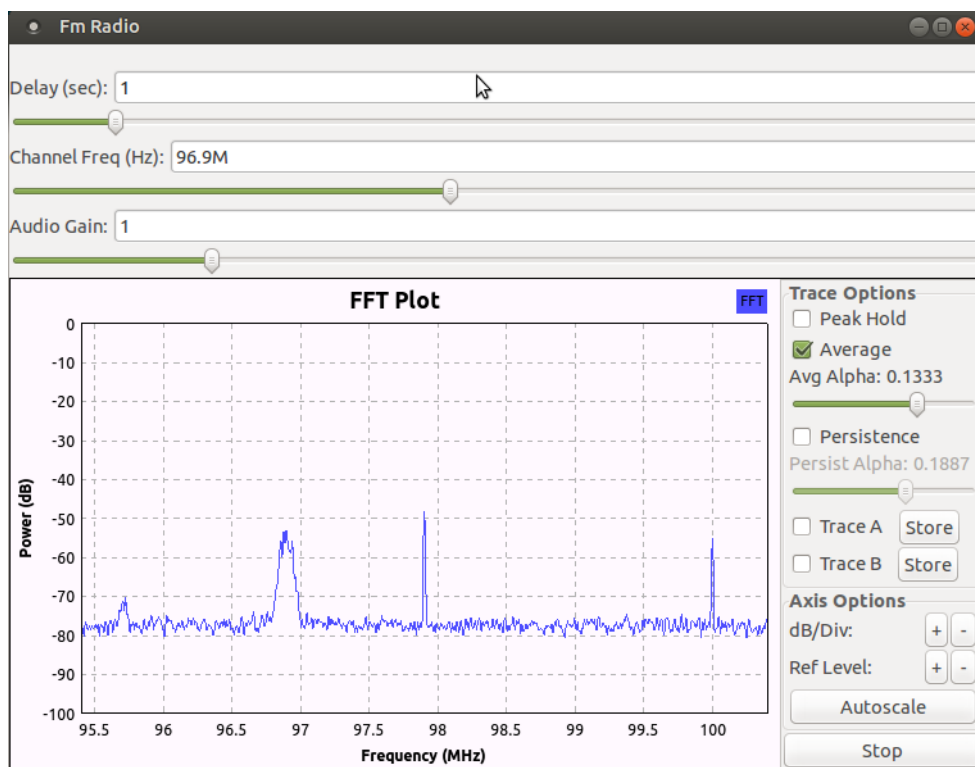
After this we checked that we could interact with the HackRF by running `osmocombb` from the `gr-osmosdr` module. We found a 2.4 GHz wifi channel and saw activity.



Problem 2: Building FM Radio Receiver

Part 2 involved creating a FM radio receiver and a tool to play recorded audio at different speeds.

We encountered a few problems with this part. Although we could see one or two radio stations there weren't nearly as many as we were expecting. There were some very strong signals around 96.9 and 100.2, but other than this, we couldn't see much else. This may be due to our antenna being too short. We tried compensating by increasing the RX gain in the osmocombb source, but it didn't seem to have too much affect.



We also encountered issues with audio underrun. Because we were running the environment in a virtual machine, this resulted in issues with the audio sink output. Although we processed the FM signal correctly, the audio was clipped and warped. At first we thought that this was some kind of processing issue, but after dumping the audio to a wav file and playing it back, we realized that the signal was fine. According to the GNU radio-companion documentation, there is no simple solution to this problem. It recommended a quick hack of supplying information to the audio sink at a slightly faster rate than it expects, but this did not seem to work when we tried.

```

jnhazel@ubuntu: ~/dev/WirelessNetworking/ps3/prob2 [master *]
$ ./fm_radio.py
Using Volk machine: avx_32_mmx_orc
gr-osmosdr v0.1.4-67-gac15e789 (0.1.5git) gnuradio 3.7.9.1
built-in source types: file fcd rtl_tcp hackrf rfspc redpitaya
Number of USB devices: 6
USB device 1d50:6089: 0000000000000000457863c82e85651f match
Using HackRF One with firmware git-unknown
INFO: Audio sink arch: alsa

```

Each aU is an audio underrun error

To create the delay effect, we added a delay block and a WX Slider. We fed the output from the low pass filter into the delay block which we configured with the sample rate times the value of the slider (seconds). We then multiplied the output of the delay block with the original signal. This created resulted in overlapping signals. One consequence of this is that when the delay is still filling its buffer, the output is zero, which overruns the original output.

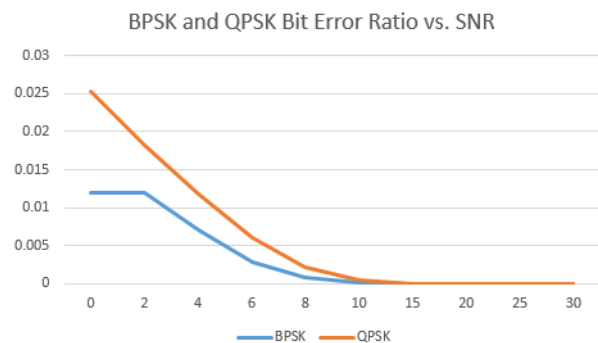
To create the playback script, we stored the signal from the FM receiver to a file. We then read this file and throttled the data to the default rate. We then took this data and interpolated it at a ratio defined using a WX slider. This resulted in the signal playing faster or slower than normal.

Problem 3: BPSK/QPSK Transmission Simulation

Problem 3 involved creating flowgraphs to represent BPSK and QPSK modulators and demodulators. Additionally, we needed to write Python scripts to read

gnuradio file outputs and determine bit error ratios between two files.

BSPK was relatively straightforward to encode by following the instructions; changing the flowgraph to accomodate QPSK required some better understanding of gnuradio and how to use the constellation object. Ultimately, though, the differences between the two flowgraphs were minor. In addition, the python scripts to process them are essentially the same -- they just use different file parameters and were split so that the two encodings could be analyzed more quickly. Calculating the BER was as simple as reading in the files for pre- and post-modulated bits, putting them into arrays of binary, and then checking the number of differences between the two.



Problem 4: Real Transmission using HackRF

Problem 4 involved creating a wireless transmitter and receiver and using them to transfer a set of random data.

In this part, we had some minor issues getting two HackRFs to work at the same time. We expected that we would be able to specify the transmitter and receiver by changing the serial number in the osmocom source and sink. This did not work as expected. Regardless of the ordering, we couldn't get the information to transmit. The solution we came up with was to disconnect one of the HackRFs and force the receiver to start on the connected one. We then attached the second one and started the transmitter using the serial number.

The output from the receiver was stored to prob4_rx_output. After running it for a little bit, this file contained 174592 bytes, which we counted using `wc -c`. Since we used the payload length of 0 (defaults to 512), this means that $174592/512 = 341$ packets were correctly received. If we ran it for a different length of time, this would obviously change.