Receiving Slow Scan TV images from space using GNURadio and a Terrestrial TV receiver dongle

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This is a short abstract of the experiment aimed at introducing the reader to the topic being discussed. It should not be too long to convince the reader that the topic is worth investigating further at first glance.
We investigate the use of GNU Radio as a radiofrequency signal processing frontend in combination with other dedicated software as backend for extracting and displaying an image emitted from a spaceborne source.

Keywords: ARISS, ISS, SSTV

1 Introduction

The introduction reminds the reader of the background of the work being presented and its context within the existing literature framework. Please remember to define all acronyms the reader might not be familiar with.

In our example, the ham radio community has been using for a long time Slow Scan TeleVision (SSTV) transmission to send images on the High Frequency (HF) and Very High Frequency (VHF) bands. A space-borne emitter is the ARISS emitter on-board the International Space Station (ISS) [1], which is either used for transmitting voice or, during dedicated events, SSTV images on the 145.800 MHz carrier with a Narrow Band FM (NBFM) modulation.

2 Experimental setup

GNURadio focuses on practical demonstrations of signal processing results, whether using synthetic signals or real measurements. The experimental setup description should allow for the reader to reproduce the experiment: ideally, a GNURadio Companion flowchart or Python script is given for the reader to be able to reproduce the experiment.

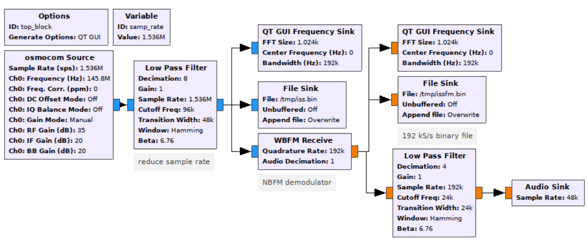

Figure 1: GNURadio Companion flow graph for acquiring and processing data.

We demonstrate the reception of ARISS transmission and SSTV decoding using GNURadio as a software defined radio demodulator front-end, feeding a dedicated backend for demodulating the SSTV signal, namely `qsstv` in this example. As discussed by Tom Rondeau during the introductory session of the 2018 FOSDEM devroom presentation [2], GNURadio does not aim at implementing the full signal processing chain but might be best suited for addressing part of the analysis process, using at best existing tools through data transfer mechanisms such as named pipes or RPC (Fig. 1).

As described at `www.chonky.net/hamradio/decoding-sstv-from-a-file-on-a-linux-system`, the audio output classically handled by ALSA from GNU Radio audio sink can be routed using Pulse Audio to a virtual cable using the `module-null-sink` module. Doing so creates a new interface in the graphical user interface `pavucontrol` in which the Python module output is routed to the Null output.

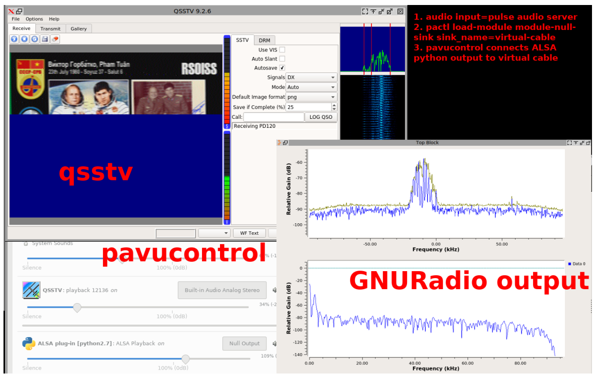

Figure 2: Screenshot of GNURadio taking care of FM demodulation, feeding `qsstv` through the Pulse Audio server configured with a Null Sink acting as a virtual cable between applications.

Since the SSTV decoder `qsstv` reads data from the PulseAudio server, demodulating the FM signal in GNURadio and feeding the 48 kb/s output to the Audio sink will allow the real time display of the SSTV image as it is decoded by a dedicated software external to GNURadio (Fig. 2).

3 Results

The "Results" section demonstrates that the concept introduced earlier and implemented following the Experimental Setup description are actually functional.

Figure 3: Acquisition result: a basic DVB-T receiver fitted with a 3-element Yagi-Uda antenna was used to acquire this SSTV picture from ISS.

In our example, images have been received and successfully demodulated from ISS during multiple passes, despite a very poor antenna setting of a single element Yagi-Uda antenna pointing towards the sky, as shown in Fig. 3.

4 Conclusion

The conclusion summarizes the main results of the experimental setup and results obtained: if the reader only focuses on the abstract and conclusion, (s)he should be interested in reading the full document to get familiar with the details of the experiment in order to reproduce and enhance the measurement setup.

We have demonstrated the use of a low-cost Software Defined Radio solution based on Digital Visual Broadcast-Terrestrial (DVB-T) receiver used as general purpose radiofrequency front-end for receiving signals from the International Space Station flying at an altitude of 400 km. Beyond the cost effective introductory demonstration to SDR, this experiment offers the opportunity to attract an audience towards digital signal processing and demonstrate how long range communication is achieved using radiofrequency signals.

References

[1] J.E. Catchpole, *The international space station – building the future*, Springer Praxis (2008)

[2] T. Rondeau, *Recapping DARPA's First Big Hackfest*, FOSDEM 2018, at `https://fosdem.org/2018/schedule/event/recappingdarpa/`