Satellite Data Project

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Abstract

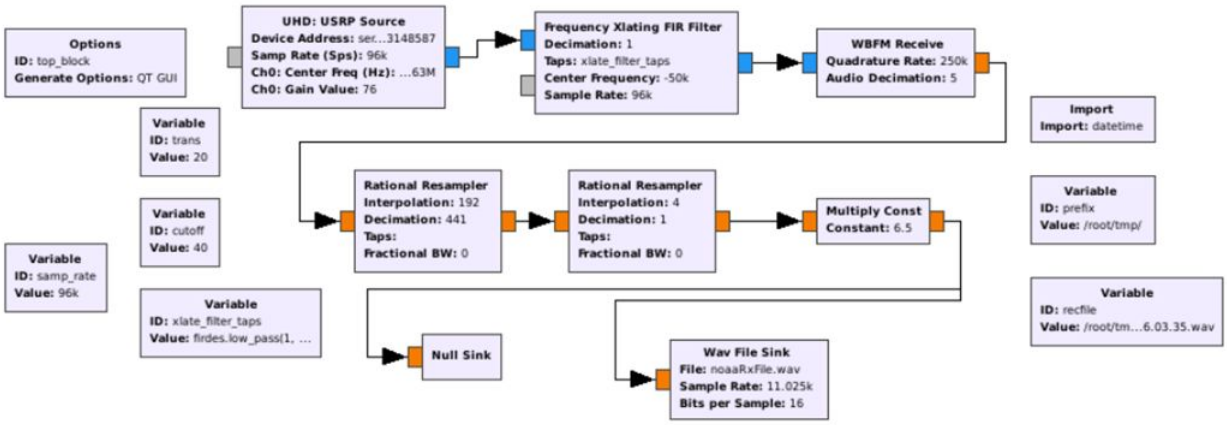
Satellites play an essential role in improving everyday life of populations in today's digital economy. Almost all sectors use technology in one way or another, whether it's agriculture, banking or transportation. Satellites help save lives in emergencies and provide fundamental data to achieve better protection of the environment. This paper will discuss the satellite data project and the results. The project's purpose is to work on the wireless communication program, research and figure out how to get the flow graph as well as figure out how to decode the data to view the results. The present project uses GnuRadio to apply decoding of the satellite data.

Introduction

With the advance of technology, the data acquired by a satellite must be transmitted to a receiving antenna on Earth. There are different methods of transmitting data, but what caught our attention are the following: Data can be transmitted directly to an antenna on Earth if the satellite is located at this point in range of the antenna, if the satellite is not in the receiving circle of the antenna, the data can be stored on board the satellite to a recorder, and finally the data can be retransmitted from satellite to satellite until we can retransmit it to the receiving antenna. Because this is a short term project, we decided to collect the data just when the satellite is in the desired range. This project receives data from NOAA(National Oceanic and Atmospheric Administration) satellites. There are 3 satellites we used to get data from, NOAA-15, NOAA-18, and NOAA-19. The data was collected from whichever one of those satellites was in range at the time which we were able to tell by using a program called GPredict. After choosing which satellite to get data from, we'd run our program to collect the data and save it to a wav file, then

use another program called WXtoImg to decode the wav file and display a map that the satellite transmitted to us. We were able to provide a map of almost all North America.

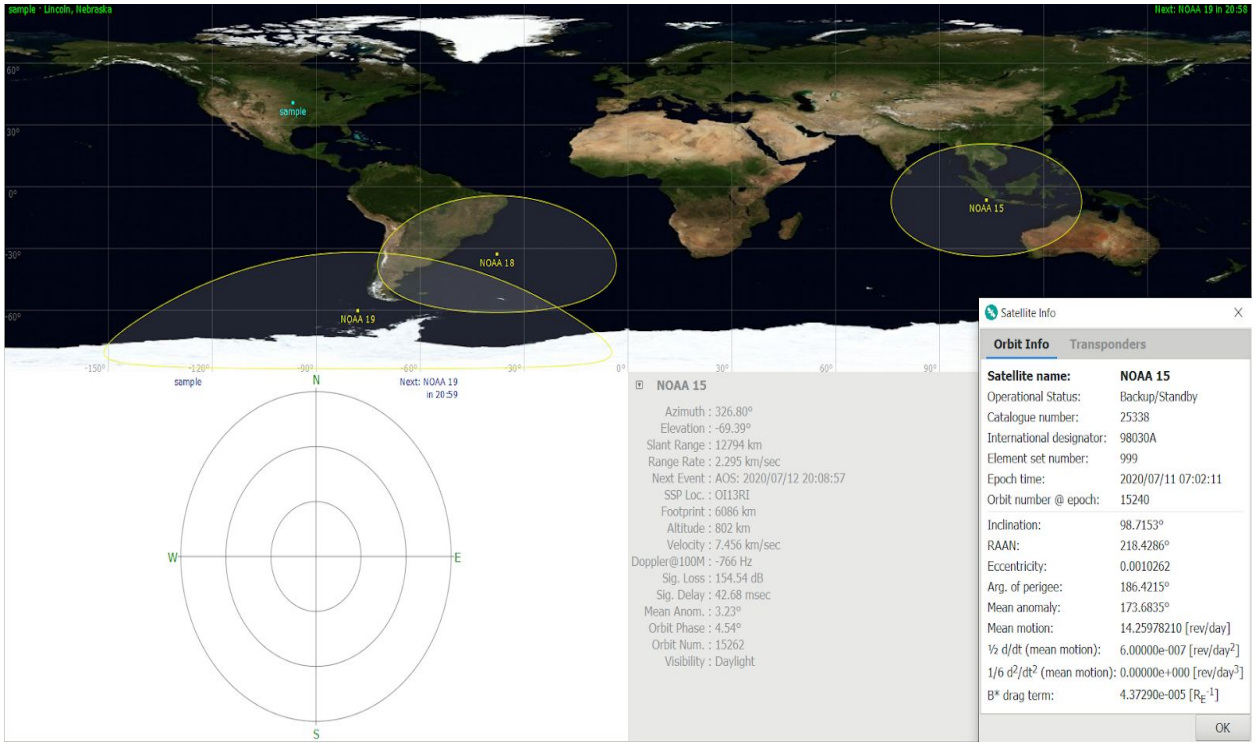
Design



Our flow graph to collect the data is pictured above. The following is what each block does:

UHD: USRP Source – acts as a receiver to collect data, Frequency Xlating FIR Filter – performs frequency translation on signal and down samples the signal, WBFM Receive – demodulates a signal, output is demodulated audio, Rational Resampler – converts data to desired sample rate, Multiply Const – multiplies input by a constant, Wav File Sink – writes data to a file specified by the user.

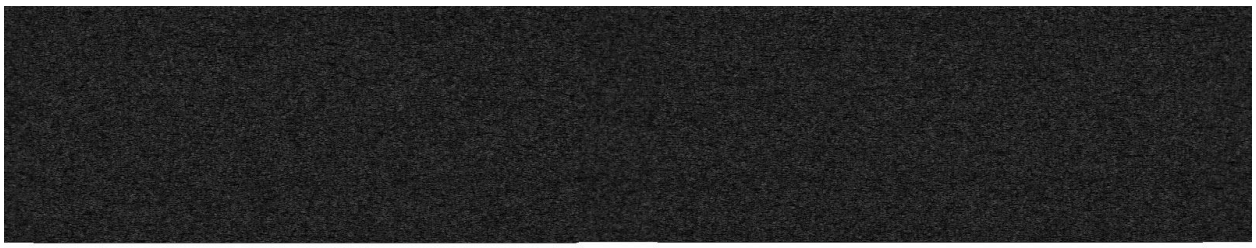
We primarily used NOAA-15 to collect data as that satellite was usually in our range most often when we happened to be wanting to collect data. As stated previously, we used GPredict to show us when a satellite was in range to allow us to receive data from it. A screenshot of GPredict is below:



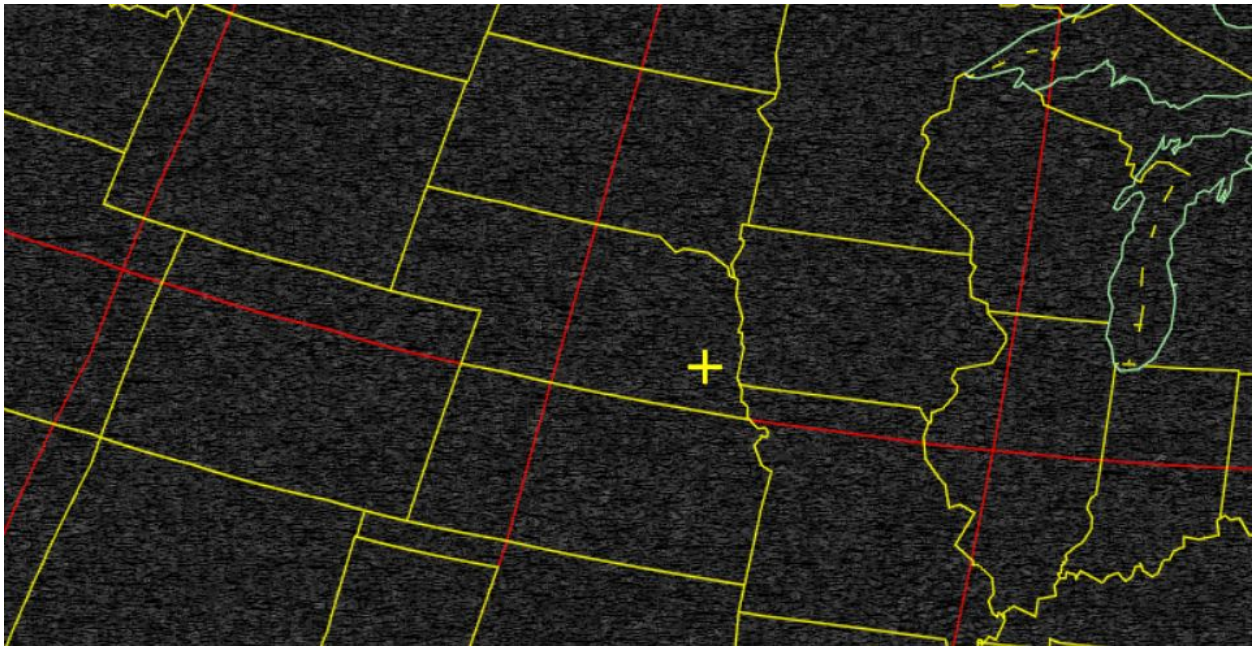
When a satellite was in our range, indicated by the area highlighted around the satellites on the map, we would set the Center Freq value in the UHD: USRP Source block to the APT downlink frequency of the desired satellite; GPredict provides these frequencies in the "Transponders" section of the satellite info. We also had to set the device address in the UHD: USRP Source block, we always used Andersen Hall antenna.

Results

Once we had wav files, we then had to decode them to get our map image. We used a program called WXtoImg to do this. Upon opening up a wav audio file, it first looks like this:



After decoding and applying map enhancements to the image, we get the following:



Everything worked perfectly as long as the satellites were in range according to the map and satellite locations in GPredict. If the satellites were out of range and we ran a recording and tried to view a map out of it, WXtoImg would simply not produce a map as it didn't have the data to do so.

Discussion

Initially as we reported in our final demo, we couldn't figure out how to get an actual map on our image we'd get from the wav file. We hadn't realized we had to follow some instructions we weren't doing in WXtoImg to decode then have the software draw out the map on the image. Before discovering this, we thought there was something wrong with our graph so we were attempting to collect data using different sample rates which at the time wouldn't do anything different for us since we weren't using WXtoImg correctly. We also thought signal could have been obstructed by buildings around Andersen Hall which is why we weren't getting

our map but upon looking at the location of the antennas on the building in Google Earth and the altitude of the satellites we realized that the angle at which the signal would've been coming in at couldn't have been obstructed by anything major enough to completely block the signal for us, leading us to eliminate that idea. Eventually after doing some researching, we found out how to correctly use WXtoImg. Improvements to this project that could be made in the future include extending the use of the graph to also receive weather data as well as receive stored data from the satellites that they collected when they were out of range.

References

M. Lunar, S. Suman, D. Rico, Leveraging iLNK Testbed to Acquire NOAA Satellite Weather Data for the State of Nebraska, CSCE 990 Final Project, 2020

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