Super Cheap Scintillation Console

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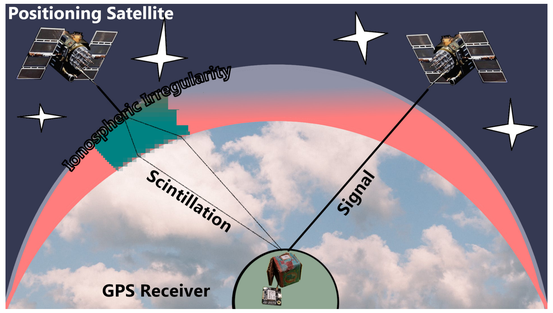
Abstract

We've made yet another "low cost" console for calculating scintillation caused by ionospheric irregularities. Using some of the cheapest devices that come up in a simple google search for gps receivers and computers we've kept cost below $60 USD. As an exercise in seeing if anything useful can be obtained by bashing the cheapest stuff on the internet together, who knows, they may even be capable of making useful observations to detect ionospheric irregularities. Some basic software has been produced to process the NMEA data from the device. Currently under development, this software is public and open source. The hard part now, is finding the right combination of data product and online accesss to make historical scintillation data available to future scientists. With mass market parts and completely free and open source software, perhaps this community can even find novel uses for this data beyond the intent of this work.

Introduction

We want to continue the work of Rodrigues and Moraes, and do it at a lower cost:

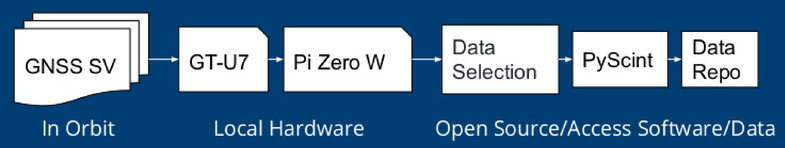
- Detect Scintillation with a small form factor apparatus.
- It's been done before, but we've got cheaper devices.



Ionospheric irregularities cause scintillation of GPS signals. We can observe this scintillation by analyzing standard data transmitted to mass market products. Initial use will utilize the S_4 amplitude scintillation index.

For less than $60: measurement of the intensity of L1 signals from GPS satellites at 10 Hz.

Could this low cost device provide something useful for citizen science or science education? All the data is there, but the open source software component and new user roadmap are still in their infancy.



References

Rodrigues, F. S., Moraes, A. O. (2019). ScintPi: A Low-Cost, Easy-to-Build GPS Ionospheric Scintillation Monitor https://doi.org/10.1029/2019EA000588

The Math to Come

The scintillation will be calculated from the Signal To Noise ratio contained in the NMEA GSV sentence for each Positioning Satellite, or Space Vehicle (SV) in view.

$$S_4 = \sigma_I / \bar{I}$$

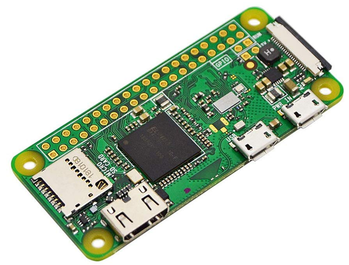
$$I = 10^{SNR/10}$$

The code for these calculations will be hooked into the *pysat* toolkit as part of the PyScint package aimed at higher rate data from larger networks of ground based ionospheric observations.

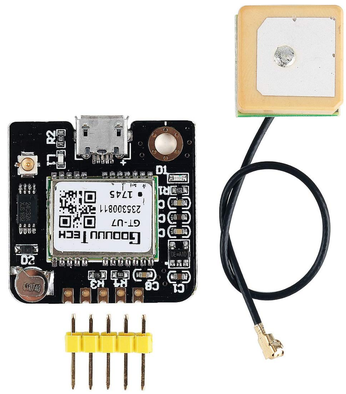
Status

Currently collecting NMEA sentences with the requisite information at 10 Hz. However the integral software to organize and compute the S_4 from this information is very much a work in progress. Now we need to produce an easy to traverse data set and find a home for it on the internet.

The computer:



The Receiver:



Item	Cost
GT-U7 GPS Receiver	$14.99
Pi Zero W	$10.00
Enokay Power Supply	$8.99
UH2100 USB 2.0 Hub	$7.99
UGREEN USB Type A to Mini B	$5.59
ULTIMAXX HDMI to Mini HDMI	$2.95
Total Cost	$50.51