

Harmonic Radar: Drone Trial 2022-06-09

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1 Objective

The objective of this trial was to map the location of a single harmonic radar target placed beneath a linear transect flown by a drone.

2 Methods

A RECCO hand-held harmonic radar transceiver was suspended with rope about 1.5 feet beneath the landing struts of a DJI AGRIS MG-1 drone. A target consisting of 2 harmonic radar tags with antennae placed at right angles ([Figure 1](#)) was positioned in an open field and the drone was programmed to fly along a line which crossed this position.



Figure 1: Target.

2.1 Harmonic radar recording

The RECCO hand-held harmonic radar device generates an audio signal to indicate that a reflection from a harmonic radar tag has been detected. The amplitude of this signal is maximum when the receiving antennae points at the target and it increases as the target gets closer. A human operator locates the direction of a tag by directional scanning with the antenna while monitoring the signal using a built-in speaker or headphones. In this application, we point the receiving antenna straight down and record the signal by connecting a small digital audio field recorder (ZOOM F2) to the audio jack. The F2 records monophonic 32-bit floating point WAV files at a rate of 48,000 samples per second.

An Audacity screenshot displays the waveform and spectrogram of the record created during the trial ([Figure 2](#)). The WAV file was processed using a Jupyter notebook which performed the following steps.

- Noise reduction: Background noise was removed from the signal by the [noisereduce Python library](#).
- Data reduction: The mean absolute amplitude (MAA) of the signal was calculated for each second within the WAV file. MAA is used as a measure of signal strength.

Figure 3

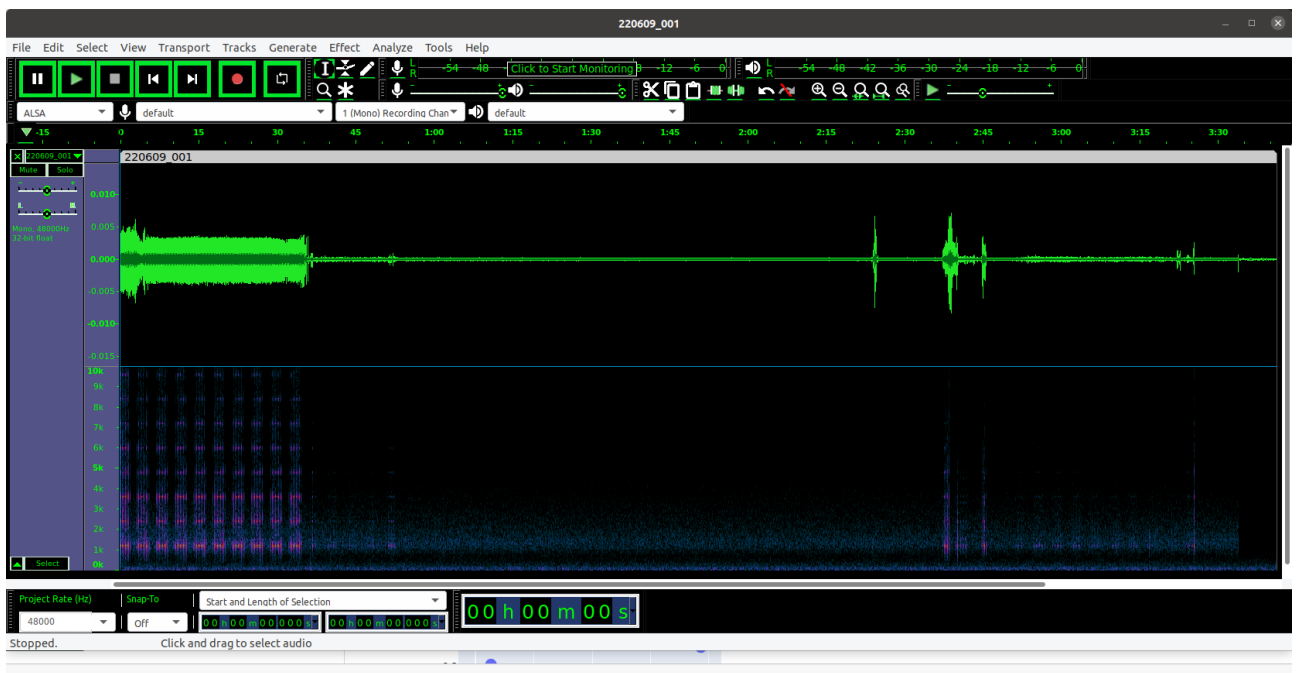


Figure 2: Audacity.

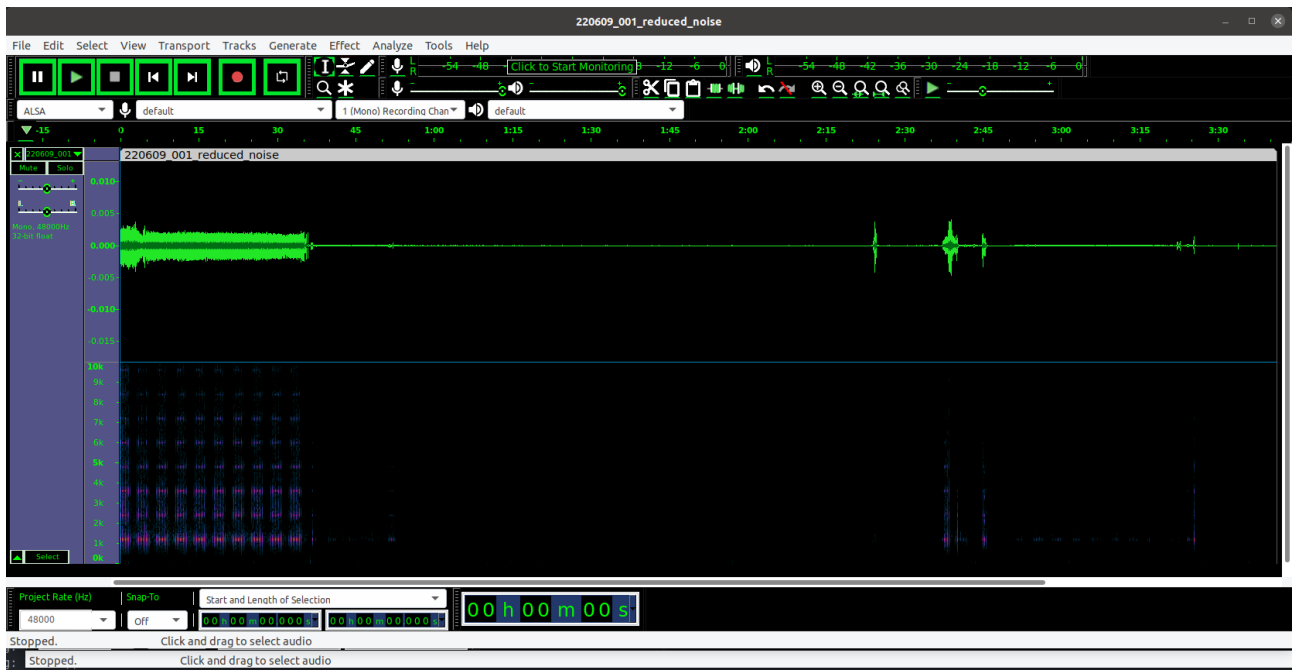


Figure 3: Audacity-noise-reduction.

2.2 GPS track recording

The flight data log was downloaded as FLY275.DAT from the drone. This file was parsed using a free Java program named DatCon using parameters recorded in [Figure 5](#). DataCon creates three files:

- a CSV containing 1,275 columns. I set the sample rate to one row per second (1 Hz).
- a text file containing event messages.
- a KML file containing latitude and longitude of points along the drone's track ??.

The screenshot shows the DatCon application window (Version 4.2.3) with the following settings:

- .DAT file:** /home/aubrey/Desktop/Harmonic-Radar/experiments/2022-06-09-drone/FLY275.DAT
- Output Dir:** /home/aubrey/Desktop/Harmonic-Radar/experiments/2022-06-09-drone (with a View It button)
- Time Axis:**
 - Offset - time axis 0 point: ☒ Recording Start, ☐ Motor Start, ☐ Flight Start
 - Lower: .000, Upper: 638.583
 - Time: .000, TickNo: 335826539, 3209451395
 - ☐ Recording Start, ☒ Motor Stop, ☒ Motor Start, ☐ Recording Stop, ☐ GPS Lock
- CSV:**
 - Sample Rate: 1 Hz
 - ☒ .CSV: FLY275.csv (with a View It button)
 - ☐ Event Log (column in .csv)
- Log Files:**
 - ☒ Event Log File: FLY275.log.txt (with a View It button)
 - ☐ Config Log File: FLY275.config.txt (with a View It button)
 - ☐ RecDefs File: FLY275.recDefs.txt (with a View It button)
- KML:**
 - KML File: FLY275.kml (with a View It button)
 - ☒ Ground Track
 - ☐ Profile: Enter HP Elevation (with a Meters label)

At the bottom, a text box shows the output of the conversion:

```
kml File : /home/aubrey/Desktop/Harmonic-Radar/experiments/2022-06-09-drone\FLY275.kml  
Converting /home/aubrey/Desktop/Harmonic-Radar/experiments/2022-06-09-drone/FLY275.DAT  
Csv file : /home/aubrey/Desktop/Harmonic-Radar/experiments/2022-06-09-drone\FLY275.csv  
eventLog : /home/aubrey/Desktop/Harmonic-Radar/experiments/2022-06-09-drone\FLY275.log.txt  
kml File : /home/aubrey/Desktop/Harmonic-Radar/experiments/2022-06-09-drone\FLY275.kml
```

Figure 4: DataCon.

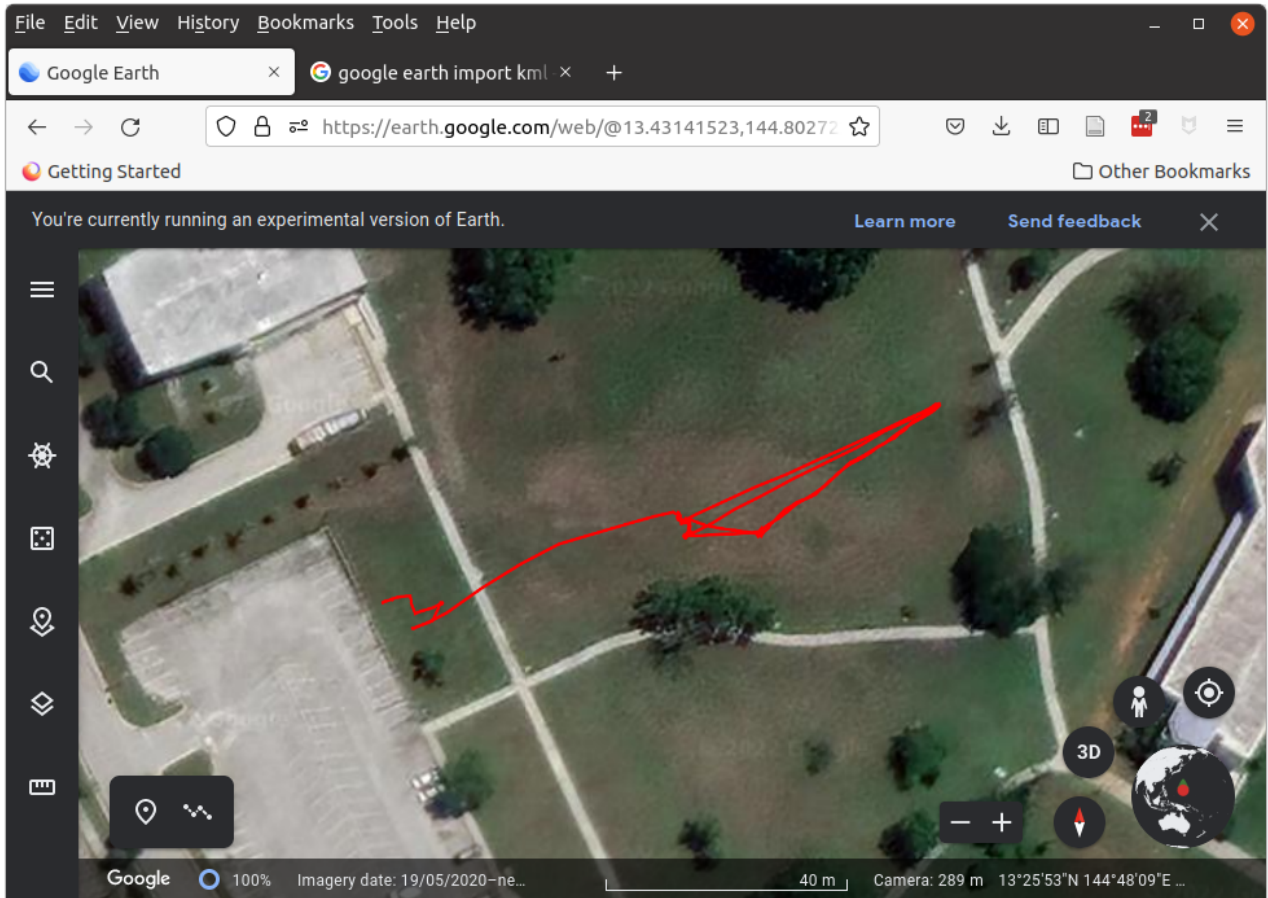


Figure 5: Google Earth.

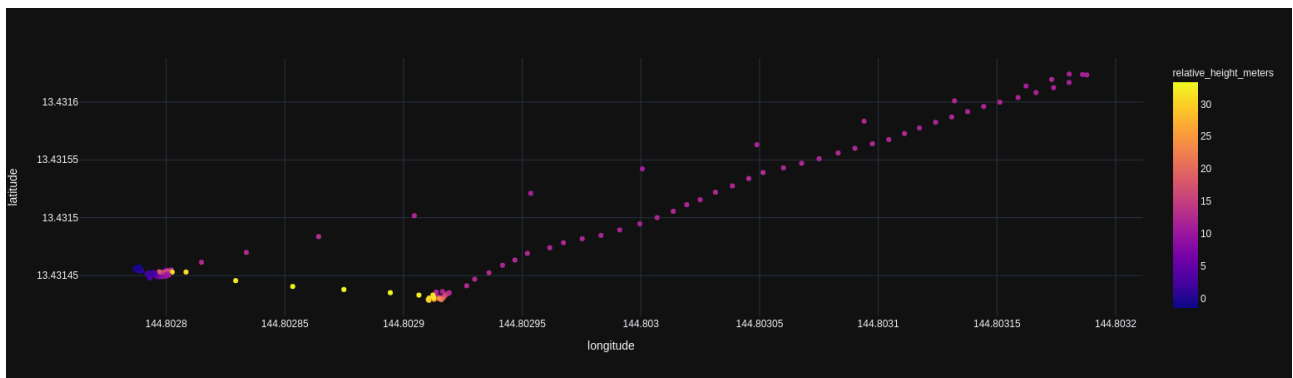


Figure 6: flightpath

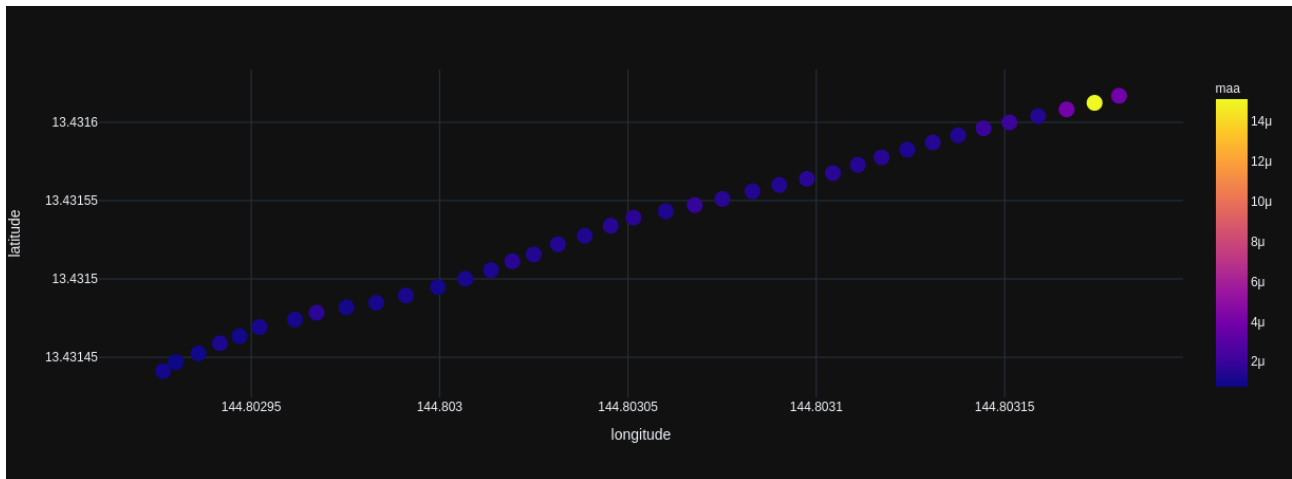


Figure 7: latlonmaah

3 Results and Discussion

3.1 Harmonic radar recording

3.2 GPS track recording