UMAR Airspeed Sensor Tech Memo

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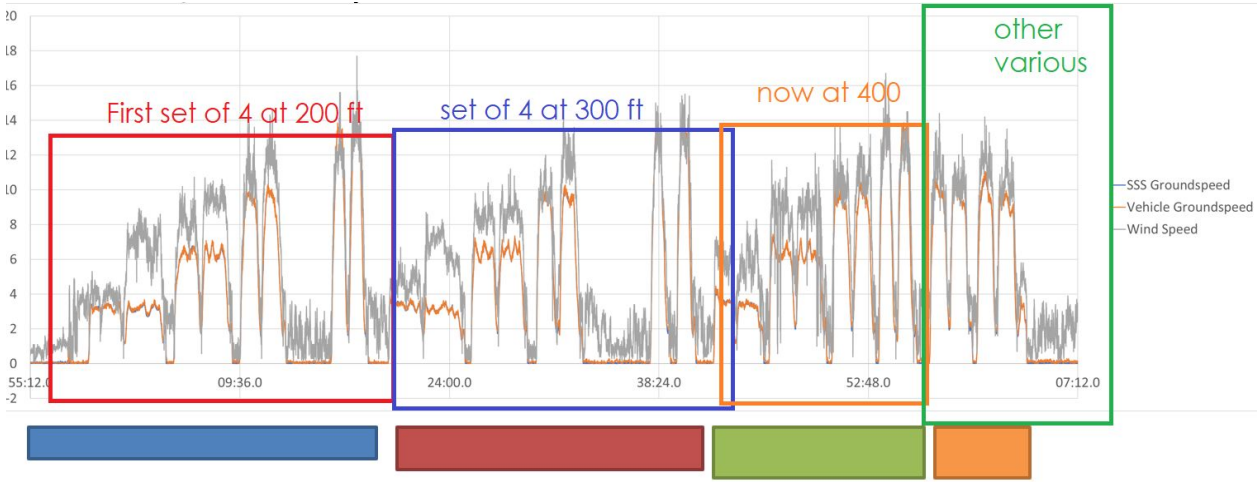
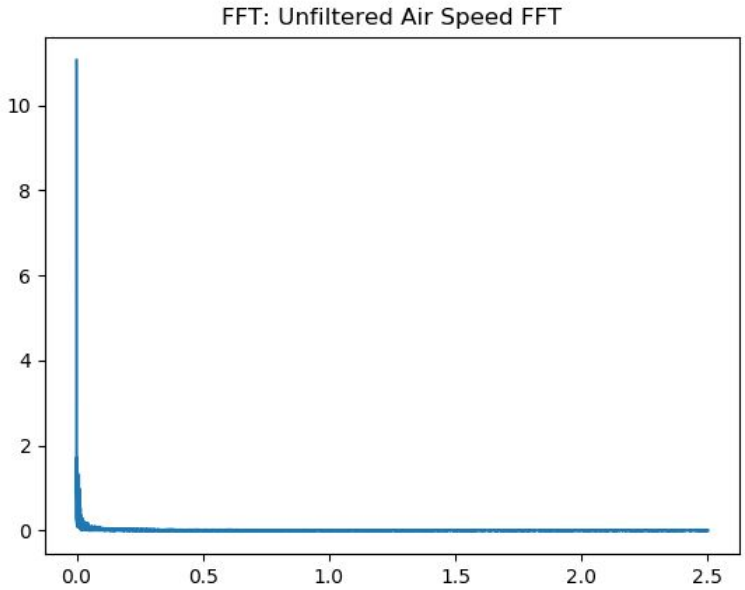
Spitfire Data Set Analysis



Initial assumptions and observations:

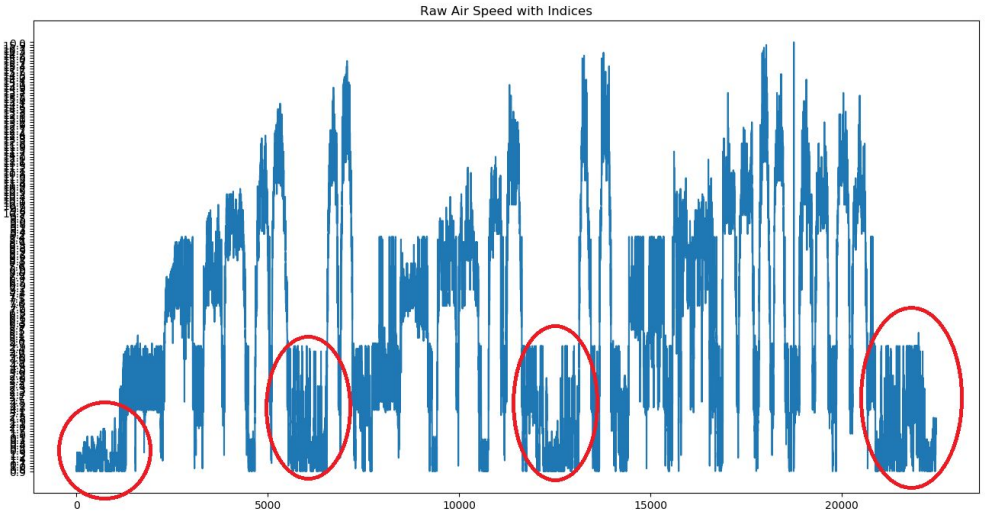
- Data set taken with no wind
  - Airspeed should ideally match groundspeed
- Possible error from prop wash effects and generated wind field, sensor placement, vibrations, attitude changes
- 4 sets of trial runs with increasing altitudes with hover trims in between trials
- Noticeable DC bias between measured (gray) and ground truth (orange), bias varies between each set of trials

FFT Analysis: Unfiltered Air Speed Data



- DC Bias present (Peak at 0)
- No noticeable high frequency noise
- Need more test data to fully understand stochastics
- Assuming that noise present in signal is semi-uniform gaussian (white noise or static)

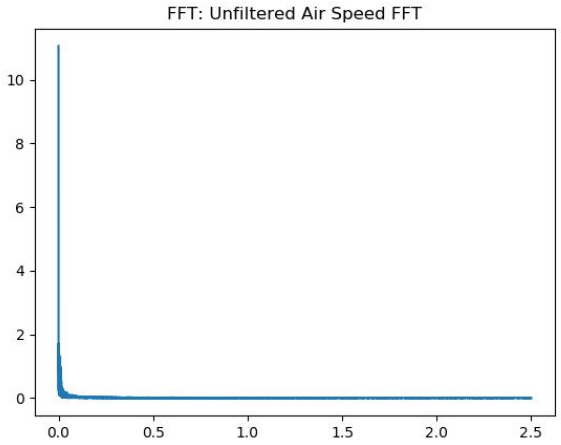
FFT Analysis: Debiasing Signal

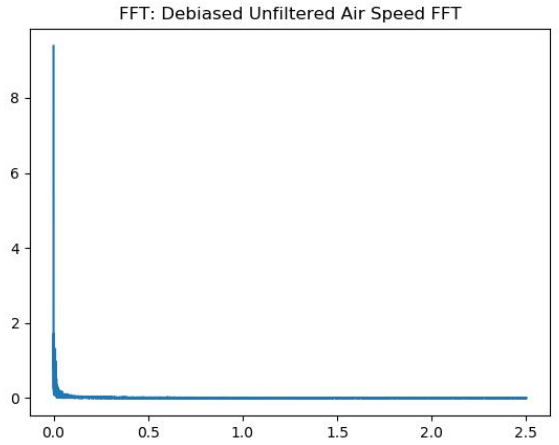


- From unfiltered data, sectioned out initial trim data (200 ft) and obtained mean of signal
- Obtained a bias value of around 0.837684
- Notice other trim values have different stochastics/mean values
- Need to data that shows vehicle moving away/to trim at varying altitudes to learn more
- Removed bias from data, results on next slide

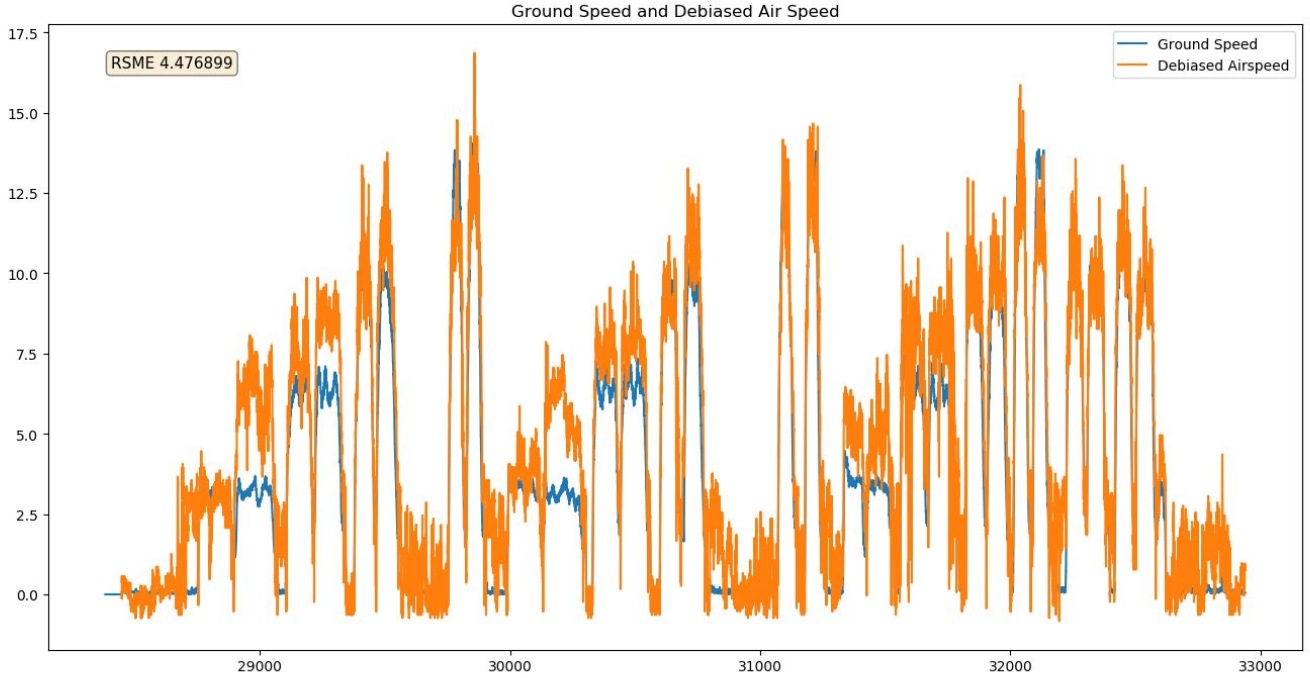
FFT Analysis: Debiasing the Signal

- FFT Before and After debiasing, peak is reduced but still present
- Shows that bias still present in signal and may change with respect to varying flight conditions

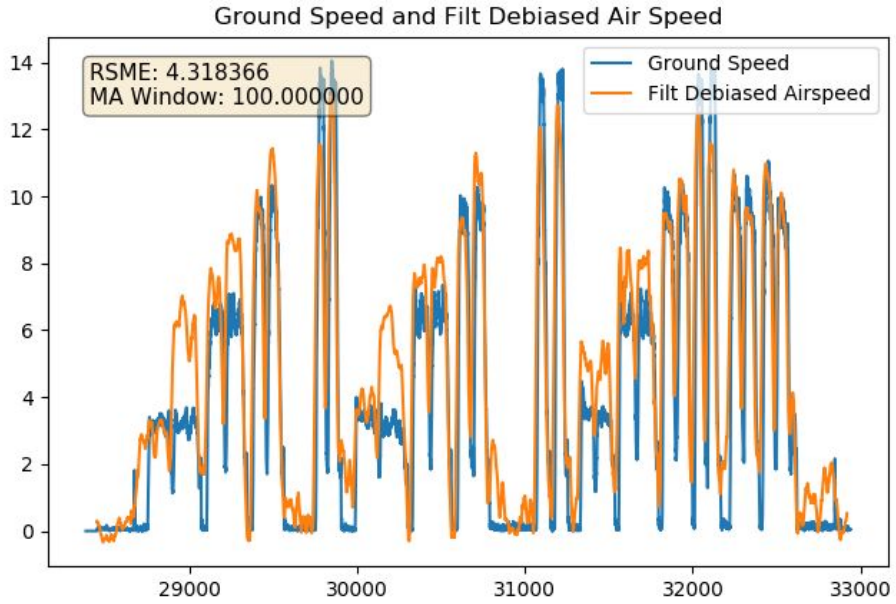




FFT Analysis: Debiasing the Signal



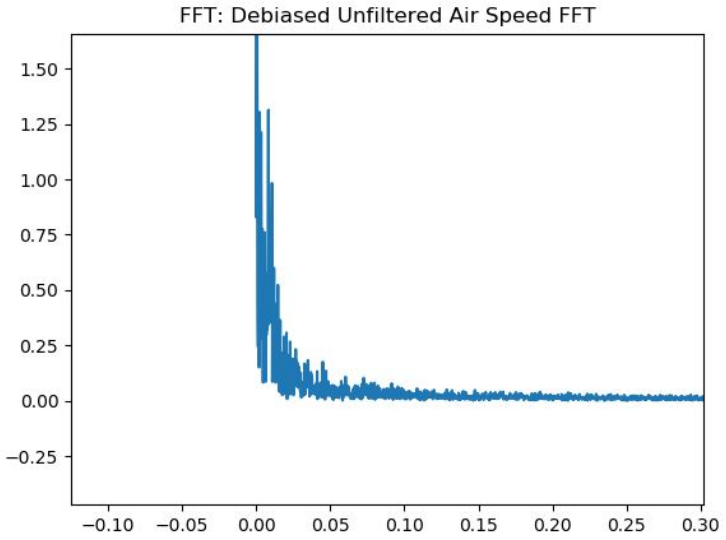
Filtering

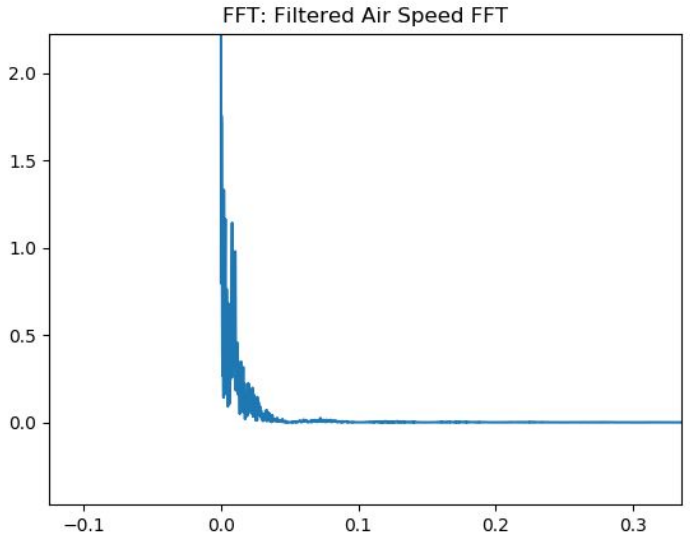


- Started with a low-pass FIR filter (moving average)
- DC bias reduced
- Improved RSME
- Changing DC bias value can cause RSME to go down further, trims may be off however (go to negative, etc.)
- Possibly wind is actually present, or some induced airflow with drone attitude changes

Filtering

- Some noticeable reduction in noise across spectrum with the linear filter
- Another set of data can be used to verify if this technique may work

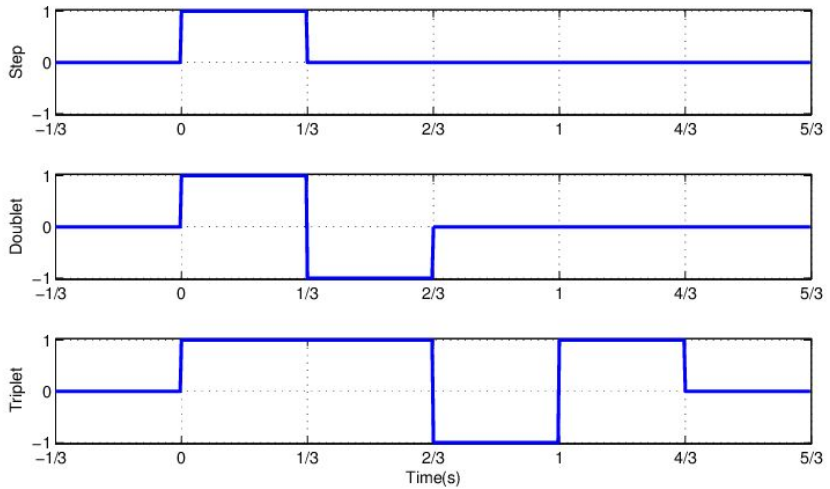




Software and Further Steps

- Python scripts to analyze data
- Take more samples of data and analyze in Python
  - Flight routine described on next page
- Identify if a linear filter (Low pass FIR or IIR) is suitable, or if a model-based filter (UKF or Alpha-Beta) technique may be of use (Could provide data for ground speed, air speed, and wind speed all isolated, incorporate varying stochastics, etc.)
- Links on next page to some resources for model-based filtering

Recommended Flight routine



- Aim is to provide a maneuver that can capture the relevant sensor dynamics and it’s coupling to the drone dynamics
- Goal is to get drone to move away/return to hover trim in a clean manner
  - Doublet recommended
- Provide RC inputs and state estimation data from aircraft to capture the vehicle movements

Resources and Links

- https://www.mdpi.com/1424-8220/18/12/4504/htm
- https://journals.ametsoc.org/doi/pdf/10.1175/JTECH-D-16-0177.1
- https://en.wikipedia.org/wiki/Wind_triangle
- https://www.gaussianwaves.com/2010/11/moving-average-filter-ma-filter-2/
- https://en.wikipedia.org/wiki/Alpha_beta_filter