Integrating an Ultrasonic Anemometer Onboard a Quadrotor Drone for Wind Data Collection

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Introduction

- Quadrotor drones have the potential to offer a range of services in urban areas such as monitoring weather conditions, package delivery, and infrastructure monitoring.
- Integrating an anemometer onboard a drone can allow measurement of wind data from an arbitrary geographical location and height to allow wind-field modeling in support of path planning in urban environments.

Objectives

- This research aims to integrate an ultrasonic anemometer with a custom quadrotor based on the QAV500 V2 chassis to provide 3D wind vector measurements.

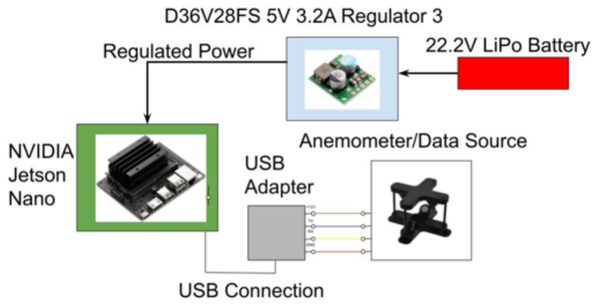
The ARSL drone with anemometer

Methods and Data Collected

- Custom components for the drone were designed in the CAD software Solidworks for later 3D printing.
- The Prusa MK3 printer was used along with PLA filament due to its stress/strain properties.
- Mounts were created for the NVIDIA Jetson Nano (onboard computer), voltage step downs, and the anemometer as shown below.

Examples of CAD used in the project

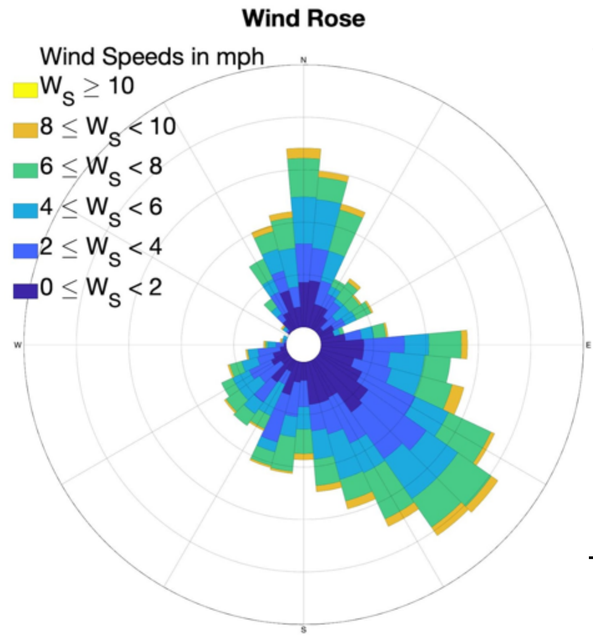
- After confirming that the onboard computer (NVIDIA Jetson Nano) was recording data, a flight test at 10 feet above ground level was conducted.
- A ground computer was wirelessly linked to the drone for data transfer.

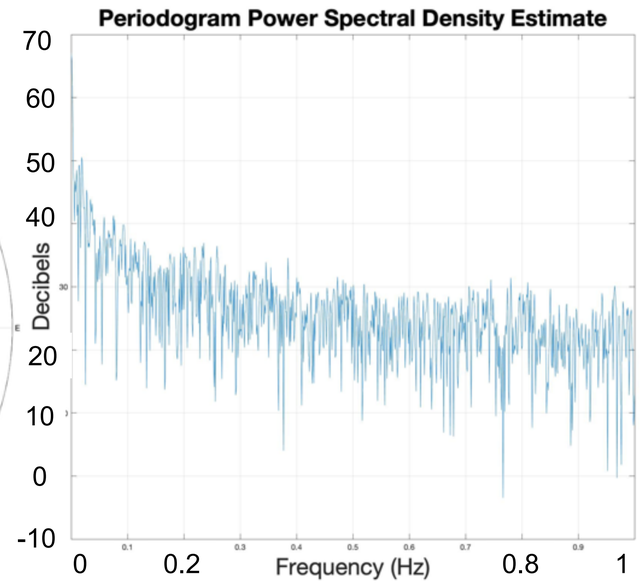


Overview of wiring schematic developed for anemometer integration

Results

- Wind velocity data were analyzed to produce a wind rose plot as well as a power spectral density graph as shown below.





Left: Wind rose diagram displaying the wind speed and direction in a 360-degree view
Right: Power spectral density based on wind speed

Discussion and Conclusion

- The wind rose results are consistent with the baseline wind measurement of approximately 3 mph eastward on the ground using a handheld anemometer.
- The power spectral density can be interpreted as the amount of wind energy at each of the frequency. The results suggested slow wind gusts with frequency < 1 Hz were present.
- This project successfully integrated an ultrasonic anemometer on a quadrotor for inflight wind data collection. Ongoing research in the Autonomous Robots and Systems Laboratory (ARSL) at UNC Charlotte that aims to use such measurements to improve quadrotor flight control and path planning in urban environments.

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