Propeller Vibration in an Unmanned Aerial Vehicle Quadcopter

James Sewell, Dr. Monty Smith (Mentor)

Department of Mechanical Engineering, Arkansas Tech University

Introduction

Unmanned aerial vehicles (UAV's, or drones) are increasing in demand for a broad range of purposes. UAV technology is being implemented in the military for uses such as reconnaissance and surveillance, civilian hobbies, and is even making a debut in the gaming community by racing drones. Market pressures demand improved design and a better understanding of component dynamics. The scope of this project is to attempt to measure propeller-rotor flutter for low Reynolds number, small format, propellers, the type of which are used for unmanned aerial vehicles (UAV)

Results and Discussion

Propeller-rotor flutter is a dynamic instability that can occur in a nonrigid thin blade. The instabilities occur due to the aeroelastic coupling of the aerodynamic forces creating a feedback loop with structural flex of the blade. Blade flex creates a change in the section airfoil angle of attack which in turn changes the aerodynamic forces.

An Mbientlab MetaTracker, mountable sensor equipped with wireless accelerometers was mounted to the 10inch propeller blade of an existing UAV. The accelerometers transmitted the vibration spectrum to an iPhone with an interface app provided by the vendor. The app logged and processed the data into a comma separated variable (csv) file. Matlab will be used to separate the data for vibration magnitude and direction.

The original intention of the project was to capture measurements at steady motor RPM's and RPM transition; however, do to controller interface errors, propeller rotation had to be created manually. This accounts for the spikes in measurements and gradual tampering off as the propeller rotation trailed away to zero.

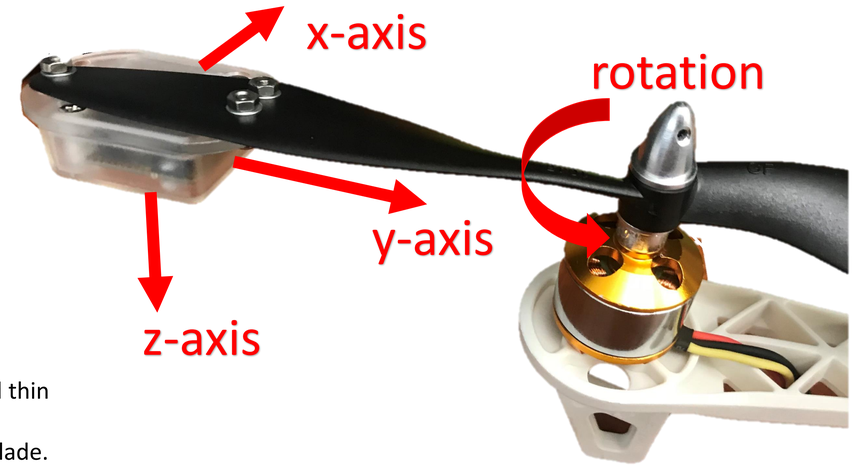
Additionally, the default sensor sampling rate is not sufficient to allow accurate data post processing. Additional work will be required to increase sensor data rate.

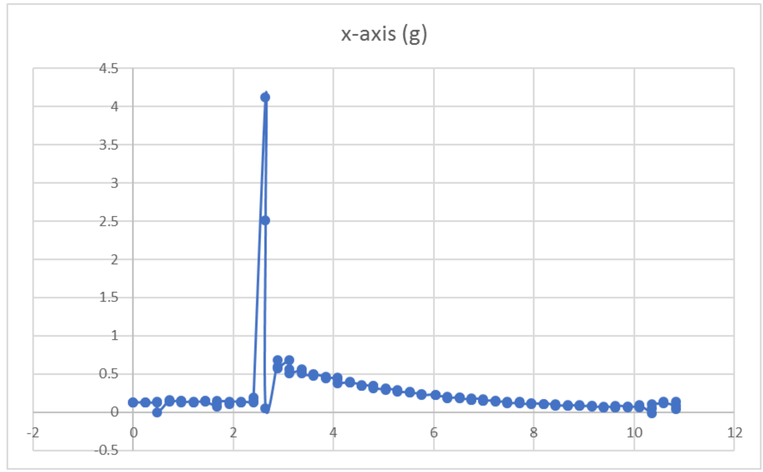
Conclusions

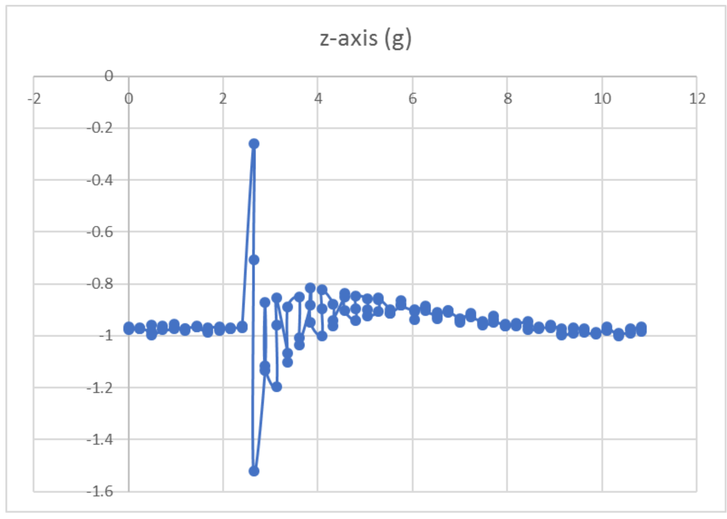
Results were consistent with both the crude rotational input and the coarseness of the data acquisition rate. More time needs to be spent with the UAV controller to enable manual input of motor RPM.

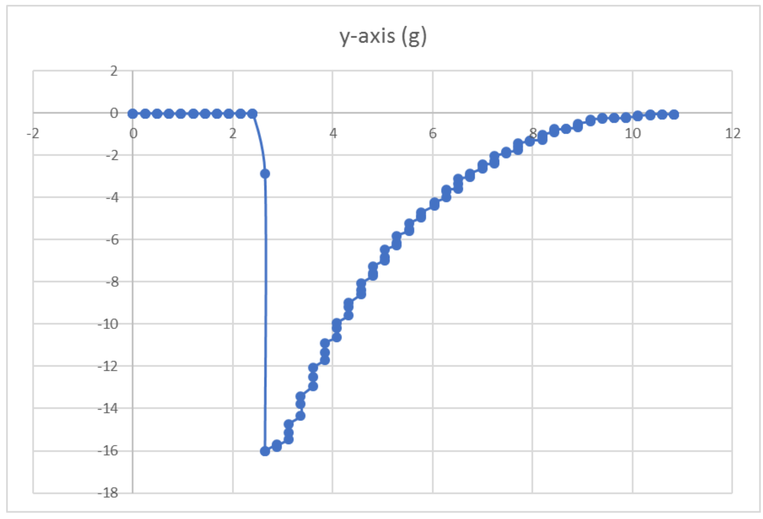
Increasing the data capture rate is currently being researched. This task requires development within the Software Development Kit (SDK) utilizing the programming language Python. Implementation of the Python SDK will also enable usage of a Bluetooth equipped laptop to capture sensor and process sensor data in real time.

Once data capture and propeller rotation errors are corrected, investigation into the effects of the sensor's mass and aerodynamic drag will have to conducted as well.









mbientlab

- Bosch® BMI160 6-Axis Accelerometer/Gyroscope
  - ±2g/±4g/±8g/±16g selectable scale
  - 125/250/500/1000/2000 degrees/sec
  - Industry leading 900uA active current gyro