Three Dimensional Online Wind Estimation Onboard a Class of Vertical Take-Off and Landing Unmanned Aerial Vehicles

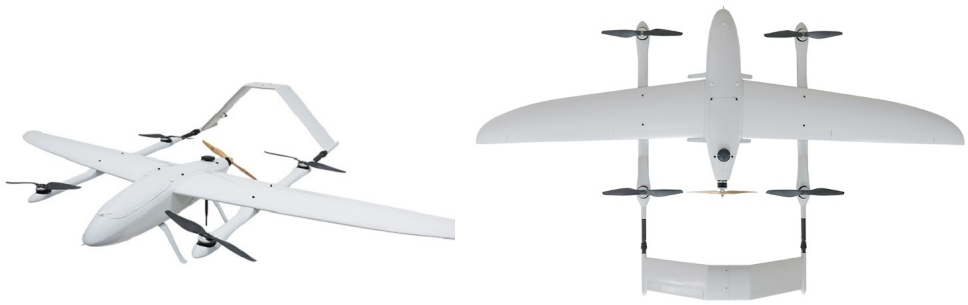

Figure 1: Pictures of the VTOL aircraft.

Overview

This thesis aims to develop an online estimation framework and sensor suite for full three dimensional wind estimation onboard a special class of Vertical Take-Off and Landing (VTOL) Unmanned Aerial Vehicles (UAVs) capable of convertible flight, namely from multi-rotor mode to fixed-wing mode.

The thesis will emphasize the research and development of a sensor suite capable of accurately measuring and estimating wind in all three dimensions during flight. This will include the development of a hardware prototype capable of measuring airspeeds in the x-axis, y-axis and z-axis in the body frame of the vehicle, through the use of three separate differential pressure (pitot) tubes. Further, an estimation framework will be developed and implemented in hardware, before the sensor suite will be integrated in the modified PX4 open-source autopilot software running on the drone. Finally, the entire sensor and estimation suite will be implemented and tested in real flights onboard the prototype VTOL UAV depicted in fig. 1.

Tasks and Sub-objectives

1. Literature review:

2. Hardware development and prototyping
3. Wind estimation framework
4. Implementation in PX4 state estimation
5. Testing in real flights

Aviant

This thesis is written in collaboration with Aviant, a Norwegian company specializing in autonomous drone transportation of blood samples and critical medical supplies between hospitals. Transportation of biological samples is currently one of the biggest bottlenecks in diagnosing patients, a problem that can be greatly alleviated using drone technology. Aviant has a collaboration with St. Olav Hospital, one of the largest hospitals in Norway, where this solution is currently being tested and implemented. The goal of this thesis is to implement the results on the vehicle that is used in day-to-day operations between hospitals in Norway.

References

[1] Ravirai Jangir, Nekkanti Sitaram, and Ct Gajanan. "A miniature four-hole probe for measurement of three-dimensional flow with large gradients". In: *International Journal of Rotating Machinery* 2014 (2014). ISSN: 15423034. DOI: 10.1155/2014/297861.

[2] Takuma Hino, Satoshi Takagi, and Takeshi Tsuchiya. "Multi orifice pitot tube as air data sensor for small unmanned aerial vehicles". In: *Transactions of the Japan Society for Aeronautical and Space Sciences* 53.182 (2010), pp. 320–322. ISSN: 05493811. DOI: 10.2322/tjsass.53.320.

[3] Tor A. Johansen et al. "On estimation of wind velocity, angle-of-attack and sideslip angle of small UAVs using standard sensors". In: *2015 International Conference on Unmanned Aircraft Systems, ICUAS 2015* (2015), pp. 510–519. DOI: 10.1109/ICUAS.2015.7152330.

[4] B. Sahin and A. J. Ward-Smith. "The measurement of air-flow characteristics using a five-hole Pitot probe in conjunction with a microcomputer". In: *Transactions of the Institute of Measurement and Control* 7.3 (1985), pp. 110–116. ISSN: 01423312. DOI: 10.1177/014233128500700301.