Understanding the Vortex-Ring State for VTOL Aircraft in Vertical and Oblique Descending Flight

Most Electric Vertical Take-off-and-Landing (eVTOL) vehicles designed for UAM use multiple rotors for vertical flight (example in Figure 1). Such systems are known to be prone to the Vortex Ring State (VRS) during descent. The VRS may arise when the vehicle descent speed causes the rotor to ingest its own wake, resulting in abrupt loss of thrust and controllability.

The aim of this thesis is to determine the flow pattern around a propeller in VRS and understand how it affects the flight mechanics characteristics. An experimental investigation is conducted to determine the velocity field around the propeller in both axial and oblique descent, through Particle Image Velocimetry (PIV, Figure 2). The data from PIV measurements are used to simulate a VTOL (helicopter) in descent.

How does the flow pattern change in a multi-rotor configuration? And if the rotor is ducted? Many aspects can be interesting source questions for possible future research.

FIGURE 1 EHANG 216

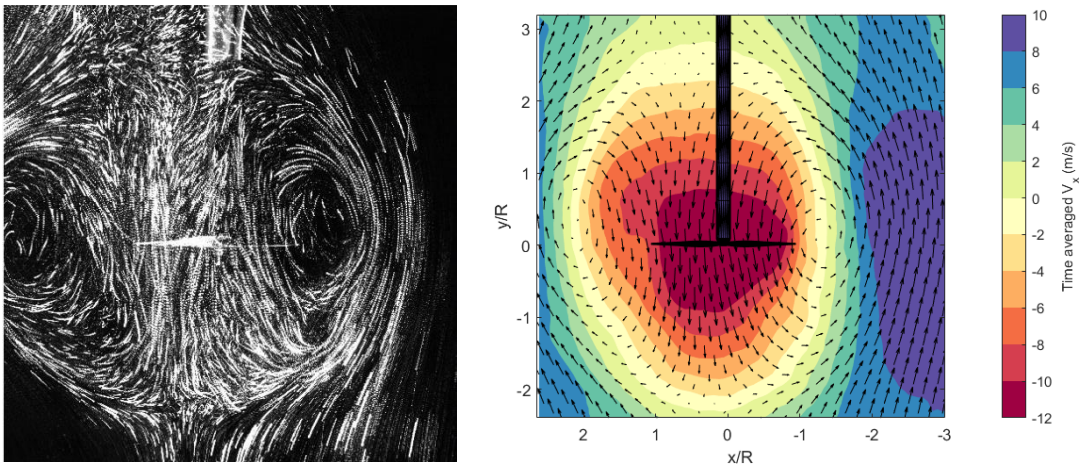

FIGURE 2 FLOW VISUALIZATION AND MEASUREMENTS. ON THE LEFT: STREAKLINES OF THE PROPELLER IN VRS; ON THE RIGHT: TIME-AVERAGED VELOCITY FIELD V_X AND 2D VELOCITY VECTORS

Student: Palma Caputo

Supervisor(s): Prof. Fulvio Scarano, Prof. Marilena D. Pavel, Ir. Hasse N. J. Dekker