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Effect of Rotor-Rotor Interactions in Aerodynamic Performance of Multi-Rotor Air Vehicle

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The present study deals with the effects of rotor-rotor interactions in the evaluation of aerodyanamic performance of multi-rotor air vehicle in hover. Aerodynamic forces such as lift, drag, thrust are evaluated by changing the rotating speed (Ω) and the center distance (CD) between rotors to identify the flow interactions among rotors.

The fluid models of two-rotor and four-rotor air vehicles [1,2] are shown Figure 1, wherein ANSYS-CFD is used for the trnasient viscous laminar flow analysis with air density = 1.225kg/m^3, and viscosity = 1.7894x10^{-5}kg/ms. Thrust forces for left and right rotors are shown in Figure 2. Pressure and induced velocity distributions are presented in Figure 3 and Figure 4, respectively. The hovering performances of a two-rotor case are compared in terms of center distance in Table 1, wherein left and right rotors well converges to the same values in thrust, power and torque.

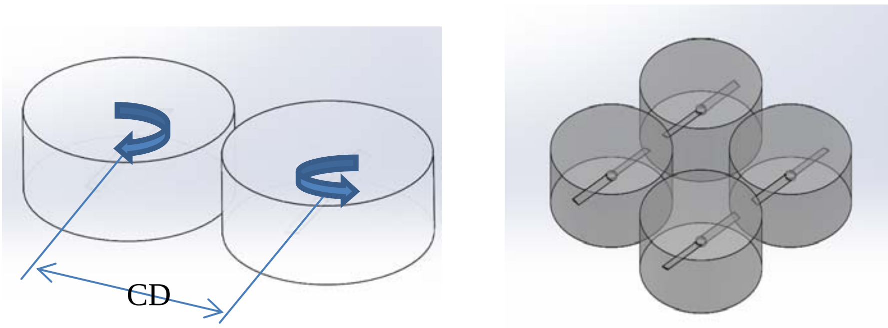

Figure 1: Rotational fluid domains for two-rotor and four-rotor

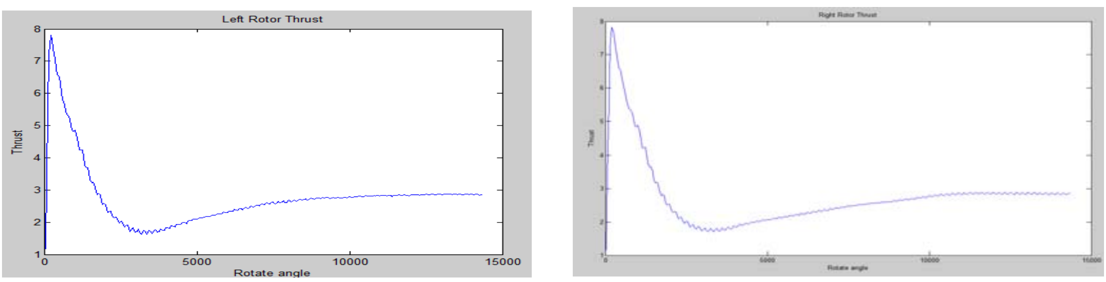

Figure 2: Thrust forces for left and right rotors with Ω = 4,900rpm and CD = 400mm

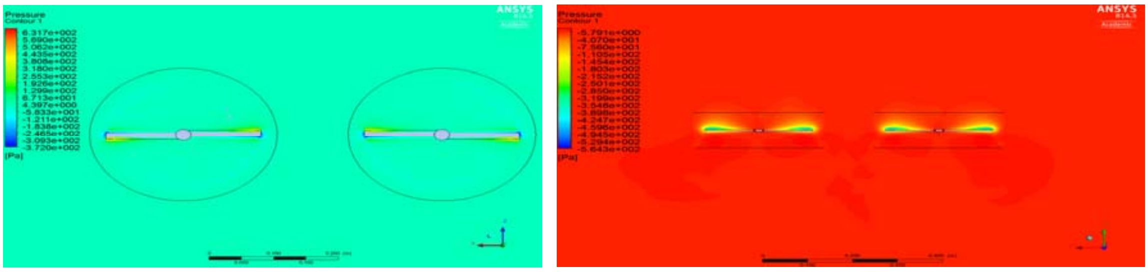

Figure 3: Pressure contours with Ω = 4,900rpm and CD = 400mm

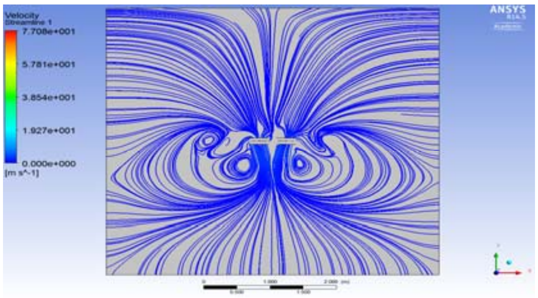

Figure 4: Induced velicity distribution with Ω = 4,900rpm and CD = 400mm

The present study also identifies the airfoil-sectional pressure distribution at R=0.11m of the blade with Ω = 4,900rpm and CD = 400mm; there exists a small amount of the pressure deviation between left-rotor and right-rotor that may results in the thrust intability due to the flow interactions between rotors. The full paper will discuss the complex flow interactions for two-rotor (bi-copter) and four-rotor (quad-copter) cases in a greater detail.

Table 1: Hovering Performance with Ω = 4,900rpm

CD [mm]	Thrust [N]		Power [HP]		Torque Coeff.	
	Rotor-L	Rotor-R	Rotor-L	Rotor-R	Rotor-L	Rotor-R
300	2.2877	2.3674	0.0140	0.0174	0.0008	0.0008
400	2.8558	2.8442	0.0195	0.0193	0.0011	0.0011
500	2.9205	2.7222	0.0201	0.0181	0.0012	0.0011

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