Development of a Rotor with Improved Aerodynamics to Propel a Quadcopter - Design and Manufacture According to the Laws of the Propeller Theory by Betz and Schmitz

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The goal of my paper was to manufacture a rotor for DJI's Mavic Pro quadcopter. Using the laws of the Propeller Theory by Betz and Schmitz, I examined the aerodynamic characteristics of existing quadcopter rotor blades and utilized the findings to manufacture my own models. To create a rotor structure, suitable airfoils were selected and further modified along two parameters: the airfoil chord and the construction angle. The airfoils were then converted into a 3D model, modified with winglets, 3D printed, and tested on a self-built test rig. To evaluate the lift performance of each rotor, the generated lift force was plotted against the rotational rates of the rotors. For the Mavic Pro to hover, Prototype I had to rotate at 6,800 rpm and Prototype II at 6,100 rpm. Both required a higher rotational rate than DJI's standard rotors with 5,600 rpm. The best performing prototype was Prototype II with sloped winglets with a critical rate of 5,400 rpm. Using test flights, the rotors were additionally evaluated for their electrodynamic properties. To keep the Mavic Pro hovering, the motors had to deliver 118 watts of electrical power for Prototype II with sloped winglets and 110 watts for DJI's standard rotors. The original goal of the project was exceeded. A prototype was produced that surpassed the lift characteristics of the industrially manufactured rotors of the quadcopter world market leader DJI. In follow-up projects, it will be of specific interest to investigate material and manufacturing aspects.

Awards Won:

Third Award of $1,000

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