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Using CFD to develop a fully Electric Motor Driven Contra-rotating propulsion system for Marine Vessels

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ABSTRACT

The transition to electric propulsion systems in marine technology is a critical step toward achieving sustainability and operational efficiency. DuoDrive Ltd have devised a novel electric-driven propulsion system that combines the efficiency advantages of contra-rotating propellers (CRPs) with the precision and sustainability of electric drives. Unlike traditional single-propeller systems, CRPs consist of two coaxial propellers rotating in opposite directions, effectively neutralizing the rotational flow imparted by the forward propeller. This paper presents a computational framework for optimizing a contra-rotating propeller set to maximize thrust under practical constraints such as cavitation, efficiency of the electric drivetrain, and hydrodynamic performance. Leveraging advanced computational fluid dynamics (CFD) simulations integrated with genetic optimization algorithms, the study explores a robust methodology to optimize high-efficiency propeller design tailored for various marine applications. The proposed approach employs parametric modelling to define the propeller blade geometry, incorporating key parameters such as camber, chord length, pitch distribution, skewness ratio, blade number and rotational speed. High-fidelity CFD simulations are conducted to evaluate the hydrodynamic performance of each design, focusing on key metrics such as thrust coefficient, torque coefficient, and cavitation inception. Commercial CFD tool Simerics-MP+ is used for the accurate prediction of the flow characteristics around the propeller blades. The CFD tool is fast enough to perform multiple Design of Experiments (DoE) runs within a short time span even on a desktop computer, therefore enabling fast and accurate optimization. Case studies are presented for a low-speed propeller and a high-speed propeller design optimization with multiple Design of Experiments (DoE) runs for various design parameters. The optimized designs demonstrate a significant improvement in thrust performance compared to baseline propellers, hence enhancing overall efficiency of the contra-rotating propeller.

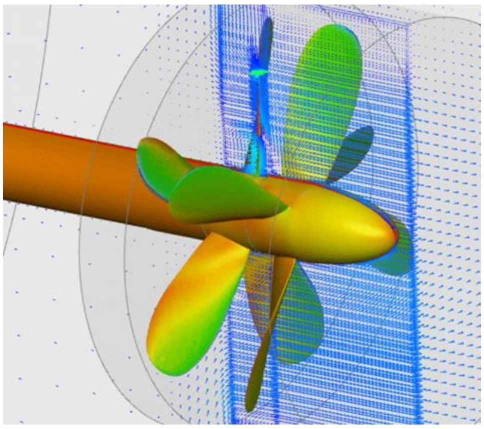

Figure 1: Contra-rotating propeller

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