Hydrodynamic Interactions of an Unmanned Underwater Vehicle Operating in Close Proximity to a Moving Submarine

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While the United States Navy has developed a strong arsenal of tools to model the hydrodynamic forces and moments of different vehicles in different conditions, they do not have a model that enables them to understand the forces and moments that an Unmanned Underwater Vehicle (UUV) experiences when operating in close proximity to a moving submarine as a result of the interactions between their potential fields and wakes. The launch and recovery of UUVs from submarines is very challenging because these hydrodynamic interactions make UUVs hard to control near submarines and my even cause collisions between the two vehicles. The mapping of these forces and moments is vital to simulate the motion of the vehicles and enable developers to create UUV control and autonomy systems that are adaptive to these hydrodynamic interactions to further enable UUV launch and recovery. Due to the complex nature of the hydrodynamic interactions, this study used computational fluid dynamics to expand the current understanding of the forces and moments between these two vehicles. A Gaussian process regression model was used to perform an optimal experimental design and map the resulting hydrodynamic interactions based on the UUVs longitudinal position, lateral position, speed, heading angle, UUV diameter, and UUV length. The model was validated using an out of sampling method and was shown to be capable of accurately predicting the hydrodynamic interactions between a submarine and UUV.

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