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Physics-informed Predictive Model of Flapping Flight Aerodynamics using Gaussian Process Regression[1] YAGIZ BAYIZ, KEEGAN HARRIS, The Pennsylvania State University, YU PAN, HAIBO DONG, University of Virginia, BO CHENG, The Pennsylvania State University — An accurate and computationally efficient model for predicting the aerodynamic force, moment and power of flapping flight can significantly advance the understanding animal flight and the design of bioinspired micro aerial vehicles. In this work, we develop such a predictive model based on Gaussian Process (GP), informed by quasi-steady aerodynamic model and trained by Computational Fluid Dynamics (CFD) simulation data for a wide range of flapping wing kinematics. The GP receives instantaneous wing kinematics as the input and uses statistical inference methods to predict the resulting forces, moment and power. The training set consists of a nominal wing trajectory and a set of trajectories highlighting a deviation from the vanilla trajectory in one particular kinematic feature. The resulting GP model is tested on a separate set of wing trajectories with a mixed change of kinematic features and is shown to provide more accurate predictions than the conventional quasi-steady models. The accuracy of the predictions relies on the proximity to the training set, and for a relatively wide range of trajectories, they show excellent agreement with the CFD results. The GP model also provides uncertainty information, indicating the regions where the prediction has a high variance.

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