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Geometric Control Theory Applied to the Analysis of a Pitching-Plunging Airfoil LAURA PLA OLEA, HAITHEM TAHA, University of California, Irvine — The geometric control theory is the application of differential geometry to control theory. It provides a means to study nonlinear dynamical systems that evolve on curvy spaces or manifolds. First developed in the 1970s, the geometric control theory is capable of capturing the higher order effects that are usually neglected in the classical linear theories, allowing for the discovery of unconventional force generation mechanisms. The aim of this study is to exploit the benefits of the geometric control theory in the field of unsteady aerodynamics. To do so, the aerodynamics of a two-dimensional pitching-plunging airfoil are formulated in a control framework using a state-space system. This reduced-order model (ROM) provides only the dynamics of some chosen output variables; it does not aim for the reconstruction of the entire flow field. The system is rich enough to capture the main physical aspects of the flow, but also compact to permit an analytic study of the results. The geometric control theory is then applied to analyze the behavior of the outputs, in this case the lift and drag forces. The results are studied in a fluid dynamics framework to determine if the unsteady motion of the airfoil can provide an enhancement or reduction of the mentioned parameters.

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