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Detection and estimation of the instantaneous flow topology on an airfoil using proper orthogonal decomposition JURGEN SEIDEL, CASEY FAGLEY, TOM MCLAUGHLIN, US Air Force Academy — For the control of the lift distribution on a wing, the local flow state has to be known instantaneously, in particular, the location of critical points in the flow topology such as stagnation point, separation point and reattachment point. Unsteady CFD simulations are used to determine the flow field around a Naca 0018 airfoil at moderate Reynolds number. These simulations are then analyzed using Proper Orthogonal Decomposition (POD) to develop a database of flow states at a wide range of angles of attack. In addition, POD is performed using data on the airfoil surface. A mapping between the two databases is used to develop a global flow state estimator. Robustly estimating the critical points in the flow topology in real time allows for the formulation of a Reduced Order Model (ROM) which relates flow field characteristics and surface data, including the effect of controlled forcing input. The accuracy of this model and its efficacy for developing feedback control strategies for the control of the lift distribution are determined.

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