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Corresponding author: Seungkeun Kim
e-mail of corresponding author: skim78@cnu.ac.kr
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Title

Aerodynamic Parameter Estimation for Fixed-wing UAV Using Iterated Extended Kalman Filter

Authors

Junhyun Lim [1], Heetae Park [2], Jinyoung Suk [3] and Seungkeun Kim [4]*

** Corresponding author*
[1,2,3,4] Department of Aerospace Engineering, Chungnam National University, Daejeon, Republic of Korea
[1] seole222@o.cnu.ac.kr, [2] pht1321@naver.com, [3] jsuk@cnu.ac.kr, [4] skim78@cnu.ac.kr*

Abstract

This paper discusses the results of aerodynamic parameter estimation for a fixed-wing Unmanned Aerial Vehicle (UAV) using Iterated Extended Kalman Filter (IEKF). Aerodynamic parameter estimation is important for creating an environment for sophisticated simulations as well as more accurate aircraft dynamic modeling and flight control. Traditional commercial manned aircraft have used computational methods such as Computational Fluid Dynamics (CFD) or wind tunnel tests to identify aerodynamic parameter, but these are not suitable for application to the UAV with relatively short design cycle due to high cost and computing power. Instead, estimating aerodynamic parameter using flight data is not only much simpler than computational methods but also the accuracy is relatively high, making them appropriate for application to UAVs. In many ways of estimating aerodynamic parameter from flight data, one of the filter-based methods, the extended Kalman Filter (EKF), is used against the non-linearity of aircraft dynamics and noise of the measurement. The EKF approximates non-linearity by obtaining a Jacobian of system dynamics and measurement equations using first-order Taylor series around current estimates. If the degree of non-linearity is high, it does not approximate well, and the linearization errors affect the estimation performance or filter convergence. On the other hand, IEKF is one of the ways to improve the performance reduction of filters caused by the linearization of system models and measurement equations and has theoretically better performance by iteratively calculating the measurement Jacobian at the update steps until certain stop conditions are met. Accordingly, to verify the advantages of IEKF, a longitudinal dynamic simulation of the fixed-wing UAV is carried out and simulation data is used to design an aerodynamic parameter estimation filter using IEKF. To be similar to a realistic flight environment, the sensor model commonly used in the UAV is utilized as a measurement for the update step in the filter. The estimation performance of the IEKF is compared with the EKF and UKF results. As a result, IEKF provides as accurate estimated performance as other filters and shows faster convergence in certain estimation variables.

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