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Identification of a quadcopter autopilot system via Box–Jenkins structure

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Abstract

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This paper presents a method to precisely model a four rotor unmanned aerial vehicle, widely known as quadcopter autopilot system. Common system identification methods limit quadcopter models into first or second order systems, and do not count for noise characteristics. This leads to poor prediction accuracy of its longitudinal and lateral motion dynamics that ultimately affects the aircraft stabilization during flight and landing. To improve the quality of the estimated models, we utilized a statistically suitable discrete-time linear Box–Jenkins structure to model the plant and noise characteristics of the horizontal subsystems of a quadcopter autopilot system. The models were estimated using flight data acquired when the system were provided with pseudo-random binary sequence input. In this proposed method, by employing the prediction error method and least squares approach, the aircraft dynamics could be modeled up until the fifth order. The normalized root mean square fitness value showed that the predicted model output matches the experimental flight data by 94.72% in the one-step-ahead prediction test, and 84.52% in the infinite-step-ahead prediction test. These prediction results demonstrated an improvement of 52.8% when compared with a first and second order model structures proposed in previous works for the same quadcopter model. The output from this research works confirmed the effectiveness of the proposed method to adequately capture the autopilot dynamics and accurately predict the quadcopter outputs. These would greatly assist in designing robust flight controllers for the autopilot system.

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