ABSTRACT

The present work describes the practical implementation of systems identification techniques to the development of a linear aerodynamic model for a small low-cost UAV equipped with a basic navigational and inertial measurement systems. The assessment of the applicability of the techniques were based on determining whether adequate aerodynamic models could be developed to aid in the reduction of wind tunnel testing when characterising new UAVs. The identification process consisted of postulating a model structure, flight test manoeuvre design, data reconstruction, aerodynamic parameter estimation, and model validation. The estimators that were used for the post-flight identification were the output error maximum likelihood method and an iterated extended Kalman filter with a global smoother. SIDPAC and FVSysID systems identification toolboxes were utilised and modified where appropriate. The instrumentation system on board the UAV consisted of three-axis accelerometers and gyroscopes, a three-axis vector magnetometer and GPS tracking while data was logged at 25 Hz. The angle of attack and angle of sideslip were not measured directly and were estimated using tailored data reconstruction methods. Adequate time domain lateral model correlation with flight data was achieved for the cruise flight condition. Adequacy was assessed against Theil's inequality coefficients and Theil's covariance. It was found that the simplified estimation algorithms based on the linearized equations of motion yielded the most promising model matches. Due to the high correlation between the pitch damping derivatives, the longitudinal analysis did not yield valid model parameter estimates. Even though the accuracy of the resulting models was below initial expectations, the detailed data compatibility analysis provided valuable insight into estimator limitations, instrumentation requirements and test procedures for systems identification on low-cost UAVs.