Design and Performance Evaluation of a Transport Aircraft with Retractable Canards

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Increasing efficiency for passenger aircraft is invaluable for preserving viability for airlines, motivating the investigation of advanced aerodynamic technologies. One such technology is retractable canards, which can increase fuel efficiency by reducing cruise drag but introduce changes in stability and handling between deployed and retracted configurations. This work evaluates the design and performance of a low-wing, aft-mounted twin-pusher, medium-haul, jet transport with retractable canard control surfaces initially derived from a NASA study. A mission performance model was developed to calculate fuel burn over a mission profile from aircraft geometry and aerodynamics. This model was verified using a Boeing 737 MAX 8 benchmark, which reproduced published fuel efficiency by 2.6%. Trade studies were conducted on wing aspect ratio to optimize lift-to-drag ratio, center-of-gravity location to reduce negative static margin, and canard and horizontal-tail sizing to limit neutral point shift. The aircraft's handling qualities and natural dynamic responses were characterized using a linearized six-degree-of-freedom Simulink model. A sub-scale technology demonstrator was built to evaluate the transient response of canard retraction and deployment. The results showed increased fuel efficiency over the 737, however static margin shifts between canard out and in configurations decreased longitudinal stability during takeoff and landing. Overall, while efficiency improvements are plausible, the stability and handling risks pose challenges that limit practical viability without stability augmentation.

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