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Title
Longitudinal Flight Dynamics And Stability Of Blended Wing-Body Unmanned Aerial Vehicle With Canard As Control Surface

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Blended wing-body (BWB) aircraft concept has its body „blended" with the wing in smooth transition. Unlike conventional aircraft design, BWB aircraft"s body produces lift force and this causes large impact on the flight dynamics and stability. This thesis focuses on flight dynamics of a small unmanned aerial vehicle (UAV) with BWB configuration incorporating a set of canard as longitudinal control surface. The objective is to predict the flight dynamics and stability behaviour of UiTM"s Blended Wing-Body (BWB) unmanned aerial vehicle (UAV) with canard as control surface, known as Baseline-II E-2, in longitudinal mode with classical-approach stability augmentation to achieve level 1 phugoid and short-period modes flying qualities (restricted to damping ratios) as stated in MIL-F-8785C standard. This study proposes simple scheduled feedback gains to the canard. Wind tunnel experiments, computational simulations and empirical estimations were conducted to characterize its aerodynamics and to come up with its aerodynamic mathematical model for flight dynamics derivatives calculation. The flight dynamics model was derived to become Model-N state-space representation and compared to established models. Transient response to a unit step canard input was simulated using these models for flight conditions inside the airplane operating flight envelope (OFE) within its allowed angle of attacks. It was found that the BWB airplane without SAS, despite being statically and dynamically stable, has poor flying qualities for both short-period and phugoid modes. The change of short-period and phugoid modes" natural frequencies and damping ratios with respect to airspeed, dynamic pressure and altitude were studied to establish mathematical relationships that were used to design a suitable scheduled gains to be fed to the canard control surface. Classical method was used to come up with feedback gains relationships with respect to dynamic pressure. By setting the required damping ratios for both modes to a demanded value couples with simplifications to these equations, the magnitude of feedback gains could be determined. The relationship between feedback gains and dynamic pressure was used to construct a representative block diagram of the complete aircraft control system with stability augmentation using canard control surface in Matlab SIMULINK. The resulting transient response were analyzed to compute values of short-period and phugoid modes" damping ratios. The results of these damping ratios show that the aircraft with SAS has good flying qualities (Level 1) while maintaining short-period and phugoid modes" damping ratios to around 0.7. This study has shown that it is possible to provide adequate stability and good flying quality for a flight limited to its operational flight envelope to a small BWB aircraft with canard as its control surface via simple feedback gains governed by dynamic pressure.