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Investigation of helicopter flight dynamics in hover and low velocity flight

Abstract

In hover, climb and flight with low forward velocity helicopter encounters various environmental conditions which influence flight dynamics sometimes in adverse way then pilot action. Usually vertical autorotation and low speed descending flight are avoided due to higher induced power requirements and such phenomena like vortex ring state.
The emergency and military applications sometimes require performing flight in such conditions. Determination of H-V diagram is based on conservative assumption and not validated in-flight due to requirements of pilot safety. Recently research of autorotation and low velocity flight phases was reported in [1-3].
In Warsaw University of Technology the simulation and in-flight research was initiated to investigate vertical and low speed regions of helicopter flight envelope.
For computer simulations two models are used: FLIGHTLAB software and specially developed in WUT dedicated simplified model. These two models are used in complementary way: the simplified for optimization procedures in approximate way and FLIGHTLAB for confirmation of the results obtained. The final validation will be done by flight tests.
The simplified model, which is the main topic of the paper combines fuselage velocities and rates and rotor angular velocity as degrees of freedom. Rotor flapping angles are calculated in a quasi-steady manner including influence of helicopter degrees of freedom. The tail rotor is described by Bailey model. For aerodynamic loads calculation on main rotor blades, 2D aerodynamic model is applied with induced velocity based on dynamic inflow approach with corrections based on empirical data. The ground effect is taken into consideration in both models.
The model parameters were adjusted to helicopter steady flight data. Then the model was used for comparison with low speed flight data. Using validated model the flight conditions which are difficult to investigate in flight were simulated.

References

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