Trajectory Tracking Controller Design and Simulation of a Tethered Aircraft

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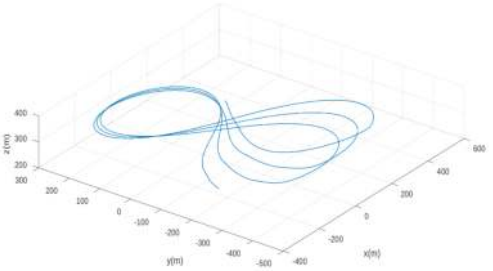
Control problem of an airborne wind energy aircraft, generating power on the ground is addressed. The proposed control tracks a pre-defined trajectory in the power generation phase. The reference attitude information is computed by the trajectory tracking controller such that the aircraft carries out a coordinated turn as well as maintains a proper pitch attitude to generate the necessary lift. A novel quaternion based nonlinear attitude controller is designed, utilizing the attitude commands generated by the tracking controller. These commands are in terms of to-go quaternions to utilize a similar nonlinear attitude controller previously developed for quadrotor flight control as well as solar sail attitude control [1]. However, the approach is extended to the fixed wing airborne wind energy aircraft with aerodynamic nonlinearities. The six degrees of freedom mathematical model of the aircraft includes aerodynamic, gravitational, and environmental sub-models combined with nonlinear equations of motion. The aerodynamic model includes the variation of aerodynamic forces and moments with respect to the angles of attack and sideslip, as well as control surface deflections. The aerodynamic damping terms due to body angular rates are also included. The drag contribution of the tether is computed in the aerodynamic model of the nonlinear simulation. In addition, the winch which is also an important part of the energy generation system on the ground is modelled. It is assumed that the tension in the tether is kept constant with the feedback controller of the winch.



Flight trajectory

References:

[1] Ariyibi, S., Tekinalp, O.: Quaternion-based nonlinear attitude control of quadrotor formations carrying a slung load. Journal of Aerospace Science and Technology, 105,105995 (2020)

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