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Title

A Tailless Flapping Wing MAV's Attitude Stabilization using observer-based sliding mode control

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Abstract

Research on the development of Flapping Wing MAV(FWMAV) is active in aviation to mimic insects and birds. Recently, several commercial FWMAVs have been developed and sold. A typical example is Flapper, developed by Flapper Drones[1]. Many FWMAV development studies focus on developing air vehicles by improving aerodynamic efficiency through flapping or developing control mechanisms for hovering flights. PID control is mainly used as a control algorithm for FWMAV and demonstrates reasonable control performance in a normal flight environment. However, the FWMAV has a larger drag area than a small quadcopter of the same mass because it needs the main wings to flap periodically to generate aerodynamic force. And this periodic movement of the main wings results in uncertain parameter variations. This paper discusses an application of observer-based Sliding mode control(SMC) to attitude stabilization of FWMAV in windy environments. Since wind affects the FWMAV's force and moment, we need to estimate the wind-induced disturbance and achieve attitude stabilization by actively canceling the estimated disturbance. A finite-time observer is used for estimating both the state and the disturbance, and sliding mode control is adopted to be robust against system uncertainty. Our previous study[2] proposed an observer-based SMC through simple FWMAV modeling and simulation. Using the numerical modeling of the Flapper, we validate the design of the observer-based sliding mode controller and the stability of the closed-loop system. After that, the flight test in a windy environment is conducted and compared with PID control to verify the validity and performance of the designed control system.

References

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