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Abstract

Quadrotor UAV Altitude Control Using FOPID, PID and Integral State Feedback Controller †

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This research presents the development of an altitude control for a quadrotor unmanned aerial vehicle (UAV) using a fractional-order proportional-integral-derivative (FOPID) controller, a proportional-integral-derivative (PID) controller, and an integral state feedback (ISF) controller. The quadrotor UAV, which is a nonlinear, multiple-input, multiple-output, and underactuated system, was modelled using the Newton-Euler modelling system, in which the UAV's translational and angular velocity was derived mathematically. The quadrotor UAV was then linearized for easy analysis and modelled in MATLAB/Simulink (9.13.0.2049777: 2022b). The simulation was carried out in the MATLAB/Simulink 2022b environment. Two cases were considered: the open-loop and closed-loop responses. The two cases were simulated, and the system performed satisfactorily in both open-loop and closed-loop scenarios. Also, FOPID, PID, and ISF controllers were applied on the closed-loop scenario for the altitude control of the UAV. From the simulation results, it can be deduced that FOPID outperformed PID and ISF controllers in terms of settling time and rise time, with values of 0.008 s and 0.0236 s, respectively. Also, the ISF controller had a better overshoot of 0%, while the PID controller had a better steady-state error (SSE) of 7.1524×10^{-10}, which were all obtained from the simulations. The contribution of this work is the application of FOPID with respect to the altitude control of quadrotor UAV. This shows the advantages of the FOPID controller regarding the altitude control of the quadrotor UAV in terms of robustness and reliability.

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