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Nonlinear Control of Hexarotor System Using Proportional Derivative Sliding Mode Controller (PD-SMC)

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Abstract

An Unmanned Aerial Vehicle (UAV) or Uncrewed Aerial Vehicle is a multirotor type of vehicle and is commonly known as a drone. Hexarotor type of UAV has six rotors and has several characteristics that give more operational advantages over lower rotors of UAV. This paper presents the mathematical modeling of the hexarotor system with the Proportional Derivative Sliding Mode Controller (PD-SMC) approach as the nonlinear controller . The mathematical model of the UAV's body dynamics was modeled using the Newtonian method. This research implemented the SMC controller to the hexarotor system and coupled it with PD as the sliding surface for the attitudes controller . For comparison, Proportional Integral Derivative (PID), PD, and Linear Quadratic Regulator (LQR) controllers were also applied to the hexarotor system . Hence, better attitudes controller performances were achieved using the coupled controller , which is the PD-SMC controller . The performances were analyzed in percentage overshoot, settling time, rise time, and steady-state error. Matlab Simulink simulation was used throughout the research to measure the performances of hexarotor . As a result, for roll angle, rise time was 0.06 s, settling time was 0.50 s, percentage of overshoot was 0.0002%, and the steady-state error was 0.0001. In conclusion, PD-SMC shows the best stabilization controller for the hexarotor system with almost zero overshoot, zero steady-state errors, and faster settling times, and faster rising time. © 2022, The Author(s), under exclusive license to Springer Nature Singapore Pte Ltd.

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