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Simulation and Analysis of Nonlinear Controller

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Abstract. This paper first introduces this topic in the nonlinear simulation controller constructed by the nonlinear simulation platform; Then respectively for conventional controller technology based on IID and UDE the sliding mode controller and the controller based on nonlinear simulation environment, this topic further verified the validity and the correctness of the designed controller.

Introduction

In this paper, the designed controller is based on linear model, is through the study of the state of nonlinear model plane balancing and model linearization. Real aircraft are nonlinear, controller is also work in non-linear environment, design the parameters of the linear environment may not be able to adapt to nonlinear environment. So, in order to further verify the correctness and effectiveness of the controller, the need for the design of controller for nonlinear simulation environment.

Track Angle Controller of Nonlinear Simulation Platform

Matlab/Simulink toolbox for the design of the control system provides abundant basic module, and can meet most of controller in control engineering design, implementation, and part of the validation and related work. In this paper, by using the toolkit set the path Angle control nonlinear simulation platform, the convenience of the nonlinear simulation of the controller. Dead reckoning Angle nonlinear control simulation platform model is shown in Fig. 1.

The nonlinear simulation platform is mainly included aircraft nonlinear model and controller of two parts. Among them, the nonlinear model of aircraft based on the six degrees of freedom equation, using the actual aerodynamic data. As far as possible in order to reduce the horizontal course channels for vertical said influence, in the nonlinear simulation validation, given the rudder and aileron deflection degree as constant, try to keep the plane only motor of the longitudinal channel. Direction of snakes, aileron deflection degree is set to the height, speed and engine thrust balancing value of straight and level flight.

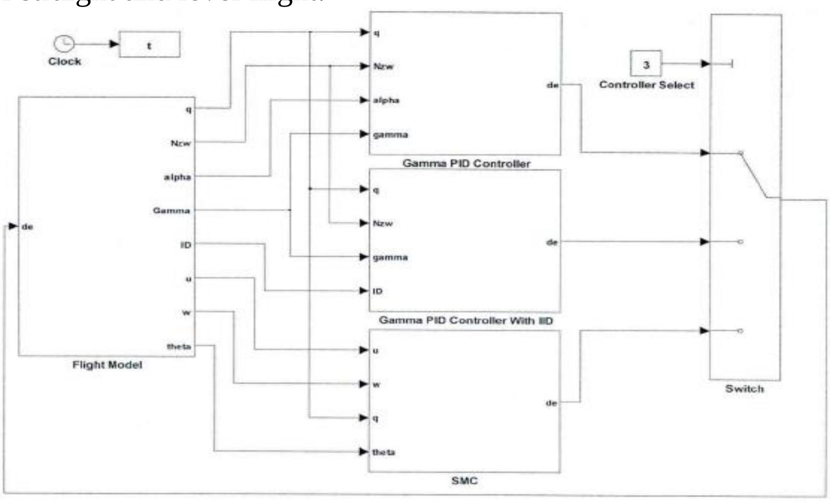

Figure 1. Track angle controller of nonlinear simulation diagram

The Controller is a Nonlinear Simulation

Conventional controller and based on the improved controller both has the very high similarity and comparability, and based on the sliding mode controller with the former two have bigger difference, and the use of the technology. In view of this, this topic in the controller of nonlinear simulation analysis, the main analysis of the conventional controller and based on the improvement of control performance difference of the controller, and analyzed the sliding mode controller of control performance.

The Controller Nonlinear Simulation Analysis. For linear design environment is using a high level, speed, and is in a state of straight and level flight, therefore, when the nonlinear simulation, set up the aircraft's initial state is respectively: axial velocity, lateral velocity, normal speed, roll Angle rate, rate of pitching Angle and yaw Angle rate, pitch Angle and roll Angle, yaw Angle, east to the position, north to the position and height. Conventional controller and the controller based nonlinear simulation environment each of time domain response as shown in Fig. 2 to Fig. 6.

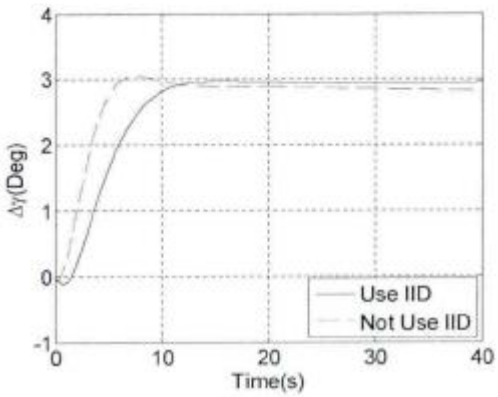

Figure 2. Track angle step response

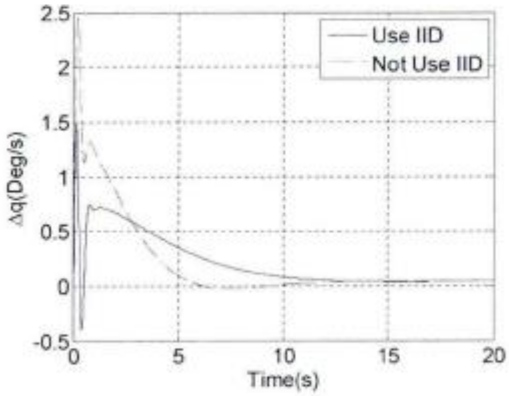

Figure 3. Pitching angle rate time response

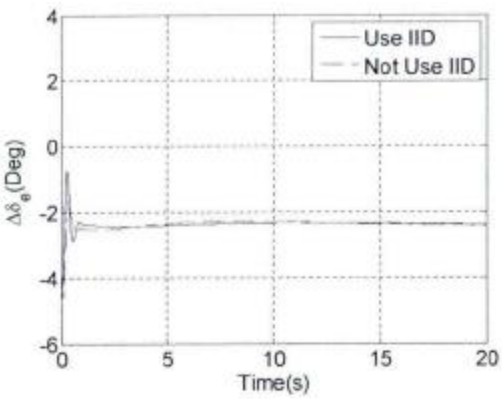

Figure 4. Lift snake of skewness

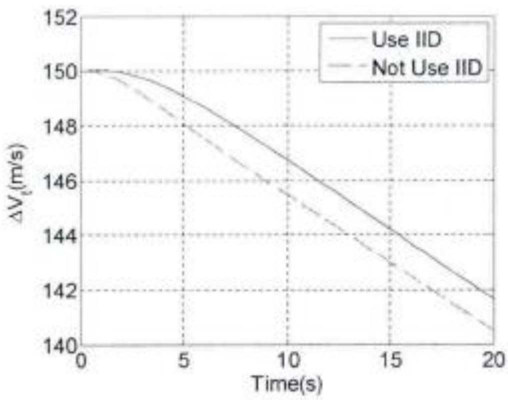

Figure 5. Fast time response

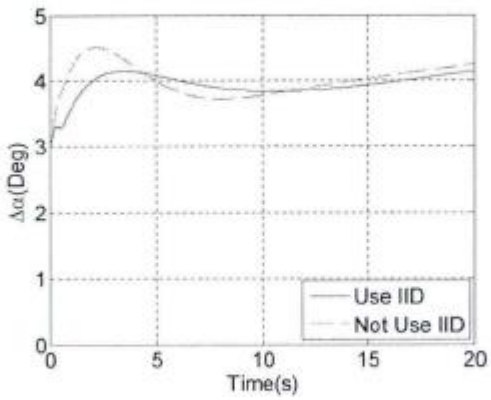

Figure 6. Angle of attack time response

As can be seen from the Fig. 2 to Fig. 6: under the environment of the linear design of the controller in nonlinear environment still has good control performance; With unstable internal mode control function of the PID controller the control performance is better than the conventional PID controller, the control process more smooth and better tracking accuracy and smaller overshoot. The consequences of rise time is relatively long some, but less than the second, in a reasonable range (less than the long period of time);Rudder is improved PID controller out smaller, the pitching Angle rate transition smoother, both the speed and Angle of attack at the same time the influence of the amount less.

Mode Controller IID and UDE Simulation Analysis Based on the Nonlinear Sliding. Initial state is set to the plane of the simulation are consistent with the PID controller simulation, at the same time adjust the following parameter values are: $\rho = 0.5$, $\nu = 0.1$, deadzone = [0.01, 0.01].The nonlinear sliding mode controller based on IID and UDE environment simulation results are shown in Fig. 7 to Fig. 8.

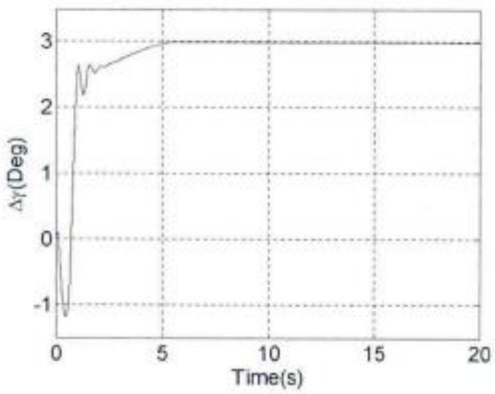

Figure 7. Track angle step response figure

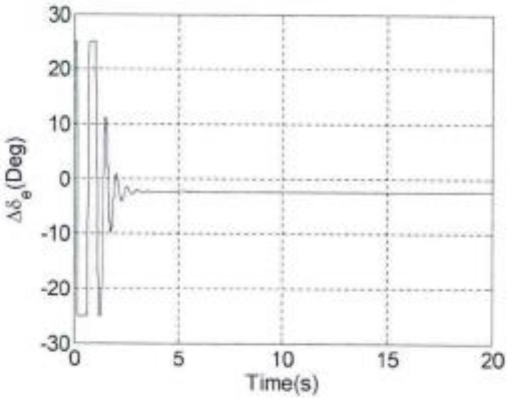

Figure 8. Elevator of skewness

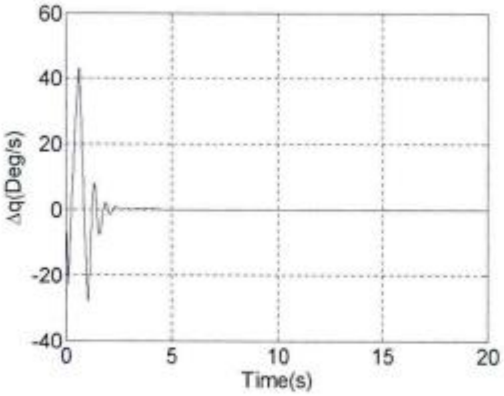

Figure 9. Pitching angle rate of time domain response

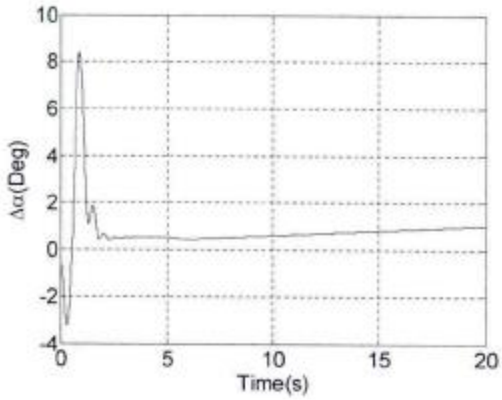

Figure 10. Angle of attack time response.

Quicker than the PID controller, the rise time is less than 5 seconds; Tracking precision is higher than improved PID controller, and at the same time pitching Angle rate and Angle of attack change also more intense, higher requirement for lifting the snake; Prefilter and dead zone and the application of saturation function, weaken the chattering of the system successfully. The use of dead zone link lowers the system's robustness and disturbance resistance, but the application of can make up for the effects of dead zone link. Linear environment simulation and nonlinear simulation results are in good similarity.

Summary

In linear environment design of the controller and its parameters in nonlinear environment also has good control performance; at the same time also show the correctness of the balancing point design and linearization. Under the environment of linear UDE effect is not obvious, but can be seen in the nonlinear environment UDE larger influence on sliding mode controller. In the linear model based on the design of PID controller based on IID under nonlinear model has good effectiveness, to solve the internal model and internal model ideal algorithm is not sensitive to balancing design point.

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