Fixed-time adaptive neural tracking control for a helicopter-like twin rotor MIMO system

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Abstract. In this paper, a fixed-time adaptive neural control (FTANC) for a helicopter-like Twin Rotor MIMO System (TRMS) is presented. The proposed controller has been developed to achieve finite-time convergence of the system dynamics independently of the initial conditions. The control of the TRMS system is a challenging problem due to the significant non-linearities and the cross-coupling between the main and tail rotors. In this study, we proposed an adaptive radial basis function neural networks (RBFNNs) to estimate all unknown nonlinear functions and disturbances. The RBFNN is combined with backsteeping technique to guarantee the trajectory tracking and the overall closed-loop stability. The effectiveness of the proposed control strategy is demonstrated through simulation tests in Matlab/Simulink software environment.

Introduction

The twin rotor MIMO system is an aerodynamic system similar to a helicopter flight. Its dynamic is highly nonlinear and unstable with a cross-coupled between the main and tail rotors. The TRMS has 2 DOF which can rotate in both vertical axes (yaw) and horizontal axes (pitch) [1]. So, it is a popular and challenging experimental platform for designing various control strategies. In the control literature, several controllers from linear to nonlinear and intelligent approaches have been developed to solve the TRMS stabilization problem and trajectory tracking, such as PID and LQR linear controllers, and feedback linearization, sliding mode and backstepping nonlinear control methods. In this paper, motivated by the control approach developed in [2], a fixed-time adaptive neural backstepping controller (FTANC) is designed to ensure both tracking performance and closed-loop stability of the TRMS system. The proposed controller can deal with the problems of parametric uncertainties, unknown nonlinear dynamic and disturbances. The convergence and stability of the fly system is ensured in finite time independently of the initial conditions.

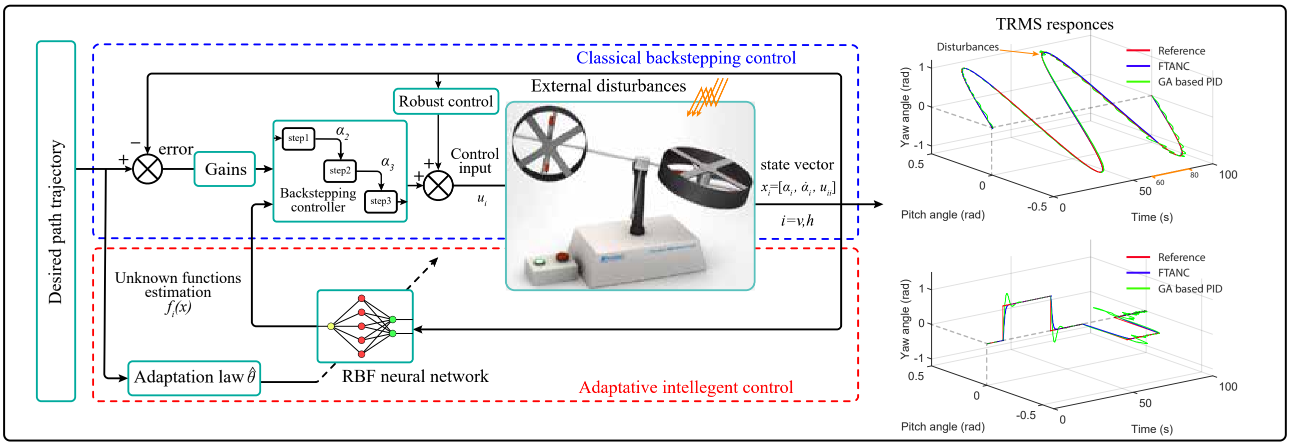

Figure 1: Block diagram of the proposed fixed-time adaptive neural control scheme for TRMS.

Fixed-time adaptive neural tracking control

In this approach, a radial basis function neural network (RBFNN) is combined with a backstepping control method to propose an intelligent adaptive control scheme for driving the TRMS. The RBFNN is introduced here to approximate all unknown nonlinear functions and disturbances, where the updating laws are derived using the rigorous Lyapunov proof. The proposed fixed-time controller has faster convergence and the upper bound of settling time can be estimated without any restriction on the initial conditions. The effectiveness and robustness of the proposed controller are demonstrated in a simulation environment. Our future research topics will aim to focus on the hardware implementation and the fault-tolerant control problem for the TRMS system.

References

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