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YAW CONTROL OF HELICOPTER: AN ADAPTIVE GUARANTEED COST CONTROL APPROACH

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Abstract. *This paper discusses the adaptive robust guaranteed cost tracking control problem of linear systems with time-varying uncertainties. The bounds of varying uncertainty ellipsoidal are obtained by set membership identification method. The proposed adaptive robust controller consists of a constant gain determined by the nominal system and a variable gain tuned by the designed adaptive laws. The application of this approach to the yaw control of a small-scale helicopter mounted on an experiment platform shows the effectiveness.*

Keywords: Helicopter, Guaranteed cost control, Robust control, Adaptive control

1. **Introduction.** Helicopter is a naturally unstable system with nonlinear dynamics [1,2]. The complicated dynamics of helicopter lead to both parametric and dynamic uncertainty, so the controller should be designed robust to those effects and advanced control strategies need to be used in order for a Rotorcraft-based Unmanned Aerial Vehicles (RUAV) to fly autonomously [3,4]. The system under study is a small-scale helicopter, which shares most of the properties of a real helicopter. The complicated dynamics of the small-scale helicopter, unmeasurable states, sensor and actuator noise, saturation, bandwidth limitations, friction and delays lead to both parametric and dynamic uncertainties.

Robustness of control systems to uncertainties has always been the central issue in feedback control and therefore for dynamical systems with uncertainties, a large number of robust controller design methods have been well studied. In particular, many robust controllers achieving some robust performances, such as H_∞ disturbance attenuation, guaranteed cost control method and so on have been presented in [5-13]. The guaranteed cost control approach has the advantage of providing an upper bound on a given performance index and thus the system performance degradation incurred by the uncertainties is guaranteed to be less than this bound. Based on this idea, many significant results have been proposed [10-13].

While a single controller with a fixed gain is considered, the resulting controllers designed by these methods inherently become conservative. On the other hand, adaptive control [14] has been long developed as controller design methodologies for system with uncertainties. The typical adaptive control scheme is the parameter adaptive control, in which unknown parameters are estimated explicitly, and control parameters are determined based on these estimates.

Recently, the author of this paper presented an adaptive robust H_∞ tracking control method for the helicopter control with time-invariant uncertainty [15]. Using adaptive method, a variable gain controller is designed to reduce conservatism inherent in fixed