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MODEL PREDICTIVE CONTROL FOR NONLINEAR SYSTEMS REPRESENTED BY A TAKAGI-SUGENO MODEL

Baocang Ding

College of Automation, Chongqing University, 400044, P. R. China

Corresponding author email:baocang.ding@gmail.com

Abstract. This paper deals with the model predictive control problem for nonlinear systems represented by a Takagi-Sugeno (T-S) fuzzy model. A control design based on a robust model predictive control algorithm for systems with polytopic description and nonquadratic stabilization techniques for the T-S fuzzy model will be presented. Our controller optimizes an infinite-horizon performance cost with input and state constraints. Infinite-horizon control moves are parameterized as a single free control move followed by a non-parallel distributed compensation law. Two simulation examples are given to demonstrate the effectiveness of the proposed techniques.

Keywords. Model predictive control; T-S fuzzy model; Non-parallel distributed compensation; Nonquadratic Lyapunov function; Linear matrix inequality.

1 Introduction

The importance of researches on the stabilization of constrained nonlinear systems has gained a widespread acceptance. For constrained systems, a well-known approach is model predictive control (MPC). Usually, MPC optimizes a performance cost under various constraints, so as to obtain a sequence of control moves. But only the most recent control move among this sequence is applied. MPC has been developed from the classical dynamic matrix control, generalized predictive control, etc., to algorithms with guaranteed stability [35]. In MPC studies, control of systems with bounded disturbance [3, 17], control of nonlinear systems [25, 26], control of hybrid systems [1, 4, 36] and explicit solution of MPC [16, 22] are among the hot topics. For nonlinear systems, a well-known approach is the fuzzy control based on Takagi-Sugeno model [37]. Rather than directly dealing with the nonlinearity, the T-S fuzzy method transforms the nonlinear model into a set of linear sub-models. The controller design and synthesis are simplified based on the linear sub-models, while the implementation of the controller clearly depends on the membership function accounting for the nonlinearity.

In MPC studies, real nonlinear systems are often approximated or included by the model of polytopic description; then the robust MPC problem