

Computational Stability Analysis of an Uncertain Bioreactor Model

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Abstract The computational stability analysis of a frequently used fermentation process model is reported in this paper. Linear fractional transformation (LFT) and computer algebra tools are used to transform the model into appropriate form. The Lyapunov function is searched in a general quadratic form composed of rational terms. The positivity of the Lyapunov function and the negativity of its derivative, respectively, are ensured through the solution of linear matrix inequalities (LMIs). The stability region is estimated by determining the level set of the Lyapunov function within a suitable convex domain. The stability analysis is performed for the controlled uncertain system with a linear proportional and integral substrate feedback considering different feedback gains. Computation results show that the studied simple linear feedback can guarantee stability in a wide neighborhood of the operating point.

1 Introduction

Approximating the domain of attraction is often a fundamental task in the analysis and control of nonlinear systems. The stability properties of dynamical systems are most often studied using Lyapunov functions. Therefore, an extensive literature exists on the computational construction of Lyapunov functions [2]. A fundamental result in this field is the existence of so-called maximal Lyapunov functions for a wide class of nonlinear systems and the

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