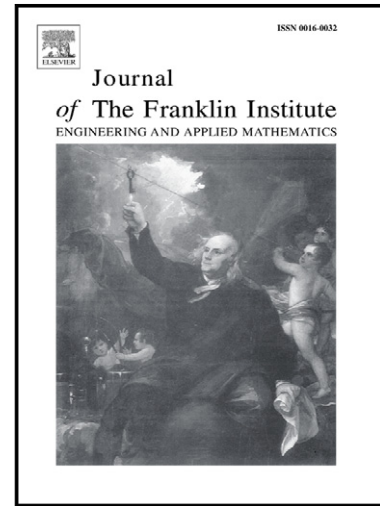


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Exponential synchronization of switched genetic oscillators with time-varying delays

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Abstract

This paper addresses the problem of exponential synchronization of switched genetic oscillators with time-varying delays. Switching parameters and three types of nonidentical time-varying delays, that is, the self-delay, the inter-cellular coupling delay, and the regulatory delay are taken into consideration in genetic oscillators. By utilizing the Kronecker product techniques and ‘delay-partition’ approach, a new Lyapunov-Krasovskii functional is proposed. Then, based on the average dwell time approach, Jensen’s integral inequality, and free-weighting matrix method, delay-dependent sufficient conditions are derived in terms of linear matrix inequalities (LMIs). These conditions guarantee the exponential synchronization of switched genetic oscillators with time-varying delays whose upper bounds of derivatives are known and unknown, respectively. A numerical example is presented to demonstrate the effectiveness of our results.

Keywords: Switched genetic oscillators, Exponential synchronization, Average dwell time, Time-varying delays.

1. Introduction

Over the past decades, genetic networks have received considerable attention due to their wide application in biological and biomedical sciences. Modeling genetic networks as dynamic systems has provided a powerful tool for elucidating genetic regulation process in living organisms. The existing genetic network models include Boolean models [1], differential equation models [2,3], Petri net models [4], and discrete-time piecewise affine model [5,6]. Among them, differential equation models are the most popular ones in which the state variables usually denote the concentrations of proteins, messenger ribonucleic acids (mRNAs) and other small molecules, and the regulatory functions are usually in Michaelis-Menten or Hill form [7-13].

The oscillatory behavior of genetic networks is a fundamental challenge in the research field of systems biology. There are two typical examples of genetic oscillators, that is, the cell cycle oscillators [14] and circadian clocks [15]. Understanding the molecular mechanisms of oscillations and their collective behaviors is important for clarifying the

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