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Control Design for Output Tracking of Delayed Boolean Control Networks[1]

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Abstract

This paper investigates the output tracking control of delayed Boolean control networks (DBCNs) by using the algebraic state space representation method. Firstly, the output tracking control problem of DBCNs is formulated, and the dynamics of DBCNs is converted into an equivalent algebraic form. Secondly, based on the algebraic form and controllability of DBCNs, a necessary and sufficient condition is presented for the output tracking control of DBCNs without state constraints. Thirdly, a necessary and sufficient condition is presented for the output tracking control of DBCNs with state constraints by constructing a constrained reachability matrix. The study of an illustrative example shows the effectiveness of the obtained new results.

Keywords: Boolean control network, Output tracking, Time delay, State constraints, Semi-tensor product of matrices.

1 Introduction

Recent years have witnessed the rapid development of systems biology and medical science. Especially, genetic regulatory networks have been paid a great deal of attention from biologists, physicists and cybernetician [5,8,23,25]. As an important model of genetic regulatory networks, Boolean control networks were firstly proposed by Kauffman in 1969 [10], and then were extensively studied by many scholars [1, 6, 9, 22]. The main feature of Boolean control networks is that all the state, input and output variables only take values from $\mathcal{D} := \{0, 1\}$.

It is noted that in the real genetic regulatory networks, due to slow biochemical reactions such as gene transcription and translation, time delay often occurs [7, 12, 20, 23–25]. Boolean control networks with time delay are called delayed Boolean control networks (DBCNs). The

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