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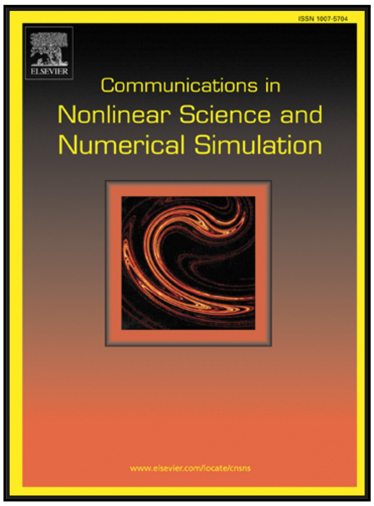


A novel stability criterion of the time-lag fractional-order gene regulatory network system for stability analysis

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# A novel stability criterion of the time-lag fractional-order gene regulatory network system for stability analysis

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**Abstract.** This paper presents a novel stability criterion of the time-lag fractional-order gene regulation network system(FGRNs) for stability analysis by means of Jensen inequality, Wirtinger inequality, fractional-order Lyapunov method and integral mean value theorem. The two inequalities are often seen, applied to the stability analysis of integer-order gene regulation network system, but rarely to that the FGRNs. However, this paper extends the general form of the Lyapunov-krasovskii function to a new fractional expression form by applying the definition of Caputo fractional derivative to the FGRNs. From the fractional-order Lyapunov method, the integral mean value theorem and the two inequalities, the novel stability criterion are deduced. It is the integral mean value theorem that reduces the conservatism of the stability criteria. Experiments show that the proposed criterion can satisfy all fractional-order operators from 0 to 1. It can not only solve the stability problem of the constant time-lag FGRNs, but also that of the time-varying time-lag FGRNs. Consequently, the novel stability criterion has generality and universality, which has been verified by numerical simulations for its effectiveness and generality.

**Keywords.** Fractional-order;Stability;Time-lag ;Gene regulatory network system.

## 1. Introduction

Recently fractional calculus (FC) has been an important part of mathematical analysis. Its applications have attracted considerable attention[1-5], because it can more accurately describe the actual dynamic characteristics of the physical system and provide wider stability region to the complex network. All this has increased the scope of the study and enhanced its accuracy. In fact, the traditional research of complex network system is only limited to integer order. However the fractional-order systems (FOs) are recognized to be an effective tool for modeling many physical processes[6], and the form of fractional differential equations can more intuitively and accurately represent the dynamic characteristics of complex network systems. Therefore, there have been more and more studies on FOs in recent years. Distinct phenomena are successfully modeled in the FOs perspective, such as earthquakes [7] , the Rayleighs piston [8] , stock markets [9] , pendula [10] , muscular blood vessels[11], electromagnetism[12] viscoelastic system[13], dielectric polarization[14], electrode-electrolyte polarization[15], electromagnetic waves[16], colored noise[17] and gene regulation network system[18]. Specifically, as the FC can describe memory and hereditary in different ways[19,20], the use of FOs gradually attracted people’s attention in the study of