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Stabilizaton of fractional discrete -time linear systems

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Abstract

In this article a new notion of the practical stability of fractional discrete-time linear systems is introduced. Necessary and sufficient conditions for this kind of systems are established. It is shown that the fractional systems are practically unstable if corresponding standard fractional systems are asymptotically unstable.

Keywords: practical stability, fractional, discrete-time, linear system
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1 Introduction

Development of models based on fractional-order differential systems has recently gained popularity in the investigation of dynamical systems [4-8]. Fractional derivatives provide an excellent instrument to describe memory and hereditary properties of various materials and processes. The advantages or the real objects of the fractional-order systems are that we have more degrees of freedom in the model and that a memory is included in the model (fractional-order systems have an unlimited memory).Recently, studying fractional-order systems has become an active research area. In this paper a new concept of the practical stability of fractional discrete-time linear systems will be introduced and necessary and sufficient conditions for the practical stability will be established. In this paper, we recall and present some stability results for linear fractional-order systems.

2 Preliminaries and definitions

2.1 Fractional-order derivatives

Definition 2.1. The disctere-time fractional derivative defined by Grunwald−Letnikov is

$$ {}_GD^{\alpha}x(t_k) = \lim_{\mathrm{h}\to 0} \frac{1}{h^{\alpha}} \sum_{i=0}^{k} (-1)^i \begin{pmatrix} \alpha \\ i \end{pmatrix} x(t_{k-i}) \tag{1} $$

where

$$ \begin{pmatrix} \alpha \\ i \end{pmatrix} = \frac{\Gamma(\alpha+1)}{\Gamma(\alpha+1-i)\times\Gamma(i+1)} \tag{2} $$

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