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THE STABILITY PROPERTIES OF THE ZEROS OF SAMPLED MODELS FOR TIME DELAY SYSTEMS IN FRACTIONAL ORDER HOLD CASE

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Abstract. This paper deals with the stability properties of the limiting zeros of sampled models for time delay systems. When the fractional-order hold (FROH) is used for signal reconstruction, the stability of the limiting zeros of sampled models for time delay systems is discussed and the conditions for obtaining stable zeros are given and proven. In addition, in the case of an approximate fractional-order hold (AFROH), an approximate implementation of the FROH that utilizes ZOH device, stability of the zeros is also discussed. It is shown that both of them can locate the zeros of sampled models for time delay systems inside the stable region and improve stability properties when ZOH cannot.

Keywords. Time delay systems, Zeros, Stability, Discrete-time systems, Fractional-order hold

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1 Introduction

Zeros play an important role in control system design. It is well known that unstable zeros limit the performance that can be achieved when controlling a system. Further, many techniques for design of adaptive control systems are based on the cancellation of the zeros. Such methods will not work when the system has unstable zeros [3, 4]. However, when a continuous-time system is discretized by a sampler and a hold circuit, the stability of the zeros is not necessarily preserved [2]. In the past years, for this reason the stability of zeros of the sampled system is studied by many researchers [2, 8, 9, 11, 15, 16, 18]. Because of its simplicity, most digital control systems use a zero-order hold (ZOH) and the studies on properties of zeros of the discretized system are mainly limited in the ZOH case. On the other hand, it is found that, compared with ZOH, the fractional-order hold (FROH) can improve stability of zeros of the sampled system [5, 6, 7, 13, 16]. Furthermore, the stability conditions of the limiting zeros have been given in the case of the FROH by Ishitobi [13].