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A DESIGN METHOD FOR 1-D IIR FILTERS WITH A NECESSARY AND SUFFICIENT STABILITY CRITERION

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Abstract. *In general, it is necessary to guarantee stability when designing of One-dimensional (1-D) infinite impulse response (IIR) filters. Methods for guaranteeing stability by using Rouché's theorem, the positive realness condition, or a method based on the positive realness have previously been proposed for defining the necessary iterative approximation algorithm. In these cases, the conventional stability criteria become the sufficient condition to guarantee stability. As a result, the stability domains obtained using these criteria are narrow and variable. In the present paper, we propose a design method of 1-D IIR filters, which applies a stability criterion based on the system matrix to the successive projection (SP) method. The stability criterion based on the system matrix in the proposed method becomes the necessary and sufficient condition for guaranteeing stability. Therefore, the stability domain does not depend on denominator polynomial coefficients, and the domain is not variable. Moreover, the stability domain is wider than that by the conventional stability criteria. As a result, 1-D IIR filters obtained using the proposed method have a smaller ripple than those from using conventional methods. In addition, the proposed design method realizes faster design times than those from using the conventional design methods.*

Keywords: IIR filter, Filter stability, System matrix, Successive projection method

1. **Introduction.** Recently, digital signal processing is in use in various various fields (e.g., information and communication, measurement and control, and medical fields) in [13-16]. In short, digital filters technology is important. One-dimensional (1-D) digital filters can be classified as finite impulse response (FIR) filters or infinite impulse response (IIR) filters. IIR filters can be implemented with less memory and with fewer computations per output sample than equivalent FIR filters. However, unlike FIR filters, the design problem for IIR filters is nonlinear because of the nonlinear interdependence of the filter coefficients and the frequency response. In addition, the stability of IIR filters must be guaranteed.

In the past decade, a number of methods for designing 1-D IIR filters using semidefinite programming (SDP), linear programming, least-squares, the p-th norm optimal method or the successive projection (SP) method have been proposed in [1-8]. SDP, linear programming, least-squares, and the p-th norm optimization method, all require large amounts of memory to solve the design problem. In contrast, using the SP method has the advantage that it uses less memory and the algorithm is a simple iterative approximation technique [5]. In the field of control regulation, there have been many stability-related studies in