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H_∞ NORM OF STATE-SPACE MODELS FOR 2-D DIGITAL FILTERS

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Abstract. In this work an efficient algorithm to calculate the H_∞ norm of two-dimensional (2-D) digital filters described by Roesser models is derived as an extension of the work in [3] by using a para-hermitian matrix function and level sets methods of maximum singular value of the transfer function, this method converges quadratically in a few steps towards the frequency ω_1 and ω_2. We present an illustrative examples in order to show the efficiency and the accuracy of our approach.

Keywords. 2-D digital Filters, Causal recursive separable denominator, Parahermitian function, Singular value, H_∞ norm.

AMS (MOS) subject classification: 94A12, 93A10, 46C15, 93B40, 93C05.

1 Introduction

Two-dimensional (2-D) digital filters have attracted considerable interest in many applications such as image processing, including image enhancement, restoration of linearly degraded images, detection patterns by matched filtering and edge extraction [12], among these systems, which are recursive filters, they have been a great importance due to their potential that requires less computation time and saves memory costs [12], [15]. There are several models in bi-dimensional (2D) that represent these systems like Attasi [1], Fornasini-Marchesini [9], and Roesser [20]. The analysis of a 2-D digital filter is very important throughout the literature, especially when this system can be separable in the denominator [12], [19], [17] and [22]. In control theory the H_∞ approaches is used to synthesize controllers to achieve stabilization with guaranteed performance. These tools have the advantage over classical control techniques in that H_∞ methods are readily applicable to problems involving multivariate systems. To use H_∞ methods, a control designer expresses the control problem as a mathematical optimization problem and then finds the controller that solves this optimization, thus the design of 2-D control systems is an interesting and challenging problem, and it received considerable attention [21], [18], and [7].

The H_∞ norm of a stable transfer function is appeared in [8] and [4]. There are different methods for calculating the H_∞-norm for the 1D system [4], [11], [5], and [10]. In this paper we propose a practical algorithm to compute the 2D separable recursive causality H_∞ norm in Roesser Models as an extension of the work in [3] using the concepts of parahermitian transfer functions [11] and level sets.