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Nonlinear Adaptive Filter Based on Pipelined Bilinear Function Link Neural Networks Architecture

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Abstract. In order to further enhance the computational efficiency and application scope of the bilinear functional links neural networks (BFLNN) filter, a pipelined BFLNN (PBFLNN) filter has been developed in this paper. The idea of the method is to divide the complex BFLNN structure into multiple simple BFLNN modules (with a smaller memory-length) and cascade connection in a pipelined fashion. Thanks to the simultaneous processing and the nested nonlinearity of the modules, the PBFLNN achieves a significant improvement in computation without degrading its performance. The simulation results have demonstrated the effectiveness of the proposed method and the potentials of the PBFLNN filter in many different applications.

Keywords: Pipelined · Generalized FLNN · Nonlinear adaptive filtering

1 Introduction

Many practical systems (such as system identification, signal prediction, channel equalization, and echo and noise cancelation,…) may contain nonlinearity. The linear adaptation technique cannot model well enough because of the nonlinear nature of these systems [1]. To overcome this problem, many new classes of nonlinear filters are based on neural networks (NNs) and truncated Volterra series (VFs) has been developed [1, 2]. However, they also reveal many disadvantages such as complex architecture and heavy computing burden in their implementation [3, 4].

It is well known that the FLNN has been proposed to replace the multilayer artificial neural network (MLANN) in some simple nonlinear applications because it has a single layer structure, low computational complexity, and the simple learning rule [4]. It has been successfully applied in other areas of nonlinear filtering including nonlinear dynamic systems identification, channel equalization, active noise control, nonlinear acoustic echo cancellation [4–8]. However, the performance of the FLNN-based model may be significantly impaired when faced with systems containing strong nonlinear distortion. As pointed out in [9], the main reason may be that the basic functions of FLNN lack the cross-terms (for example $x(n) * x(n-1)$, $x(n-1) * x(n-2), \ldots$. To mitigate this disadvantage, some studies have added appropriate cross-terms into the conventional FLNN structure [9, 10]. Research results

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