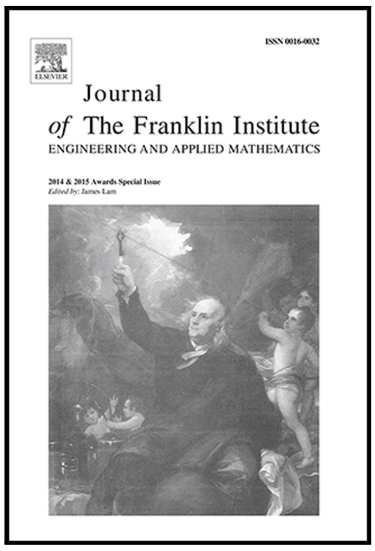

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Kernel Recursive Generalized Mixed Norm Algorithm

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Abstract: This work studies the problem of kernel adaptive filtering (KAF) for nonlinear signal processing under non-Gaussian noise environments. A new KAF algorithm, called kernel recursive generalized mixed norm (KRGMN), is derived by minimizing the generalized mixed norm (GMN) cost instead of the well-known mean square error (MSE). A single error norm such as l_p error norm can be used as a cost function in KAF to deal with non-Gaussian noises but it may exhibit slow convergence speed and poor misadjustments in some situations. To improve the convergence performance, the GMN cost is formed as a convex mixture of l_p and l_q norms to increase the convergence rate and substantially reduce the steady-state errors. The proposed KRGMN algorithm can solve efficiently the problems such as nonlinear channel equalization and system identification in non-Gaussian noises. Simulation results confirm the desirable performance of the new algorithm.

Keywords: Kernel adaptive filtering, generalized mixed norm, recursive algorithm, non-Gaussian noise.

1 INTRODUCTION

Kernel adaptive filtering (KAF) [1] algorithms have shown to be effective in nonlinear signal processing, such as chaotic time series prediction, nonlinear system identification, nonlinear channel equalization and so on, because they can continually approximate the desired nonlinear function and are particularly applicable to cases where data arrive sequentially. Most of the KAF algorithms search the optimal solution by minimizing the mean square error (MSE), which in general perform well in Gaussian noise environments. The kernel recursive least squares (KRLS) [2] and kernel least mean square (KLMS) [3] and their variations [4-19] are typical examples of such KAF algorithms. However, these algorithms may perform very poorly in non-Gaussian noise environments because they capture merely the second-order statistics of the error signal [20-21].

Selection of a proper cost function (usually a statistical measure of the errors) beyond the second-order statistics is very important for adaptive filtering with non-Gaussian noises [22-26]. The least mean p-power (LMP) [27-30] error criterion is very efficient for non-Gaussian adaptive filtering. With LMP only a single error norm is used as the cost function for adaptive filtering, which may still suffer from bad convergence performance such as the family of least mean fourth (LMF) [31-33] algorithms because their convergence properties may be sensitive to the proximity of the adaptive weights to the optimum wiener solution [34]. To tackle this problem, convex combination of different norms was proposed to develop new KAF algorithms recently, such as the kernel least mean mixed-norm (KLMMN) [35-37] and kernel robust mixed norm (KRMN) [38]. The KLMMN combines the benefits of the well-established LMS and LMF algorithms in kernel space motivated by the idea of the least mean mixed-norm (LMMN) algorithm [34, 39-40].