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ADAPTIVE FILTERING WITH ADAPTIVE p-POWER ERROR CRITERION

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Abstract. *In a previous paper, we have proposed a novel approach to choose an optimal p-power error criterion for adaptive filtering, by minimizing a Kullback-Leibler information divergence (KL-divergence). However, the method requires exact knowledge of the noise PDF, which reduces its practicality since in real life scenario the noise distribution is usually unknown. In the present paper, we propose a more practicable method, in which the optimal p value is approximately determined by using the error samples on-line, without resorting to a priori knowledge of the noise. The mean-square convergence of the proposed algorithm is studied, and an upper bound of the step-size is derived. Monte Carlo simulation results confirm the effectiveness and superiority of the new method.*
Keywords: Adaptive filtering, p-power error criterion, Generalized Gaussian density

1. **Introduction.** Adaptive filtering has been receiving a great deal of attentions in the area of communication, radar, sonar, navigation, biomedical electronics and control systems [1, 2, 3, 4, 5, 6]. In traditional adaptive filtering theory, for reasons of mathematic convenience, the minimum mean square error (MSE) criterion and corresponding least mean square (LMS) algorithm are widely used [1]. The MSE criterion makes sense in the linear signal processing with Gaussian assumption, because it only takes into account the second-order statistics. However, in most practical situations, the system will be non-linear and non-Gaussian; in these cases, the MSE criterion fails to extract all the information in the error signals, hence, its performance will degrade. In order to take into account higher-order (or lower-order) statistics, many non-MSE error criteria have been studied, including the least mean fourth (LMF) error criterion [7], least mean p-power (LMP) error criterion [8], fractional lower-order moments (FLOM) error criterion [9], least mean mixed-norm (LMMN) error criterion [10], general error criterion [11, 12] and many others [13, 14, 15, 16, 17].

For adaptive filtering, there are many choices of adaptation criterion, and it is an interesting research topic on how to choose a suitable error criterion to improve the performance (e.g., convergence speed, steady-state misadjustment, etc.). In [7], Walach and Widrow proposed a method to select an optimum error criterion from the LMF family criteria. In their approach, the optimum choice is determined by minimizing a cost function which depends on the moments of the interfering noise. In [11], Douglas and Meng utilized the calculus of variations method to derive the optimum error criterion among a large family of general error criteria. In [12], Al-Naffouri and Sayed optimized the error nonlinearity (and hence the error criterion) by minimizing the steady-state excess mean-square error (EMSE). More recently, we propose an information theoretic approach for the choice of p-power error criterion, in which the optimum value is determined by