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AN ALGORITHM FOR LINEARLY CONSTRAINED ADAPTIVE FILTERING OF NONSTATIONARY SIGNALS

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A new multichannel RLS-algorithm of adaptive filtering with a sliding window and linear constraints is considered. The algorithm is based on the inverse QR-decomposition of the matrix of input signals of an adaptive filter. A peculiar feature of the algorithm is absence of square root operations in it. The algorithm's effectiveness is demonstrated by simulation. The simulation concerns a problem of identification of a three-channel linear adaptive filter, whose input signals represent speech signals. The ERLE parameter value obtained by the new algorithm for this problem is roughly by 20 dB larger compared to the linearly constrained RLS-algorithm with an infinite window.

At the present time the recursive algorithms using the least squares criterion (Recursive Least Squares — RLS) are the most effective algorithms of adaptive signal processing [1]. Adaptive filters based on RLS-algorithms with an exponentially weighted growing window (so called "prewindowed" — PW) are frequent in applications to nonstationary signals. However, processing of such signals can be performed more effectively with the aid of RLS-algorithms with a sliding window (SW).

Most adaptive filtration algorithms are based on the methods of unconstrained optimization. Nevertheless, in a number of cases, when dealing with adaptive filtering problems, methods of constrained optimization must be used. For the first time the constrained optimization was applied to adaptive processing of signals in the problems of antenna array control [2]. Single-channel linearly constrained (LC) PW RLS-algorithms were considered in [3], while multichannel LC SW RLS-algorithms — by the author in [7].

A number of RLS-algorithms for adaptive filtering are based on the lemma of matrix inversion [1]. They may also comprise Holetsky's factorization (QR-decomposition) of the matrix of input signals of an adaptive filter [1]. In order to obtain the weight coefficients for linearly constrained adaptive filtering in RLS-algorithms based on the direct QR-decomposition, one has to use inverse substitutions demanding additional computational expenditures. On the other hand, the PW RLS-algorithm [4] based on the inverse QR-decomposition makes it possible to calculate adaptive filter's weight coefficients without inverse substitutions.

A disadvantage of QR RLS-algorithms is that they cannot do without taking the square root. The adaptive algorithms with a sliding window require $2N$ such operations per iteration. Improvement of computational efficiency of RLS-algorithms based on direct QR-decomposition can be achieved by applying some techniques making it possible to avoid root extraction [5]. A similar approach may be used in RLS-algorithms based on the inverse QR-decomposition.

The purpose of this work is presentation of a new LC SW RLS-algorithm of adaptive filtering based on the inverse QR-decomposition. The algorithm does not include operations of square root extraction. The paper also contains some recommendations on how to improve the quality of this algorithm with the aid of dynamic regularization [6]. The efficiency of this technique in RLS-algorithms has been already demonstrated in other works [7].

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