Array square-root approach for the maximum likelihood estimation via adaptive Kalman filtering methods

M. V. Kulikova
CEMAT (Centro de Matemática e Aplicações)
Instituto Superior Técnico, TU Lisbon
Av. Rovisco Pais 1, 1049-001 Lisboa, Portugal
Kulikova.Maria@yahoo.com

The maximum likelihood technique for identification of linear discrete-time stochastic systems incorporates optimization algorithms that may require calculation of the log likelihood gradient (known as a "score") and the Fisher information matrix (FIM). The gradient evaluation demands the determination of the sensitivities of the system state to unknown parameters. It leads to implementation of roughly $p+1$ equivalent Kalman filters (KFs), where p is the dimension of the unknown system parameter vector.

Algorithms for the score and FIM calculation could be described and derived more compactly and simply by recasting the filtering problem in the so-called *array form*. Such algorithms do not propagate the Riccati recursion directly and, hence, are often much simpler to describe and implement (in software and hardware) than explicit sets of equations. They are becoming the method of choice in many applications.

Having been inspired by these and related problems, we construct a new square-root algorithm for the log-likelihood gradient evaluation. This avoids the use of the conventional KF with its inherent numerical instabilities and improves the robustness of computations against roundoff errors. Apart from the numerical advantages, the convenient array form allows for effective calculation method where the required "bank" of the filters is replaced by an augmented array to which the orthogonal transformations are applied.