Abstract

High signal to quantization noise ratio over a reasonably large dynamic range is an important desirable feature for digital signal processing systems in several application areas. The block floating point (BFP) data format is a viable alternative to the floating point concept for achieving this, requiring much less processing time than the latter at a moderately low processor complexity and cost. Under this scheme, the incoming data is partitioned into non-overlapping blocks and based on the data sample with the highest magnitude in each block, a common exponent is assigned for the block. This permits an overall floating point like representation of the data, with fixed point like computation within every block. The advantages provided by the BFP format, namely, a wide dynamic range like the floating point scheme with temporal and processor complexity, power requirement and cost comparable to that of fixed point based processing, have prompted its usage in efficient implementation of many signal processing algorithms, like state space digital filters, direct form digital filters, distributed digital filters, fast Fourier transform, fast Hartley transform etc. Some studies have also been made to investigate the associated numerical error behavior. However, to the best of our knowledge, no effort has so far been made to extend the BFP treatment to adaptive filters which present more complex structures including error feedback. A BFP treatment to adaptive filters faces certain difficulties, not encountered in the fixed coefficient case, namely, (a) unlike a fixed coefficient filter, the filter coefficients in an adaptive filter can *not* be represented in the simpler fixed point form, as the coefficients in effect evolve from the data by a time update relation, and (b) the two principal operations in an adaptive filter – filtering and weight updating, are mutually coupled, thus requiring an appropriate arrangement for joint prevention of overflow.

In this thesis, we develop appropriate BFP treatments to a class of adaptive filters belonging to the stochastic gradient family. Towards this, both the transversal and the lattice counterparts are considered. First, a suitable BFP scheme is proposed

for efficient realization of the least mean square (LMS) algorithm. The approach adopted is, however, sufficiently general, making it possible to extend it to other variants of the LMS family. Finite wordlength effects for this scheme are then studied by carrying out a steady state roundoff error analysis with the help of an appropriate BFP roundoff error model. A similar BFP treatment to implement the gradient adaptive lattice (GAL) algorithm efficiently is proposed next, where, as before, a major consideration has been to keep the realization sufficiently general. Like its transversal counterpart, a roundoff error investigation of the proposed BFP-GAL algorithm is also carried out. Finally, the general approach of the BFP-LMS realization scheme is extended to implement two useful variants of the LMS family, namely, the normalized LMS algorithm and the sign LMS algorithm. The thesis is concluded by identifying several possibilities of future research in this and related areas.