Abstract

Often the adaptive decision feedback equalizer (ADFE) is required to process signals that vary rapidly over a wide range due to effects like fading. The floating point (FP) system is the ideal data format to represent such input, but its accompanying high processing complexity and cost render its usage rather restrictive. The block floating point (BFP) data format ia a viable alternative for the realization of such systems, requiring much less processing time than the FP based realization 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 overall FP like representation of the data, with fixed point like computation within every block.

In this thesis, we first develop appropriate BFP treatment to an LMS-based ADFE. The proposed scheme adopts appropriate BFP format for the data as well as the filter weights and works out separate update relations for the filter weight mantissas and exponents. Both the feed forward and the feedback filter input are block formatted using an efficient block formatting algorithm which also employs dynamic scaling of the data to prevent overflow at the two filter output. Prevention of overflow in filter weight updating results in two upper bounds for the algorithm step size μ, coming respectively from the feed forward filter and the feedback filter considerations. The two bounds are related by a simple constant and the lesser of them is used as an upper limit of μ. Next, we extended the philosophy of the LMS based BFP-ADFE to all the three versions of signed LMS based ADFEs, which are computationally superior having multiplier free weight update loops. Such extensions require special adjustments like scaled format for the step size, with time varying mantissa and exponents and new upper bounds for the step size. Separately, as a framework for developing a BFP based block ADFE, we extended the BFP treatment to efficient realization of the Block LMS (BLMS) algorithm. The advantage of the BLMS algorithm lies in its realizability using FFT, leading to the so-called fast BLMS (FBLMS) algorithm. In this thesis, we have presented a BFP-based FBLMS algorithm, by appropriate modifications in the conventional FBLMS algorithm, to obtain the output and filter coefficient mantissas. Lastly, we combined the proposed BFP-ADFE and BFP-BLMS approaches to realize a Block ADFE in BFP format, which first uses an iterative scheme to evaluate a block of unknown decisions. FFT based block processing is then used on the received input block and the decision block to carry out the block ADFE operation. The proposed schemes deploy mostly simple, fixed point operations and are shown to achieve considerable computational gain over the floating point based realization.

Index Terms - Adaptive decision feedback equalizer (ADFE), Block ADFE, Block floating point, Block formatting algorithm, Block LMS algorithm, Block processing, Fast Block LMS algorithm, Frequency domain equalization, Overflow.