

On recursive computation of the convolution of an image with a two-dimensional inseparable FIR filter

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Abstract:

The paper proposes a method for constructing an algorithm for the recursive calculation of the convolution of an image and a two-dimensional filter with an inseparable finite impulse response (FIR). This method is based on the representation of the final impulse response of the filter through vertical and horizontal recurrence relations. Each of the recurrence relations leads to a semi-recursive procedure for calculating the convolution of the image and the two-dimensional FIR filter. In turn, each of these semi-recursive procedures consists of two parts. The first part of the procedure is a recursive relation designed to recalculate the values in the procedure, and the second part is the non-recursive calculation of convolutions at the boundaries of the impulse response. In order to move from the developed semi-recursive procedure to a completely recursive algorithm for computing the desired convolution, a special statement is proved in the paper. This statement shows that if the impulse response of the target filter satisfies the recurrence relations both vertically and horizontally, then all the additional impulse responses involved in the calculation of convolutions at the borders of the FIR filter correspond to the same recurrence relations. This statement allows to modify the resulting procedure into a fully recursive algorithm for calculating the convolution of the image and the two-dimensional inseparable FIR filter. The paper also provides estimates of the computational complexity of the proposed recursive algorithm, shown by the number of arithmetic operations.

Keywords: FIR filter, inseparable finite impulse response, recurrence relations, recursive algorithm

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