Study of the Dependence of Image Compression Efficiency on the Choice of Wavelet Filter Type

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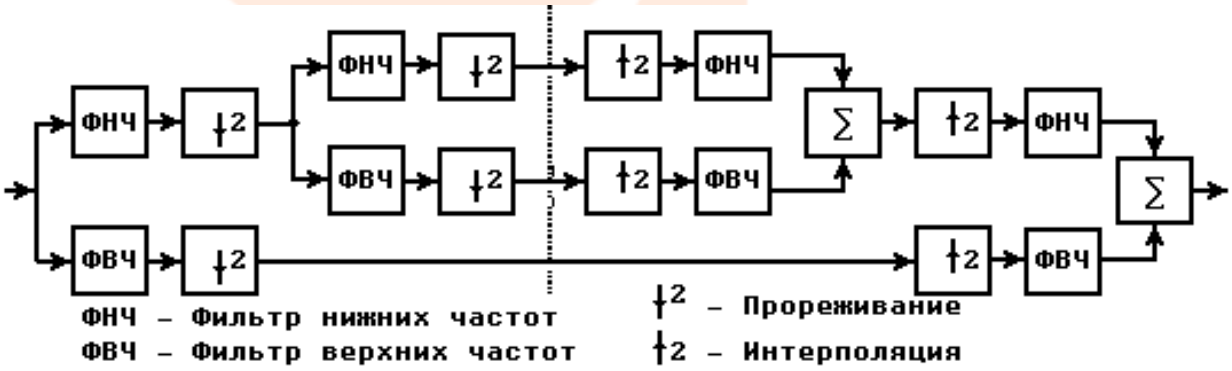
Currently, methods of image compression based on wavelet transforms, introduced by Grossman and Morlet in the mid-80s of the last century, are becoming increasingly widespread. The main disadvantage of Fourier transforms and DCT in particular is that their harmonic basis functions work poorly with non-periodic signals, as a result of which some useful information is irretrievably lost. As a result, with high compression ratios, images acquire a mosaic appearance, greatly deteriorating their quality.

The wavelet transform is based on the use of non-harmonic (spike-like) functions, shown in Pic. 1.

Pic. 1. The most common wavelet functions.

Currently, there are many wavelet functions that differ in properties and areas of application. Some of them are actively used for image processing, among which are the **Cohen-Daubechies-Fauveau wavelet functions (CDF22, CDF24, CDF97), Villasenor -V610, Koifman-BCW3, TS2/6, MIT97, Dobeshi7/10, etc.** When processing images, wavelet transforms are a set of high-pass and low-pass filters (Pic. 2) through which an array of image data is passed. In this case, a thinning operation is introduced that removes every second sample from the array, since if the signal value at some point in time and its derivative are known, then the signal value at the next point in time can be calculated.

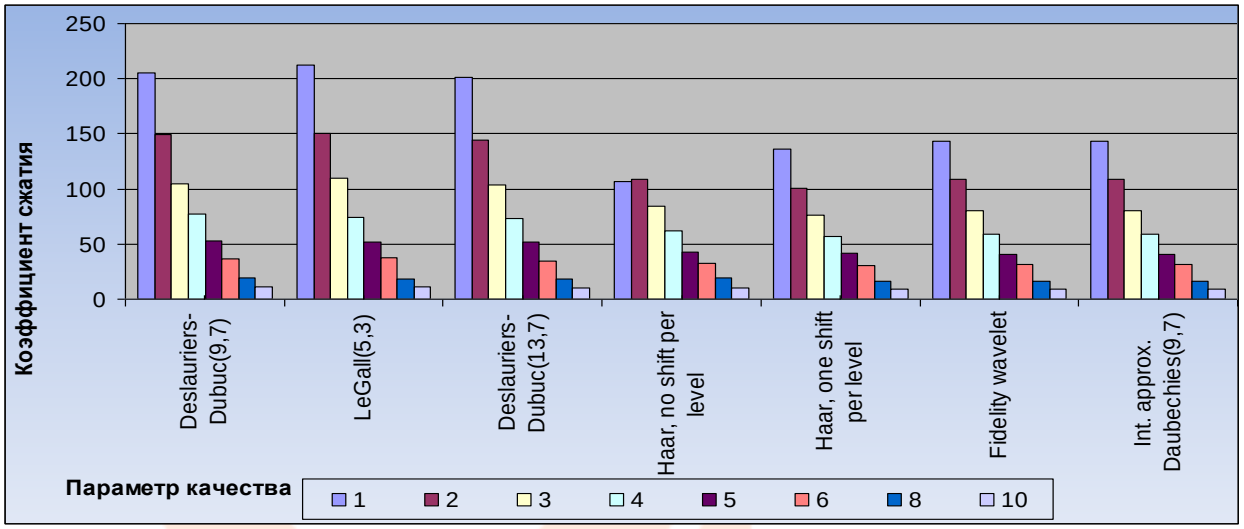


Pic. 2. Generalized structural diagram of the wavelet transform.

Since the compression parameters and quality characteristics of images strongly depend on both the structure of the processed image and the type of wavelet filter used, an experimental study of the efficiency of various wavelets was conducted when processing 4 test images of different formats and genres (Fig. 3). The following wavelet filters were studied: Deslauriers-Dubuc (9.7), LeGall (5.3), Deslauriers-Dubuc (13.7), Haar, no shift per level, Haar, one shift per level, Fidelity wavelet, Int. approx, Daubechies (9.7), used in the DIRAK video codec.

Pic.3. Types of test images

During the research, each image was processed by 7 wavelet filters with different quality parameters and the number of wavelet decompositions. Based on the experimental data of the "Airplane" image, histograms were constructed (Fig. 4), showing the distribution of the codec compression coefficients at different quality parameters.



Pic.4. Comparative results of compression of the test image “Airplane” using different wavelet filters.

As can be seen from the histograms provided, the filters based on the LeGall(5.3), Deslauriers-Dubuc(9.7) and Deslauriers-Dubuc(13.7) wavelets have the highest image compression efficiency.

The report materials provide more detailed research results with demonstration photographs of large graphic materials.