Fast Color Wavelet–Haar–Prometheus Transforms For Image Processing

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Fourier analysis based on orthogonal and unitary transforms plays an important role in digital image processing. Transforms, notably the classical discrete Fourier transform (DFT), are extensively used in digital image filtering and in power spectrum estimation. Other Fourier transforms – e.g. the discrete cosine/sine transforms (DCT/DST), wavelet transforms – are frequently employed in digital image compression. All the above–mentioned transforms are used in single–channel digital image processing. However, in recent years an increasing interest in multichannel (color, multicolor) processing has been observed. In the case of digital image processing, this interest expresses the current need for processing, analysis, and compression of both color images and multicolored satellite images. The main tendency in this area was to decorrelate the color image channels and then to apply single channel techniques for color image coding. Our approach to color (multicolor) image processing is to use so–called color triplet numbers for color images (or hypercomplex numbers for multicolor images) and to operate directly on three–channel (RGB–valued) images as on single–channel triplet–valued images. In the classical approach every color is associated to a point of the 3D color RGB vector space. In our approach, each image color pixel is considered not as a 3D RGB vector but as a triplet (color) number, and RGB color space is identified with the so–called triplet (color) algebra. Note that both these suppositions are only hypotheses. We have no biological evidence in the form of experiments that would verify that the brain actually uses any of the algebraic properties coming from the structures of vector spaces or the triplet algebra.

A natural question that arises in our approach is the definition of color (RGB–channel) transforms that can be used efficiently in edge detection and digital image compression applications. So–called orthounitary (triplet–valued or color–valued) Fourier transforms are introduced and are used for color (multichannel) image processing. These transforms are similar to fast orthogonal and unitary transforms. Therefore, fast algorithms for their computation can be easily constructed. Simulations on the use of color transforms on color image compression have also been performed. The main contributions of this paper are the definition and analysis of the properties of orthounitary (color) Fourier transforms (in particular, color Wavelet–Haar–Prometheus transforms) and to show that the triplet (color) algebra can be used to solve color image processing problems in a natural and effective manner.

The paper contains the definition of the triplet (color) algebra and the description of a wide family of color Fourier transforms and color Wavelet–Haar–like transforms. Simulations and discussion on the use of these transforms in color image compression and color edge detection are presented too.