

CONTENT-BASED IMAGE QUERYING WITH COMPLEX WAVELETS: THE COMPLEX DISCRETE WAVELET TRANSFORM*

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Abstract

Introduction to the complex discrete wavelet transform and its properties that make it an appropriate transform for the image querying.

Because of its desirable multiresolution properties, the two-dimensional wavelet transform happens to be highly applicable to many areas, very notably to the field of image processing. However, its lack of shift-invariance tends to be a major inconvenience, and a transform that provides multiresolution as well as shift-invariance would be highly useful almost everywhere wavelets are used. Complex wavelets are an answer to this problem, and a solid mathematical foundation that allowed practical use of complex wavelets in image processing was originally set up in 1997 by Nick Kingsbury of Cambridge University.

The complex two-dimensional wavelet transform provides all of the advantages that the separable discrete wavelet transform provides – multiresolution, sparse representation, and useful characterization of the structure of an image. What makes the complex wavelet basis exceptionally useful for our purposes is that it provides a high degree of shift-invariance in its magnitude. A drawback to this transform is that it is four-times redundant. That is, if you have an original $N \times N$ image, and take the DWT, you get back $N \times N$ numbers, whereas using the CDWT, you get back $4 N \times N$ numbers. So, for the price of four-times redundancy, you get a high degree of shift-invariance in magnitude – which seems like a reasonable tradeoff for applications that need a shift-invariant, multiresolution transform.

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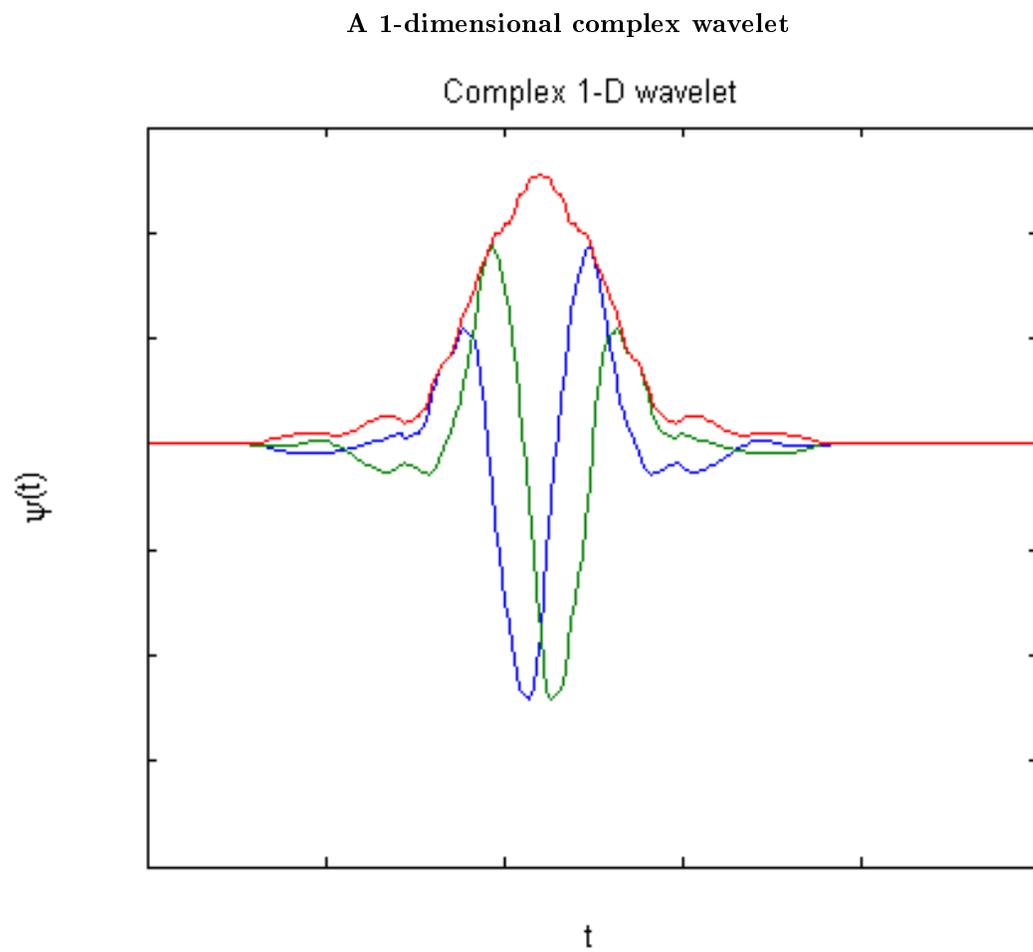


Figure 1: Figure generated using Ivan Selesnick's code.
