Image Processing by Directional Tensor Product Complex Tight Framelets

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Framelets with directionality are of interest in both theory and application for high dimensional problems. Though it is well known that tensor product real-valued wavelets or framelets can only handle directional singularities along coordinate axes, we show that directionality can be significantly improved by using tensor product complex tight framelets. We introduce a family of bandlimited directional tensor product complex tight framelets TPCTF_m with $m \geq 3$ and show their impressive performance for image/video denoising/inpainting over many other known transform-based methods such as dual tree complex wavelet transform, curvelets, shearlets, and compactly supported tensor product real-valued tight framelets, etc. These TPCTF_m take advantages and retain desirable properties of both classic wavelets/framelets and discrete cosine transform, which are widely used in applications. Though the redundancy rates of such TPCTF_m are not very high, we can further significantly reduce the redundancy rates of such TPCTF_m (but without scarifying their performance in image processing) so that they can be efficiently applied to problems in three and higher dimensions. Moreover, we can construct compactly supported directional tensor product complex tight framelets with finitely supported filter banks. The properties of compact support and tensor product transform make them computationally attractive for many multidimensional problems. This talk is based on several joint papers collaborating with Qun Mo, Yi Shen, Zhenpeng Zhao, and Xiaosheng Zhuang.