Sparse Geometrical Representations with Bandelets

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Abstract

Finding sparse representations is at the core of signal processing for applications such as compression, estimation and inverse problems. For images, representations in wavelet bases are sub-optimal because they do not take advantage of existing geometrical regularities. Integrating geometry in harmonic analysis representations can potentially improve most image processing algorithms. After reviewing existing approaches, we introduce bandelet orthogonal bases whose vectors are adapted to follow the geometrical regularity of images. It is shown that the approximation error of piece-wise regular images in a bandelet basis has an optimal decay rate. This result is illustrated by applications to noise removal with thresholding estimators and to image compression.

Biosketch: Stephane Mallat was born in Paris, France. He graduated from Ecole Polytechnique in 1984 and from Ecole Nationale Superieure des Telecommunications, Paris, in 1985. He received the Ph.D. degree in electrical engineering from the University of Pennsylvania, Philadelphia, in 1988. In 1988, he joined the Computer Science Department of the Courant Institue of Mathematical Sciences at New York University, and became Associate Professor in 1993. In the fall 1994, he was a visiting Professor in the Electrical Engineering Department at MIT and in the spring 1994 in the Applied Mathematics Department at the University of Tel Aviv. Since 1995, he has been a Professor in the Applied Mathematics Department at Ecole Polytechnique, Paris. His research interests include computer vision, signal processing and diverse applications of wavelet transforms. He is the author of a recent book A Wavelet Tour of Signal Processing, Academic Press, 1998. Dr. Mallat received the 1990 IEEE Signal Processing Society's paper award, the 1993 Alfred Sloan fellowship in Mathematics, the 1997 Outstanding Achievement Award from the SPIE Optical Engineering Society, and the 1997 Blaise Pascal Prize in applied mathematics, from the French Academy of Sciences.