Abstract

This dissertation deals with the choice of wavelet basis functions for image processing. These can be characterized by several properties: null moments, regularity, smoothness, etc. Naturally the efficiency of an image processing pipeline is dependent on the particular choice of the wavelet base. Up to now, there is no definite answer for the question of which wavelet is the best for a given task. In this work, we present a new property to classify wavelets taking into account the bi-dimensional properties of filters in a better way than before. Using the intuitive requirement that the overall procedure should be rotationally invariant, we study the sensitivity of the filters to rotation.

We then develop a precise way to measure the degree of invariance to rotation using the fact that image processing filters are generally separable. We have also constructed new wavelets, both orthonormal and biorthogonal, to optimize the so-called "sphericity". Since each wavelet is defined by a pair of filters, it has two sphericity measures. Thus the optimal solutions appear as a Pareto front. The newly built wavelets outperform existing ones with respect to sphericity.

To assess the usefulness of sphericity as a classifying criterion, two applications are used as benchmarks: the detection of pointwise singularities and the compression of images. The detection of singularities is done first on synthetic backgrounds and then on real mammographic images. To test the compression of images, a commonly used set of images (BragZone) is chosen along with X-Ray images. On both tasks, the sphericity proved to be very effective.