Applications of wavelets and multiwavelets to signal and image processing

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Wavelet and, more recently, multiwavelet analyses [4] have revealed to be powerful tools for typical problems in signal and image processing, such as compression and detection of fundamental characteristics.
In this work we present some developments and applications of these techniques. In particular:

- A study of multiwavelets in the context of signal analysis [3]. A method for the construction of semi-orthogonal multiwavelets is presented in the algebraic framework of recursive matrices [1]. The problem of prefiltering of the data, which is crucial in a multiwavelet setting, is explored, by means of several examples, which show the strong dependance of the prefilter on the chosen multiwavelet basis. Criteria for the choice of good prefilters are given, which take into account their effectiveness in the problem of signal compression.

- An applications of multiwavelets to image compression [2]. For evaluating the effectiveness of bi-dimensional multiwavelet transform for coding images at low bit-rates, an efficient embedded coding of multiwavelet coefficients has been realized. The performance of this multiwavelet-based coder is compared with the results obtained for scalar wavelets.

- An application of a particular class of multiwavelets for the characterization of curves associated to cellular profiles, obtained from electronic microscope images. The goal is a method for the assessment of their form descriptors [5]. In particular Hermite quintic multiwavelets, with multiplicity 3, are used. In this case no prefiltering step is required, due to the nature of the initial data. In fact, they come from a spline approximation, which not only allows to have an analytical description of the curve, but also to evaluate, for every point, the first and second derivative (tangent and curvature), needed by the Hermite basis.

- An analysis of blood pressure in hypertensive patiens based on the Continuous Wavelet Transform (in collaboration with Matthias Holschneider, Institut de Physique du Glob, Paris). CWT allows to analyze entirely the data (provided by "Istituto di Medicina Interna del Policlinico dell'Università di Messina"), which consist in 8 hour monitoring. The procedures normally used by medical staff are based on a Short Time Fourier Transform and can analyze just a set of 256 samples, corresponding to 4 minutes monitoring.

References

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