IRISA • Campus universitaire de Beaulieu • 35042 Rennes Cedex France • Tél. : +33 2 99 84 71 00 • Télécopie : +33 2 99 84 71 71 • Internet : www.irisa.fr

Post-doc position in TEMICS Team at INRIA/ IRISA

Direction-Adaptive Wavelet Transforms for Image Compression and Description

Keywords

Image indexing, compression, scalability, 2nd generation wavelet transforms (oriented wavelets, bandlets).

Contact

Christine GUILLEMOT (Christine.Guillemot@irisa.fr)
INRIA
Campus de Beaulieu
35042 Rennes cedex
France
Tel. +33 2 99 84 74 29
Fax. +33 2 99 84 71 71

Description of work

The work proposed is at the frontier of two research areas: image indexing and image compression, which both exploit the properties of image signals, however for two different objectives. In a compression perspective, one searches to reconstruct the image from a minimal amount of information, provided by quantized transform coefficients. Thus, the image representation should be sparse, critically-sampled (or minimally redundant), and transform coefficients should be as independent as possible. In order to distribute audiovisual contents through more and more heterogeneous networks, the compressed representation should also be scalable, i.e. the content will be coded with a single compression process producing a unique bitstream, which can then be decoded at various levels of quality and in various formats.

Wavelets are well-known mathematical tools for representing 1-D signals with a finite number of discontinuities with a small number of coefficients. They are also very useful tools to construct scalable signal representations. However, these critically-sampled transforms do not allow the extraction of low level signal features (points, edges, risdges, blobs) or of local descriptors. Yet, many visual tasks such as segmentation, motion detection, object tracking and recognition, content-based image retrieval, require prior extraction of low level features which have to be robust to a set of admissible transformations.

In addition, for images modeled as homogeneous regions delimitated by contours, curve discontinuities are not fully captured by separable wavelets. In image compression applications, high energy coefficients cluster around the edges and most of the bitrate is spent to code the contours. Thus, new transforms (e.g., curvelets, contourlets, directionlets, oriented

wavelets, bandlets) [1], [2], have been designed to better take into account - and capture - geometrical patterns present in images. For most of these transforms, maps of local orientations need first to be determined according to rate-distortion (R-D) criteria. Regularization methods, some relying on quadtree analysis techniques are then used to decrease the transmission cost of orientation maps. These trees together with the orientations attached to the leaves provide structural (geometric) information on the image.

The objective of this post-doc position will be to investigate second generation wavelet transforms for both compression and indexing. A coding/decoding algorithm based on second generation wavelet transforms will first be designed. The first step of the encoder will be to extract the image structural information, such as orientation maps at different scales, which will then be used for generating the different transform basis functions. Different methods, e.g. based on Markov random fields (MRF), or simple methods based on quadtrees, will be considered to regularize the map. The produced geometric information on the image, e.g. the structural information given by the quadtree (or the MRF) together with the R-D optimized local orientations will be considered both for local and global image description. Statistical texture models [3] in these wavelet transform domains will also be studied for indexing and image retrieval.

The work will be carried out in the context of the national ICOS-HD project funded by the ANR.

[1] V. Chappelier and C. Guillemot, "«Oriented wavelet transform for image compression and de-noising», IEEE Trans. on Image Processing, Vol. 15, No. 10, pp. 2892-2903, Oct. 2006.
[2] C-L. Chang and B. Girod, "Direction-adaptive discrete wavelet transform for image compression", IEEE Trans. On Image Processing, vol. 16, no.5, pp. 1289-1302, May 2007.
[3] M. Do and M. Vetterli, "Rotation invariant texture characterization and retrieval using steerable wavelet-domain Hidden Markov models", IEEE Trans. On Multimedia, vol.4, no.4, pp. 517-527, Dec 2002

Pre-requisites

- Programming languages: C and C++
- Signal and Image processing.
- Notions of image and video coding