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Tesis Doctoral

New contributions in overcomplete image
representations inspired from the functional
architecture of the primary visual cortex

Nuevas contribuciones en representaciones sobrecompletas de
imágenes inspiradas por la arquitectura funcional de la corteza
visual primaria

SYLVAIN GAEL FREDERIC FISCHER

Directores de Tesis:

GABRIEL CRISTÓBAL PÉREZ

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Abstract

The present thesis aims at investigating parallelisms between the functional architecture of primary visual areas and image processing methods. A first objective is to refine existing models of biological vision on the base of information theory statements and a second is to develop original solutions for image processing inspired from natural vision. The available data on visual systems contains physiological and psychophysical studies, Gestalt psychology and statistics on natural images. The thesis is mostly centered in overcomplete representations (i.e. representations increasing the dimensionality of the data) for multiple reasons. First because they allow to overcome existing drawbacks of critically sampled transforms, second because biological vision models appear overcomplete and third because building efficient overcomplete representations raises challenging and actual mathematical problems, in particular the problem of sparse approximation.

The thesis proposes first a self-invertible log-Gabor wavelet transformation inspired from the receptive field and multiresolution arrangement of the simple cells in the primary visual cortex (V1). This transform shows promising abilities for noise elimination. Second, interactions observed between V1 cells consisting in lateral inhibition and in facilitation between aligned cells are shown efficient for extracting edges of natural images. As a third point, the redundancy introduced by the overcompleteness is reduced by a dedicated sparse approximation algorithm which builds a sparse representation of the images based on their edge content. For an additional decorrelation of the image information and for improving the image compression performances, edges arranged along continuous contours are coded in a predictive manner through chains of coefficients. This offers then an efficient representation of contours. Fourth, a study on contour completion using the tensor voting framework based on Gestalt psychology is presented. There, the use of iterations and of the curvature information allow to improve the robustness and the perceptual quality of the existing method.

Tribunal nombrado por el Mgco. y Excmo. Sr. Rector de la Universidad Politécnica de Madrid, el día

PRESIDENTE: JUAN ALBERTO SIGÜENZA PIZARRO

VOCAL: BALTASAR BEFERULL LOZANO

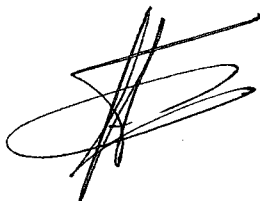
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VOCAL: LAURENT PERRINET

SECRETARIO: M^º JESÚS LEDERMA CARBAYO

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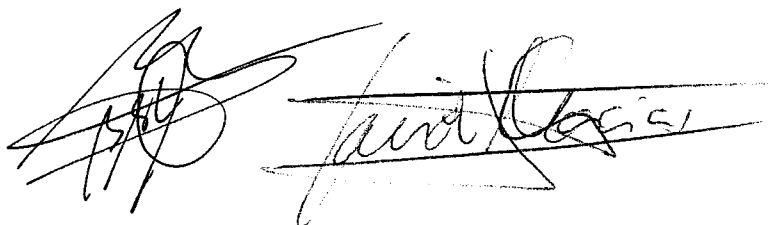
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LOS VOCALES



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