Building the what and where systems:
multi-scale lines, edges and keypoints

J. Rodrigues, D. Almeida, S. Nunes, R. Lam and J.M.H. du Buf
University of Algarve, Vision Laboratory
Campus de Gambelas–FCT, 8000-810 Faro, Portugal
{jrodrig,dalmeida,srnunes,rlam,dubuf}@ualg.pt
http://w3.ualg.pt/ dubuf/vision.html

Computer vision for realtime applications requires tremendous computational power because all images must be processed from the first to the last pixel. Active vision by probing specific objects on the basis of already acquired context may lead to a significant reduction of processing. This idea is based on a few concepts from our visual cortex (Rensink, Visual Cogn. 7, 17-42, 2000): (1) our physical surround can be seen as memory, i.e. there is no need to construct detailed and complete maps, (2) the bandwidth of the what and where systems is limited, i.e. only one object can be probed at any time, and (3) bottom-up, low-level feature extraction is complemented by top-down hypothesis testing, i.e. there is a rapid convergence of activities in dendritic/axonal connections. We developed state-of-the-art models for multi-scale line/edge and keypoint detection based on simple, complex and end-stopped cells in V1. Keypoint scale-space is ideal for constructing a saliency map for Focus-of-Attention, and faces can be detected by grouping landmarks on eyes, nose and mouth, independent from facial expression. Line/edge scale-space is ideal for face recognition. Obviously, these two representations complement each other and both can be used for object categorisation and identification, but our impression is that keypoints are used more in the fast where system (FoA), whereas lines and edges are exploited more in the slower what system. However, this still needs to be tested in the context of a complete cortical architecture with ventral and dorsal data streams linking V1, V2, V4 and IT (Deco and Rolls, Vision Res. 44, 621-642, 2004). Unfortunately, the required processing power will be tremendous.

[Supported by PRODEP III Medida 5-Acção 5.3, and by the FCT program POSI, framework QCA III.]