Filter transformations for shift-insensitive feature detection

Miles Hansard, Radu Horaud
INRIA Rhone-Alpes.; email: miles.hansard@inrialpes.fr

The representation of oriented image-structure is an important part of most biological vision models. It is possible, for example, to estimate both motion and binocular disparity from the responses of oriented filters (Adelson & Bergen 1985, JOSA A 2(2), 284-299). It is particularly useful to combine the responses of different filters, in order to obtain a response to edge-like structures that is insensitive to slight shifts (in the direction perpendicular to the edge). It has been hypothesized that complex cells achieve this by separating the local energy of the signal from its phase. We describe an alternative approach, which is based on the 'local jet' representation (Koenderink & van Doorn 1987, Biol. Cyb. 55, 367-375). Each jet is computed from a set of oriented derivative filters, of order 1 to N, which are applied at a given image location. We show that these filters can be used as a basis for a new set, which contains filters of a single order, each at a slightly different location. The maximum response, over the new set, is insensitive to small image-shifts. This approach can be justified by noting that a Taylor approximation of the shifted Kth order filter can be obtained from the N-K higher-order filters in the jet. It is shown, however, that a least-squares construction is more practical. Finally, it is noted that the responses of the new filters can be obtained from a linear transformation of the original N image derivatives.