Gabor phase space molecules for image understanding

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Exemplar-based object recognition algorithms usually consist of the following steps.

1. Extraction of "atomic" visual primitives.
2. Combination of these to higher order "molecular" structures.
3. Estimation of correspondence maps ("matching") between the actual visual scene and stored object prototypes.
4. Organization of the memory of object prototypes such that matching and comparison can be efficient.
5. Filtering of the video stream from the camera

Gabor wavelet transforms provide a rich and convenient description of an image. They are atomic in the sense that they subdivide the 4-dimensional phase space spanned by all possible combinations of these parameters into cells of minimal volume. They provide a good model of simple cells in V1. The precise form of the function is not crucial, but the matched filter property (positivity in frequency space) turns out to be very helpful. It makes it very natural to describe the atoms in terms of a *local amplitude* (model for complex cells) and *local phase*. The former has very favorable properties concerning matching robustness, the latter is required for precise localization of correspondences.

Successful examples include

Jets used for face recognition by elastic graph matching;

Minijets used for face recognition by Gabor pyramid matching;

Graphs and pyramids as structures coding for whole object aspects;

Correspondence structures the intermediate and final results of matching;

Endstopped cells a model for a special kind of cells in the visual areas V1 and V2.

Corner detectors a multiscale combination of endstopped cells

Line elements connection structures which support the Gestalt rule of *collinearity*;

Texture operators used for the classification of natural textures.

I have described in detail the methods of Elastic Graph Matching, its extension to bunch graph matching,and its embedding into a real-time recognition system. Conceptual problems with the background have been solved by the method of Gabor pyramid matching, which has a detailed neuronal implementation. Finally, I gave an outlook on further applications of the concept.