Context-based structuring action on optic flow fields by generative models of first-order motion primitives: velocity likelihoods and Gestalt detection

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The problem of evidencing the presence of a certain complex feature in the optic flow can be posed as an adaptive filtering problem,where local information act as the input measurements and the context acts as the reference signal, e.g., representing a specific motion Gestalt.
In this context, we defined a set of context-sensitive filters (CSFs) built on opponent and non-opponent elementary gradient-type velocity patterns (Treue and Andersen, 1996 Vis. Neurosci. 13 797-804), as cardinal components of a linear deformation space (Koenderink, 1986 Vis. Res. 26 161-179). By checking the presence of such Gestalts in optic flow fields, we make the interpretation of visual motion more confident, by assigning the most probable pattern to a group of velocity vectors, on the basis of their spatial relationships. Casting the problem as a Kalman filter, the detection occurs through a spatial recurrent process that checks the consistency between the spatial structural properties of the input flow field pattern and a structural rule expressed by the model equation of the Kalman filter.
The resulting CSF behaves as a template model. Yet, its specificity lies in the fact that the template character is not built by highly specific feed-forward connections, but emerges by stereotyped recurrent interactions.
We expect the approach can be extended to consider adaptive cross-modal templates (e.g., motion and stereo). By proper specification of the transition matrix in the model equation of the Kalman filter, it can, indeed, potentially model any type of multimodal spatio-temporal relationships (i.e., multimodal spatio-temporal context).