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Invited Speakers

A framework for invariant visual operations based on receptive field responses

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The brain is able to maintain a stable perception although the visual stimuli vary substantially on the retina due to geometric transformations and lighting variations in the environment. This talk presents a unified theory for achieving basic invariance properties of visual operations already at the level of receptive fields.

This generalized framework for invariant receptive field responses comprises:

- local scaling transformations caused by objects of different size and at different distances to the observer,
- locally linearized image deformations caused by variations in the viewing direction in relation to the object,
- locally linearized relative motions between the object and the observer and
- local multiplicative intensity transformations caused by illumination variations.

The receptive field model can be derived by necessity from symmetry properties of the environment and leads to predictions about receptive field profiles in good agreement with receptive field profiles measured by cell recordings in mammalian vision. Indeed, the receptive field profiles in the retina, LGN and V1 can be seen as close to ideal to what is motivated by the idealized requirements.

By complementing receptive field measurements with selection mechanisms over the parameters in the receptive field families, it is shown how true invariance of receptive field responses can be obtained under scaling transformations, affine transformations and Galilean transformations. Thereby, the framework provides a mathematically well-founded and biologically plausible model for how basic invariance properties can be achieved already at the level of receptive fields and support invariant recognition of objects and events under variations in viewpoint, retinal size, object motion and illumination.

The theory can explain the different shapes of receptive field profiles found in biological vision, which are tuned to different sizes and orientations in the image domain as well as to different image velocities in space-time, from a requirement that the visual system should be invariant to the natural types of image transformations that occur in its environment.

References:

- T. Lindeberg (2011) "Generalized Gaussian scale-space axiomatics comprising linear scale-space, affine scale-space and spatio-temporal scale-space". *Journal of Mathematical Imaging and Vision*, volume 40, number 1, pages 36-81, May 2011.
- T. Lindeberg (2012) "Invariance of visual operations at the level of receptive fields", arXiv preprint 1210.0754, submitted to PLoS One.
- T. Lindeberg (2013) "Generalized axiomatic scale-space theory", *Advances in Imaging and Electron Physics*, (P. Hawkes, ed.), Elsevier, in press.