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Presentation Abstract

Program#/Poster#:	109.7/MMM66
Title:	Translation-invariant independent component analysis of natural images yields "double" gabor filters
Location:	Halls B-H
Presentation Time:	Saturday, Nov 13, 2010, 3:00 PM - 4:00 PM
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Abstract:	We recognize objects despite the large changes in their retinal projections produced by transformations such as translation, rotation and scaling. The analysis of natural images with Independent Component Analysis (ICA) yields localized Gabor type filters similar to receptive fields of simple cells in visual cortex (Bell and Sejnowski, 1997). This approach has been extended to analyzing topographically organized pools of neurons with ICA, which gives rise to topographic organization of orientation tuning and complex cell properties, which are locally translationally invariant (Hyvarinen and Hoyer, 2001). In this study we have taken a different approach to invariance by translating the center of mass of the intensity in patches from natural images to the centers of the patches. The source filters from ICA no longer need to form a translationally invariant basis set and should reveal new features for representing objects. We used informax ICA and applied it to 20x20 centered patches from the van Hateren database of natural images. The resulting set of 400 filters were a mixture of the Gabor type, but with a wider range of spatial frequencies and spectral properties than found with random patches. In addition, a new class of filters was found that have not been described previously. Like Gabor filters, they could be parameterized by their (x,y) position in the patch, and by two Gaussian width parameters corresponding to the extent of the filter along the orientation axis and the perpendicular axis. The new filters had two additional parameters for the cosine-modulated wavelengths along

these axes, but for Gabor filters, there is only one parameter for the wavelength along the orientation axis. These "double" Gabor filters have a checkerboard appearance for some values of the parameters. Neurons have been found in the primary visual cortex that resemble the double Gabor filters found by ICA (Chen, Han, Poo and Dan, 2007). These neurons could be coding translation invariant features of objects in natural images. This approach can be extended to find features that are derived from other types of invariance.

Disclosures: **S. Saremi:** None. **T.D. Albright:** Employment; Salk Institute for Biological Studies. **T.J. Sejnowski:** University of California, San Diego. **T. Sharpee:** None.

Keyword(s): COMPUTATIONAL MODEL

VISION

Support: HHMI (TJS)

NIH Grant R01EY019493 (TS)

Searle Funds (TS)

McKnight Scholarship (TS)

Sloan Fellowship (TS)

[Authors]. [Abstract Title]. Program No. XXX.XX. 2010 Neuroscience Meeting Planner. San Diego, CA: Society for Neuroscience, 2010. Online.