A new biologically inspired color image descriptor
Jun Zhang\textsuperscript{1,2}, Youssef Barhomi\textsuperscript{1}, Thomas Serre\textsuperscript{1}
\textsuperscript{1}Brown University, \textsuperscript{2}Hefei University of Technology

1. Motivation
Luminance neurons with “ON” and “OFF” subunit organization are selective to orientations (and high spatial frequency) thus contribute to edge detection.

Single-Opponent (SO) neurons (color-prefering) with “ON” and “OFF” subunit organization with different cone inputs exhibit little or weak orientation selectivity but strong selectivity to color regions.

Double-Opponent (DO) neurons (color-luminance) with no defined “ON” and “OFF” subunit organization are selective for both color and orientations (and spatial frequency), and thought to influence the perception of form.

Consider chromatic axes as found in cortex.

2. Computer vision approaches
- Applying shape-based descriptors on individual color channels, e.g. HSVSIFT.
- Concatenation of shape-based descriptors with color histograms, e.g. HueSIFT.

3. Biological mechanisms
- Chromatic and spatial information should be represented jointly as done in the primate visual cortex.
- Neurons maintain positive firing rates, and neural circuits have been identified for contrast gain controls.

4. Approach overview

5. Approach details
Spatio-chromatic sensitivity function
\[ f(x,y,\lambda) = w_1 R(\lambda) f_1(x,y) + w_2 G(\lambda) f_2(x,y) + w_3 B(\lambda) f_3(x,y) \]

SO unit response: \[ s = f(x,y,\lambda) \]
DO unit response: \[ d = s(x,y,c) \]

Non-linear operations:

Response maps:

SO S1 units
DO S1 units
DO C1 units

6. Color-gradient comparisons

7. System extensions

Datasets
- Soccer team
- 17-category flowers
- PASCAL VOC 2007
- 8-category scenes
- BSDS500

Shape predominant

Method | SIFT | HueSIFT | OpponentSIFT | CSIFT | SODOSIFT | SODOHMAX
---|---|---|---|---|---|---
AP | 40(38.4) | 41 | 43(42.5) | 43(44.0) | 46.5(33.3/39.8) | 46.8(30.1/36.4)

Color predominant

Method | GIST | RGBGIST | SOGIST | DOGIST | SODOGIST
---|---|---|---|---|---
Accuracies | 83.5 | 84.1 | 70.5 | 85.9 | 87.1

8. Results

8. Conclusions

9. References

10. Acknowledgments
This work was supported by DARPA (N10AP2013) and ONR (N000141110743), the Center for Computation and Visualization of Brown University, and the Robert J. and Nancy D. Carney Fund for Scientific Innovation. J. Zhang was supported by China Scholarship Council (2010669020).

11. Software available online! http://serre-lab.clps.brown.edu/projects/color