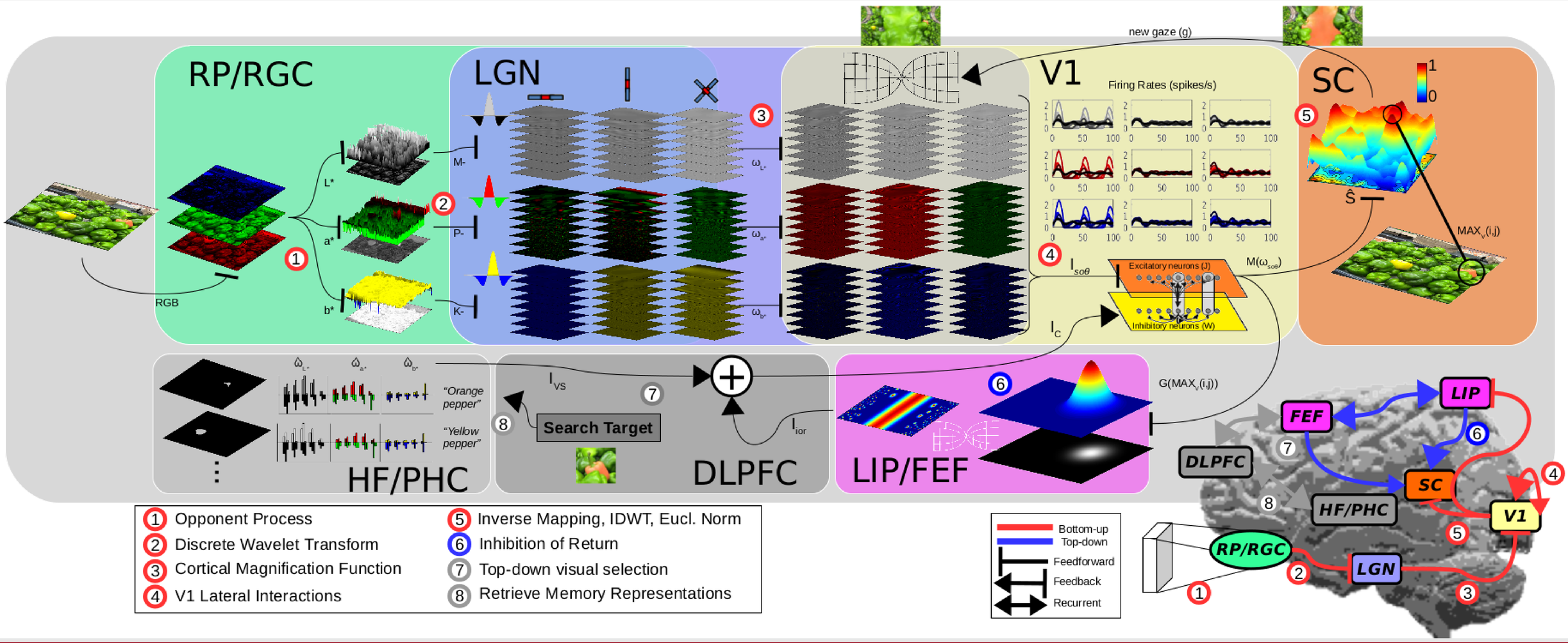
David Berga & Xavier Otazu
Dept. Ciències de la Computació – Centre de Visió per Computador
Univ. Autònoma de Barcelona, Spain.
http://www.cvc.uab.cat {dberga, xotazu@cvc.uab.es}

Computations of inhibition of return mechanisms by modulating V1 dynamics

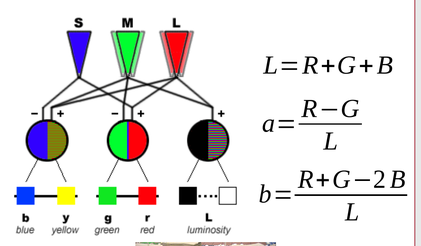
Neurodynamic Saliency Wavelet Model with Cortical Magnification (NSWAM-CM)



(1)

Opponent Process

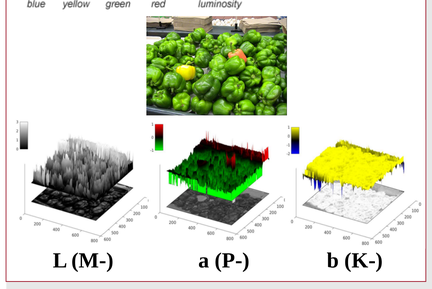
Signals from RGB are transformed to the CIELab space [3]. This approximates the process of transforming RP (rods/cones) to RGC (M-,P-,K-).



$$L = R + G + B$$

$$a = \frac{R - G}{L}$$

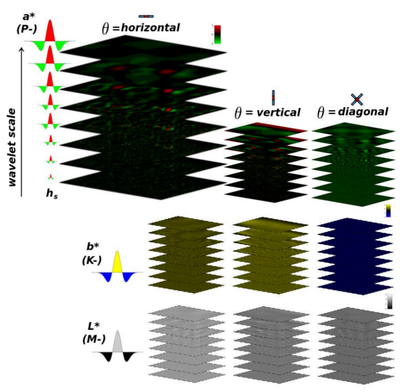
$$b = \frac{R + G - 2B}{L}$$



(2&5)

Hypercolumnar Organization

Sensitivities to orientation (Θ) and scales (s) are simulated with a Discrete Wavelet Transform (DWT) [4]. Wavelet coefficients (ω) shown below represents the receptive field activity of simple cells in V1 for each chromatic opponency.



(3&5)

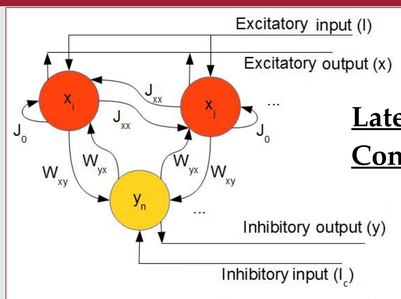
Cortical Magnification

Receptive field activity from RGC/LGN (image plane) is mapped to the corresponding retinotopic positions in V1 (cortical plane) [5].

$$X + Yi = \lambda \log\left(r e^{i\Phi} + e_0\right)$$

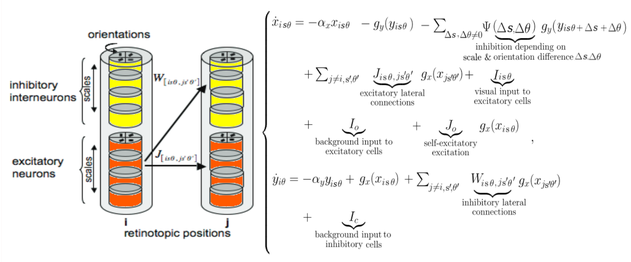
Cortical coordinates in mm mapped from the image pixel positions in polar coordinates with respect to the fixation point (λ: mm to pixels conversion constant, e0: foveal vicinity constant)

(4)



Lateral/Horizontal Connections in V1

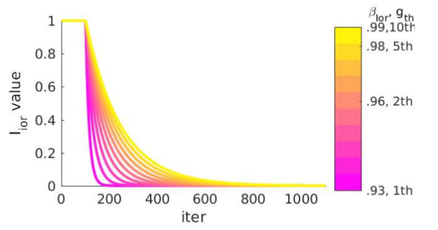
Excitatory neurons (x) are connected monosynaptically (J) with themselves and connected dysinaptically (W) through all other inhibitory interneurons (y). Neurons interact locally in retinotopic, scale and orientation domains. Membrane potentials (ẋ,ẏ) based on Li [6-7], Penacchio et al. [8, 19] and Berga & Otazu [1-2] models.

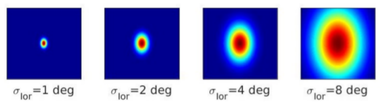


(6)

Inhibition of Return*

Maximal activity in V1 is selected for inhibition of subsequent saccades (simulating activity in V1-LIP/FEF-SC [9-11]). IoR is modeled with a decay factor (β) and a gaussian-like shape (σ).



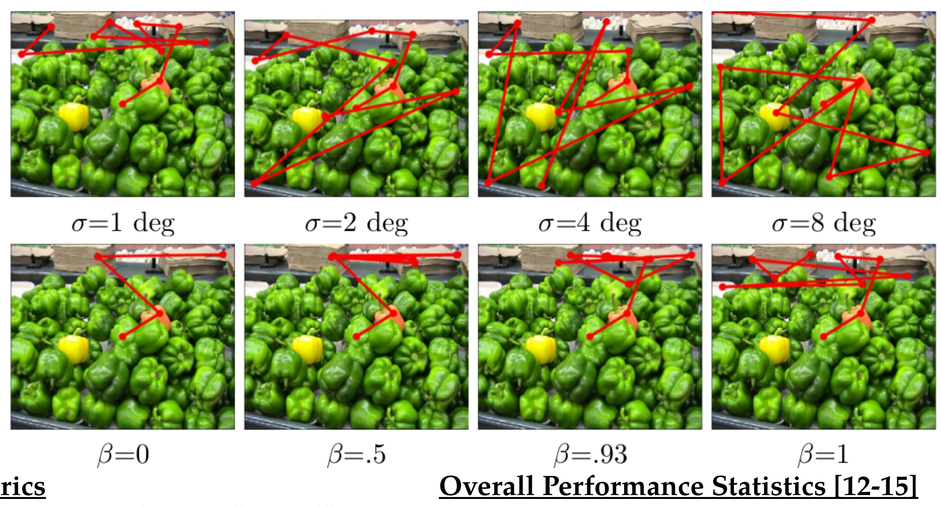


$$I^{g,t=0}_{\{IoR\}} = MAX(\hat{S}) G(MAX_V(x,y)) + I^{g-1}_{\{IoR\}},$$

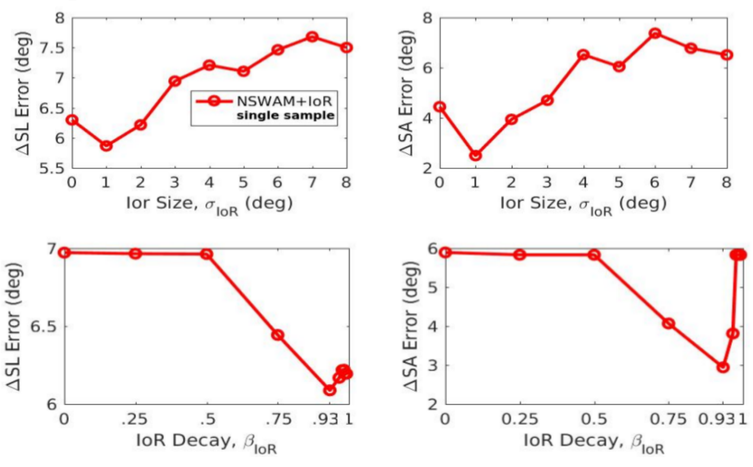
$$I^{g,t>0}_{\{IoR\}} = \alpha_{\{IoR\}}(I^{t-1}_{\{IoR\}}) \prod_{i=1}^{10\tau} e^{log(\beta_{\{IoR\}})/\tau}.$$

Results

Example



Sample Performance Statistics

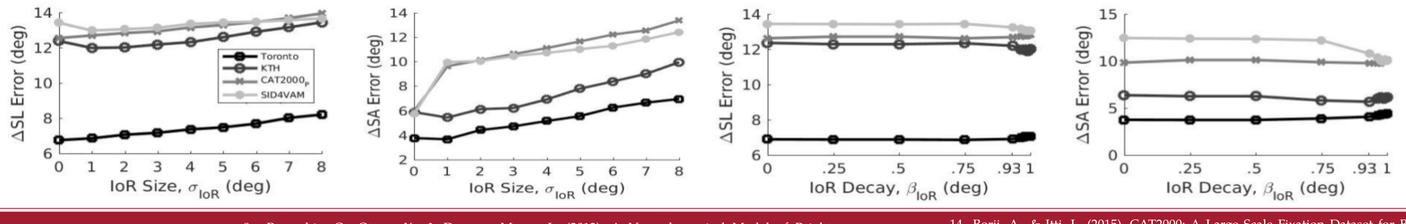


Metrics

ΔSL = Saccade Landing Difference (eucl.dist. with respect human saccade coordinates)

ΔSA = Saccade Amplitude Difference (eucl.dist. between each subsequent saccade, difference with respect humans)

Overall Performance Statistics [12-15]



Conclusions

-Inhibition of return improves saccade statistics, reproducing eye movement psychophysics [12,16,17]:
  -At size of 1-3 deg. of visual angle
  -At decay of 1-5 fixation time (.93-98)
-Lateral interactions in V1 can represent bottom-up attention, and can reproduce other effects (using same model) such as Brightness [8] & Chromatic Induction [18] and Visual Discomfort [19].

Download

https://github.com/dberga/NSWAM

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