

POSTER PRESENTATION

Open Access

A biological plausible recurrent model of V1 hypercolumns

Atahan Afşar^{1*}, Tunca Ulubilge¹, Baran Çürüklü²

From Twentieth Annual Computational Neuroscience Meeting: CNS*2011
Stockholm, Sweden. 23-28 July 2011

A biological plausible model of hypercolumn of V1 layer in the Primary Visual Cortex, modeled in the NEST Environment [1], is presented. The model addresses experimental findings on emergence of orientation selectivity which occurs in the V1 [2]. The network model is derived from the Bayesian confidence propagation neural network, which was presented earlier [3,4]. It is hypothesized that a modular recurrent network model can be used to address orientation selectivity mechanism [2]. Thus, the columnar organization of primary visual cortex is assumed [5]. The network consists of 16 minicolumn models each representing an orientation, ranging from 0° to 168.75°, with the angular distance of 11.25° between two adjacent minicolumn models. LGN input is broadly tuned, half-width of half-height (HWHH) is 40°. Excitatory->Excitatory network targets all neurons with the probability of 60% inside the host minicolumn with a HWHH of 25° as a function of distance (ESPSs = 3.15 mV). Inhibitory->Excitatory is connected with the probability of 40% (ISPSs =

-5.85mV). Excitatory->Inhibitory connections target all neurons with the probability of 40%, and HWHH of 67.5° as a function of distance (ESPSs = 1.35 mV). Furthermore, LGN input is 1/3 of cortical excitation. Hypercolumn model also reflects biological phenomenon of background activity caused by random cortical inputs, as suggested by the experimental findings. In the absence of LGN input, background activity of the population is around 0.5-2 spikes/sec.

Conclusions

LGN input ranges from low to high contrast (5%, 10%, 50%, and 100%), and is fed into the neurons during 2 seconds for each contrast level (mean activities of the excitatory population is shown in Figs 1A and 1B). Simulation results suggest that cortical connections of excitatory and inhibitory neurons play an important role in sharpen of the broadly tuned LGN input. Emergence of contrast invariance of orientation selectivity is also evident (Fig. 1A.). As demonstrated in this specific

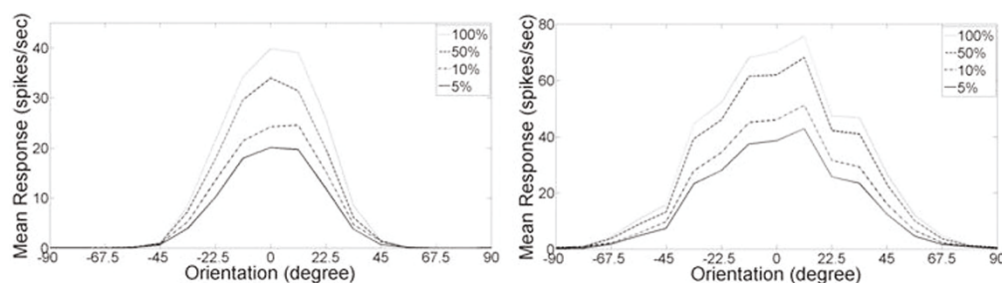


Figure 1 Mean excitatory population activity. A) Orientation response curves of a cortical hypercolumns. LGN input and cortical excitatory and inhibitory connections are present B) Response to broadly tuned LGN input in absence of cortical excitatory and inhibitory connections.

¹Faculty of Engineering and Natural Sciences, Sabanci University, Istanbul, 34956, Turkey

Full list of author information is available at the end of the article

simulation the cortical network is also efficient in correcting network activity, which is the function of the LGN input solely; when cortical network is absent mini-column model representing 15° is most active, whereas in presence of cortical connections 0° comes out as the winner.

Author details

¹Faculty of Engineering and Natural Sciences, Sabanci University, Istanbul, 34956, Turkey. ²School of Innovation, Design and Engineering, Mälardalen University, Västerås, 721 23, Sweden.

Published: 18 July 2011

References

1. Gewaltig MO, Diesmann M: NEST (Neural Simulation Tool). *Scholarpedia* 2007, **2**(4):1430.
2. Ferster D, Miller KD: Neural mechanisms of orientation selectivity in the visual cortex. *Annu Rev Neurosci* 2000, **23**:441-471.
3. Curuklu B, Lansner A: An Abstract Model of a Cortical Hypercolumn. *Proc. of Int. Conf. on Neural Information Processing* 2002, 80-85.
4. Çürüklü B, Lansner A: Quantitative assessment of the local and long-range horizontal connections within the striate cortex. *IEEE Proceedings of the Computational Intelligence, Robotics and Autonomous Systems* 2003.
5. Mountcastle VB: The columnar organization of the neocortex. *Brain* 1997, **120**:701-722.

doi:10.1186/1471-2202-12-S1-P48

Cite this article as: Afşar et al.: A biological plausible recurrent model of V1 hypercolumns. *BMC Neuroscience* 2011 **12**(Suppl 1):P48.

Submit your next manuscript to BioMed Central
and take full advantage of:

- Convenient online submission
- Thorough peer review
- No space constraints or color figure charges
- Immediate publication on acceptance
- Inclusion in PubMed, CAS, Scopus and Google Scholar
- Research which is freely available for redistribution

Submit your manuscript at
www.biomedcentral.com/submit

