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An investigation into plausible neural mechanisms related to the the CIWaM computational model for brightness induction

Xavier Otazu, Olivier Penacchio, Laura Dempere-Marco

Abstract

Brightness induction is the modulation of the perceived intensity of an area by the luminance of surrounding areas. From a purely computational perspective, we built a low-level computational model (CIWaM) of early sensory processing based on multi-resolution wavelets with the aim of replicating brightness and colour (Otazu et al., 2010, Journal of Vision, 10(12):5) induction effects. Furthermore, we successfully used the CIWaM architecture to define a computational saliency model (Murray et al, 2011, CVPR, 433-440; Vanrell et al, submitted to AVA/BMVA'12). From a biological perspective, neurophysiological evidence suggests that perceived brightness information may be explicitly represented in V1.

In this work we investigate possible neural mechanisms that offer a plausible explanation for such effects. To this end, we consider the model by Z.Li (Li, 1999, Network:Comput. Neural Syst., 10, 187-212) which is based on biological data and focuses on the part of V1 responsible for contextual influences, namely, layer 2-3 pyramidal cells, interneurons, and horizontal intracortical connections. This model has proven to account for phenomena such as visual saliency, which share with brightness induction the relevant effect of contextual influences (the ones modelled by CIWaM). In the proposed model, the input to the network is derived from a complete multiscale and multiorientation wavelet decomposition taken from the computational model (CIWaM). This model successfully accounts for well known pyschophysical effects (among them: the White's and modied White's effects, the Todorovic, Chevreul, achromatic ring patterns, and grating induction effects) for static contexts and also for brigthness induction in dynamic contexts defined by modulating the luminance of surrounding areas. From a methodological point of view, we conclude that the results obtained by the computational model (CIWaM) are compatible with the ones obtained by the neurodynamical model proposed here.