COMPUTER SIMULATIONS OF THE VISION EARLY PROCESSING STAGES: FEATURE SELECTION, CONTOUR EXTRACTION, SEGMENTATION AND ATTENTION

MAURO URSINO

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The present work describes some mathematical models and computer simulations of the early vision processing stages. The models aspire to represent a good compromise between neurophysiological reliability and computational simplicity. Three distinct but related problems are analyzed:

(1) the genesis of orientation and direction preference in simple and complex cells in V1. These properties emerge due to the interaction of feedforward and feedback intracortical mechanisms.
(2) Contour extraction according to contextual influences among intracortical neurons. Excitatory influences respect co-axial and co-modularity criteria, while a long-range isotropic feedback inhibition contributes to noise suppression. Examples of contour exctraction from real images are shown.
(3) Segmentation of distinct objects in the visual scene modulated by an attention mechanism. Model assumes that segmentation is realized by a two-layer process: The first layer extracts all object contours from the image. Information on contour is used to selectively inhibit neural oscillators in the second layer, thus realizing a strong separation among neurons in different objects. Moreover, the model uses a global inhibitor which realizes an attention mechanism to segment objects at different detail levels.

The main models assumptions and results are presented and discussed, their integration into a comprehensive structure is proposed, and lines for future investigation pointed out.