Chapter 6
Visual Processing as Described by Contemporary Main-Stream Neuroscience

This Auxiliary Chapter complements the main part of the book by presenting the conventional views on vision for those readers who are not familiar with them. It also allows comparisons with the Holonomic Brain Theory and critiques, and also some mutual complementing of views and descriptions, although they are presently not compatible. For instance, the work of large numbers of neuroscientists provides many details and experimental data relevant for modeling purposes.

6.1 RETINA

Eye. The light enters the eye at cornea. The optic flow then proceeds through the *pupil*, a circular hole with muscle-conditioned variable radius, then through the

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lens, which bends (refracts) and focuses (because of ciliary-muscle-conditioned flexibility) the rays, to the eye's back where it impinges on the pigment-layer of *photoreceptor cells*[1] on the surface of the retina. A 2-dimensional projection of the 3-dimensional world emerges on retina.[2]

Retinal image. Stimulus intensities, which affect the activities of retinal cells, are mainly determined by: the light source, the surface reflectance and shape of the viewed object, the viewer's standpoint and angle of view. Each location in the image can be described by two primary characteristics of the wave-modulated stimulus (Berne & Levy, 1993):

1. *Brightness (luminance)*, the intensity of light falling on retina, which determines the photoreceptors' activation-level;
2. Spectral decomposition (frequency or *wavelength*) which determines the differential activation of different cone types, leading to the perceived color.[3]

Derived information. Let us mention here that other characteristics can be in later stages (up to the cortex) derived from the primary retinal features 1 and 2. Such secondary characteristics are (De Yoe & Van Essen, 1988):

3. 2-dimensional velocity of the retinal image;
4. Spatial contrast;
5. 2-dimensional orientation of the stimulus;
6. Binocular disparity (which is also a source of stereopsis, i.e. 3-dimensional vision).[4]

Sensation. Photoreceptor cells are *cones*, which are color-sensitive and used for low-sensitive (for daylight), high-acuity vision, and *rods*, which are high-sensitive (for dark), "color-blind" and provide a rough "sketch" only. In the central part of retina, *vis-a-vis* to the lens-center (on the visual axis), lies *fovea* where visual acuity is the highest, because there is extremely high density of cones. Density of rods is, in contrast, high at all other parts of the retina except at fovea and at the location where the optic nerve starts to extend towards the visual cortex. In response to a flash of light within the receptive field[5], a photoreceptor runs a biochemical cascade process and changes voltage. Over a limited range of stimulus intensity, the change in the light-modulated signal is proportional to the change in the light stimulus (Smith in Arbib, 1995). Retina realizes a sort of scale-invariant gaussian-profile sampling (details in Van Essen & Anderson in Zornetzer, Davis & Lau, 1990, pp. 45-47).

Retinal net processing. Retina is a multi-layer neural network. Details of its non-trivial hierarchical feed-forward[6] processing, in spite of its importance for further visual processing, will not be presented here. However, description of