

A CNN-Inspired Model for Degradation Mechanism of Retina to V1



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Abstract The visual system is under heated investigation in the field of neuroscience and computer vision (CV). In alignment with the implementation of some large brain projects across the world such as those in China, Europe, the USA and Japan, the intersection of visual system in these two fields has been promoted. Therefore, as the most important source of human perception towards the objective world, research on mechanisms of the visual information processing bears great significance for exploring biological vision and developing CV. However, there is a scarcity of soundly established and widely accepted theory that can be used to explain the mechanisms. Specifically, what remains unknown is the degradation mechanism of visual information data during the topological mapping between retina and V1. Hence, in view of the characteristics of convolutional neural network (CNN), this paper draws on the concept of convolution algorithm to propose an edge detection model based on retina to V1 (EDMRV1), which is built on the pathway of photoreceptors-ganglion cells-LGN-V1 in the functional channel of image features detection. The results not only match the neurobiological experimental data but also show that the image edge features of visual information are detected by the convolution algorithm according to the function of synaptic plasticity, when visual signals are hierarchically processed from low-level to high-level in visual cortex. Findings are expected to lay a solid foundation for revealing the mechanisms of the visual information processing in future research. In CV, applying the model to the scenes with different brightness has a better performance on the edge features detection than that in the traditional algorithms, providing an intelligent basis for breakthroughs. This research also opens up opportunities for the integration of CV and neuroscience.

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A. Lintas et al. (eds.), *Advances in Cognitive Neurodynamics (VII)*, Advances in Cognitive Neurodynamics,

https://doi.org/10.1007/978-981-16-0317-4_30