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Origins of illusory percepts in digital images

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Abstract

Here we show the relation between illusory percepts and statistical regularities across scales and orientations. To this aim, the performance of a computational model for the partitioning of statistical regularities is analyzed on several tasks such as long-range boundary completion, phase-induced contour detection, as well as shape and size illusions. The system for the automatically learned partitioning of statistical regularities in 2D images, is based on a sophisticated, band-pass, filtering operation, with fixed scale and orientation sensitivity. Experimental results are provided to illustrate this analysis on several examples: (i) Kanizsa-type subjective figures; (ii) phase-induced subjective contours; (iii) the Zöllner illusion; and (iv) the Müller–Lyer illusion. © 2000 Pattern Recognition Society. Published by Elsevier Science Ltd. All rights reserved.

Keywords: Illusory percept; Log-Gabor functions; Invariant features; Natural cluster of log-Gabors; Uncertainty effects

1. Introduction

Despite the lack of actual sides, the Kanizsa-type illusions shown in Figs. 3(A)–5(A) appear as quite distinct figures [1]: (i) they appear to have substance, (ii) they appear to be in front of the ground; and (iii) the subjective contours belongs to the triangle and the square, respectively, rather than to the eclipsed circles. Of course, these percepts are called illusory because they are not actually present in the pointwise description of the image.

The perception of illusory contours supports the idea that the perception of parts of a stimulus depends on the overall stimulus configuration. Thus, examining the Poggendorf illusion in Fig. 5(E) with a rectangle generated by subjective contours, we find that there is an illusory effect caused by the subjective rectangle (the segment to the left appears to fall below the segment to the right).

Much of object perception requires the integration of image information for features that are separated in space or in time. Therefore, a computational model capable of working with real-world images should perform tasks such as long-range figure completion, or phase-induced boundary detection.

There have been a variety of techniques developed by computational researchers to deal with the problem of illusory contours:

- Ullman [2] suggested that illusory contours may be computed in a network by pairs of circular arcs which minimize total bending energy.
- Grossberg and Mingolla [3] proposed that, in addition to two local inhibitory mechanisms, a long-range excitatory mechanism should act to complete discontinuous boundaries and influence local choices to achieve a context sensitive representation of scenic forms and groupings. This long-range boundary completion is achieved through connectivity which excites collinear or slightly curvilinear cells when they occur between locally detected boundaries.
- Kass et al. [4] used active splines for determining the locations of some types of illusory contours.
- Peterhans and von der Heydt [5] proposed two distinct mechanisms which converge onto a common path: a first group of complex oriented units responds

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to lines and edges, whereas a second group of end-stopped units responds well to the alignment of line-ends in the stimulus.

- Guy and Medioni [6] described a model using point extension fields to extend and complete line segments.

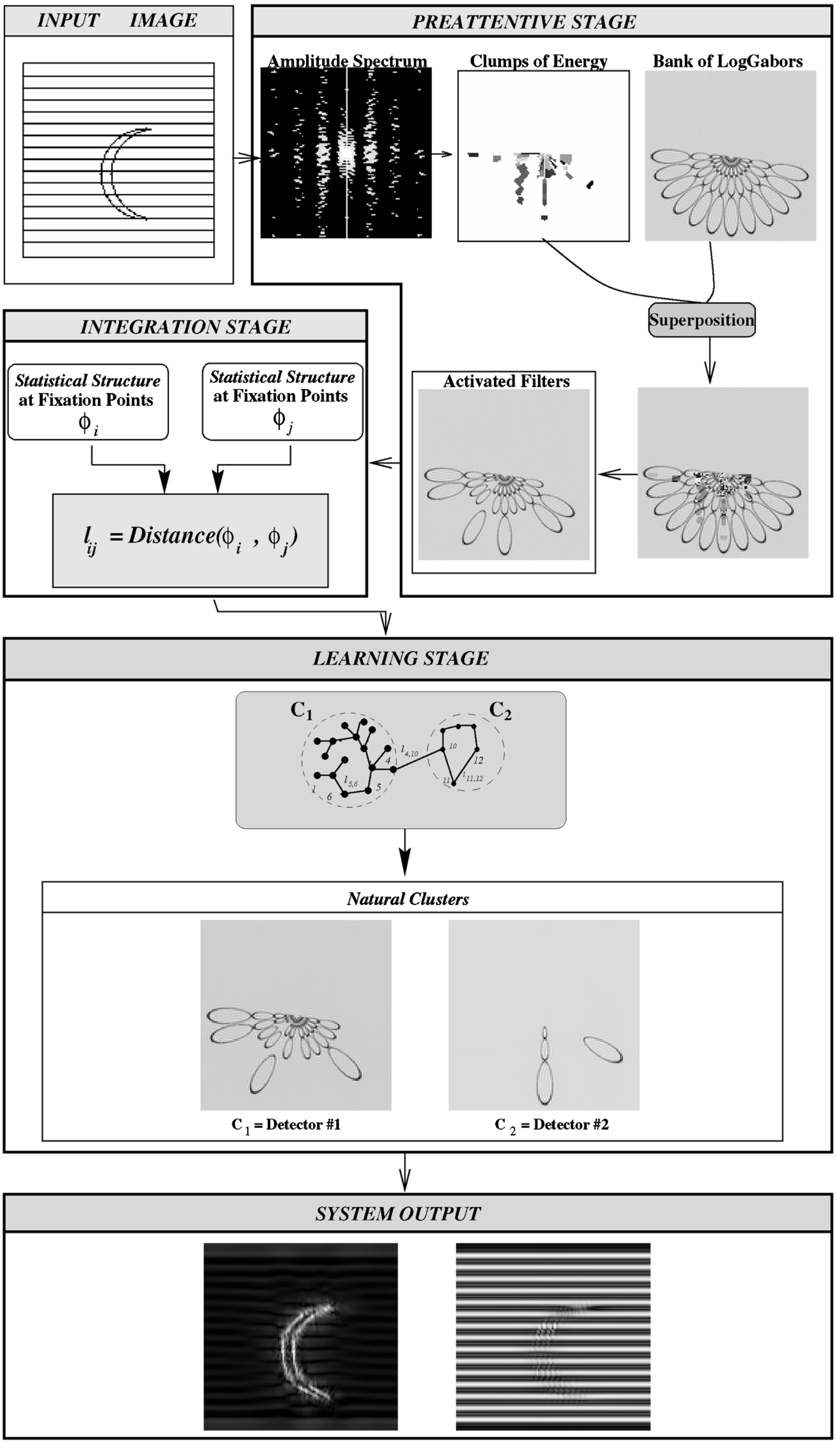

Fig. 1. A general diagram describing how the data flows through the RGFF model.