SPEEDED PHASE DISCRIMINATION :

EVIDENCE FOR GLOBAL TO LOCAL PROCESSING

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Abstract

In recent years much attention has been given to the advantages of multiple resolution pre-processing methods in computer vision. There is strong evidence that the parallel extraction of luminance changes over different spatial scales also occurs in human visual perception. The first experiment confirms the strong evidence that responses to low resolution signals can be elicited as much as 100 msec faster than to high spatial frequency stimuli of the same contrast. A further experiment measured the reaction time to discriminate the relative phase of the higher frequency component of a luminance grating comprising a fundamental and its second harmonic. It was found that the decision can be made more rapidly when the fundamental is low than high frequency. On the assumption that the gross structure of spatial forms is conveyed by low spatial frequencies, this supports the idea that the substrate for the subjective impression that rough descriptions of visual forms precede detailed perception, is the progressive increase in response time with frequency, of the visual mechanisms implementing spatial filtering.

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Introduction

Within most natural scenes, intensity changes occur over a range of spatial scales, so it has been suggested that a general purpose vision system may require some form of early representation that captures and makes this explicit. Over the past decade a number of multi-resolution schemes have been described in the image processing literature, [1,2,3,4,5,6].

Over the same period and independently, considerable empirical evidence has been amassed from both psychological and neurophysiological research, supporting the idea that a form of multiple resolution representation is employed in the early processing stages of biological visual systems. It is asserted that at each point in the retina there exist several contrast sensitive mechanisms each detecting luminance changes over a different spatial scale. As spatial scale is equivalent to spatial frequency (for signals containing a single frequency component) the neural mechanisms can be described as filters in the spatial frequency domain. The simplest model of the filter impulse response is the difference of two circularly symmetric Gaussian functions. The output of a set of filters tuned to the same frequency, covering the entire retina is termed a channel, and is equivalent to the parallel convolution of the image with a single operator. Each channel is assumed to act independently of any other, hence this processing scheme is known as the multiple independent channels model [7].

The independent channels model has been remarkably successful in predicting contrast thresholds in a variety of laboratory experiments, and in generating a great deal of further research attempting to specify the spatial filter characteristics. However little attention has been given to their organization, function or utility. A description of the properties of