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Adaptive network structure for texture discrimination by a 1-D oscillator system

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Abstract. We investigated 1-D oscillator networks that can discriminate isotrigon textures as humans and bees do. The triangular network system investigated discriminated isotrigon texture pairs in the sense of differences in response dynamics for different textures.

Keywords: 1-D oscillator; Texture; Discrimination; Box; Random; Nonlinear dynamics; Oscillator networks; Isotrigon; Triangular network

1. Introduction

Our previous work investigating sensory receptive fields of 1-D oscillator networks with receptor inputs showed that 1-D oscillators can follow the shape of temporally rectangular inputs [1]. This implies that these 1-D oscillator networks can imitate input shapes. The subject of the present paper is whether the 1-D oscillator networks are able to discriminate the combination of inputs from photoreceptor outputs whose expected magnitudes differ. We have been investigating how humans discriminate *isotrigon textures* from random textures: such pairings differ only in their 4th and higher order spatial correlations [2,3]. Here we investigate whether oscillator networks can discriminate isotrigon textures. We postulate that information gained from studying the dynamics of these networks [4,5] may indicate how humans use higher order structure to discriminate isotrigon textures and similar structure in natural images.

When the 1-D oscillator networks imitate input shapes, sensory receptive fields will be realized in the 1-D oscillator networks [1]. These types of *receptive fields* are applicable for modelling texture discrimination by 1-D oscillator networks. The isotrigon textures have the statistical characteristics of zero ensemble averages of their first through third order

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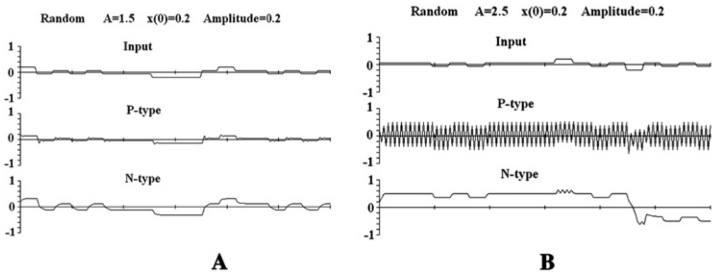

Fig. 1. The elementary responses to the three pixel averaged inputs from isotrigon texture.

spatial correlation functions. Thus, it is expected that the average responses will provide null temporal development in a statistical sense. We therefore investigated some kinds of nonlinear responses to the isotrigon textures that yield differences between superposed responses from a statistical viewpoint.

2. Isotrigon texture discrimination on triangular network system

2.1. Elementary responses of 1-D oscillators to the inputs

The responses of elementary 1-D oscillators to locally averaged inputs from isotrigon texture fields are shown in Fig. 1. We employ two kinds of 1-D oscillators: P-type and N-type [6]. As seen from Fig. 1, both types of 1-D oscillators imitate the inputs when the parameter A is lower than 2, while values higher than 2 yield nonlinear responses exhibiting *gap* behaviour as seen in Fig. 1B. The inputs shown in Fig. 1 are averaged over domains of three vertically neighbouring pixels that are distributed along the horizontal direction of the input texture field (Fig. 2A).

2.2. The 1-D oscillator network for tasking texture discrimination

A network system for testing texture discrimination is shown in Fig. 2A. The receptors in the network system shown in Fig. 2A average three pixels from the texture field, and each sends their output to a 1-D oscillator connected to it.

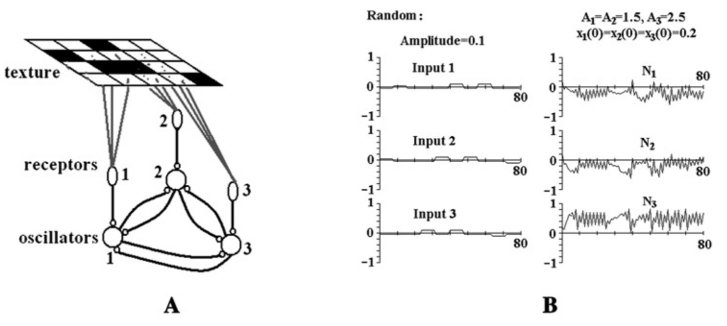

Fig. 2. Triangular network system for texture discrimination (A), and an example of response (B).