Autonomous Optical Thinking Machine Dealing with Impression of Pictures
-Displaying an Impression on Picture Formed by Many Figures-

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Abstract
An optical system which can autonomously form and display an impression of a picture made up by many figures has been developed. This system consists of optical fuzzy-neurons which calculate the correlation between the input picture and the reference image by incoherent optics. The calculated signal is applied to an amplifier whereby the output signal increases, then decreases according to increase of the input signal. These outputs are synthesized, and are used for changing the position where the system gazes on a part of the input picture by light beam. In this system, the light intensity used for gazing changes chaotically. The attractor drawn from the change of light intensity corresponds to the impression of the picture. This paper shows the results that are calculated by the numerical simulation. The system has been simulated to express the impression for a picture formed by 4 figures.

Keywords: Optical computing, Fuzzy-Neuro-Chaos system, Kansei(Sensibility) computing, Soft computing, Perceptual system, Image processing

1 Introduction

A machine that can recognize the meaning of pictures is very useful for avoiding immediate danger in traffic accident and coping with trouble in production facility. Pictures can also be used to communicate with handicapped people.

A picture represents multiple-valued state in high speed, and has diverse and multivocal meaning instantaneously [1, 2]. These characteristics are convenient for representing imagery that springs up in our mind when we look at pictures or events. Impression of a picture is the base of expression of the meaning of the picture.

This paper proposes an optical system that can represent autonomously the impression of picture. The proposed optical system produces an output signal that represents the position of gazing on a part of the input pictures composed with 4 figures. This system uses 4 optical Fuzzy-Neurons that calculate correlation between figures on the basis of the incoherent optics [5, 6]. The light intensity representing the pattern recognition increases and decreases chaotically while the position of gaze changes successively accompanied with the pattern recognition. This gazing action is similar to the movement of the eyes gazing on

a picture. The author regards an attractor drawn by the output signal while gazing the input picture as the impression formed autonomously by the system.

The paper demonstrates the response of such optical system through numerical simulation.

2 Relation between Meaning and Structure in a Picture

When we look at a picture, we gaze at it and move our focus and viewpoint. The impressions of partial images are conceived first and an overall imagery is built up gradually through this process. The meaning of the picture is gathered by associating and corresponding these conceived impressions with knowledge previously acquired from experience [1, 2]. The knowledge that associates meaning to the impression is related to the structure of the picture shown in Figure 1 [2], and conveys the meaning through the geometric structures [3].

The description of a story using images expresses the context like linguistic expression. The text described by only pictograph like the cartoon

is an instance of this style. Spatiality, however, is something uniquely found in pictorial expression only [4]. The picture transfers the meaning to the viewers directly though the reproduction and the sign. Even a work of picture, the thought and the feeling can be reproduced as the imagery in our mind through painting or looking at the picture. This characteristic is used for the diagnosis in the mental healing by the clinical psychologists, too. Sign is classified into index, symbol, and icon. These characteristics are used in various fields of our society, for instance, signposts, marks in the factory, and religious pictures.
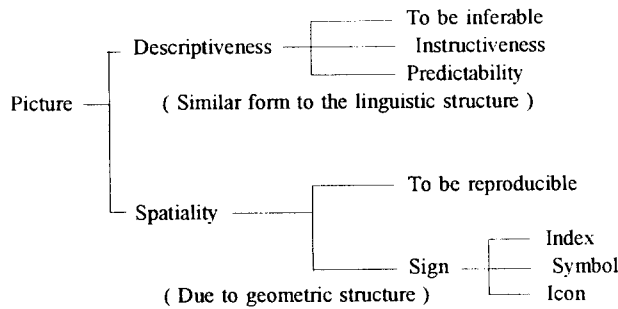

Figure 1: Structure expression by picture.

The mechanism of transferring the meaning through the structure on the picture however still remained unexplained.

The author proposes that the meaning is formed through the association of the impressions with the previously acquired knowledge when we gaze on the partial images and the whole of the picture. The impression assumes an important role in the early stage of bringing meaning into the mind. This paper expresses that the impression is formed autonomously by gazing on the picture.

3 Simulation on Displaying Impression of Picture Formed by 4 Figures

Figure 2 shows the optical diagram that represents the impression of a picture by a chaotic signal. This signal is applied to an actuating device that changes the part of image indicated by the light beam. This operation simulates the movement of eyes that gaze on partial figure and move away from it.

This system uses 4 Fuzzy-Neurons. The Fuzzy-Neuron calculates the correlation between the input and the reference image on the basis of the incoherent optics [5, 6]. The non-linear ampli-

fier simulates the signal processing property in the nerve cell that magnifies small input signal but restrains the magnitude of the signal above input as if the cell calms down its excitement for enough input. A matrix circuit synthesizes the outputs from these amplifiers. This circuit applies weight to each output from amplifiers and gathers them. The signals for the actuating device and corresponding to the impression of picture are took out from this matrix circuit. In this numerical experiment, each weight given in the simulation equals to one, and the sum of 4 input signals are outputted. This output is used for actuating device and representing the impression. The non-linear amplifier and the matrix circuit can be implemented in the optical system using mirrors, glasses coated with a dielectric material, and a spatial light modulator composed of the liquid crystal device.
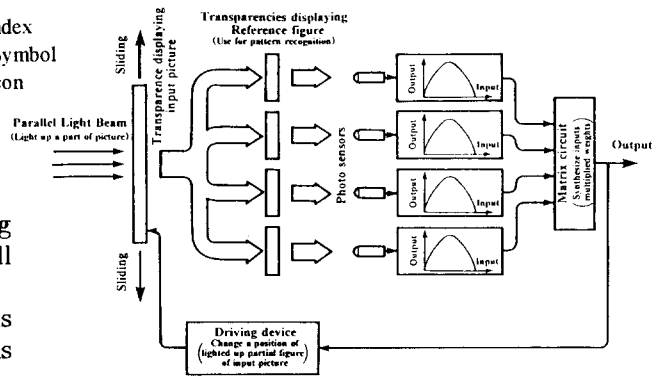

Figure 2: Flow diagram of optical and electric signal for simulating the movement of eyes, which gaze and shift glance on the picture formed by 4 figures.

The signal outputted from the matrix circuit shifts a position of light spot on the input picture by moving the transparence displaying it. The movement of the transparence, that is, the change of the position indicated by the light spot represents the gaze of the eyes.

Figure 3 shows the output from the matrix circuit, and displays the attractor drawn using this signal and delayed it.

The signal changes randomly, and the figure of attractor draws a circle like a reeled yarn. The attractor shows that this signal changes as the attractor draws a multi-dimensional torus. This signal varies sensitively like a chaotic signal by the change of the input image. In this experiment, the input image is represented by the values of agreement between the partial figure forming the

input picture and the reference figure. The figure of attractor changed by the input image can be used to display the impression of the input picture, which was created by the system.

The mechanism of recognizing the meaning of the picture can not be described by an analytical approach that typically explains a system by its partial elements and a piece of knowledge. But rather, a perceptual approach that explains the system as a whole should be adopted [7, 8]. The system proposed in this paper responds chaotically. The chaotic signal is fractal, and the partial parts are similar to the whole of the signal. This characteristic suggests the possibility of explaining the perceptual system on the whole, and creating the impression of the picture autonomously like animal without algorithm.
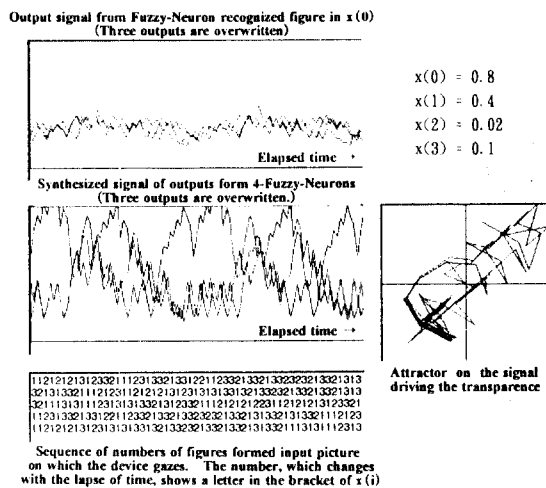

Figure 3: Signal outputted from the matrix circuit, and the attractor drawn from this signal. x(0)~x(3) are values of recognition for figures obtained by Fuzzy-Neurons, by which the shape of the input picture is represented. Calculated lines are overwritten on the charts in order to display that the outputs change randomly.

4   Conclusions

This paper has shown an optical system can create an impression of a picture by the simulation of gaze and glance. Although the impression of the picture is not expressed by only gaze and glance, the response based on gaze and glance can be used to express the impression because this response shows unique change autonomously for different input image.

The association and correspondence of conceived impression with the meaning on the pic-

ture is currently being studied. The meaning can probably be explained on the basis of the relation between a symbol of the impression and the knowledge previously acquired form experience. The knowledge describes geometrical construction among figures of the picture, and shows the context on matters displayed on the picture. The knowledge also relates to the short- and long-term memory and the learning of the human being. The optical system that can display the knowledge and symbolize the impression is being considered.

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