A face/object recognition system using coarse region segmentation and dynamic-link matching

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Abstract. An image recognition model that combines some neural-network-based image processing models is proposed. The recognition procedure consists of coarse region segmentation/extraction performed by a resistive-fuse network, Gabor wavelet transformation and dynamic-link matching. We have also developed a PC-based face/object recognition system including FPGA implementation of the resistive-fuse network. The system has successfully achieved real-time face recognition from a natural scene image.

Keywords: face recognition; region segmentation; Gabor wavelet transformation; dynamic-link matching

1. Introduction

For realizing human-like intelligent processing, one of the most important challenges is the vision. It is almost impossible for the current artificial vision systems to obtain the correct information from complicated and vague visual scenes with fluctuating illumination. We propose an image recognition model that combines some neural-network-based image processing models inspired by the brain functions. We have also developed a real-time face/object recognition system including FPGA implementation of vision processing.

2. Recognition Model for Natural Scene Images

It is desirable for natural-scene image recognition that meaningful image regions are segmented, extracted and processed separately, because several objects usually exist in a natural scene. Figure 1 shows the processing flow of our model for face/object recognition from natural scene images [1]. Our recognition procedure consists of coarse region segmentation/extraction, Gabor wavelet transformation (GWT) and dynamic-link matching.

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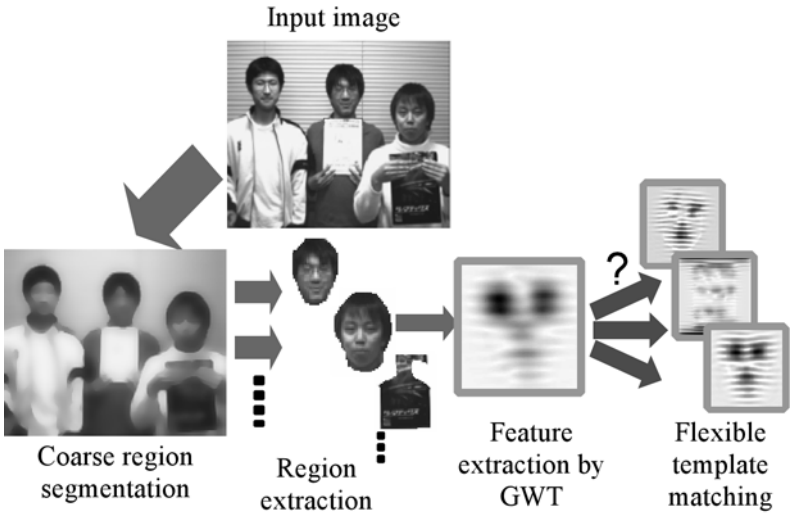

Fig. 1. Processing flow for face/object recognition from natural scene images.

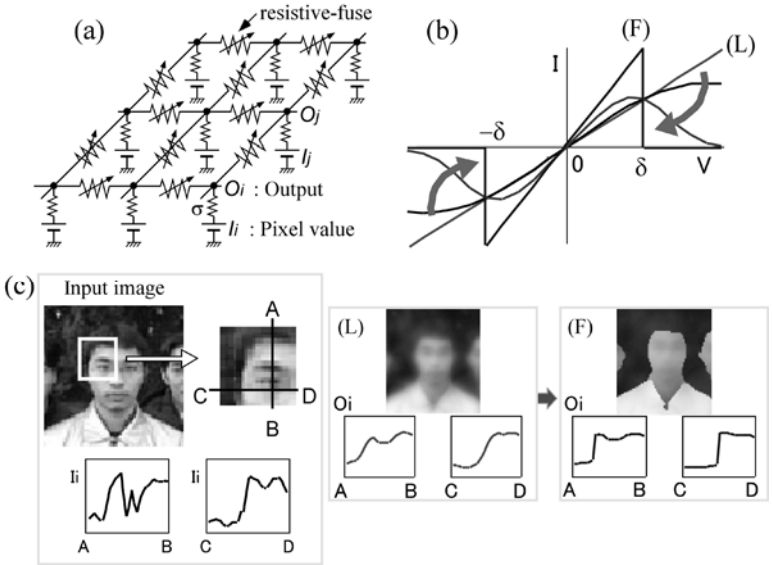

Fig. 2. Coarse region segmentation using a resistive-fuse network: (a) resistive-fuse network model. (b) I-V characteristics of a resistive-fuse element. The characteristic is changed from linear resistance (L) to resistive-fuse (F), which is called *annealing*. (c) Image processing results using a resistive-fuse network with annealing.

Coarse region segmentation performed by a resistive-fuse network is a unique process in our model. The resistive-fuse network was proposed originally for image segmentation in which image edges are preserved and noise is eliminated [2].

All image regions segmented by the resistive-fuse network are extracted one by one, and then, feature extraction using GWT is performed for each extracted region image. Using the Gabor features, recognition processing based on flexible template matching is performed.

Using the template matching based on the dynamic-link architecture [3], the best matched stored image is searched by moving the corresponding sampling points for matching between input and stored images. The matching evaluation is done by a trade-off between better matching in Gabor features and less distortion in the sampling points. In the memory phase, Gabor features at all pixels of the image are stored, while, in the recognition phase, Gabor features at only sampling points (for example, 8 x 8 points) of the image are used for the matching process. Therefore, the processing time for GWT in the recognition phase is much shorter than that in the memory phase.

3. Face/Object Recognition System

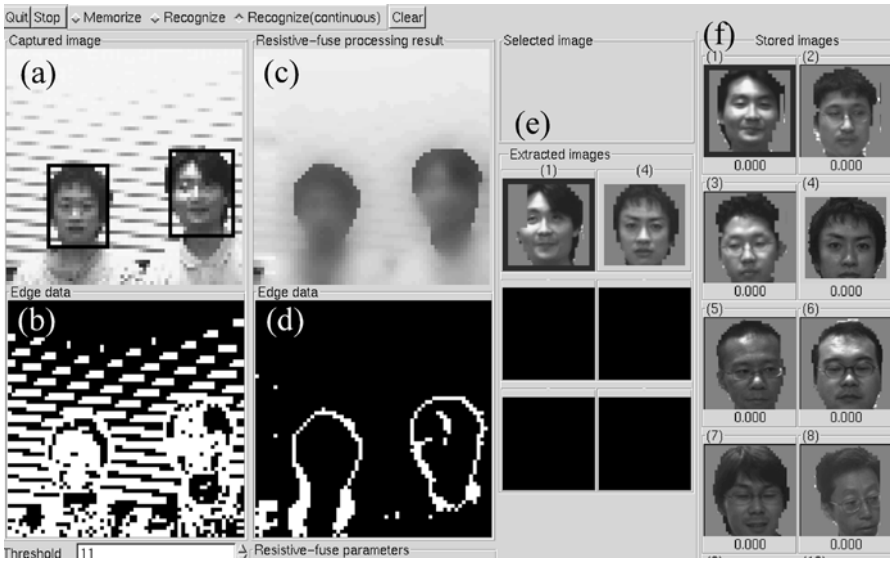

Fig. 3. PC display image of our recognition system.

We have developed a PC-based real-time face/object recognition system. Figure 3 shows a PC display of our recognition system. Figure 3 (a) shows an input image, which is a snapshot of two persons standing in front of a window shade. In the usual edge

detection result of this image (b), all edges of the detail of the human faces and the shade are detected, and no meaningful region can be segmented. In the resistive-fuse processing result (c) and its edge detection result (d), only the whole human face regions are successfully segmented. The extracted regions are shown at (e), and they are compared with the stored images listed at (f). The best matching image for each extracted face image is indicated by the corresponding number above the image. The figure shows correct recognition results.

In this system, the resistive-fuse network for coarse region segmentation is digitally implemented by an FPGA [4]. Toward faster implementation of the image processing, we are developing a resistive-fuse network LSI using the merged analog/digital LSI architecture [5]. We have also developed a nonlinear oscillator network LSI for image region extraction [6] and a Gabor filter LSI [7].

Acknowledgements

This work was partially supported by the 21th Century COE (Center of Excellence) Program in Kyushu Institute of Technology, entitled "World of brain computing interwoven out of animals and robots". This work was also partially supported by fund from the Japanese Ministry of Education, Culture, Sports, Science and Technology via Kitakyushu innovative cluster project and under Grant-in-Aid for Scientific Research on Priority Areas (A).

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