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Texture Boundary Detection Based on Color and Orientation Using CNN

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1. Introduction

Cellular Neural Networks (CNN) [1] were introduced by Chua and Yang in 1988. The idea of the CNN was inspired from the architecture of the cellular automata and the neural networks. The CNN can be used for various image processing application.

Some scenes in the real world may have some regions and boundaries. Hence, it is important in image processing to detect those boundaries. C.T. Lin et al. have proposed the texture segregation as early vision using CNN [2]. They have confirmed the texture boundary detection of high accuracy by considering the orientation feature. However, those texture images are gray-scale image, and we feel that the color information should be considered in texture segregation tasks. In particular, when we segregate the two textures having the same orientation feature and different color, those texture can be segregated by considering the color information. Thus, this paper will focus on the color texture boundary detection.

In this study, we propose the texture boundary detection based on color information and orientation feature using CNN. The proposed CNN can consider color information and orientation feature at the same time, hence, we can realize the advanced texture boundary detection. In this paper, we show some texture boundary detection results using the proposed algorithm.

2. Proposed Algorithm

In this section, we describe the proposed algorithm for texture boundary detection. Figure 1 shows the structure of the proposed CNN. The proposed CNN consists of three single CNN. One of the three layers decides the independent layer and the other two layers have mutual coupling. Namely, independent layer considers the color information by using binarization process and two layers consider the orientation feature by using Gabor filter. Thus, the proposed CNN can consider the both information at the same time.

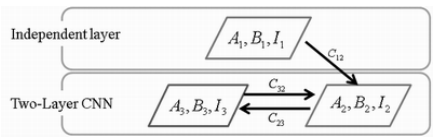

Figure 1: Structure of proposed CNN.

Figure 2 shows the proposed algorithm. First, a color image is converted to three gray-scale images by using the HSB model. Second, we make the histogram from three gray-scale images, and we decide the color of independent layer from the histogram analysis. Third, the proposed CNN processes the three gray-scale images in considering the color information and orientation feature. From third processing, some regions having the different color and different orientation are segregated. Forth, the boundaries of segregated regions are detected by using some processes such as "Full Wave Rectification" in the conventional CNN. Finally, we can obtain the texture boundary detection result.

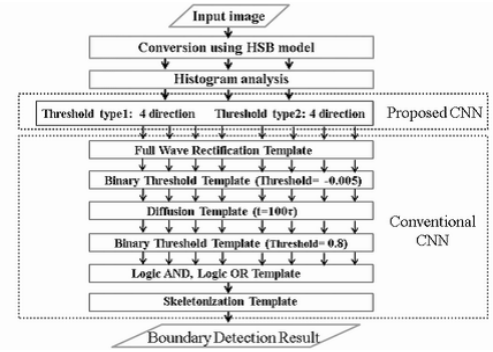

Figure 2: Proposed algorithm for boundary detection.

3. Simulation Results

In this section, we show some texture boundary detection results. Figures 3 (a) and (c) are color texture input images, and those images have four regions. In these four regions, right up region and left up region have the same color and different orientation feature. Further, right up region and right down region have different color and the same orientation feature.

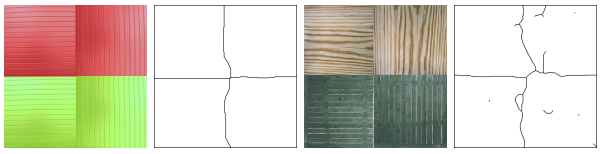

Figure 3: Simulation results. (a) Color texture image. (b) Boundary detection result for Fig. 3(a). (c) Color texture image. (d) Boundary detection result for Fig. 3(c).

Figure 3(b) shows the texture boundary detection result for Fig. 3(a), and we can see that the two textures having the same orientation and different color can be segregated. However, in Fig. 3(d), we can see that the boundaries of four regions in Fig. 3(c) can not be detected well.

4. Conclusions

In this study, we have proposed the CNN that could consider the both information at the same time, and the texture boundary detection algorithm. By computer simulation, we could confirm advanced texture boundary detection. However, in this paper, we used only simple texture images. In the future works, we should carry out the texture boundary detection for complex texture images.

References

[1] L.O. Chua and L. Yang, "Cellular Neural Networks: Theory," IEEE Trans. Circuits Syst., vol. 32, no. 10, pp. 1257-1272, Oct. 1988.

[2] C.T. Lin, C.H. Huang and S.A. Chen,"CNN-Based Hybrid-Order Texture Segregation as Early Vision Processing and Its Implementation on CNN-UM," IEEE Trans. Circuits Syst., vol. 54, no. 10, pp. 2277-2287, Oct. 2007.