Cellular Neural Networks with Switching Two Templates for Image Processing

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I. Introduction

In 1998, the Cellular Neural Networks (CNN) is introduced by L. O. Chua and L.Yang [1]. In the image processing of the Cellular Neural Networks (CNN), it is difficult to process complex parts of the input image; edge, background, etc. Some reserach are reported that it is possible to process complex parts by switching two templates which have the different feature. Therefore, we propose, in this study, a new CNN method of switching two templates; 3×3 and 5×5 templates. We apply our proposed method to edge detection and investigate its performance.

II. Our proposed method

The feature of our proposed method is switching two templates by using the maximum and the minimum output values (v_{ymax}: cell's maximum output value, v_{ymin}: cell's minimum output value) surrounding the center cell. The concept of our proposed method is shown in Fig. 1. The processing steps of our proposed method are described as followed:

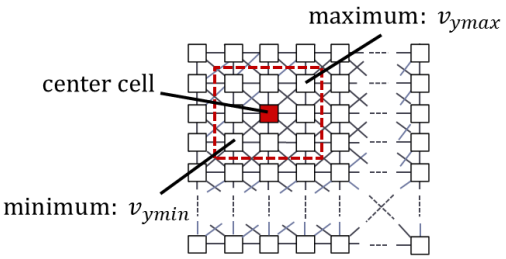

Fig. 1. Proposed CNN

Step 1: First, decide the center cell. Then, find the v_{ymax}, and v_{ymin} from the 3×3 neighborhood.

Step 2: Secondly, calculate the difference value between v_{ymax} and v_{ymin}; $|v_{ymax} - v_{ymin}|$.

Step 3: Finally, determine the template by the threshold value a according to the following equations.

$$\begin{aligned} &3 \times 3 \text{ template: } |v_{ymax} - v_{ymin}| \leq a \\ &5 \times 5 \text{ template: } |v_{ymax} - v_{ymin}| > a. \end{aligned} \quad (1)$$

This process is applied to all cells in the input image.

Step 4: Step1 to step3 are repeated every 0.15 [τ].

III. Simulation Results

We apply our proposed method to edge detection. Figure 2 shows the simulation results and Fig. 2 (a) shows the input image. In Fig. 2 (b), edge lines are not detected clearly using the 3×3 template. On the other hand, in Fig. 2 (c), edge lines of the text parts can be detected using the 5×5 template. However, some noise remains in black areas of the input image. In Fig. 2 (d), our proposed method can detect edge lines clearly and receive less noise effect. Edge detection using the 3×3 template is insusceptible to noise effect. Therefore, 3×3 template applies to black areas of the input image. Moreover, 5×5 template applies to the text parts. Hence, our proposed method removed noise by switching two templates.

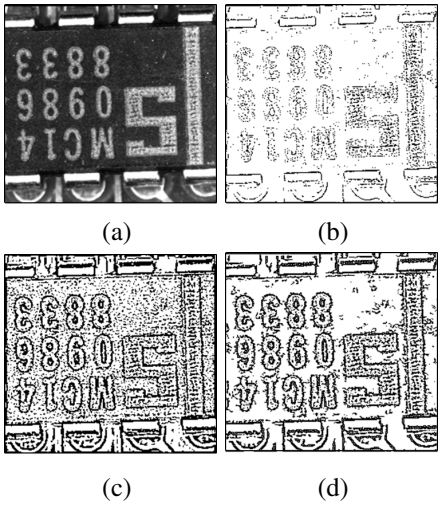

Fig. 2. Simulation results. (a) Input image. (b) Simulation result using the 3×3 template. (c) Simulation result using the 5×5 template. (d) Simulation result of our proposed method ($a = 1.8$).

IV. Conclusion

In this study, we have proposed a new CNN method of switching two templates. The simulation results show that our proposed method is effective to detect edge lines of complex parts and to remove some noise. Therefore, our proposed method is more effective than the CNN in edge detection.

References

[1] L. O. Chua and L. Yang, "Cellular Neural Networks: Theory," IEEE Trans. Circuits Syst, vol. 35, pp. 1257-1272, Oct. 1988.