1-34

Cellular Neural Networks with Switching Two-Type Templates for Edge Detection

Takahisa Ando, Yoko Uwate and Yoshifumi Nishio
(Tokushima University)

1. Introduction

In this study, we propose switching two-type templates CNN. In our proposed method, 3×3 template and 5×5 template are switched. When 3×3 template is used, processing speed is quick, however the delicate process is difficult. When 5×5 template is used, processing speed is brady and easy to receive noise effect, however the delicate process is possible. We investigate this method in edge detection.

2. Proposed Method

In our proposed method, two templates are switched according to the output values around cells in processing. Switching condition depends on the difference value between the maximum and minimum output values y_{max}, y_{min} of each 5×5 neighborhood and is given as follows:

$$\begin{cases} |y_{max} - y_{min}| \leq a \\ |y_{max} - y_{min}| > a \end{cases} \quad (1)$$

We fix a certain value a as threshold about switching template. When the top inequality of (1) is satisfied , 3×3 template is used. In the other case, 5×5 template is used. This switching process is conducted every certain number of calculation n.

3. Simulation Results

In this section, we show simulation results of the edge detection for using our proposed method and the conventional CNN. Using 3×3 and 5×5 templates of the edge detection is described as follows.

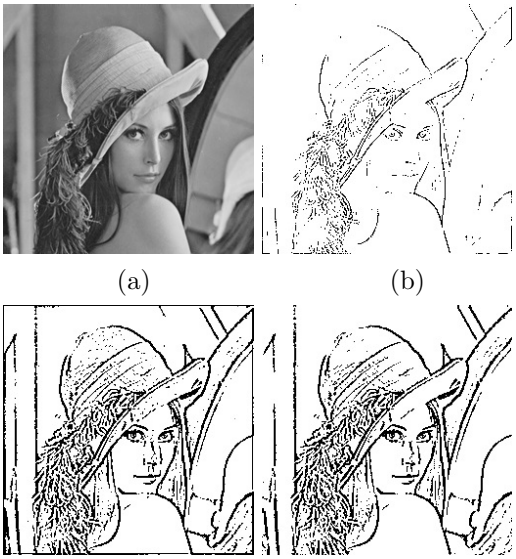
Edge detection template :

$$A = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 0 \end{bmatrix},$$

$$B = \begin{bmatrix} -1 & -1 & -1 \\ -1 & 8 & -1 \\ -1 & -1 & -1 \end{bmatrix}, \ I = -1. \quad (2)$$

$$A = \begin{bmatrix} 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \end{bmatrix},$$

$$B = \begin{bmatrix} -1 & -1 & -1 & -1 & -1 \\ -1 & 0 & 0 & 0 & -1 \\ -1 & 0 & 16 & 0 & -1 \\ -1 & 0 & 0 & 0 & -1 \\ -1 & -1 & -1 & -1 & -1 \end{bmatrix}, \ I = -1. \quad (3)$$



(a) (b) (c) (d)

Figure 1: Simulation results. (a) Input image. (b) Simulation result of the 3×3 CNN. (c) Simulation result of the 5×5 CNN. (d)Simulation result of the proposed method ($a = 0.8$, $n = 60$).

Figure 1(a) shows an input image. The input image has indistinct portions. Indistinct portions are the pillar of the left-side and an outline of a woman's face. Figure 1(b) shows the simulation result of the 3×3 CNN. The 3×3 CNN cannot detect edge lines of indistinct portions. Figure 1(c) shows the simulation result of the 5×5 CNN. The 5×5 CNN can detect edge lines of indistinct portions, however image processed by this method receives noise effect. Figure 1(d) shows the simulation result of our proposed method ($a = 0.8$, $n = 60$). In Fig. 1(d), our proposed method can detect edge lines of indistinct portions and receive less noise effect compared to Fig. 1(c). From the simulation results, our proposed method is more effective than the conventional CNN.

4. Conclusions

In this study, we proposed the new method of switching two-type templates by the threshold a and the certain number of calculation n for CNN. In order to confirm the effectiveness of our proposed method, we tried our proposed method as a method of edge detection. As a result, our proposed method is more effective than the conventional CNN in edge detection. In future work, we will introduce the third template as the noise removal template and switch three-type templates.