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Edge Detection by Using Switching System with Cellular Neural Networks and Delayed Cellular Neural Networks

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1. Introduction

In our previous study, we applied the DCNN to image processing and obtained good results. However, we have a problem of the noise in image processing. We consider past information of the DCNN have a profound effect.

In this study, we propose a new algorithm of switching system with the conventional CNN and the DCNN. Our proposed method is switched the conventional CNN and the DCNN by iteration values. Therefore, our proposed method is less past influence than the DCNN. In order to confirm the effectiveness of the proposed method, we investigate the effect of the proposed method in image processing.

2. Proposed method

In this section, we explain the algorithm of our proposed method. The proposed method is switched with the conventional CNN and the DCNN by iteration values. The algorithm is described as follows.

[Step1]: We set the parameter of iteration values τ_1 and τ_2. In the parameter of iteration values, τ_1 is less than τ_2.

[Step2]: We select the conventional CNN or the DCNN by iteration values τ_1 and τ_2. Figure 1 shows the switching rule of the proposed method. If the iteration value is range 0 to τ_1 or more than τ_2, we select "the conventional CNN". On the other hand, if the iteration value is range τ_1 to τ_2, we select "the DCNN".

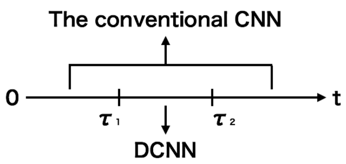

Figure 1: Switching Rule.

3. Simulation results

In this section, in order to confirm the effectiveness of the proposed method, we investigate the proposed method in the edge detection. We show some simulation results of the edge detection. Edge detection templates of the conventional CNN and the DCNN are described as follows.

Edge detection templates of the conventional CNN :

$$A = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 0 \end{bmatrix},$$
$$B = \begin{bmatrix} -1 & -1 & -1 \\ -1 & 8 & -1 \\ -1 & -1 & -1 \end{bmatrix}, \quad T = -1. \qquad (1)$$

Edge detection templates of the DCNN :

$$A = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 0 \end{bmatrix}, \quad B = \begin{bmatrix} -1 & -1 & -1 \\ -1 & 8 & -1 \\ -1 & -1 & -1 \end{bmatrix},$$
$$D = \begin{bmatrix} -0.1 & -0.1 & -0.1 \\ -0.1 & 0.1 & -0.1 \\ -0.1 & -0.1 & -0.1 \end{bmatrix}, \quad T = -1. \qquad (2)$$

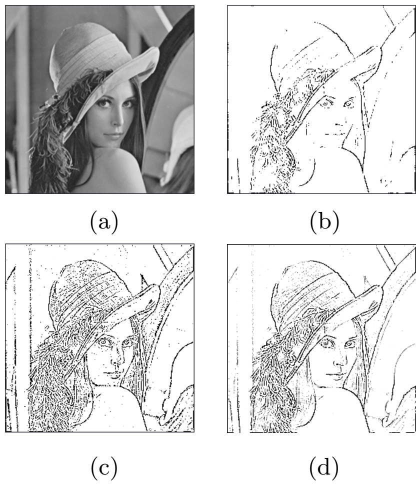

Figure 2: Simulation results of LENNA 256×256. (a) Input image. (b) Simulation result of the conventional CNN. (c) Simulation result of the DCNN($\tau = 0.05$). (d) Simulation result of the proposed method ($\tau_1 = 0.1$ and $\tau_2 = 4$).

Figure 2 shows simulation results of the edge detection. Figure 2(a) shows an input image. Indistinct parts are a pillar and mirror of the background. Figure 2(b) shows the simulation result of the conventional CNN. In Fig. 2(b), the conventional CNN detects less edge lines of indistinct parts. Figure 2(c) shows the simulation results of the DCNN ($\tau = 0.05$). In Fig. 2(c), the DCNN detects edge lines of indistinct parts. However, the processing of the DCNN have a problem of the noise. Figure 2(d) shows simulation result of the proposed method ($\tau_1 = 0.1$ and $\tau_2 = 4$). In Fig. 2(d), the proposed method detects edge lines of indistinct parts. Moreover, the proposed method solves the problem of noise. Therefore, the proposed method is more effective than the conventional CNN and the DCNN in the edge detection.

4. Conclusions

In this study, we proposed the new algorithm of switching system with the conventional CNN and the DCNN. In order to confirm the effectiveness of the proposed method, we investigate the effect of the proposed method in edge detection. From some simulation results, the proposed method is more effective than the conventional CNN and the DCNN in the edge detection.