1-10

Cellular Neural Networks with Partial Delay Output for Edge Detection

Fumiki Sugano　Takahisa Ando　Yoko Uwate　Yoshifumi Nishio
(Tokushima University)

1. Introduction

Cellular Neural Networks with Delay Output (DCNN) has been applied in the time-varying image processing, however it was not applied in the still image processing. Since video is continuous of images, we considered that the DCNN could be applied to images.

In the previous study, it is reported that the DCNN was applied to the image processing and obtained good results. However, it has problem that noise effect is observed in the output image.

In this study, we propose a method of CNN with partial delay output (DCNN). We investigate the performance of the proposed method in edge detection.

2. Proposed Method

In this section, we explain the algorithm of the proposed method. The proposed method is CNN with partial delay output (DCNN). The algorithm is described as follows.

[Step1]: Set parameter of a and N.

$$-1 \leq a \leq 1,\ 0 \leq N \leq 8. \tag{1}$$

[Step2]: Calculate difference values between the output value of the center cell and the output values of the neighboring cells.

[Step3]: Count number of cells which have the difference value smaller than a. Then, determine the method according to the following equations.

$$\begin{cases} CNN : x > N \\ DCNN : x \leq N \end{cases} \tag{2}$$

3. Simulation Results

In this section, we apply the proposed method to edge detection. Edge detection templates of the conventional CNN and the DCNN are described as follows.

Edge detection templates of the conventional CNN :

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

$$B = \begin{bmatrix} -1 & -1 & -1 \\ -1 & 8 & -1 \\ -1 & -1 & -1 \end{bmatrix},\ I = -1. \tag{3}$$

Edge detection templates of the DCNN :

$$A = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 0 \end{bmatrix},\ B = \begin{bmatrix} -1 & -1 & -1 \\ -1 & 8 & -1 \\ -1 & -1 & -1 \end{bmatrix},$$

$$D = \begin{bmatrix} -0.1 & -0.1 & -0.1 \\ -0.1 & 0.1 & -0.1 \\ -0.1 & -0.1 & -0.1 \end{bmatrix},\ I = -1. \tag{4}$$

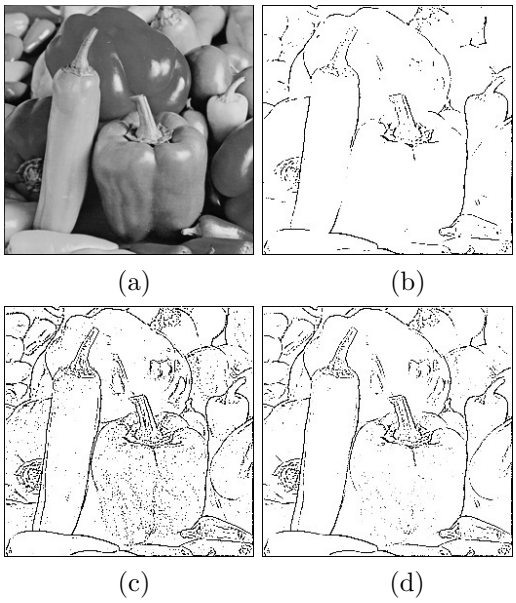

Figure 1: Simulation results. (a) Input image. (b) Simulation result of the conventional CNN. (c) Simulation result of the DCNN(τ=0.01). (d) Simulation result of the proposed method ($a = 0.00017, x = 5$).

In Fig. 1, we show the input image and the simulation results of the edge detection. Figure 1(a) shows the input image. In the input image, indistinct parts are the right side of the red pepper and the vegetable in the upper left. In Fig. 1(b), we show the simulation result of the conventional CNN. The conventional CNN cannot detect edge lines of the indistinct parts. In Fig. 1(c), we show the simulation result of the DCNN (τ=0.01). The DCNN can detect edge lines of indistinct parts, however, remains the noise effect. In Fig. 1(d), we show the simulation result of the proposed method (a=0.00017, x=5). The proposed method can detect edge lines of indistinct parts and receive less noise effect compared with the DCNN. It is because we applied the DCNN to indistinct parts.

4. Conclusions

In this study, we have proposed a new CNN method of adding delay output (DCNN) to the conventional CNN partially. From the simulation results, the proposed method can detect edge lines of indistinct parts and decrease effect of noise compared with the DCNN. Therefore, the proposed method is more effective than the conventional CNN and the DCNN in the edge detection. In the future work, we will investigate the performance of the proposed method for another image processing.