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Two-Layer DT-CNN with Switching Template

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1. Introduction

In this study, we propose a new system of two-layer Discrete-Time Cellular Neural Network (DT-CNN) and investigate the output characteristics. The proposed system has different structure of conventional DT-CNN. In particular, the structure of proposed system is two-layer. Also two templates are switched by outputs value of each layer. From simulation results, we confirm that the proposed system is more effective than the conventional CNN for some image processings.

2. Proposed system

In this section, we explain the system of the proposed two-layer DT-CNN. Figure 1 shows the block diagram of the proposed system. The structure of the proposed system based on conventional two-layer CNN. Also, the proposed system has two switching templates A_S and C_S that are switched by outputs value of each layer. In the two switching templates, A_S, C_S templates are switched two types by outputs value of each layer.

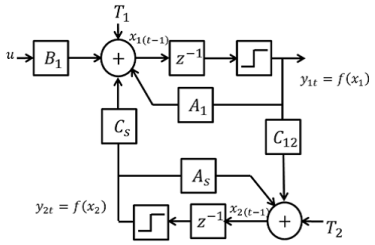

Figure 1: Block diagram of the proposed system.

The switching condition expression and state, output equation are shown as follows.

Switching condition expression :

$$v_{y1ij}(t) = v_{y2ij}(t) : A_{21} and C_{21} templates \quad (1)$$

$$v_{y1ij}(t) \neq v_{y2ij}(t) : A_{22} and C_{22} templates \quad (2)$$

3. Simulation result

In this section, we show simulation results by using proposed system. In this simulation, we simulated edge detection and binarization. Templates and thresholds of each layer are assigned as follows.

Template of first-layer, coupling template and thresholds:

$$A_1 = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 0 \end{bmatrix}, \; B = \begin{bmatrix} -1 & -1 & -1 \\ -1 & 8 & -1 \\ -1 & -1 & -1 \end{bmatrix},$$

$$C_{12} = \begin{bmatrix} 1 & 1 & 1 \\ 1 & 8 & 1 \\ 1 & 1 & 1 \end{bmatrix}, \; T_1 = T_2 = 0. \quad (3)$$

Switching template:

$$A_{21} = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 0 \end{bmatrix}, \; A_{22} = \begin{bmatrix} 0 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 0 \end{bmatrix},$$

$$C_{21} = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 0 \end{bmatrix}, \; C_{22} = \begin{bmatrix} 0 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 0 \end{bmatrix}. \quad (4)$$

In the Fig. 2(a), the buildings of the background are indistinct portions. Figures 2(b) and (c) show the simulation result by using conventional DT-CNN. One the other hand, Fig 2(d) shows the simulation result by using proposed system. In the Fig. 2(b) and (c), the indistinct portions can not be detected. In addition, in the Fig. 3(b), a detail that the camera and the aspect of face can not be shown. In contrast, in the Figs. 2(c), indistinct portions can be detected. In addition, in the Figs. 3(c), the detail that the camera and the aspect of face can be shown. From simulation results, we can say that the proposed system is more effective than the conventional DT-CNN.

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

Figure 2: Simulation results. (a) Input image, (b) Binarization by conventional DT-CNN, (c) Edge detection by conventional DT-CNN, (d) First-layer of proposed system.

(a) (b) (c)

Figure 3: Closeup of simulation results. (a) Binarization by conventional DT-CNN, (b) Edge detection by conventional DT-CNN, (c) First-layer of proposed system.

4. Conclusions

In this study, we proposed two-layer DT-CNN with switching template. From simulation results, the proposed system could detect about the indistinct and the detail portions. Therefore, we could say that the proposed system is more effective than the conventional DT-CNN.