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Application of Periodic Pattern Formation for Number Measurement and Object Extractionin in Cellular Neural Networks

Sosuke Nakano, Yoko Uwate and Yoshifumi Nishio
(Tokushima University)

1. Introduction

In this study, we propose a new method using periodic pattern formation in the CNN. First, we investigate spot templates producing periodic patterns. Next, we develop two image processing algorithms using the template. One is an algorithm to measure the number of objects in an image. The other one is an algorithm to extract the objects in an image.

2. Proposed Method

We use SPOT template for the two proposed algorithms. SPOT template makes white spots in a black area having spatial uniformity and black spots in a white area having spatial uniformity in Fig. 1(b). The spots are made only in areas wider than a certain size. Also, this template enhances periodicity in the area having spatial periodicity. In Fig. 1(b), as the result of spatial periodicity enhancement, lines are formed.

(a) (b) (c)

Figure 1: Simulation results. (a) Input image. (b) Simulation result of using the SPOT template. (c) Binarized input image.

The background and objects are not separated in Fig. 1(c). Thus, the accuracy of number measurement and object extraction is not good. We can separate the background and objects into spots and lines by using the SPOT template. Comparing Fig. 1(b) and Fig. 1(c), we can see that the background and objects are more separated in Fig. 1(b) than in Fig. 1(c). As a result, the accuracy of number measurement and object extraction has been improved.

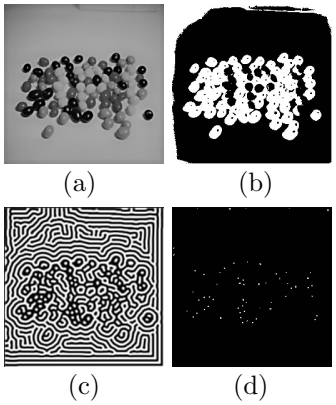
3. Simulation Results

In this section, we show simulation results for the two algorithms, object measurement and object extraction. The SPOT template used in both algorithms is described as follows.

SPOT template :

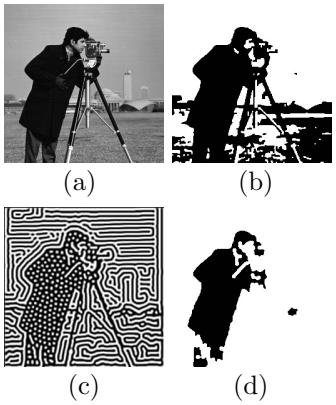
$$A = \begin{bmatrix} -0.25 & -1 & -1.5 & -1 & -0.25 \\ -1 & 2.5 & 7 & 2.5 & -1 \\ -1.5 & 7 & -23.25 & 7 & -1.5 \\ -1 & 2.5 & 7 & 2.5 & -1 \\ -0.25 & -1 & -1.5 & -1 & -0.25 \end{bmatrix},$$

$$B = \begin{bmatrix} 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \end{bmatrix}, \qquad I = 0. \qquad (1)$$



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

Figure 2: Simulation results. (a) Input image. (b) Binarized input image. (c) Simulation result of using the SPOT template. (d) Simulation result of using the proposed method.



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

Figure 3: Simulation results. (a) Input image. (b) Binarized input image. (c) Simulation result of using the SPOT template. (d) Simulation result of using the proposed method.

Figure 2(a) shows input image contains 82 objects to be measured. In Fig. 2(b), the background is still visible, but in Fig. 2(c), the lines are also displayed in the background area. This allows us to focus on the object. The number of objects to be measured from the image in Fig. 2(d) was 60.

Figure 3(a) shows input image containing the object to be extracted. The background is still visible In Fig. 3(b). In contrast, the lines are also displayed in the background area in Fig. 3(c). This allows us to focus on the object. Figure 3(d) shows only the objects can be extracted.

4. Conclusions

In this study, we proposed the two new algorisms by using spot template in CNN. We were able to separate the object from the background in the image by using SPOT template. As a result, we were able to improve the accuracy of the number measurement and also the extraction of objects.