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CNN Template Learning by BP with Annealing Noise

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1. Introduction

Cellular Neural Networks(CNN) were introduced by Chua and Yang in 1988. The idea of CNN was inspired from the architecture of the cellular automata and the neural networks. The CNN can be used for various image processing application. The output image of CNN is decided by the parameter called a template. Therefore, a template is the most important parameter in CNN. However, there is a problem that the design of the suitable template for obtaining the ideal output image is difficult. Then, some template designs are proposed, for example, Genetic Algorithm (GA) is representative.

In the previous study, we proposed template learnings of CNN using Back Propagation Algorithm (BP), and estimated the accuracy of learning [1]. Concretely, we designed the template of CNN dynamically, by BP learning using the error between the output image and the ideal image. Furthermore, we conducted more detailed investigation by changing the number of learning times and the learning rate in BP, we verified better conditions of template designs.

However, there is a problem in BP that a solution sinks into local minima, cannot reach the optimal solution. So, in this study, we add annealing noise inspired from Simulated Annealing (SA) to BP. We add annealing noise at the time of renewal of a template in BP learning, we verify the conditions which slip out of local minima, and reach the optimal solution.

2. Proposed Algorithm

We define annealing noise ϵ as follow.

$$\epsilon = \text{“}SN\ ratio\text{”} \times \left(1 - \frac{Current\ learning\ times}{Total\ learning\ times}\right) \times \text{“}random\ noise\text{”}, \quad (1)$$

In SA, influence on search of a solution is reduced by decreasing the temparture parameter T according to the schedule. So, in this study, we replace time line with the number of learning times. Therefore, the more the number of learning times increase, the less adding noise decreases.

We add annealing noise ϵ to renewal equation of template.

$$(A, B)^{Renewed} = (A, B)^{Before} + D + \epsilon, \quad (2)$$

where, (A, B) is template, D is renewal quantity of template.

We verify whether the annealing noise prevent from lapsing into local minima and being able to obtain the optimal solution.

3. Simulation Results

In this section, we show error between the ideal image and the output image obtained from learning results.

An example of an input image and its ideal image are shown in Figs. 1 and 2, respectively.

Input image:

Figure 1: Input image.

Ideal image:

Figure 2: Ideal image.

The error curve is shown in Fig. 3. In this study, we change two parameters; the number of learning times and the learning rate. Three lines in Fig. 3 show the error of respective learning rates. The horizontal axis shows the number of learning times and the vertical axis shows the error between the ideal image and the output image. We set the value of “SN ratio” as 0.1 and the value of random noise from -1.0 to 1.0.

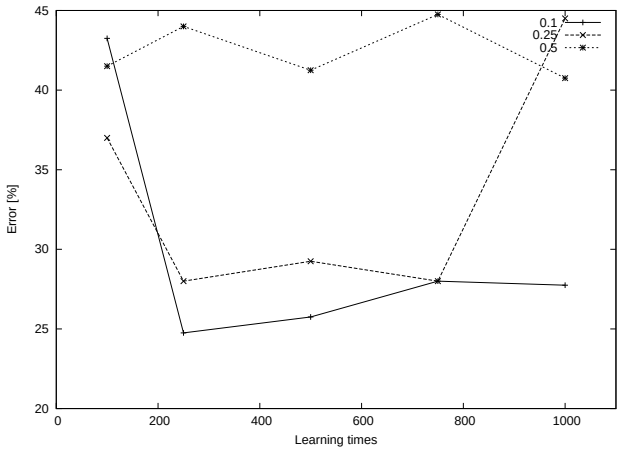

Figure 3: Error curve.

Fig. 3 shows three results. First, the bigger learning rate set, the bigger error appears. Second, in the case of learning rate “0.5”, all of the errors are big. Third, when the number of learning times from 250 to 500, the error tend to become small. However, all of errors are so big, we have to improve our proposed method.

4. Conclusions

In this study, we have added annealing noise to BP, and we verified its effect by computer simulation. From the results, we verified the good conditions of parameter. However, all of errors are so big, we have to improve our proposed method. Improving the method to obtain the smaller error, and for more complicated images is our important future works.

Reference

[1] M.Nakagawa, T.Inoue and Y.Nishio, “CNN Template Design Using Back Propagation Algorithm,” Proc. of CNNA’10, pp. 47-51, Feb. 2010.