A Radical-Partitioned Neural Network System Using a Modified Sigmoid Function and a Weight-Dotted Radical Selector for Large-Volume Chinese Characters Recognition VLSI

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Abstract

This paper presents a radical-partitioned neural network system using a modified Sigmoid function and a weight-dotted radical selector for large-volume Chinese characters recognition VLSI. With a modified Sigmoid function and the weight-dotted radical selector, the recognition rate of 1000 radical-partitioned Chinese characters can be enhanced to 90% *from* 70% *for the input samples with 15% random errors as compared to the system without it.*

Introduction

A coded block neural network system with a radical-partitioned structure for large-volume Chinese characters recognition VLSI was reported [1]. With the coded block structure, VLSI implementation of neural network for large-volume Chinese characters become feasible [2]. With the radical-partitioned structure, training a large-volume Chinese characters can be achieved [2][3]. However, due to the radical-partioned structure and the Sigmoid function, the recognition rate may be limited. In this paper, using a modified Sigmoid function and a weight-dotted radical selector structure, a radical-partitioned neural network system for large-volume Chinese characters recognition VLSI is described. In the following sections, the radical-partitioned structure with the radical selector is described first, followed by the back propagation algorithm with the modified Sigmoid function and results.

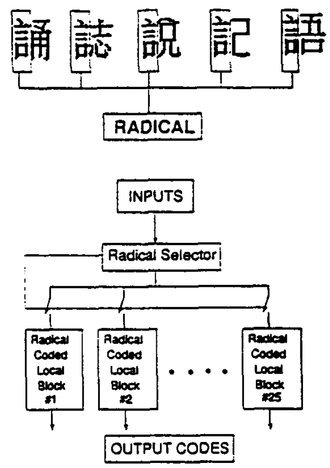

Figure 1: (a) The radical of Chinese characters. (b)The coded block adaptive neural network system with a radical-partitioned structure for large-volume Chinese characters recognition.

The Radical-Partitioned Structure

Although there are over twenty thousand Chinese characters, they can be categorized into around 230 radical groups. Each radical group has 5–200 characters containing an identical radical portion as shown in Fig. 1(a). Taking advantage of the radical properties, the coded block neural network system has been reconfigured as shown in Fig. 1(b), such that each coded block is assigned to be responsible for training Chinese characters having the same radical portion. Using the coded block system with a radical-partitioned structure, the overall training procedure is simplified. Therefore, convergence is guaranteed and training time is much shorter.

As shown in Fig. 2(a), in a radical selector, it is composed of 82 radical pattern selectors, which are used to identify 82 target radical patterns in 1000 Chinese characters. Below the 82 radical pattern selectors, a multiplexer is used to select one of the 25 specific radicals since some characters may have the same radical of different sizes. (Note: as shown in Fig. 2(b), a radical may have more than one target radical patterns of different sizes.)

In the radical selector, each radical pattern selector as shown in Fig. 2(c) is used to identify the radical pattern of each input character. During the training process, in an epoch, each of the 1000 characters is imposed on the input sequentially. The training principle is to raise the fulfillment rate up to 85% for the target input radical patterns and to lower the fulfillment rate down to 25% for the non-target input radical patterns such that noise margin can be enlarged. During recognition, in the radical selector, as shown in Fig. 2(d), multiple dot products of each input Chinese character vector and all target radical vectors and the weight are carried out. According to the highest value of the normalized dot products, a decision is made on the input character about which radical group it belongs to. Then, the input character is transferred to the associated radical block for further processing.

Back propagation algorithm [4][5] has been used in the system. A modified Sigmoid function has been used: $h_k = \frac{1}{1+e^{-a\sum_i v_{ik} x_i}}$ Compared to the conventional Sigmoid function, the modified Sigmoid function is with a position parameter (a). As shown in Fig. 3, the conventional Sigmoid function has a steep transition ($a = 1$), which may result in input noise immunity problems in recognition. In order to reduce this problem, a modified Sigmoid function with a reduced transition slope ($a < 1$) has been used such that the noise amplification effects can be suppressed.

Simulation Results

In order to investigate the potential of the neural network system with a radical-partitioned structure using the modified Sigmoid function and the weight-dotted radical selector for large-volume Chinese characters recognition, the reconfiguration based on simulation results has been obtained. 1000 Chinese characters composed of 24×24 lattice dots in 25 frequently-

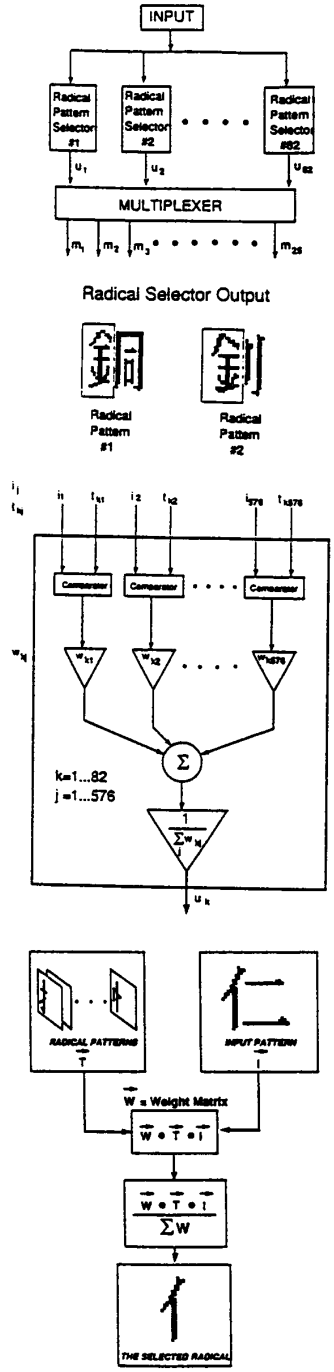

Figure 2: (a) The structure of the radical-selector.(b) A radical of variable sizes in different characters (c)The basic cell in the radical-selector. (d) The normalized weight-dotted products method used for recognition in the radical selector.

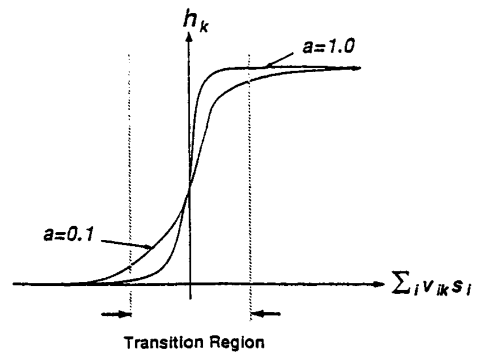

Figure 3: The modified Sigmoid function.

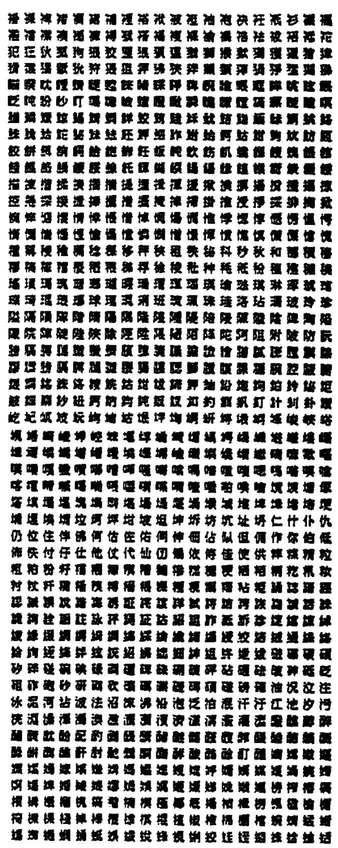

Figure 4: The 1000 Chinese characters.

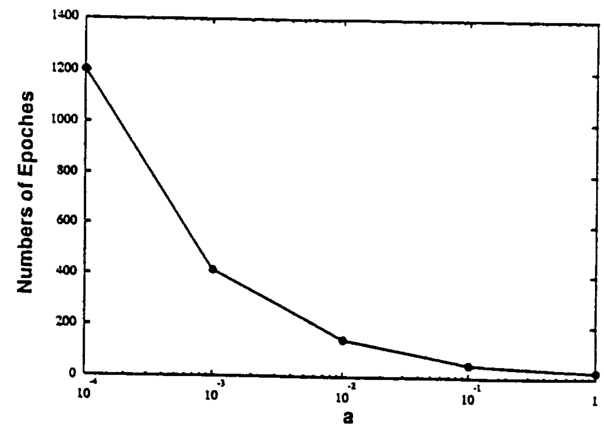

Figure 5: The learning time of a local block of a radical group of 40 Chinese characters vs. "a" in the modified Sigmoid function.

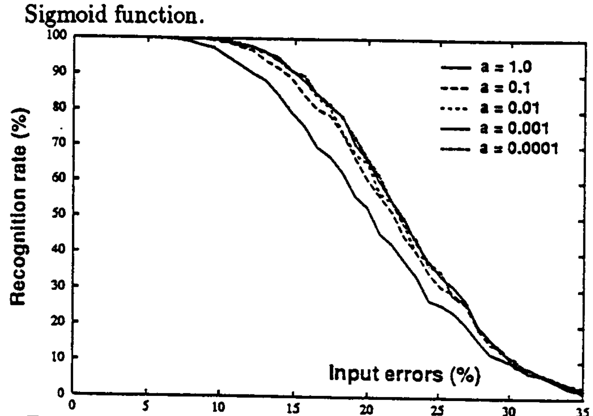

Figure 6: The average output percentage error vs. input percentage error curves for a radical local block in the system Each input sample is with random errors.

used radical groups as shown in Fig. 4 have been used as the training patterns. Each radical block is trained with its 40 associated Chinese characters independently.

Fig. 5 shows the learning time of a local block of a radical group of 40 Chinese characters vs. "a" in the modified Sigmoid function. Due to the reduced transition slope of the modified Sigmoid function, the learning time increases as a decreases. As $a = 1$, it is the conventional Sigmoid function. Using a smaller "a", the increase in the learning time is still tolerable owing to the intrinsic good properties of the local block structure.

Fig. 6 shows the average output percentage error vs. input percentage error curves for a radical local block in the radical-partitioned neural network system using a modified Sigmoid function and a weight-dotted radical selector for input samples taken randomly from each radical. A modified Sigmoid function of different

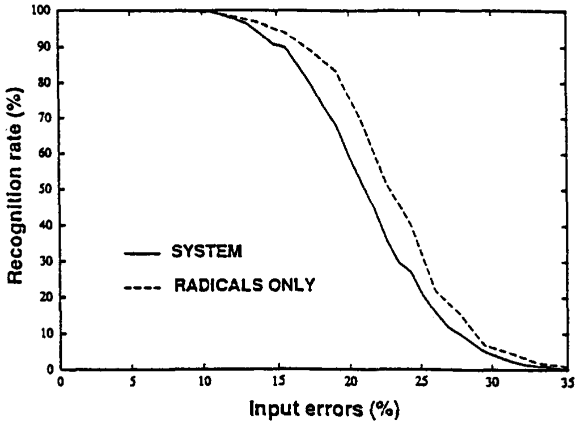

Figure 7: The reconfigurability of the radical-partitioned neural network system using a modified Sigmoid function with "a=0.0001"- The average output percentage error vs. input percentage error curves for theoverall system including the radical selector and only the radical selector.

"a" has been used. Using an "a" of 0.0001, the recognition rate of 1000 radical-partitioned Chinese characters can be enhanced to over 90% from 70% with input samples with 15% random errors as compared to the system without it.

Discussion

In fact, the recognition rate is mainly determined by the radical selector and the radical blocks under it.

Fig. 7 shows the reconfigurability of the coded block neural network system using a modified Sigmoid function with "a=0.0001"- the average output percentage error vs. input percentage error curves for the overall system including the radical selector and only the radical selector. In the figure, the recognition rate of a radical block only is also attached. Input samples are taken randomly from 25 radicals of 1000 Chinese characters. Each input sample is with random errors. The total bits of random errors out of the 24 × 24 lattice dots in each input sample are expressed as the percentage random error. Thanks to the superior recognition property of the radical selector, the overall recognition rate of 1000 radical-partitioned Chinese characters is 90% for the system with input samples with 15% random errors.

Conclusion

In this paper, a radical-partitioned neural network system using a modified Sigmoid function and a weight-dotted radical selector for large-volume Chinese characters recognition VLSI has been reported. With a modified Sigmoid function and the weight-dotted radical selector, the recognition rate of 1000 radical-partitioned Chinese characters can be enhanced to 90% from 70% for input samples with 15% random errors as compared to the system without it.

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