A Study on the Recognition System of the Il-Pa Stenographic Character Images using EBP Algorithm

Sang-Keun Kim and Gwi-Tae Park

Abstract - In this paper, we would study the applicability of neural networks to the recognition process of Korean stenographic character image, applying the classification function, which is the greatest merit of those of neural networks applied to the various parts so far, to the stenographic character recognition, relatively simple classification work. Korean stenographic recognition algorithms, which recognize the characters by using some methods, have a quantitative problem that despite the simplicity of the structure, a lot of basic characters are impossible to classify into a type. They also have qualitative one that it is not easy to classify characters for the delicacy of the character forms. Even though this is the result of experiment under the limited environment of the basic characters, this shows the possibility that the stenographic characters can be recognized effectively by neural network system. In this system, we got 90.86% recognition rate as an average.
Keywords - recognition, EBP(Error Back Propagation), stenographic character, preprocessing, filtering, recognition rate

1. Introduction

As we are living in the information age in which much information is deluged, we need to develop the ability to process much information quickly. Here, the media which are able to record, keep, and process every information are essential to the information age, however media held in common by both human and machine are not numerous so much. So operative work input by keyboard may be an obstacle to promote informationalization, but it must be essential work. In selecting the way held in common by both human and machine, if it is obviously impossible to make human read disks or tapes which are exclusive for machine, it will be far easy and appropriate to make machine read printing media exclusive for human. In this meaning, it is very important task to make a computer recognize character automatically.

Also neural networks, analyzing the structure of human brain as an human intellect scientific approach, making clear the mechanism of that process and making a computer which has a structure like it is appeared as calculation paradigm and researched for over the last 40 years to imitate the human ability image recognition parts[1]. Neural network has powerful classification function and recognition ability in addition that it has the simplicity in structure, and it is expected to present a new way as a parallel data preprocessing system of all-at-once way in the part where the existing computer of *Von Neuman* pattern does not fulfill its function [2],[3],[4].

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So recently the research carrying out character recognition by neural networks with powerful pattern recognition ability and fault tolerance is in progress actively. Human is able to recognize character easily but if performing this by using the present computer system, it will be very complicated exorbitantly, therefore the research area of character recognition like this is a typical example to make good use of a merit of neural network. The good results of research by neural networks with an object to English characters, Fig.s, Japanese *KANA* characters were not only published abroad but also in the practicalization state and it was reported to achieve high recognized rate over 98% by neural networks in printed *Hangul* Korean character recognition in Korea[1].

2. The Purpose of Research and Expected Effect

Recently the research to the development in the device of character recognition to process many documents automatically according to the information socialization is in progress actively. Also the neural networks which have a powerful function of pattern classification as a model for an artificial realization of human brain, overcoming the limit in the structure of the present computer are in the limelight[5].

Clustering or pattern recognition is defined as classifying data sets into each class according to the degree of similarity. One of the pattern recognition is the character recognition, whose methods are a template matching method, a statistical method and a structural method[6]. However a template matching method has a

problem in selecting a special template for the variety of character form and a statistical method in the recognition of characters whose space between consonants and vowels is delicate, and a structural method in forming structural rule of character recognition. Recently the way by using neural networks model in character recognition is used a lot as a way of solving these problems[1].

Among some researches by neural networks, various methods in the *Hangul* Korean character recognition are developed as mentioned above, and it is almost in the practicalization state, but it is necessary to develop many algorithms for improvement of recognized rate in case of hand written style recognition. Also there are some researches in progress in the application part for the necessity, which are car number recognition, zip code recognition and etc., but there is not any research in the stenographic character recognition except some cases[7],[8].

In this paper we would study the applicability of neural networks to the recognition process of stenographic character image, applying the classification function, which is the greatest merit of those of neural networks applied to the various parts so far, to the stenographic character recognition, relatively simple classification work.

Korean stenographic recognition algorithms, which recognize the characters by using some methods, have a quantitative problem that despite the simplicity of the structure a lot of basic characters are impossible to classify into a type. They also have qualitative one that it is not easy to classify characters for the delicacy of the character forms. In this paper, it performs a recognition of basic 126 characters and after preprocessing to the stenographic character input first, it performs learning, extracting 104 DC component and inputting them to the neural networks[9]. The character learning outputs the character whose degree of the similarity is the highest of all, compared with the standard pattern.

3. An outline of Recognition System

The whole process of character recognition is shown as the Fig. 1. Character image input by scanner is represented as 26 X 26 character image through binary process. A 26 X 26 character image deletes a noise and an isolated pixel due to the fallacy of input system, performing smoothing procedure. And then after extracting a feature of target character through feature extraction procedure, the system uses these features as neural network input data and recognizes the target character through neural networks learning.

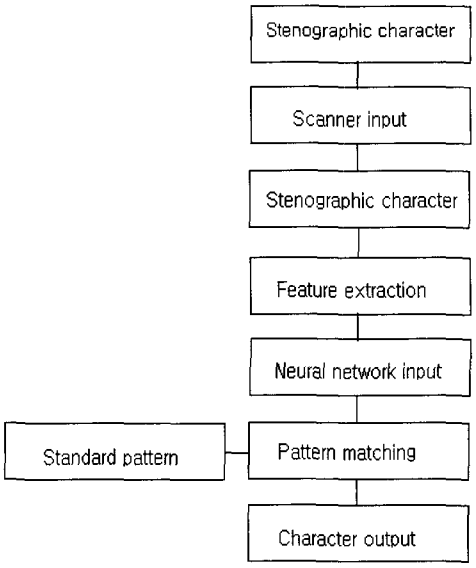

Fig. 1 Processing Procedure of Character Recognition

3.1 The Procedure of Preprocessing

The binary character image input by scanner is not able to extract feature correctly for an isolated pixel and a noise of hole or convex. It is because neural networks would be disturbed in case of such a data being made to learn a neural network as it is. Therefore it performs smoothing as a preprocessing procedure.

The original purpose of neural networks is to make neural networks recognize in the environment identical with visual data of human, so we make it a rule to preprocess input data as little as possible[10]. Therefore thinning procedure is skipped because it is considered not to affect the recognized rate or the decrease of general data number. Additionally pattern normalization as a process of input pattern is not performed, because the characteristics of stenography are considered to lose its function as a character with data in case of the change characters size and the degree of bias.

Simple smoothing methods to delete noise are a spatial filter, a nonlinear filter, a median filter and a frequency filter[9]. In this paper median filter to represent various functions, not taking a long process time. Arranging the intensity of each pixel in 3 X 3 mask in an order of size with some spot (i, j) in the center as following Fig. 2, we substitute the intensity located in the center for a new one of (x, y) pixel. This is shown as the following formula (1).

(i-1, j-1)	(i , j-1)	(i+1, j-1)
(i-1, j)	(i , j)	(i+1, j)
(i-1, j+1)	(i , j+1)	(i+1, j+1)

Fig. 2 3 X 3 Mask Performing Smoothing Operation

$$f(i, j) = g(i, j) \times M(i,j) \quad (1)$$

Only, $M(i,j) = \begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix}$

We use 12 masks of thin-line preservation to prevent the thin lines are not preserved, which is the problem of multi-logical smoothing as mentioned above. The following Fig. 3 shows the mask for a thin-line pattern confirming.

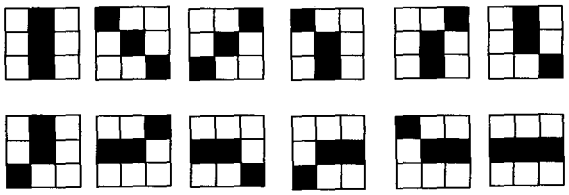

Fig. 3 12 Thin Line Preservation Masks

This filter is very effective to preserve the change of intensity observed in the end of the character, deleting noise, not losing the sharpness of original image at the same time[11].

3.2 The Procedure of Preprocessing

Character image data performing preprocessing procedure perform a feature extraction appropriate to the neural networks learning. That is, it exacts total 104 input DC elements[9] considered to include data of steno-graphic character to some extent not to use binary data of 26 X 26 pixel into input directly.

The research of using such an algorithms is that we can get the less node numbers in the middle layer than those numbers we get when we use 26 X 26 pixel into input as it is. Therefore we can reduce training time greatly and besides the input data, after feature extraction, can be more effective than original 26 X 26 image data in representing a feature of stenographic character. This algorithms, which had been ever applied to dynamic character like *Hangul*, is considered to have more powerful effect in recognizing stenographic characters[12], than in the dynamic characters, to represent the core of recognition as only DC elements being extracted in the angle of four direction.

Fig. 4, one of 104 DC element extraction procedures, shows the relative size of 104 DC elements for stenographic character RU .

104 data produced thus extract DC elements of 0, 45, 90, 135 direction, if actually we try to do a second-dimension FFT with special characters, we confirm DC elements to form a feature of that character[13]. DC element values are obtained through this procedure being integer values from 0 to 26 and we divided a value into 26 and normalized from 0.00 to 1.00 value to get a real input value.

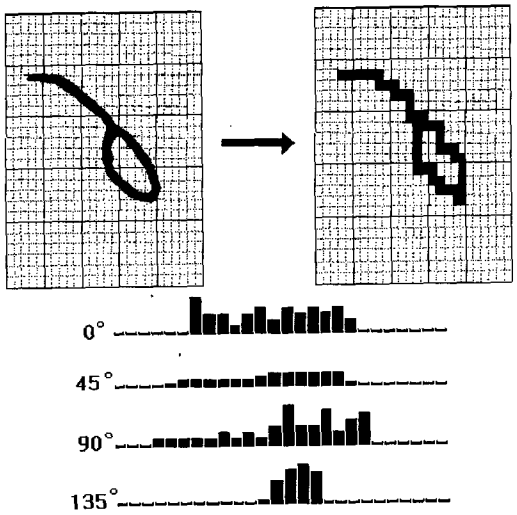

Fig. 4 The Example of DC Element Extarction for Korean Stenographic Character "Ru".

3.3 Neural Networks

Neural Networks used in this paper is Feed-forward style network as a structure of multi-layer networks with one hidden-layer including input and output layer and the signal in each layer is toward only to the upper layer as following 5. Each node is set by the product sum of the output and the weight in the lower node, which is output to the upper layer by sigmoid function with the characteristic of non-linear asymmetric increase [2],[4], [14],[15].

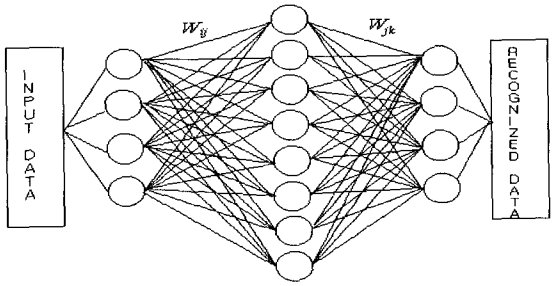

Fig. 5 Feed-forward Neural Networks

EBP(Error Back Propagation) learning way of general-ized data rule is used in neural networks learning. Using a linear function as an activation function, it is possible to transform multi-layer into single-layer of equal value, therefore we could not make good use of the merit of multi-layer. So nonlinear function as an activation function is used.

The characteristic of using the sigmoid function are that first, it is possible to estimate a result for output is represented as value between 0 and 1, second, differential

calculus is possible and the pattern of result is very simple, thereof easy to obtain transition function for each connected line. And third, with the function of automa-tical gain control, when input value is small, it changes greatly, and when input value large, it changes a little[14],[15],[17].

In this paper, learning rate 0.45 and momentum 0.7 are used and the one chooses the value used frequently in EBP algorithms, while the other chooses the optimal value within the scope of vibration not being produced through the procedure of recognition experiment.

3.4 Stenographic Character

Stenography was studied first in *Rome* in about BC 63, and in the country Korean style stenographic way called the stenographic way of Cho-sun language originated first in 1909. But the research of stenography had been almost discontinued by the Korean-Japanese annexation, after Liberation, it has been developed and pervaded as various stenography rule, passing by the transformation of various pattern.

The stenographic marks are composed of a straight line, a curved one and a spot, which contain a peculiar character data in accordance with the size and the direction. Korean stenographic character of *Il-pa* style, recognition object in this paper, forms a basic frame as Fig. 6, which each stroke as a petal represents one character. For the characteristic of stenographic character, the length and the angle of one character should follow a regular rule. That is, the initial sound is classified into each character in accordance with the angle of stroke and its kind that is curved or straight line. The middle sound except fold vowels is classified into each character in accordance with the length of the stroke (0.5*cm*, 1*cm*, 1.5*cm*) and the circle size included in the stroke. Also, fold vowels and final sounds are formed in accordance with the position in which a spot and 2*mm* brush is added and the direction of brush specify the character feature.

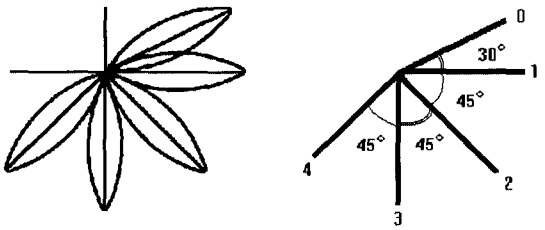

Fig. 6 The Basic Form of Korean Stenographic Character

Among 126 representative Korean stenographic characters, the above Fig. 7 represents 84 characters patterns except 42 ones of ㅐ line characters, ㅖ line characters and ㅚ line characters. Here, we write ㅐ line characters to the middle of stenographic mark with setting a circle of — line character apart about 45 degrees, ㅖ line characters with the 15*mm* size of ㅣ line characters and ㅚ line characters with the double size of ㅐ line characters in Fig. 8.

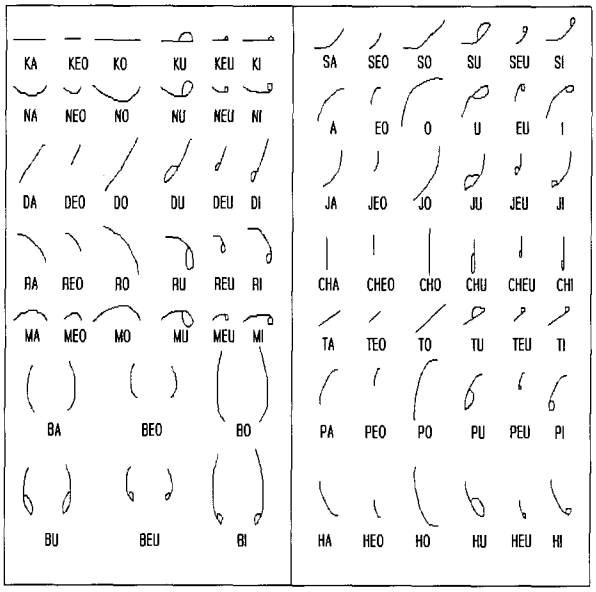

Fig. 7 The Representative Stenographic Characters

Fig. 8 " ㅐ " Line Character Image : The Example of the Chara "Kae"

4. The Result and Analysis of Experiment

In this paper, after modifying character image input by scanner with 600 DPI of 300 pixel per inch by using Global Lab image board in the aspect of IBM/PC-586, we performed a recognition experiment by neural networks embodied as C language.

As an input of the system we used stenographic characters from which we selected 126 basic characters used basically most in the list on the actual condition of *Hangul* frequency published by the department of Education in 1955. And the 5 non-specialists wrote the characters in accordance with the stenographic grammar as we requested

Data of input character are distributed and input in 104 input layer nodes and hidden layer node is made to obtain optimum node number, being changed and experimented many times. Fig. 9 shows the relation of recognized rate and the learning time when we make hidden layer number increase.

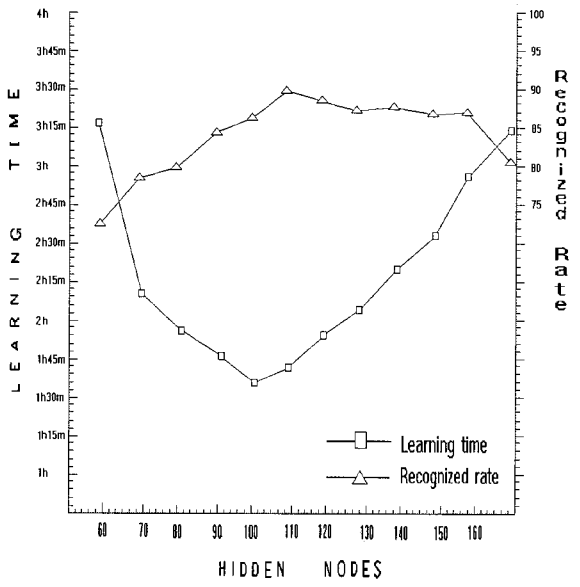

Fig. 9 The Recognized Rate and Learning Time in Accordance with Node Number of Hidden layer

Fig. 9 shows that recognized rate does not get higher any more over a certain node number. Also the node numbers in hidden layer of neural networks are very associated with one of input or output layer and treated as a parallel processing so learning time is reduced somewhat, however it is analyzed that learning time increases when exceeding a proper node number. 378 characters by 3 persons among 630 characters written by 5 persons are used in the learning procedure and the rest characters not used in learning procedure are used in our experiment. Output node sets are coded to 7, because 126 stenographic characters represent properly.

As a result of our experiment, the recognized rate of each consonant and vowel is represented in Table 1.

Table 1 Each Consonant Recognized Rate for Each 6 Line Character

Each Character	Recognition Rate(%)	Each Character	Recognition Rate(%)
'ㄱ'+char	97.2	'ㅇ'+char	80.6
'ㄴ'+char	100.0	'ㅈ'+char	86.1
'ㄷ'+char	83.3	'ㅊ'+char	91.7
'ㄹ'+char	94.4	'ㅋ'+char	97.2
'ㅁ'+char	97.2	'ㅌ'+char	83.3
'ㅂ'+char	94.4	'ㅍ'+char	86.1
'ㅅ'+char	88.9	'ㅎ'+char	91.7

The examples of representative fault-recognition which recognition are not performed correctly, one of which is to recognize ㅏ, ㅓ, ㅗ characters of ㄷ, ㅅ, ㅇ line characters as ㅌ, ㅈ, ㅍ characters, which means that the recognition about a delicate angle difference is not achieved because the data of the initial point and the last one is not known for the characteristic of off-line.

5. Conclusions

In this paper, after scanning the present situation of the general research in the characters recognition by neural networks and the background of stenographic character recognition, we present the recognition system of stenographic characters by using EBP neural networks which is one of representative neural network modes. Even though this experiment was performed under the limited environment of the basic characters, its result shows the possibility that the stenographic characters can be recognized effectively by neural network system. To practice this system, it should be able to recognize fold vowels, finals, connected typing and sentence omission besides basic character recognition. However we expected to achieve a lot if applying the additional algorithms to this work in accomplishing classification working in the general image.

Therefore we concluded that the research of the supplement of algorithms and the reduction of fault-recognized rate or the improvement of the learning speed of EBP should be achieved simultaneously. Additionally to achieve this work, the unity of stenography style should be presupposed.

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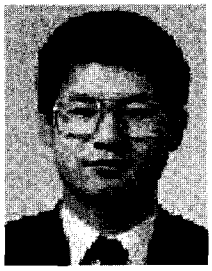

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