Neural Networks for Lampung Characters Handwritten Recognition

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***Abstract*— Character recognition technique associates a symbolic identity with the image of a character. Different characters and languages have different structures and features. Lampung character and language are different with any other languages. We have developed Lampung handwritten character recognition using back-propagation neural networks. However since some Lampung characters have similar features, hierarchical network system was performed to optimize the training and recognition algorithm. The experiment results give reasonable results of the recognition rate for the training set. 86.5% of basic characters and more than 97% for characters with tone marks can be recognized.**

Keywords-handritten recognition; Lampung characters; artificial neural networks; backpropagation

I. INTRODUCTION

The developments of digitizing tablets, personal computer, and image processing technologies have driven character recognition to grow to be an area of active research. Moreover, the latest invention of input devices for computer systems also extends this research area [1]. A character recognition technique associates a symbolic identity with the image of a character. Handwritten recognition is the ability to read and understand human language in written form and the information is then recorded in the digital form to be other uses. Currently many researchers in handwritten character recognition are carried out to classify English characters/words. Recently, there are also research interest in non-English character recognition, such as Thai [2], Japan [2,3], Chinese [4], and Korean [5].

Different characters and languages have different structures and features. Lampung character and language are different with any other languages [6]. Lampung character has complex and unique characteristics, composed from curves, zig-zag, and symbols. The Lampung script is written from left to right in a cursive manner, which is handwriting style that is designed for writing notes and letters quickly by hand. The goal of Lampung handwritten character recognition is to make a computer understand and identify which Lampung character a human wrote [7]. This research may be applied to many different types of information sources. For example, transformations and translations of handwritten ancient documents of Lampung language into text files.

In this paper, we report an effort to develop an automatic handwritten recognition system for Lampung characters with high recognition accuracy and minimum training time. This study shows that the approach used in this research is giving high recognition accuracy and minimum training time.

TABLE I. LAMPUNG BASIC LETTERS

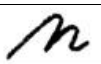
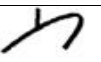
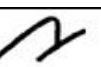
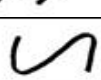
Sound	Character Image	Sound	Character Image
Ka		Ja	
Ga		Nya	
Nga		Ya	
Pa		A	
Ba		La	
Ma		Ra	
Ta		Sa	
Da		Wa	
Na		Ha	
Ca		Gha	

TABLE II. UPPER TONE MARKS

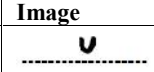
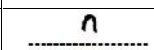
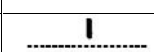
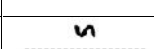
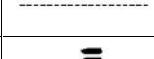
Sound	Character Image
Ulan "i"	
Ulan "e"	
Bicek "e"	
Rejunjung "r"	
Tekelubung "ng"	
Datas "an"	

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TABLE III. LOWER TONE MARKS

Sound	Character Image
Bicek "o"	
Bitan "u"	
Tekelungau "au"	

TABLE IV. SUBSEQUENT TONE MARKS

Sound	Character Image
Kelengiah "ah"	
Tekelingai "ai"	
Ngengen	

Basically, Lampung letters consist of 20 basic characters as shown in Table. I. Those of 20 basic characters are; "ka", "ga", "nga", "pa", "ba, "ma", "ta", "da", "na", "ca", "ja", "nya", "ya", "a", "la, "ra", "sa", "wa", "ha", "gha". Beside the basic letters, there are tone marks that change the sound of the basic characters. There are three types of tone marks, depend on where they are written, i.e. upper tone (above the basic letters), lower tone (below the basic letters), and subsequent tone marks (ahead the basic letters). There are totally 12 tone marks as shown in Tables II, III and IV. For example character of "*Ka*", , added with upper tone mark of "*Ulan e*", , is written and spelled "*Ke*".

II. THE RECOGNITION SYSTEM

Two phase processes are involved in our recognition system: the image pre-processing and neural network. The pre-processing step is required to prepare and manipulate the characters for feeding as input to the neural network. Further, the backpropagation neural network is performed to recognize the characters.

A. Pre-processing

The data were obtained from native Lampung writers contributed to total 50 set of sample data. Each set consists of 260 characters (20 main characters without tone marks and 20 main characters with 12 tone marks). Therefore, total data of 13,000 character images (50 x 260) will be obtained. Then, all collected data are converted to bitmap format by a scanner device. The character image is fed into the preprocessing step. Handwritten character images often have large variations in size and position, thus it is needed to reduce the unnecessary coordinate sequence data in the preprocessing step [8]. The pre-processing phase consists of 5 (five) sub-processes, which are: 1) binarization, slicing, inverting, cropping, and resizing. Each sub-process has the following details.

1) Binarization: The image binarization step make a conversion of a colored or gray-scale image into a binary image. A binary image generally is represented by 2-dimension matrice which has two intensity values ("0" and "1"). We used global thresholding category of binarization which picks one thresholding value for entire image. It is based on an estimation of the background level from the intensity histogram image to differentiate an object from the background as shown In Fig. 1.

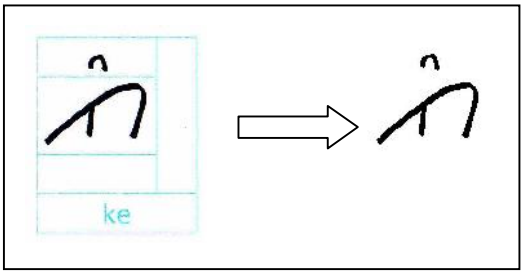

Figure 1. Binarization process.

2) Slicing: The slicing approach is performed to segment a binary image into one single character as seen in Fig. 2. The result of this step is the image consists of one primitive character.

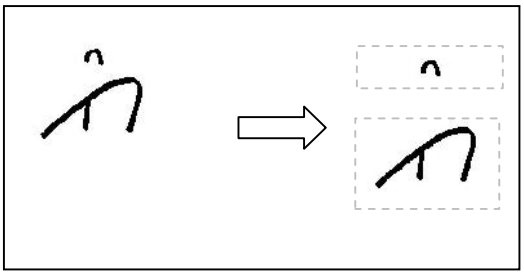

Figure 2. Slicing process.

3) Inverting: In digital image processing, inverting means changing the white colour into black, and vice versa. Fig. 3. shows the process of inverting image.

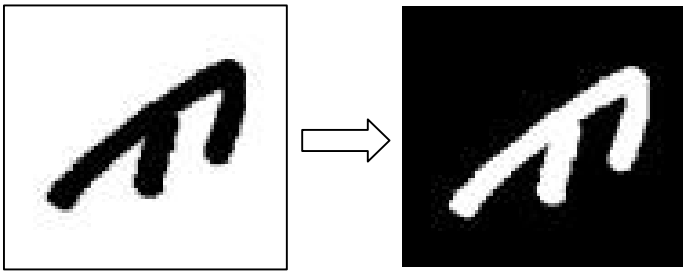

Figure 3. Inverting process.

4) Cropping: Cropping is performed to remove the outer parts of an image to increase framing. As shown in Fig. 4.,

cropping emphasizes the subject and changes the aspect ratio.

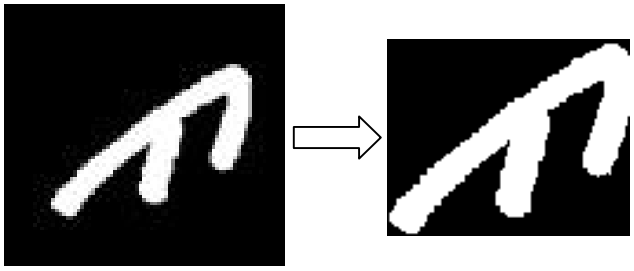

Figure 4. Cropping process.

*5) Resizing:*Image resizing step is carried out by interpolation method. Interpolation is a method to increase or decrease number of pixels in one digital image. Here, the image is reduced into 20 x 40 pixels image as illustrated in Fig. 5.

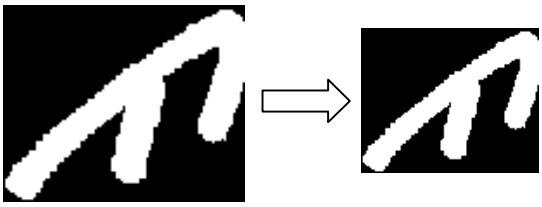

Figure 5. Resizing process.

Next step is the digitazion of the segment grids because neural networks need their inputs to be in the form of binary digits ("0" and "1"). Neural networks having different parameters are used to recognize each characters. Each digitize segment out of 800 segmented grids is then employed as input of neural network, as illustrated in Fig. 6.

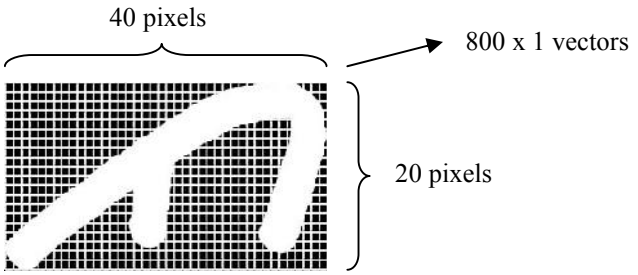

Figure 6. Image convertion into vectors.

B. Neural Networks

In the training step, artificial neural network with backpropagation method is performed. The training result is evaluated to obtain the recognition rate for each character image. Backpropagation uses the gradient decrease method to minimize total squared error of the network output. However since some characters have similar pattern then hierarchical training is performed to train those character images. For some similar characters the training process is performed repeatedly. Characters are classified into four groups, i.e. basic characters, upper tone marks, lower tone marks, subsequent tone marks. This step is illustrated in Fig. 7.

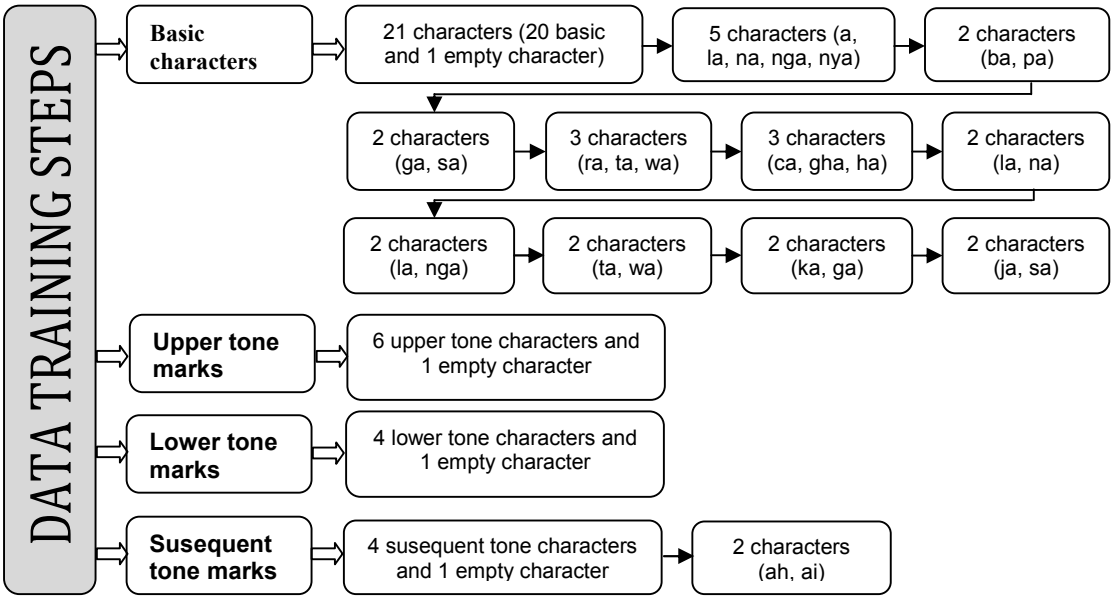

Figure 7. Data training steps.

III. RESULTS

In order to evaluate our method, the recognition system was trained based on the all collected data. The backpropagation method of artificial neural network with hierarchical training was performed. After we performed the data training step, the following results were obtained as seen in Table V. The results have more than 80% of accuracy rates for all cases. However, the accuracy results for some dominantly similar characters are somewhat lower than others.

TABLE V. ACCURACY RESULTS OF NN TRAINING

Training characters	**Accuracy result**
20 basic and 1 empty characters	86.5%
5 characters (a, la, na, nga, nya)	81.4%
2 characters (ba, pa)	98.7%
2 characters (ga, sa)	85.4%
3 characters (ra, ta, wa)	92.1%
3 characters (ca, gha, ha)	95.6%
2 characters (la, na)	96.8%
2 characters (la, nga)	89.8%
2 characters (ta, wa)	98.7%
2 characters (ka, ga)	99.6%
2 characters (ja, sa)	97.7%
6 upper tone and 1 empty characters	99.6%
4 lower tone and 1 empty characters	99.8%
4 subsequent tone and 1 empty characters	97.3%
2 subsequent tone characters (ah, ai)	100%

IV. CONCLUSSION

This paper presents a simple technique for Lampung handwritten character recognition. Training algorithm used in this research is back-propagation neural networks. The hierarchical network system was performed to optimize the training and recognition algorithm. The global feature is extracted to form reliable representation of a handwritten character. The training was performed based on all collected data from Lampung native handwriters with more than 80% of accuracy rates for all characters.

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