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Implementation Of Extreme Learning Machine Method With GVF Snake For Character Recognition

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ABSTRACT

In everyday life, sometimes it is necessary to change the contents of the printouts of certain documents, but the digital files from the printed documents have been lost. Retype the document manually will certainly spend a lot of time making it inefficient. To solve this problem, the printed document can be scanned into a digital image file and a character recognition system is implemented to recognize the characters contained therein. In this study, the Gradient Vector Flow Snake (GVF Snake) method is used to determine the boundaries of an object based on the computed vector gradient in the form of binary or gray-level values obtained from an image with several frameworks. After that, the Extreme Learning Machine (ELM) method will be used to predict the characters that have been broken up by the GVF Snake method. The results of this study are software that applies the GVF Snake and ELM methods to perform the character recognition process of an image printed by a document.

1. Introduction

In everyday life, there are often conditions where sometimes it is necessary to change the contents of the printouts of certain documents, but the digital files from the printed documents have been lost. Retype the document manually will certainly spend a lot of time making it inefficient. To overcome this problem, the user can edit the image file that is changed in the form of a text file without having to copy the document manually. In order to do this, a data entry process from hardcopy to softcopy on a computer is needed. Considering the importance of information in the electronic edition and the manual entry process that requires quite a bit of time, for this reason a print character recognition system will be developed automatically for digital images in the form of image files. For that, we need a system or application that can translate characters in digital images into text format using the concept of pattern recognition.

Pattern recognition is a science for classifying or describing something based on quantitative measurements of the features or main characteristics of an object. Pattern recognition is one of the sciences for classifying or describing something based on quantitative measurements of features or main characteristics of a subject (Sanjaya, 2015). Pattern recognition can be used for character recognition. One method that can be used for segmenting character shapes in images is the Gradient Vector Flow Snake. Gradient Vector Flow Snake (GVF Snake) is used to determine the boundaries of an object based on calculated from the vector gradient in the form of binary or gray-level values obtained from an image with several frameworks. The advantage of GVF snakes over traditional snakes is that they are more sensitive for initialization and have the ability to move to the curved boundaries (Hastuti, et al., 2009). The method used for character recognition is Extreme Learning Machine. Extreme Learning Machine (ELM) is a new learning method from Feedforward neural networks with a single hidden layer or commonly called Single Hidden Layer Feedforward neural Networks (SLFNs). This method was first introduced by Huang in 2004 (Sun et al, 2008). ELM is made to

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overcome the weaknesses of Feedforward artificial neural networks, especially in terms of speed of learning. The ELM method will be used to predict characters that have been broken up by the GVF Snake method. The recognition process is done by predicting the appropriate character if the character shape is not detected in the dataset.

2. Method

A. Gradient Vector Flow Snake (GVF Snake) Method

Snake or active contour is a curve that is defined in the image domain, can move because of the influence of the internal force of the curve itself and the external force calculated from image data. Internal and external forces are made so that the snake will go to the boundary of an object or other desired feature. Snake is widely used in many applications including edge detection, shape modeling, segmentation, and motion tracking.

Snakes can be defined as curves x (s) = [x (s), y (s)], s∈ [0,1] that move in the spatial domain. In order for snakes to be dynamic, x is made as a function of time:

$$\boldsymbol{x_t(s,t) = ax''(s,t) - \beta x''''(s,t) - \nabla E_{ext}}$$

where α and β are weighting parameters that control snake stress and stiffness, x″ and x″″ are the second and fourth derivatives of x with respect to s, whereas - ∇E_{ext} is the external force obtained from the image.

Gradient Vector Flow (GVF) is an external snake force introduced by Chenyang Xu and Jerry L. Prince. By replacing the external force in equation above with the GVF field v(x), a parametric curve equation is formed called GVF Snake:

$$\boldsymbol{x_t(s,t) = ax''(s,t) - \beta x''''(s,t) + v(x)}$$

B. Extreme Learning Machine

Extreme Learning Machine (ELM) is a training algorithm of artificial neural networks. ELM is a feedforward artificial neural network (ANN) with a single hidden layer or commonly referred to as Single Hidden Layer Feedforward Neural Networks (SLFNs).

ELM learning methods are made to overcome problems caused by feedforward artificial neural networks, especially in terms of learning speed. There are two reasons why ANN feedforward has a low learning speed, namely:

1. Using a slow gradient based learning algorithm in conducting training.
2. All parameters on the network are determined iteratively by learning.

In the Conventional gradient based learning algorithm such as Backpropagration (BP) and its Lavenberg Marquadt (LM) variants all parameters in feedforward ANN must be determined manually. The parameters in question are the input weight and hidden bias. While the ELM parameters such as input weight and hidden bias are chosen randomly, so that ELM has a good learning speed and can provide good generalization performance.

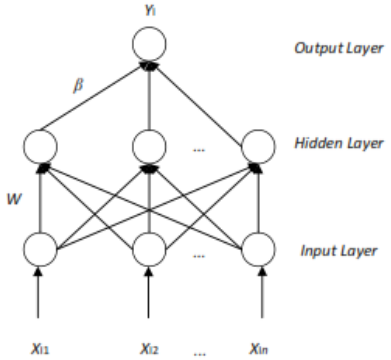

Figure 1. Extreme Learning Machine Structure

The process of solving prediction problems with Extreme Learning Machine (ELM) begins with normalizing the data, then does the training process, then the testing process, then data denomination and error value calculation are performed using Mean Square Error (MSE):

1. Normalizing Data

   Data normalization is done because the range of input values is not the same. The input will be processed to a small output value so the data used must be adjusted so that it can be processed to get a small normalized value. In this study, the data used will be adjusted by normalizing the data. The following equation is the process of normalizing data using the Min-Max Normalization method:

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$$d' = \frac{d - min}{\max - min}$$

Information:
d ' = value from the result of data normalization
d = original data value
min = the smallest value in the X feature data set
max = the largest value in the X data set feature

2. Training Process

The training process must be done before the prediction process. The training process aims to get the value of output weight. The steps taken in the training process are:
The first step is to initialize the input weight and bias. This value is initialized randomly with a range of values between -1 and 1.
The next step is to calculate the hidden layer output (H_{init}). The following equation is for calculating the hidden layer output.

$$H_{init\ train} = x_{train}.W^T + b$$

Information:
H$init_{train}$) = The hidden layer output matrix for the Training process
x_{train} = Input data using training data
WT = Transpose Input weight
b = bias value

After the H_{init} value is obtained and calculated using the binary sigmoid activation function, this activation function is perfect for solving complex and non-linear problems. The formula for the binary sigmoid activation function is shown in Eq. Below.

$$H = \frac{1}{1 + \exp(H_{init\ train})}$$

Information:
H = Binary sigmoid activation function
exp = Exponential
H$init_{train}$ = The hidden layer output matrix in the training process

3. Results and Discussion

The testing process will be carried out on a variety of different conditions to determine the accuracy of the application of the Extreme Machine Learning method in the process of character recognition. The test results will be summarized in tabular form as shown in the following details:

Document Image	Segmentation Result	Characters Detected	Information	Persentage
		b	Succes	1/1*100% = 100%
		q	Succes	1/1*100% = 100%
		s	Succes	1/1*100% = 100%
		U	Succes	1/1*100% = 100%

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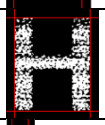
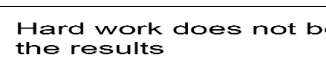
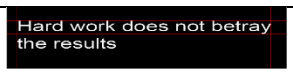
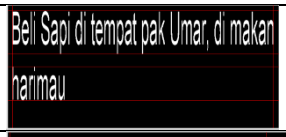
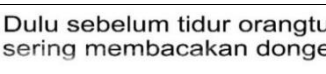
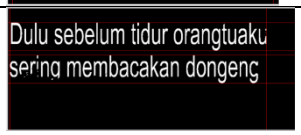
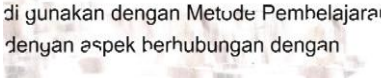
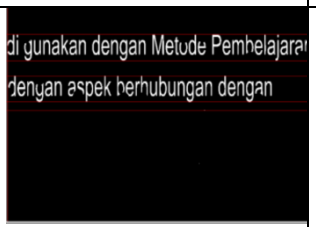
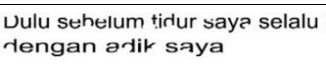
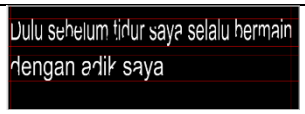
g		q	Fail	0/1*100% = 0%
H		H	Succes	1/1*100% = 100%
i		l	Fail	0/1*100% = 0%
e		e	Succes	1/1*100% = 100%
m		m	Succes	1/1*100% = 100%
C		c	Succes	1/1*100% = 100%

Accuration: 8/10 * 100 % = 80 %.
Error rate: 2/10 * 100 % = 20 %.

Document Image	Segmentation Result	Characters Detected	Information	Persentage
		Working	Succes	7/7*100% = 100%
		Hard work does not betray the results	Succes	30/30*100 % = 100%
		Beli sapi di tempat pak Umar di makan harimau	Succes	37/37*100 % = 100%
		Dulu sebelum tidur orangtuaku *sering membacakan dongeng*	Succesl	49/49*100 % = 100%
		digunakan dengan Metpde Pembelajaran dengan aspek berbubungan dengan	Fail to recognize letter“o” become “p’ and fail to recognize letter “h” become “b’	59/61*100 % = 96.7%
		uulu subelum tidur saya selalu bermain	Failure to recognize letter “D” become “u’	46/47*100 % = 97.8%

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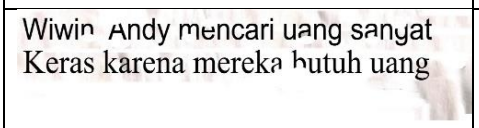
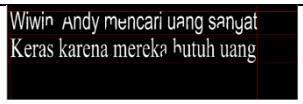
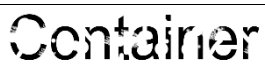
		dengan adik saya		
		Wiwin Andy muncari uang sangat keras karena merekA butuh uang	Succes	51/52*100 % = 98.1%
		Centarfer	Failure to recognize letter "n" become "rf"	8/9*100% = 88.9%
		Container	Succes	9/9*100% = 100%
		Gedung Pencakar	Succes	14/14*100 % = 100%

Accuration : 7/10 * 100 % =70 %.
Error rate: 3/10 * 100 % = 30 %.

Based on the test results above, the following information can be obtained:

1. The Extreme Machine Learning method is able to detect one character entered with an accuracy level of 80%. The character detection failure is mainly for characters that are similar to i with l and g with q.
2. The Extreme Machine Learning method is able to extract out all the lines contained in a document image with an accuracy rate of 75%. Failure mainly occurs for writing with characters that are very close together, so it is difficult to segment any characters contained therein.

4. Conclusions

Based on the results of previous studies, the following conclusions can be drawn:

a. The Extreme Machine Learning method is able to detect one character entered with an accuracy level of 80%.
b. The Extreme Machine Learning method is able to extract out all the lines contained in a document image with an accuracy rate of 75%.
c. Software can be used to convert characters from a digital image file into a text file.

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