A Study of Data Augmentation for Handwritten Character Recognition Using Deep Learning

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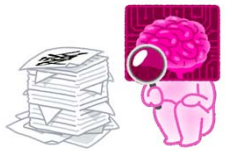
Introduction

CNN(Convolutional Neural Network) has accomplished great achievements in the field of pattern recognition, including handwritten character recognition. However, it needs plenty of training data per class, so enormous training character image data are required for classification with many character classes.



This research proposes a method to generate kanji character images of various handwritings from a small number of samples, as if they were written by many people. This method exploits statistical character structure models created from a small number of handwritten kanji character images.

Related Work

Handwritten Character Recognition Using Deep Learning

Kanji contains many types of characters to be recognized, so obtaining good performance for handwritten kanji recognition is difficult compared to handwritten numeral character recognition.

Numeral character recognition	Wan et al. [1]	99.79%
Chinese character recognition (Kanji)	Zhang et al.[2]	97.37%
	M.He et al. [3]	97.70%

Data Augmentation for Deep Learning

In deep learning, the amount of training data is an important factor directly linked to the recognition rate. For generating various character images of various appearances, many methods using a small number of character images or character generation models have been proposed.

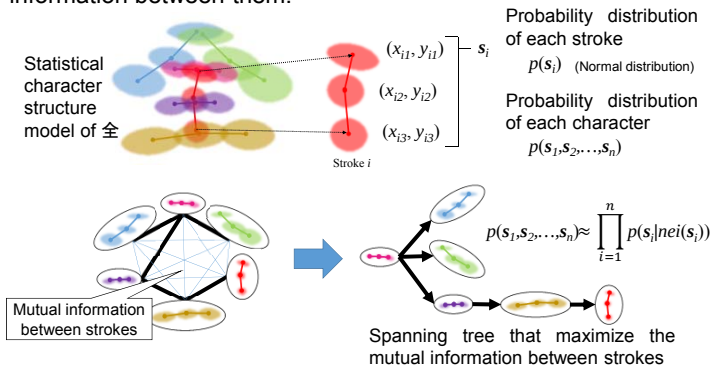
[1] L.Wan et al. "Regularization of Neural Networks using DropConnect", Proceedings of the International Conference on Machine Learning (2013)
[2] X.-Y.Zhang, et al. "Online and Offline Handwritten Chinese Character Recognition: A Comprehensive Study and New Benchmark", Pattern Recognition (2017)
[3] M.He et al. "Recognition Confidence Analysis of Handwritten Chinese Character with CNN", Proceedings of International Conference on Document Analysis and Recognition (2015)
[4] I.-J. Kim et al. "Statistical Character Structure Modeling and Its Application to Handwritten Chinese Character Recognition", IEEE Transactions on Pattern Analysis and Machine Intelligence (2003)

Proposed Method

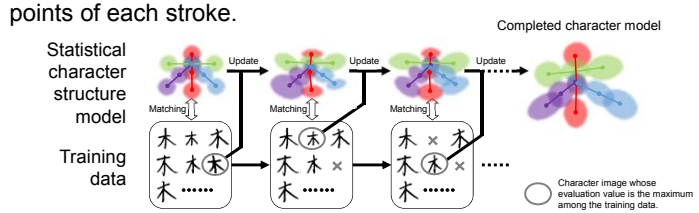
Statistical Character Structure Model

The statistical character structure model was proposed by Kim et al. for Chinese character recognition[4]. This model is expressed in the form of the joint probability distribution of feature points.

This model can express spatial correlations between strokes by obtaining the spanning tree that maximizes the mutual information between them.

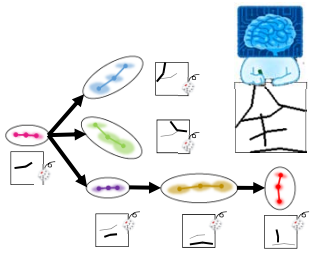


Our method updates the statistical character structure model using the training data of the character images and calculates the mean and the variance-covariance matrix of the feature points of each stroke.



Character Image Generation

By generating a random number with the probability distribution of each stroke, a character image can be obtained. Our method generates character images reflecting the spatial correlations between strokes.



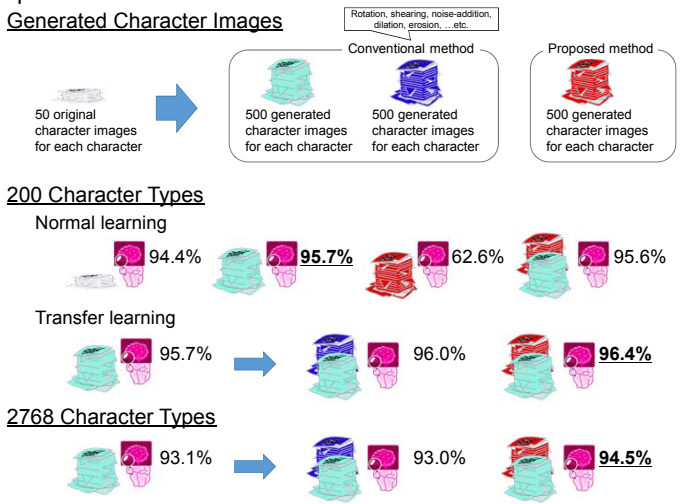
Experimental Results

Generated Handwritten Kanji Characters

The proposed method could generate kanji character images of various handwritings. However, because some stroke models did not represent the real structure of the strokes, some generated character images were unnatural.

Recognition Rates

By applying transfer learning to them using the CNN that learned the other character images generated by the conventional methods beforehand, the recognition rate was improved.



Conclusions

This research proposed a method to generate handwritten kanji character images using the statistical character structure model. By combining the generated character images with data generated by the conventional data augmentation method, the character recognition rate was improved.

The remaining problems are the followings:

- the use of the correct stroke models,
- the generation of natural character images using spline curves, GAN, …etc.