

Handwritten Editor

Hidehisa Arai

TUM Department of Informatics, Chair for Applied Software Engineering

Technical University of Munich

Munich, Germany

koukyo1213@g.ecc.u-tokyo.ac.jp

Abstract—Handwriting is still in strong demand as a way of communication and saving knowledge even in the era of new technology. Driven by the rise of electronic pens and tablets, the need for handwriting recognition on electronic devices is increasing recently.

This report focuses on handwriting recognition on iOS device and discusses how to use the recognition results using auto-completion as an example.

I. INTRODUCTION

Handwriting recognition (HWR) is a field which study and develop algorithms to interpret handwritten inputs into a format that can be easily handled by computers from sources such as papers, photographs, electronic tablets, and other devices. HWR can be roughly divided into two approaches: online approach and offline approach [1].

While online approach uses information on the trajectory of the pen tip obtained from a special pen for classification, offline method uses optically scanned images as input and performs recognition using computer vision techniques. This report focuses only on offline approach, and tackle on the recognition problem using Convolutional Neural Network (CNN), which have shown a remarkable development in recent years.

HWR is a field that has been studied for a long time, and many applications have already been made. However, in the case of tablet devices that have spread rapidly in recent years, not so many applications have been created even after APIs to incorporate with pattern recognition algorithms on device are published by developers of those devices. Although some applications have achieved very good result on normal handwritten text recognition, it is not the case when elements in other domains such as handwritten illustrations are mixed in addition to sentences.

I therefore endeavor to recognize handwritten documents which contain not only text, but also handwritten illustrations or mathematical formulas. Since this type of documents are very common in our daily life, the success of the project can potentially bring the fusion of digital technology and the long-standing human skills of handwriting.

In the following section, typical approaches of HWR and related works are introduced. Section three provides technical details of the approach to the problem addressed in this report. Section four describes the result of the approach and

discuss on that. Section five concludes this report with future prospects.

II. RELATED WORK

The problem settings of this project can be positioned as one variant of Scene Text Detection/Recognition, which is a field to study algorithms to extract and recognize text information written in natural images. Due to the recent development of Neural Networks technology, much research has been done in this field to this day [2].

Except for few methods [3] [4], most approaches of Scene Text Detection/Recognition separate detection and recognition and perform stepwise inference.

A. Detection

Scene Text Detection can be subsumed under general object detection, therefore those methods usually follow the same procedure of object detection, which is dichotomized as one-stage methods and two-stage ones [5].

B. Recognition

Some text recognition algorithms divide the task into character segmentation and character recognition [6] [7]. character segmentation is not currently widely used since it can be a cause of errors when separating connected characters such as cursive, but there is also a merit that it is only necessary to use a simpler character recognition method instead of text recognition in the subsequent processing.

III. METHODS

- Lead up to your contributions.
- Describe your research process.
- Start with theoretical work and work yourself to its applications in your reproach report.
- Document your implementation and solution to the problem described in previous sections.
- Discuss your data collection, training or implementation approach and highlight interesting technical details.
- Feel free to add more sections or subsections and rename existing sections e.g. the Contributions section as you need.

IV. RESULTS & DISCUSSION

- Describe your results in a clear and understandable way.
- Clearly differentiate between what you have achieved and what you have build upon.
- Ideally add some sort of visual representation of your result that underlines the progress you have made during the research project.
- Make sure that the results are reproducible by your reader if needed
- Critically discuss your results.
- Did you achieve what you set out to do?
- What are the strengths and weaknesses of your research?

V. FUTURE WORK & CONCLUSION

- Summarize your thoughts and state your final conclusion about the work you have performed.
- Describe possible future work in the field that is related to you work.
- Detail improvements that could be done to your work in a following project.
- Identify the importance of your work and create an arch to the related work and problem defined in the previous chapters.

REFERENCES

- [1] R. Plamondon and S. N. Srihari, "Online and off-line handwriting recognition: a comprehensive survey," *IEEE Transactions on pattern analysis and machine intelligence*, vol. 22, no. 1, pp. 63–84, 2000.
- [2] S. Long, X. He, and C. Yao, "Scene text detection and recognition: The deep learning era," 2018.
- [3] X. Liu, D. Liang, S. Yan, D. Chen, Y. Qiao, and J. Yan, "Fots: Fast oriented text spotting with a unified network," in *Proceedings of the IEEE conference on computer vision and pattern recognition*, 2018, pp. 5676–5685.
- [4] P. Lyu, M. Liao, C. Yao, W. Wu, and X. Bai, "Mask textspotter: An end-to-end trainable neural network for spotting text with arbitrary shapes," in *Proceedings of the European Conference on Computer Vision (ECCV)*, 2018, pp. 67–83.
- [5] L. Liu, W. Ouyang, X. Wang, P. Fieguth, J. Chen, X. Liu, and M. Pietikäinen, "Deep learning for generic object detection: A survey," *arXiv preprint arXiv:1809.02165*, 2018.
- [6] A. Bissacco, M. Cummins, Y. Netzer, and H. Neven, "Photoocr: Reading text in uncontrolled conditions," in *Proceedings of the IEEE International Conference on Computer Vision*, 2013, pp. 785–792.
- [7] T. Q. Phan, P. Shivakumara, B. Su, and C. L. Tan, "A gradient vector flow-based method for video character segmentation," in *2011 International Conference on Document Analysis and Recognition*. IEEE, 2011, pp. 1024–1028.