



AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
COMPUTER AND SYSTEMS ENGINEERING DEPARTMENT

A Multistage Binarization Technique for the Degraded Document Images

A Thesis Submitted in Partial Fulfillment of the Requirements of
Master's Degree in Electrical Engineering
(Computer and Systems Engineering)

by

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Postgraduate Diploma in Electrical Engineering
(Computer and Systems Engineering Department)
Faculty of Engineering, Ain Shams University, 2006

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Cairo, 2019



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Date: 12 September 2019

Statement

This thesis is submitted as a partial fulfillment of Master's Degree in Electrical Engineering, Faculty of Engineering, Ain Shams University. The author carried out the work included in this thesis, and no part of it has been submitted for a degree or a qualification at any other scientific entity.

Usama Wadie

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Date: 12 September 2019

Abstract

**Faculty of Engineering – Ain Shams University
Computer and Systems Engineering Department**

**Thesis title: A Multistage Binarization Technique
for the Degraded Document Images**

Submitted by: Usama Wadie Aziz Mousa

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Shams University, 2019.**

Abstract

Efficient image binarization technique is critical for achieving high quality in the document image analysis pipeline. The binarization process is a challenging and a very difficult task because these document images may be degraded where they may be suffering from aging, leaked ink, bleeding through, stains, smudge, spots, image contrast variation, non-uniform illumination, heat damage, etc. Conventional binarization techniques do not take all these degradations into account

and therefore do not produce efficient binarization.

Additionally, the global threshold techniques give unstable results and the local threshold techniques also do not give good results on degraded document images.

Furthermore, the modern binarization techniques make image binarization an interesting research subject for the optimizations targeted to increase the execution performance and to improve the binarization quality.

This thesis presents an efficient multistage binarization technique for the degraded document images. This binarization technique won a rank number one in H-DIBCO 2018 contest where DIBCO contest is the most popular binarization contest in the world and it is funded by the European union. Also in DIBCO 2018 contest, this binarization technique won the rank number one for two consecutive years using one of their measured formulas for all participators in DIBCO 2018 contest and all participators in DIBCO 2017 contest.

In this technique, an edge detection method is proposed to be used for the proposed selecting seeds algorithm. Another edge detection method is proposed to improve the edges of the objects in the image. Then, to find the rest of the object's contents, Markov random field is applied in an energy minimization framework using graph cuts. A combination algorithm is proposed between these results and Niblack's

method, where this algorithm depends on the flood fill algorithm. Then a proposed post processing algorithm is applied, which also depends on the flood fill algorithm to produce the binarized image.

The results of extensive experiments on many datasets show the robustness of the proposed technique on various types of degradations in the document images where the proposed technique demonstrates superior performance against many other methods.

Additionally, this thesis proves that the measurement formulas for computing the evaluation results in the contests are inaccurate and proposes binarization measurement formulas. Also, this thesis proposes new equations for the old binarization measurement formulas.

Furthermore, in the contests they use the ground truth image for the evaluation but the ground truth image itself usually has many mistakes.

This thesis presents a proposed binarization measurement algorithm with its proposed equations, where using this algorithm in the evaluation reduces the effect of the mistakes of the ground truth image in the result.

Thesis Summary

This thesis presents an efficient multistage binarization technique for the degraded document images. The results of extensive experiments on many datasets show the robustness of the proposed technique on various types of degradations in the document images where the proposed technique demonstrates superior performance against many other methods.

This thesis presents also two proposed edge detection formulas, proposed binarization measurement formulas, a proposed binarization measurement algorithm, proposed equations for old binarization measurement formulas, and proposed algorithms for the different stages of the binarization technique.

Summary

The thesis is divided into six chapters as listed below:

Chapter 1 is an introduction to this research. This chapter provides an overview about the problem of the binarization for the degraded document images, the potential applications of the proposed technique, the datasets considered in the scope of this research, the research objectives, the research steps, the research contributions, and thesis organization.

Chapter 2 mentions several different disciplines which include the research context. Additionally, this chapter provides the

necessary binarization background, the problems in the binarized image, the ground truth image, and the problems in the document image. Furthermore, this chapter explores the related works that recently proposed.

Chapter 3 describes the proposed multistage binarization technique for the degraded document images. It begins with the proposed technique architecture. Then it describes the different stages in this proposed technique as: Niblack stage, the first proposed edge detection stage, the second proposed edge detection stage, the selecting seeds stage, MRF stage to find the contents of the objects, combination stage to combine images, and finally, the post processing stage.

Chapter 4 begins with an introduction about the binarization measurement formulas that is already existed, then it describes the proposed measurements formulas, and finally, it describes the proposed measurement algorithm.

Chapter 5 presents the experimental results and the evaluation of the proposed binarization technique. It shows the results from the testing of DIBCO datasets. There is a comparison between the results from the proposed technique and other different methods. There are comparisons to show the importance of the proposed measurement formula. There is a comparison between the results of DIBCO's winners and

the proposed technique. Also it shows the results from the testing of PHIBC 12 dataset and a comparison between the results of its winner and the proposed technique.

Chapter 6 concludes this thesis. It summarizes the most significant results of this thesis and the suggested future work.

Key words: binarization, degraded document image, edge detection, error measurement, MRF, restoring text.

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