# Amethod for combining complementary techniques for document image segmentation
(2009)

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November 29, 2018

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**Abstract**

a combination method of different segmentation techniques is presented. Exploiting the segmentation results of complementary techniques and specific features of the initial image so as to generate improved segmentation results.

## 1 Introduction

The general objective is to exploit the comple- mentary information between the classifiers and find the rules for building hybrid classifiers that outperform their constituent classifiers,

A wide variety of methods have been proposed in the literature for document segmentation which can be categorized into five major categories: **(1) projection profiles methods; (2) smearing methods;** based on examining the white runs in a specified direction and usually followed by connected component analysis **(3) methods based on the Hough transform;** It has been applied for skew detection, string detection and line detection **(4) grouping methods;** building alignments by ag-gregating units in a bottom-up strategy **(5) stochastic methods;**. Techniques from each category can confront some specific problems such as overlapping, touch- ing components, image degradations, variability in skew angles and directions, disturbing elements, variability in inter-word and inter- character distances and others

## 2 Proposed method; Algorithm combination

We consider that we have some different segmentation results of an initial image and combine them in order to increase the effi- ciency and the accuracy of the segmentation result. As subregions we define the regions which are created from the intersection of the segmentation results. The combination method is composed of five steps:

- Step 1: Average feature extraction: detect the subregions in which all the segmentation techniques are in agreement over a threshold (70%-high degree of overlap), extract some features and calculate the average.
- Step 2: Detect correctly segmented regions, we detect the subregions in which all the segmentation techniques are in agreement over a threshold (90%- very high degree of overlap), these subregions are considered as correctly segmented.
- Step 3: Divide subregions into groups containing the subregions which form one or more correctly segmented regions.
- Step 4: Create correctly segmented regions from each group: start from a subregion of the group which has the highest degree of overlap according to the segmentation results. Then examine which others subregions should be merged with it until the features of the new region are closer to the average features of Step 1.

- Step 5: Final process of the new segmentation result: detect all the pixels of the foreground of the initial which have not been added to the new segmentation result and we merge them with the nearest region

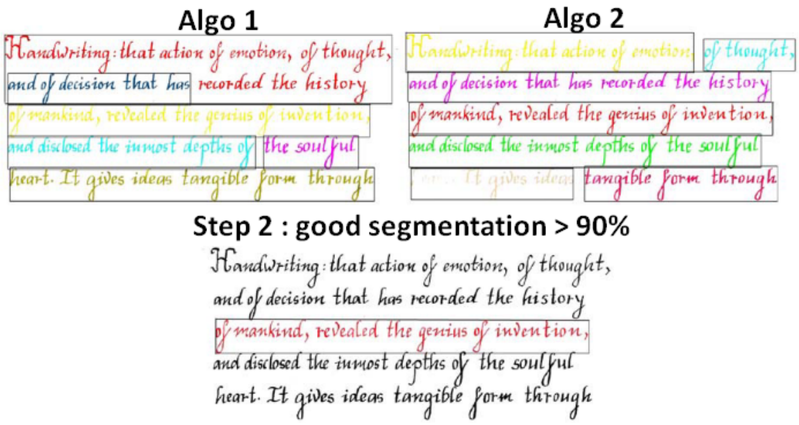



Figure 1: Finding the good segmentations

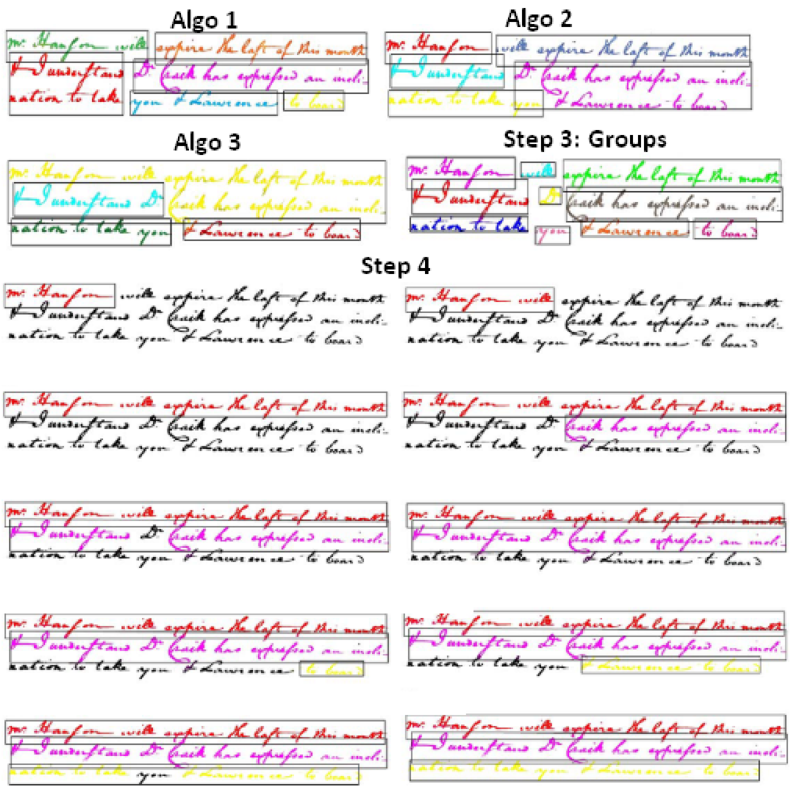
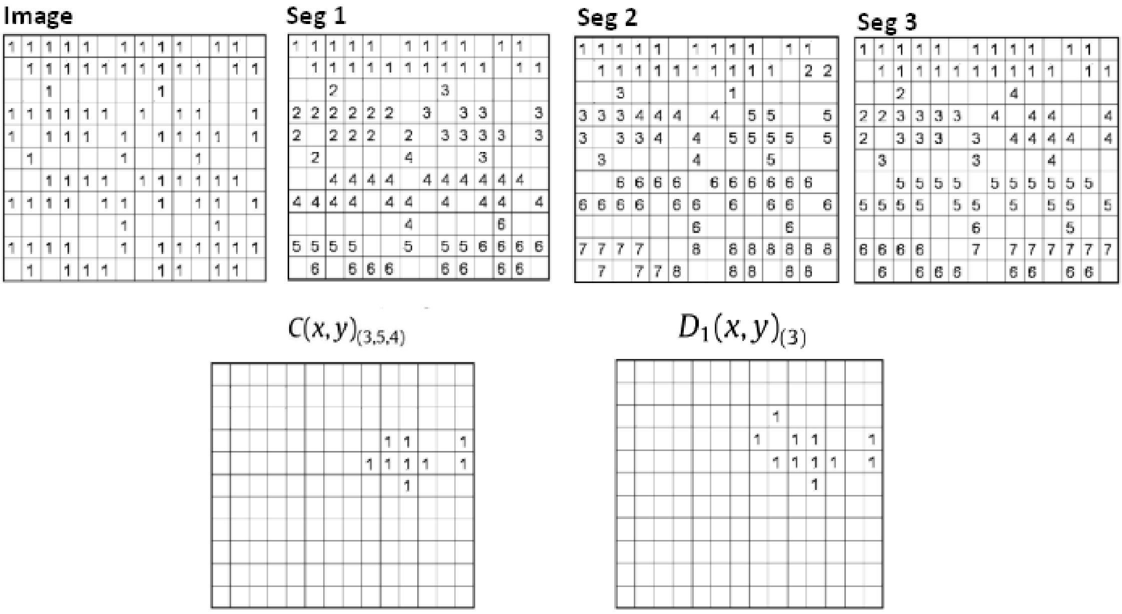



Figure 2: Repetitive merging of segmentations




$$C(x,y)_{(r_1,r_2,\dots,r_N)} = \begin{cases} 1 & \text{if } (R_1(x,y)=r_1 \text{ AND} \dots \text{AND} \\ & \quad R_N(x,y)=r_N) \\ 0 & \text{otherwise} \end{cases} \qquad D_j(x,y)_{(r_j)} = \begin{cases} 1 & \text{if } R_j(x,y)=r_j \\ 0 & \text{otherwise} \end{cases}$$

Figure 3: Formal definition of intersection

**Definition 4.** Overlap between the segmentation results

In order to represent the overlap between the segmentation results we define the following function:

$$f_j(r_1,r_2,\dots,r_N) = \begin{cases} \frac{\sum_{x,y} C(x,y)_{(r_1,r_2,\dots,r_N)}}{\sum_{x,y} D_j(x,y)_{(r_j)}} & \text{if } \sum\limits_{x,y} D_j(x,y)_{(r_j)} \neq 0 \\ 0 & \text{othewise} \end{cases} \tag{6}$$

where $1 \leqslant r_j \leqslant n_j, j = 1,\dots,N$.

For example, in Fig. 5,

$$f_1(3,5,4) = \frac{\sum_{x,y} C(x,y)_{(3,5,4)}}{\sum_{x,y} D_1(x,y)_{(3)}} = \frac{9}{11} = 0.81$$

Figure 4: The intersectino of the example above

## References

[1] Nikolaos Stamatopoulos, Basilis Gatos, Stavros J. Perantonis, *Amethod for combining complementary techniques for document image segmentation*