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Image Segmentation for a Hierarchical and Scalable Model

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Abstract: A novel color segmentation approach robust is against digitization noise and adapted to contemporary document images. This is system scalable, hierarchical, versatile and completely automated, i.e user independent. It proposes an adaptive binarization/quantization without any penalizing information loss. This model may be used for many purposes. For instance, we rely on it to carry out the first steps leading to advertisement recognition in document images. Furthermore, the color segmentation output is used to localize text areas and enhance optical character recognition (OCR) performances. We held tests on a variety of magazine images to point up our contribution to the well-known OCR product Abby Finer-Reader. We also get promising results with our ad detection system on a large set of complex layout testing images.

Keywords: Image Segmentation, Scalable Model, Mixed Raster Content (MRC), Optical Character Recognition (OCR).

INTRODUCTION

In this paper, introduce Nowadays, we encounter more and more digitized documents with overlaying color layers owing to DTP (Desktop publishing). However, few researches processing such images exist in the literature. Even the existing ones target specific applications such as mixed raster content (MRC). Without prior processing of the colors in some document pages, several applications, such as optical character recognition (OCR) and layout segmentation, cannot be efficient. Color information is imperative for further issues such as advertisement detection. Digitized documents are commonly spoiled by a conventional series of operations (printing, digitization, image compression, etc.)that affect the original colors and introduce undesirable ones. We propose to go back in time, that is to get closer to the document as it was before being spoiled, like it was designed by its author. This will enhance the image sharpness, remove noise and render more efficient many applications such as text detection, image classification, OCR, etc. The first distortion that affects a document is its printing. Printers usually use halftones of four colors that are cyan, magenta, yellow and black and to simulate the original colors of the document. Though humans should not perceive the half- toning, scanners can. Furthermore, the perceived colors are not exactly equal to the original. Most of the scanners, especially when they are improperly set, introduce several kinds of distortions in the digitized images.

TECHNOLOGY USED

Stroke Thickness Estimation

Most of the document image processing methods depends on a resolution-related parameter (e.g. width of a structuring element, size of a convolution matrix, etc.). To determine such values, it would be rather futile to lean on the digitization resolution. Indeed even if all documents were digitized in the same resolution (some providers proclaim that 300 dpi is universally suitable), each document has its own typographic characteristics. Modern letters and invoices are usually composed with 10 or 12 points fonts, but advertisements, flyers and journals have unstable typographies. Given a specific size, the strokes of a font may have variable thickness depending on the typeface anatomy. In order to ensure that the algorithms presented in this paper will be free of a ‘‘resolution’’ parameter, we will base all our metrics on an estimation of the font’s stroke thickness. A quick and easy way to estimate the strokes’ width and height without binarizing the image is to compute the autocorrelation of the image along the horizontal

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and vertical axes. The estimation would obviously be more accurate if we determined the main orientation of the strokes, but this would cost much time for a little gain.

Fig. 1: Two fonts with the same size but with different stroke thickness

A Generic Multi-layer Color Segmentation System

One of the advantages of this model is get as close as possible to the original colors of the document. To do so, we propose the color segmentation scheme in following manner

- We first separate the chromatic layer from the achromatic one. A given pixel is called chromatic if it has a defined hue (red, green, blue, yellow, etc). Otherwise, it is achromatic (shades of gray, including black and white). This step is fundamental as chromatic and achromatic pixels cannot always be treated in the same way. Indeed, it would be meaningless to apply some processes that examine the hue values to achromatic pixels, since the hue for these pixels is either undefined, or unreliable stage.
- The chromatic layer is split into monochromatic and multi-chromatic layers:
  1. A monochromatic layer consists of elements printed in flat tints; **i.e.** representable by only one color such as text. A monochromatic layer's quantization may not imply any information loss.
  2. The multi-chromatic layer corresponds to the photo-like areas.

Let us remind that this paper is designed to document images; applying our global approach on natural images would be uninteresting.

- The achromatic layer is split into gray-scale, black and white layers:

The B and W layer consists of the zones that were originally black and white. Its binarization does not cause any Information loss. It would rather enhance the contrast and remove some noise.

The gray layer usually consists in graphical elements that would be spoiled if binarized.

All the proposed approaches do not require any document model or any a priori information on the document class. As a part of industrial needs and constraints, our color segmentation system encompasses several self-contained and complementary steps. Given the necessary input, each step is reusable independently of the other ones. For instance, if we know in advance that the input image is gray-scale, only the achromatic split can be executed.

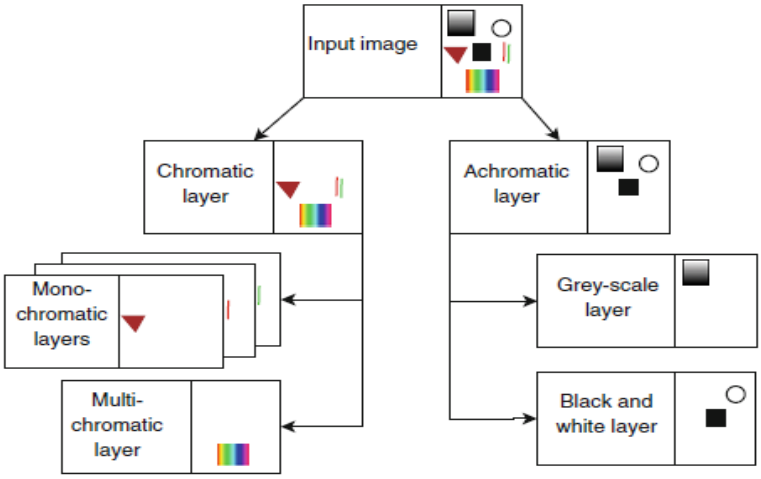

Fig. 2: Multi-layer color segmentation system

Chromatic Segmentation

A set of chromatic pixels grouped together constitute either a monochromatic or a multi-chromatic zone. Monochromatic colors are separated from one another. Multi-chromatic zones (photos) are kept unchanged. Text elements above a multi-chromatic background are considered as a part of a multi-chromatic zone. We chose the HSV color-space to represent colors. The most important factor in terms of color discrimination in this color-space is Hue. so our chromatic split is based on the Hue channel. When an image contains both monochromatic and multi-chromatic zones, the global Hue histogram is impossible to analyze. Thus, each chromatic zone is processed at a local level. A Hue histogram with wide peaks corresponds to a multi-chromatic zone, whereas narrow peaks indicate the presence monochromatic areas. The multi-chromatic areas are thus easily identified. A given peak is considered wide If it is larger than 10 % of the Hue spectrum. Definition of the local processing zones we assume that it is more reliable to process small zones such as characters together than processing each one independently of its context.

Achromatic Segmentation

The achromatic layer is segmented into a B.W. and a gray sub-layers in a similar way as chromatic one. Using the global luminance histogram's first and last peaks, we compute black and white thresholds. The lightest pixels are immediately assigned to the B.W. layer. The remaining pixels are merged into distinct processing zones. so that each zone is locally classified. Digitization, especially bad quality digitization, spreads out some black elements so that they appear gray in the resulting image. Thus, classifying the pixels independently of their neighborhood would be completely unreliable. For this reason, our classification candidates are the processing zones.

COMPARISON WITH OTHER TECHNOLOGIES

Previous Work

Here we considered some methods used in existing models. In this methods separation is simply carried out by thresholding the saturation channel. Such a method is not suited to noisy images since some achromatic noisy zones would be detected as chromatic ones.

Karatzas Method

Karatzas perform the chromatic/achromatic separation in web images based on the human perceptual model. This method consists in a thresholding of the HSV colors based on the human perception. However, web images do not include much color noise. Thus, the chromatic /achromatic separation would be simpler here than on digitized images. Once the chromatic and achromatic layers are created, each one shall be segmented in turn. A large variety of color quantization methods exist in the literature. Most of them are not suited to document images.

Image Segmentation for Ancient Documents

This method Cannot be used for ordinary document set because in ancient documents only a fixed range of colors are used. Here a color segmentation adapted to noisy ancient documents is presented. An elaborated k-means classification is applied to perform the segmentation. As we do not have any prior knowledge about the input images, we cannot take advantage of such an algorithm since the number of classes and the initial samples have to be set in advance. Many algorithms handle color classification and automatically determine the number of classes. Such algorithms group together in visually similar colors.

However, the colors that are not sufficiently represented in the image are assigned to wrong classes and this may cause a significant loss of information that we have to avoid.

EXISTING METHODS DISADVANTAGES

Depends on a Resolution-Related Parameter

Most of the document image processing methods depends on a resolution-related parameter like as width of a structuring element, size of a convolution matrix, etc. To determine such values, it would be rather futile to lean on the digitization resolution. Indeed even if all documents were digitized in the same resolution each document has its own typographic characteristics.

Not Suited to Noisy Images

The separation is simply carried out by thresholding the saturation channel. Such a method is not suited to noisy images since some achromatic noisy zones would be detected as chromatic ones. Existing methods limited layer Color segmentation scheme presented an inefficient color segmentation system

and not suited for noisy document images. The existing system is not generic, since it is not applicable on all type of document structure.

PROPOSED SYSTEM ADVANTAGES

- We get an out result as close as possible to the original colors of the document.
- Applicable on any document structure.
- Provide an efficient color segmentation system.
- All the parameters are automatically computed using a novel stroke thickness estimation.

BENEFITS

In this method, we presented an efficient color segmentation system for noisy document images. The proposed system is generic, since it is applicable on any document structure. All the parameters are automatically computed using a novel stroke thickness estimation. We introduced a new measure of pseudo-saturation to detect chromatic pixels and got rid of the saturation noise. Within the chromatic layer, we distinguished the homogeneous areas represent able by only one color from the multi-chromatic ones. In spite of the complexity of the processed data, we reached very good results compared to the ones obtained on web images and video. In future work, we aim to combine OCR results with our advertisement detection method to generate a complete ad recognition system.

APPLICATIONS

- Application to Text localization to improve OCR Results

A variety of approaches to text information extraction, that goes from detection to recognition, from images and video have been proposed for specific applications, including page segmentation, address block localization, license plate localization, etc. In spite of such extensive studies, there is still no general-purpose system.

- Text extraction in monochromatic films: Inside each monochromatic and B.W. layer, text lines are composed by connected component grouping. The grouping criteria are horizontal alignment, similar heights and a small horizontal distance between the components. This method detects horizontal and slightly slanted text lines. This restriction is, however, acceptable since vertical and highly slanted text are rare in press documents.
- Text extraction in multi-chromatic and gray films: The multi-chromatic and gray layers generally correspond to photos and may embed text. We use the cumulated gradients method to estimate the approximate text position.
- Application to advertisement detection and localization

Provided the previous text lines detection output and the color Information, we can build robust features to classify document images' blocks. In this section, we focus on a specific application: advertisement detection in magazine and newspaper images. This application answers two industrial problems:

1. Removing ads from a corpus of articles to build a press review.
2. Allowing an advertiser to check if a newspaper or journal did really publis all the advertisements that were ordered.

CONCLUSION

Nowadays, we encounter more and more digitized documents with overlaying color layers owing to DTP. Without prior processing of the colors in some document pages, several applications, such as optical character recognition (OCR) and layout segmentation, cannot be efficient. Color information is imperative for further issues such as advertisement detection. Digitized documents are commonly spoiled by a conventional series of operations like as printing, digitization, image compression, etc. Those affect the original colors and introduce undesirable ones. Here we presented an efficient color segmentation system for noisy document images. The proposed system is generic, since it is applicable on any document structure. All the parameters are automatically computed using novel stroke thickness estimation.

We introduced a new measure of pseudo-saturation to detect chromatic pixels and got rid of the saturation noise. The resulting layers made the text detection easy and efficient. Indeed, text tracking enables the OCR to retrieve additional lines, especially the ones embedded in multi-chromatic areas. The acquired color and text information was also used to detect ads in press images. Such an issue is innovative as it is the first one to handle ads in complex document images. In spite of the complexity of the processed data, we reached very good results compared to the ones obtained on web images and

video. In future work, we aim to combine OCR results with our advertisement detection method to generate a complete ad recognition system.

FUTURE TRENDS

- Aim to combine OCR results with our advertisement detection method to generate a complete ad system

The acquired color and text information was also used to detect ads in press images. Such an issue is innovative as it is the first one to handle ads in complex document images. We inferred simple visual features from our segmentation and classified them with Ada Boost. In spite of the complexity of the processed data, we reached very good results compared to the ones obtained on web images and video. In future work, we aim to combine OCR results with our advertisement detection method to generate a complete ad recognition system.

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