Design and Implementation of an Image Segmentation Method

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***Abstract*—In this paper, we design and implement an image segmentation method to isolate a body shape from a complex colorful image. For this, we use color thresholding, edge detection with Laplacian of Gaussian (LoG), Morphological filtering and region growing. This paper describes how we dispose those technics to perform an image segmentation. Our method gives a satisfying result on a given image and images very similar to it, but is quite rigid and may be useless for any other images.**

***Index Terms*—Image processing, Image segmentation, Image filtering, Morphological operations**

I. Introduction

THIS work consists in designing and implementing an image segmentation method. The method described below is in any cases a general method, and works only for this particular image. However, the general structure of the method may be reusable for other image segmentations, with other parameters.

Color thresholding is equivalent of classical gray thresholding, adapted for colors. The purpose is to hide or select some colors. As it exists many color spaces (RGB, HSV, YCbCr and L*a*b), it may be easier to isolate a color using one or another of those spaces. Color thresholding is one of the most useful and easy way to perform image segmentation for color images [1].

Edge detection may also be useful for image segmentation, as some parts of an image could have many edges, like a tree, when some other part may not have any edges, like the sky. Laplacian of Gaussian (LoG) is a powerful edge detection technic, based or zero crossing detection [2].

Morphological filtering consists in four main types of operation: dilatation, erosion, opening and closing. The global purpose of those technics is to smooth contours and delete artifacts on binary images [3].

Finally, region growing is a tool to grow a region of the image, based on the similarity of this region pixels [1]. The basic idea is to take a pixel from a given region, see if its neighbors are similar, and if yes, ad them in the region. And to repeat it until the whole region is covered.

II. Design

The purpose of this work is to isolate the shape of a human body out of a picture complex and colorful picture, presented in figure 1.

Our method consists in two main parts: mask creation and mask refining. The mask creation is the basic segmentation operation, using color threshold and edge detection. After, mask refining consists in applying morphological filtering and eventually region growing to get rid of small artifacts that may stay on the mask after its creation and to fit as much as possible the shape of the body.

Fig. 1. The original picture.

A. *The original picture*

The image we use is an image of the author, taken on the campus under a gingko tree. The picture was taken with a Samsung Galaxy S8+ and its dimensions are 4032*1960 px.

As we can see in figure 1, this image is complex because it has many very different parts, like the paved walkway, the road, the foreground gingko tree, the foreground and background grass, the body, the background trees, the background building and the sky. We will be able to identify those parts by their different colors and edge concentration.

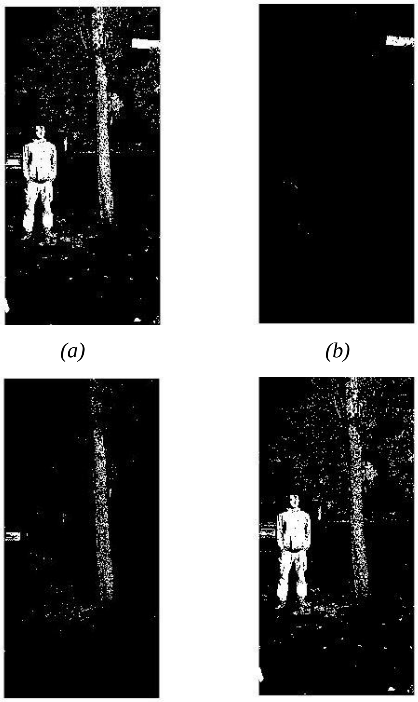
B. *Mask Creation*

The global idea of this part is to design some masks to get rid of non-desired parts of the image, and then merge those masks in a final one.

For the following parts, we will use the word *body* to describe the body shape we want to extract, and the word *background* to describe the rest of the image.

1) *Color Thresholding*

In this part, we use the *colorThresholder* tool from MATLAB. We first choose our color space, then we design our



(a) (b)

(c) (d)

Fig. 4. Here are presented the color threshold masks. First mask (a) evicts most of the background. Second mask (b) and third masks (c) evict given details of the image. The final color threshold mask is presented in (d).

color threshold mask, and then generate the code to use this mask later in our script.

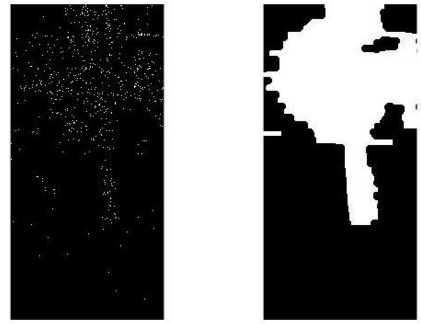
Color Thresholding is the first step because it can remove a lot of the background, as the body colors are not existing in most of the background. We perform the color thresholding in three parts:

- The first mask, shown in figure 2(a) consists in suppressing most of the background. For this mask, we use the YCbCr color space because we can visualize luminosity, which helps to remove dark and light parts, like the background building and some of the background trees.
- With the second mask, shown in figure 2(b), we remove the flat top part of the background building.
- The third mask, shown in figure 2(c), partly isolate the walkway on the left of the body.

N.B. for the second and the third masks, we show here the inverted masks to make it clearer to understand.

For the second and third masks, we use a pre-implemented tool which allows us to select a region of the picture to isolate its color. So, we don't need to manually search for the best filter, hence we don't need too think about choosing a particular color space.

We could have made all those three masks in one time. But as the isolated regions in the two last masks have some colors very similar to the body, it's much easier to isolate those parts one-by-one and then merge the masks. So, at the end of color thresholding step, we have the mask shown in figure 2(d). We can se that on this mask, the foreground tree is still very present, because the trunk's color is very similar to the trousers color.



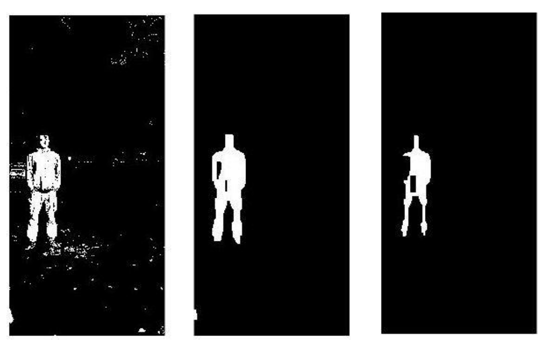
(a) (b)

Fig. 3. The result of edge detection using LoG with threshold 0.025 is presented on (a). Using (a), we craft the mask to evict the foreground tree (b).

2) *Edge Detection*

For edge detection, we use the Laplacian of Gaussian method [2]. We use this method because it is known as a very efficient edge detection technic [4].

In figure 3(a) we performed a LoG edge detection with a low threshold, so only the biggest variations in the image will appear. The foreground tree a lot of edges, so we could use edges to isolate and get rid of it. For this, we perform some morphological operations on the edge matrix presented in figure 3(a). Those operation are an image closing, to form the shape of the tree, and then an erosion to get rid of the isolated elements, and finally a strong dilatation to englobe completely the tree. We finally get a mask which erases very efficiently almost all the foreground tree, as shown in figure 3(b).



(a) (b) (c)

Fig. 2. The mask after the mask creation steps is shown in (a). After some morphological filtering, we have the mask shown in (b). However, in this mask, there is still a background element at the bottom of it. In (c), we apply a stronger erosion to get rid of this element.

C. *Mask Refining*

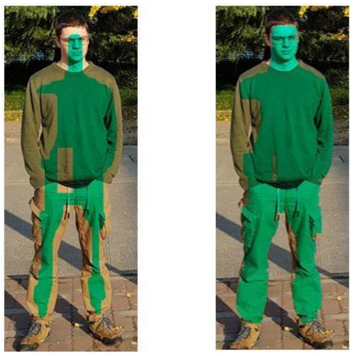
After creating the mask, we note that it still has a lot of small mistakes and artifacts, even if the shape of the body is by far the main shape. To refine this mask and make it fit as much as possible with the body, we will use morphological filtering and region growing.

1) *Morphological filtering*

Morphological filtering is used three times in our work: for the tree mask (II.B.1), and before and after the region growing.

Before the region growing is the most important part because it's the final step to shed all the background elements. For this, we do a series of dilatation, erosion and closing. The result could be satisfying, but an element is very difficult to evict at the bottom of the image, as we can see in figure 4(b). However, it is possible to evict those parts, but it implies strong erosion, which damages the body shape, as shown in figure 4(c). To recover it, we tried to use region growing.

The morphological filtering after region growing is just to smoothen the final shape of our mask.



(a) *(b)*

Fig. 5. Those pictures show the mask on the original picture, zoomed on the body. First, before region growing (a) and after region growing (b). We can see in (b) that, at the trousers level, region growing begins to overflow on the background.

2) *Region Growing*

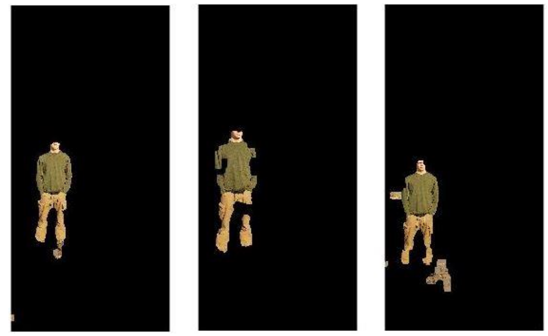
The goal of this part is to fit the body shape as much as possible using region growing. We designed an algorithm which browses the contours of the mask and extend it if the pixels from the original image are similar enough. To decide whether two pixels are similar, we just compare them for each of the three colors, and their difference have to be under the given threshold for every color. However, while testing this method, it appears that, especially for the trousers part, the background color is very similar to the body, so region growing is not as efficient as we expected. As we can see in figure 5, we weren't able to bring back the right arm in the mask.

(a) *(b)*

Fig. 6. The final result of our image segmentation script, with strong morphological filtering and region growing (a) and without region growing (b).

3) *Conclusion*

We empirically designed our solution using only one picture. The final result is shown in figure 6. We notice that figure 6(b) looks better, but there is still a little artifact at the bottom of it. we always loose the hair part because of its similarity with the background. We also loose the shoes part, because of its high concentration of details. However, even if our results are not perfect, we think that they are satisfying, considering the fact that images colors and variations are very similar between the body and the background.



(a) *(b)* *(c)*

Fig. 7. (a), (b) and (c) are the results of our script for three other pictures, very similar to the one used earlier to design our script.

III. Tests

The purpose of this part is to determine if our solution keeps working on similar pictures. For this, we took some other pictures the same day, at almost the same moment with the same camera. Still, there are slight differences in angles, background and position. We make it go through exactly the same program as described in part II, with exactly the same parameters.

The results in figure 7 are the one using region growing, as in figure 6(a). We decided to show only those images because they showed better results than the method without region growing. As we can see, they are quite satisfying because it still isolates the body, even if it could be much better by changing a few parameters.

We also tried to apply our program to a similar picture, with big angle and light difference, but it was totally impossible to perform a segmentation with the same script.

IV. Conclusion

In this work, we performed an image segmentation using color thresholding, edge detection, region growing and morphological operations. We put together all those technics and have a satisfying result. Moreover, we can apply our script to very similar images to have a quite similar result.

However, we never manage to perfectly isolate the body, because we miss the hair and shoes parts. Also, our solution is far from being scalable and is only usable for this particular image.

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