Image Segmentation using Color Thresholding and Morphological Filtering Methods

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Abstract—*This paper uses color thresholding and morphological filtering methods to segment a human standing under a gingko tree in an image. To achieve segmentation, color thresholding is used for different colors of the body such as clothes, face and hair. Afterwards dilation and erosion leads to a clear segmentation without small unwanted objects in the segment.*

Index Terms—*Image Segmentation, Color Thresholding, Morpholical Filtering, Erosion, Dilation*

1. Introduction

The image segmentation algorithm was designed for two different images where a student stands under a gingko tree in different postures [1]. Both images contain other elements such as the sky and other bushes. To detect the student using image segmentation, the main distinct colors of the student usually consisting of clothes color, face color and hair color get identified and used as a filter on the image with a small threshold. In each of these thresholded images erosion [2] and dilation [3] is performed to get rid of small unwanted objects in the segment and to lead to a clear connected area on the student's body. Finally, all filtered color images get superposed to one image and final unwanted objects are removed again by erosion.

2. Designed Algorithm

The first step of the algorithm is to identify different colors on the student. For example, if the pants and jacket that the student is wearing are the same color, then one color threshold to filter out both clothes is sufficient. In general, at least one color threshold is used for the face and atleast one color threshold for the body of the student.

The next step is to carefully determine the threshold for the color. If the color is not very present in the overall image the threshold can be large while still not segmenting too many unwanted objects in the image alongside. The closer the color gets to a large unwanted object in the image such as the tree, the smaller the threshold has to be set which will make the segmented part of the student's body unconnected and will naturally result in small unwanted objects all over the image [4].

As these small objects are unwanted but unavoidable, erosion is used to get rid of them. Afterwards dilation connects all parts of the student's body again. It Is very important to perform dilation after erosion to not dilate unwanted small objects into bigger areas that are difficult to delete afterwards.

After these morphological filtering [5] steps are done for each image individually, the images can get superposed in to one image containing the whole student. As the connected area of the student is now larger, erosion can be used again with a higher intensity to get rid of final potential unwanted small objects. Again, the order is very important to perform superposing of the images after doing erosion to each image individually so unwanted objects get not superposed into bigger harder detectable objects.

After those described steps are finished, the student is clearly segmented from the rest of the image, as multiple erosion steps get rid of all unwanted objects and dilation connects the area within the student which was not accepted by a strict color threshold.

3. Experimental Results

3.1. Image Segmentation with two color thresholds

For the first test image only two color thresholds were set, one for the cothes of the student and one for his skin color. Figure 1 shows the image. As one can see there are a range of difficulties. There are a range of different colors on the image coming from the bush in the background, the flowers on the bottom of the image and the sky in the background. Also the hand of the student is touching the tree and its color is not too different from the tree color. Additionally, the hand and face of the student are very small which makes them difficult to detect as relevant objects.

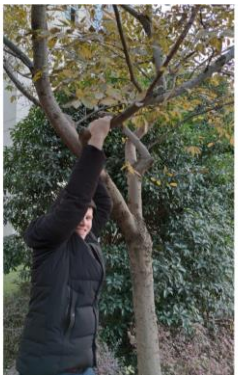
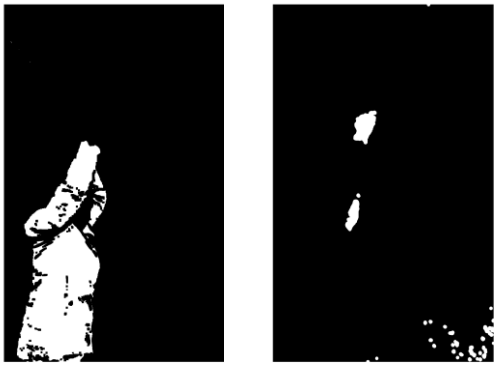


Figure 1: Original Image 1

a) Determining color thresholds

Picking the kind of two color thresholds for this image is straightforward as black and skin tone color are almost the only colors of the student. However, the threshold for both colors has to be set rather low as the bush in the background contains some black and the colors in the bottom right of the picture are similar to skin color of the student. In image a of Figure 2 one can see that segmentation of the clothes is excellent with a large connected area and no unwanted objects. Image b of Figure 2, however contains unwanted objects as the flowers got included into the color threshold. As a lower color threshold would lead not being able to segment hands and skin, this result is inevitable and will be targeted in the next steps.



(a) (b)

Figure 2: Color thresholding with two thresholds

b) Erosion

As one can see, image b in Figure 2 showed small unwanted objects. As the color threshold was set strict however, these objects are smaller than the hand or face of the student that should be detected. Thus, erosion is a suitable method to get rid of those small unwanted objects while leaving hand and face of the student mostly intact. In Figure 3 one can see a meaningful increase in segmentation quality by just using one erosion iteration.

Figure 3: Image 1 after erosion

c) Dilation and Superposing

Erosion and strict color thresholds lead to areas in the student body which are not detected by the segmentation algorithm. As the student forms one connected surface, dilation is used to enhance the connected area of the student. Now images can be superposed to connect face and body of the student. Figure 4 shows the image after superposing and dilation. Small unwanted objects that got dilated in the process have to be removed by erosion again in the next step.

Figure 4: Image 1 after superposing and dilation

d) Final Segmentation

In Figure 5 one can see the final result when segmenting the student out of the image in color. One can see that all relevant parts in student's body and skin got detected and unwanted objects apart from the student got successfully removed.

Figure 5: Image 1 after final segmentation

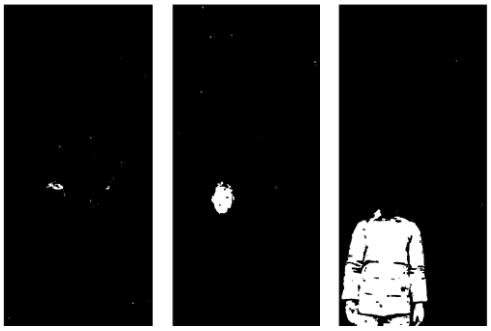
3.2. Image Segmentation with three color thresholds

For the second test image three color thresholds were set, one for the cothes of the student, one for his skin color and one for his hair color. Figure 6 shows the image. As one can see, again, there are a range of difficulties. The hair color of the student looks near identical to the wood color of the tree and the tree leafs have similar color as the face of the student. Additionally, the bottom of the background is dark and almost black which is similar to the jacket of the student.

Figure 6: Original Image 2

a) Determining color thresholds

In this test color thresholds had to set especially carefully for the hair of the student due to the similarity of the wood color of the tree. Face color threshold had also to be set low to not unintentionally segment tree leafs. The results of the three different image segmentations can be seen in Figure 7.



(a) (b) (c)

Figure 7: Color thresholding with three thresholds

b) Dilation and Superposing

As in the first test with two color thresholds, erosion and dilation is used on each of the three images seperatly first, to not stack surface area of unwanted objects. One can see that dilation was especially helpful to create a connected surface area on the whole student. Like test 1, superposing and dilation leads to small unwanted objects that have to be removed with erosion in the next step. One can see that results of superposing before erosion in Figure 8.

Figure 8: Image 2 after superposing and dilation

c) Final Segmentation

After using erosion and segmenting the student from the image the result shows clear detection of hair, face and clothes. The result can be seen below in Figure 9.

Figure 9: Image 2 after final segmentation

4. CONCLUSION

This paper demonstrated how image segmentation with two or more color thresholds with the help of erosion and dilation can lead to clear segment of a human in an image given prior knowledge. It is noticeable that using additional color thresholds leads to better segmentation but not necessarily to more unwanted objects as dilation and erosion are also performed before superposing all separate images. It should be noted that color thresholds have to be picked very carefully in order to detect enough surface area on the student but also not too much as a high threshold naturally comes with more unwanted objects on the picture. Finding a proper balance between these circumstances is the first main challenge of the algorithm. The second challenge lays in the intensity of erosion and dilation as its crucial to delete unwanted objects in the images but not to delete part of the student's body accidentally. Likewise, dilation has to be used with a high enough intensity to connect all parts of the student's surface area, but low enough to not increase the surface area of unwanted objects in a level that cannot be deleted by erosion afterwards. Thus, the balancing of erosion and dilation intensity is the second challenge of the algorithm. Comparing both test pictures it can be concluded that the algorithm performs well in both scenarios as the

student is segmented clearly and all unwanted objects get removed successfully. One should also notice that more different colors worn by the student lead to the necessity of more color thresholds. It is important to keep the exact order of dilation, erosion and superposing that the presented algorithm suggests to minimize the risk of stacking surface area of unwanted objects when performing superposing of multiple images. The test images indicate that using dilation and erosion before and after superposing is an effective way to prevent that risk. Overall, color thresholding for image segmentation seems to be effective when prior knowledge about the image is present. One should not however, that identical thresholds will most likely not work for different images. Also, more tests are needed to further confirm the effectiveness of proposed segmentation algorithm.

REFERENCES

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