CENG 466 - Fundamentals of Image Processing Take Home Exam 3 Report

1st Batuhan Çalışkan
Computer Engineering
Middle East Technical University
Ankara, Turkey
caliskan.batuhan@metu.edu.tr

2nd Alişan Yıldırım
Computer Engineering
Middle East Technical University
Ankara, Turkey
alisan.yildirim@metu.edu.tr

***Abstract*—Mathematical morphology and segmentation are such an important topics for image processing. With the morphological operations, object detection and counting, seperation an image to regions can be done.**

I. Introduction

This report presents for the THE3 (Take Home Exam 3) of the course Fundamentals of Image Processing. Object counting have object detection,counting and separating an image techniques by morphological operations and segmentation part has shift and n-cut methods.

Also, there are some code snippets that explains procedure which perform the image processing techniques.

II. Object Counting

For this part, the task is to count the number of flying balloons in the images. To achieve this purpose, converting the image o grayscale, applying thresholding to seperate balloons from the background and improvement on counting by morphology operations are main techniques. Counting done by enumerating connected regiones using **findContours** function from Opencv module.

For morphological operations, structure element is used. As structure elements, ball, disk and diamond shape structures used.

A. A1

Fig. 1. A1

After reading the image with gray scale, close and erosion operation was applied for closing small holes inside the thresholded image and erodes away the boundaries of the thresholded image with ball and diamond structures. After that, some bitwise operator applied with result of morphology operations to make image more suitable to detect balloons and dilation operation is applied to increase white region of the fragments. Finally, 4 balloons were detected as you can see on the Fig. 2.

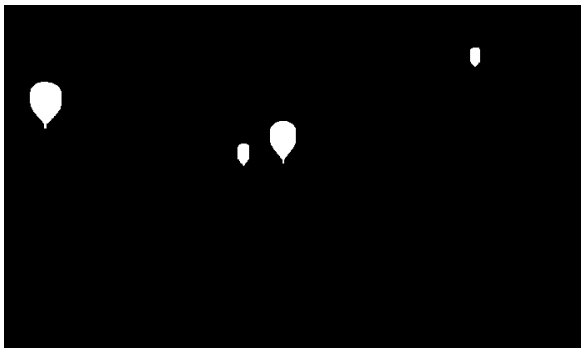

Fig. 2. A1 output

B. A2

Fig. 3. A2

After reading the image with gray scale, close operation was applied for closing small holes inside the thresholded image with ball and diamond structures. After that, some bitwise

operator applied with result of morphology operations to make image more suitable to detect balloons and dilation operation is applied to increase white region of the fragments. Finally, 6 balloons were detected as you can see on the Fig. 4.

Since some of balloons' background is land instead of sky, algorithm could not detect them.

Fig. 4. A2 output

C. A3

Fig. 5. A3

Fig. 5 is a hard image to detect and count balloons since their background mixed with sky and land. Also, some of balloons are nested. These reasons make this image hard to count flying balloons correctly.

The best result was obtained with usual grayscale thresholding method and using opening, closing, dilation and erosion operations. With the dilation operation, we increased the size of foreground object. With the erosion operation, we eroded away the boundaries of the thresholded image. With the closing operation, we closed small holes inside the thresholded image. With the opening operation, we removed the noises.

Some methods were tried to remove the land part of the image, but they did not give a result as we expected. Unfortunately, land part was not removed from the image and it affected the count of the balloons.

Finally, 12 balloons were detected as you can see on the Fig. 6.

D. A4

After reading the image with gray scale, close and open operation was applied for closing small holes inside the thresholded image and removing noises with ball and disk structures.

Fig. 6. A3 output

Fig. 7. A4

Finally, 9 balloons were detected as you can see on the Fig. 8.

Fig. 8. A4 output

E. A5

Fig. 9. A5

After reading the image with gray scale, close and erosion operation was applied for closing small holes inside the

thresholded image and erodes away the boundaries of the thresholded image with diamond and disk structures.

Finally, 17 balloons were detected as you can see on the Fig. 10.

Fig. 10. A5 output

F. Summary

Morphological operations are very handy to detect and count object and segmentation. For the A1 and A2 images, it was easy to detect and count flying balloons using thresholding with morphlogical operations since they are separated from each others and from the land generally. But for the A3, A4 and A5 images, it was hard to detect and count flying balloons since their background was land and they were nested each other.

III. Segmentation

For this part, the task is to separate water, land and sky in the given images by using mean and n-cut segmentations. Inside **segmentation_function**, there are two functions named **segmentation_function_mean_shift** and **segmentation_function_ncut** was created and used for this goal.

Main methodologies are mean shift and n-cut segmentation for this part. The main problem is here, edges between segments which are desired are not the only edges. This problem results low accuracy output with images which have a lot of edges inside. To solve this problem, open and close operations are used for mean shift segmentation. For ncut segmentation, segmentation image using k-means clustering, computing the region adjacency graph using mean colors and performing normalized graph cut on the region adjacency graph are used.

A. B1

1) Mean Shift: After mean shift segmentation, open and close operations were used with ellipse structure as mentioned before. Ellipse structure gave the best result for our script. After that, grayscale threshold image was used to find contours and image was filled with colors. Fig. 12 shows the output for mean shift of B1 image.

2) N-cut: After segmentation image using k-means clustering, we computed the region adjacency graph using mean colors. Then, we performed normalized graph cut on the region adjacency graph. Finally, we used grayscale threshold image to find contours and then filled image with colors. Fig. 13 shows the output for ncut segmentation of B1 image.

Fig. 11. B1

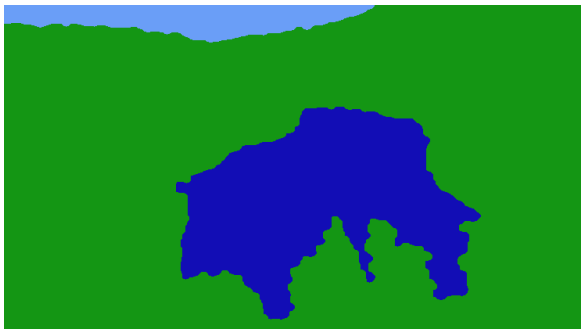

Fig. 12. Mean shift output of B1

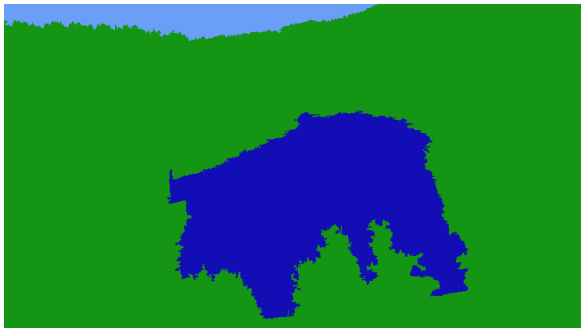

Fig. 13. N-cut output of B1

3) Comparing Mean Shift and N-cut: When we compare the outputs of mean shift and ncut, we can clearly see mean shift output has more smooth edges for its segmentation while ncut output has more sharp edges. On the other hand ncut output is more accurate than mean shift segmentation for separating segments. Because for this image, ncut have correct color for its segments and its edges seperate segments more clearly.

B. B2

1) Mean Shift: After mean shift segmentation, in addition open and close operations, erosion and dilation were used with disk structure to erodes away the boundaries and increasing the size of thresholded image green areas. For the blue areas, open and close operations are used. After that, image was

Fig. 14. B2

filled with colors. Fig. 15 shows the output for mean shift of B2 image.

Fig. 15. Mean shift output of B2

2) N-cut: After segmentation image using k-means clustering, we computed the region adjacency graph using mean colors. Then, we performed normalized graph cut on the region adjacency graph. Finally, we used green and blue thresholded images to fill up image with colors. Fig. 16 shows the output for ncut segmentation of B2 image.

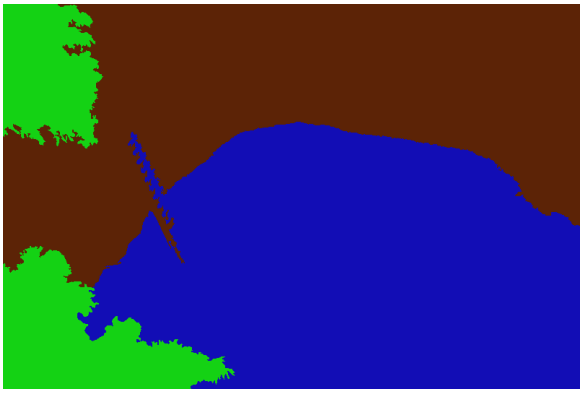

Fig. 16. N-cut output of B2

3) Comparing Mean Shift and N-cut: When we compare the outputs of mean shift and ncut, we can clearly see mean shift output has more smooth edges for its segmentation while ncut output has more sharp edges. On the other hand mean shift output is more accurate than ncut segmentation for separating segments since ncut output has wrong color scale for wrong segment.

C. B3

Fig. 17. B3

1) Mean Shift: After mean shift segmentation, open and close operations were used with ellipse and disk structure as mentioned before. After that, grayscale threshold image was used to find contours and color space changed gray to rgb to fill image with colors. Fig. 18 shows the output for mean shift of B3 image.

Fig. 18. Mean shift output of B3

2) N-cut: After segmentation image using k-means clustering, we computed the region adjacency graph using mean colors. Then, we performed normalized graph cut on the region adjacency graph. Finally, we used grayscale threshold image to find contours and then filled image with colors. Fig. 19 shows the output for ncut segmentation of B3 image.

3) Comparing Mean Shift and N-cut: When we compare the outputs of mean shift and ncut, we can clearly see mean shift output has more smooth edges for its segmentation while ncut output has more sharp edges. On the other hand

Fig. 19. N-cut output of B3

mean shift output is more accurate than ncut segmentation for separating segments.

D. Summary

All of the images were segmented into their regions of sky,land and water. Mean shift and normalized cut are used for finding the regions. But, morphological operation was required for mean shift segmentation. Generally, mean shift segmentation gave output image which is more soft edge image, on the other hand, normalized cut gave output image which is more sharp edge image.