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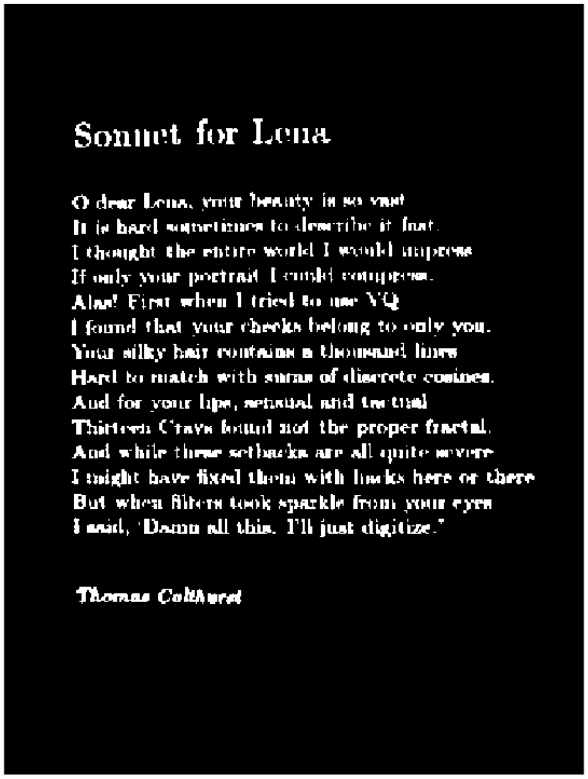
CS 484 - Image Analysis
Homework 1

Question 2)

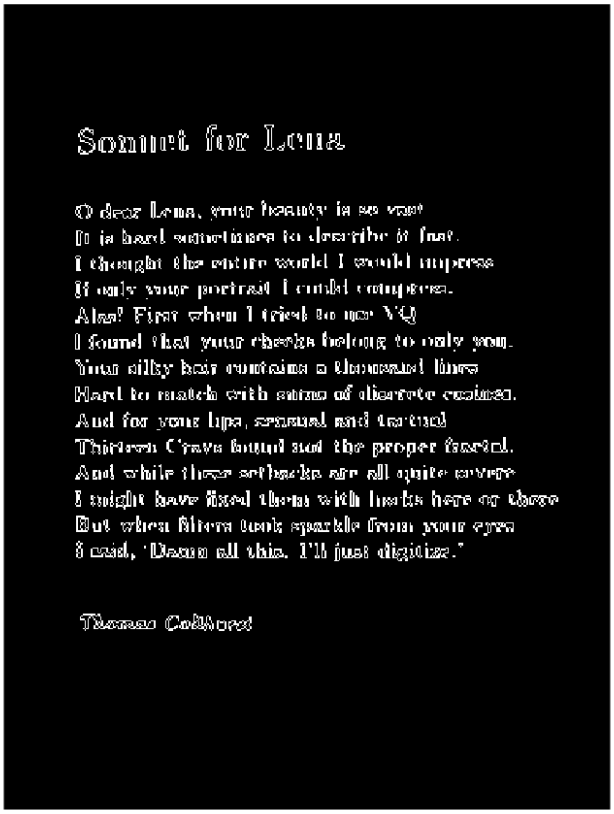
At first, after reading the image into a variable, I used adaptive thresholding with neighborhood size 31 to extract the text data without as less noise as possible. The reason of the usage of adaptive thresholding is, global thresholding techniques was result in a noisy and non-readable text image. However, adaptive thresholding resulted in a less noisy and more readable output since it uses local values to threshold. Then, I took its complement to further process its white(1) values. Taking the adaptive threshold was easy because of Matlab offers a built-in function that easily takes the threshold with desired neighborhood size.

The Result :



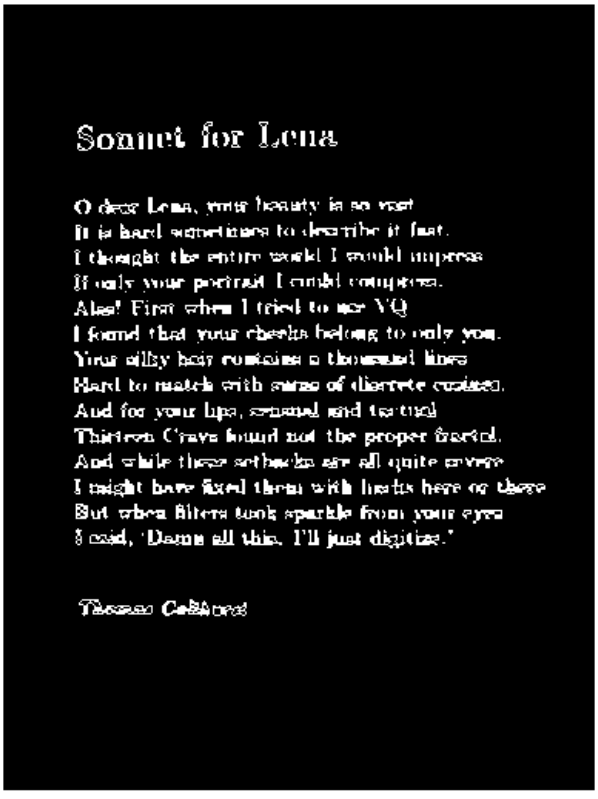
Then I eroded this image with a structuring element that is symmetrical about its origin and subtract it from the above image to find the boundaries of the each individual characters. In order to first detect the characters and then fill inside of them. I tried several methods before coming up with this one and all of them were not as effective as this one. I thought that if I can determine the characters' boundaries, filling them will give a good result. However, finding the structural element took some time but I researched and found that symmetrical structural elements give good results with text characters and I therefore used one.

The Result :



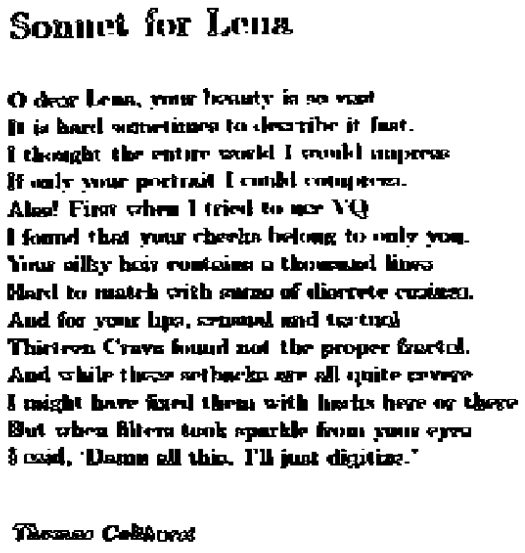
After that, the closing operation that consists of dilation followed by an erosion is used to close the inside of the boundaries as much as possible with a structuring element : [1,1,0]. The structuring element is founded to work best experimentally. I tried several options and the best result was by using it. Regardless of several options that I tried, closing the boundaries perfectly could not be possible. I experimented with several operations and elements.

The Result :



At last, a dilation operation with the same structuring element with the last operation is used to make the test as visible as possible and the complement is taken to revert it to its desired format. At this stage, I tried several dilation and erosion combinations with several structuring elements but big structuring elements tend to mix the characters and make the test non-readable since the characters are small. Finding the true structuring element was really hard. However, about the operation since I wanted to make the text more visible, I decided to use dilation.

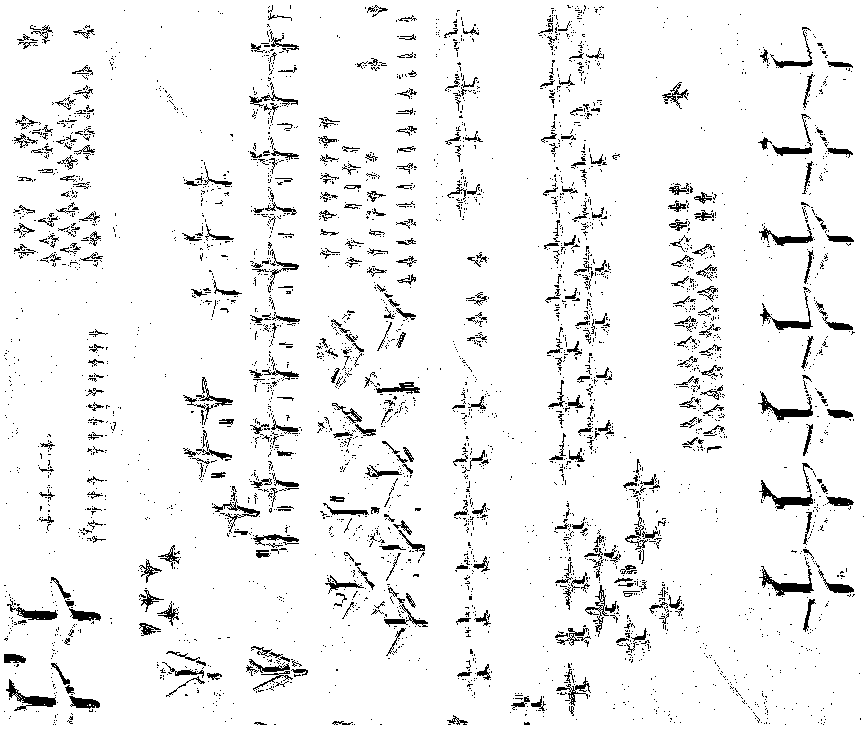
The Final Result :



Question 3)

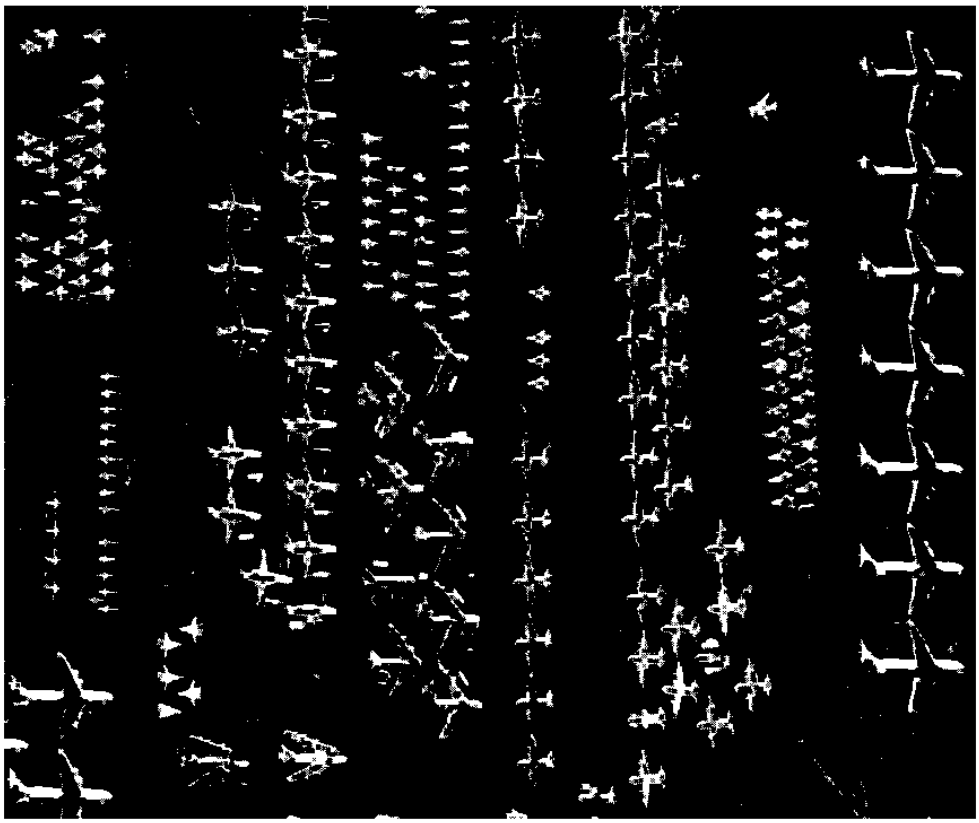
Firstly, I turned the RGB image to grayscale and observed its gray level intensities to find an interval to select as much plane as possible while keeping their figure unharmed. After few iteration I found that [50,230] interval is quite good and applied it.

The Result :



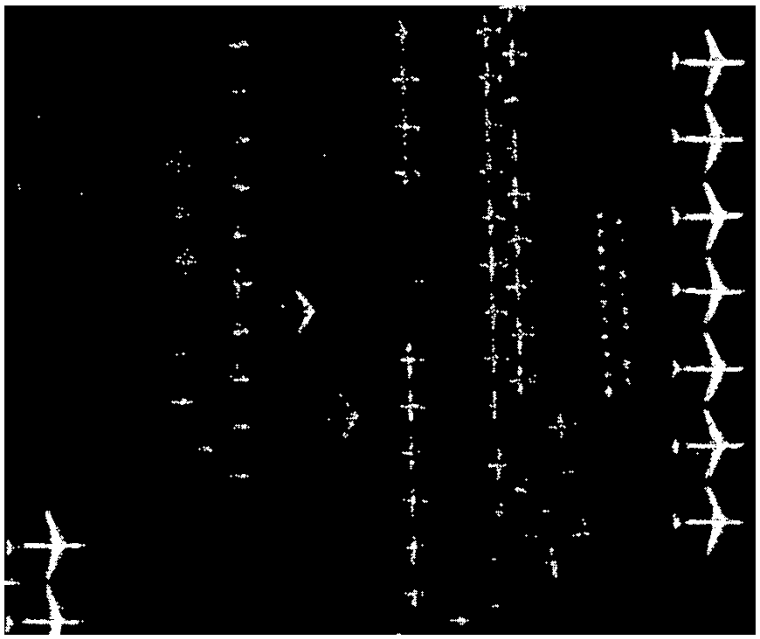
After erosion and dilation operations consecutively are applied in order to clear the noise. Finding a suitable structuring element for these operations are challenging again. I tried several options and pick origin symmetric structural elements because it was the best result experimentally. After all, the complement of the image is taken for further processing the white values.

The Result :

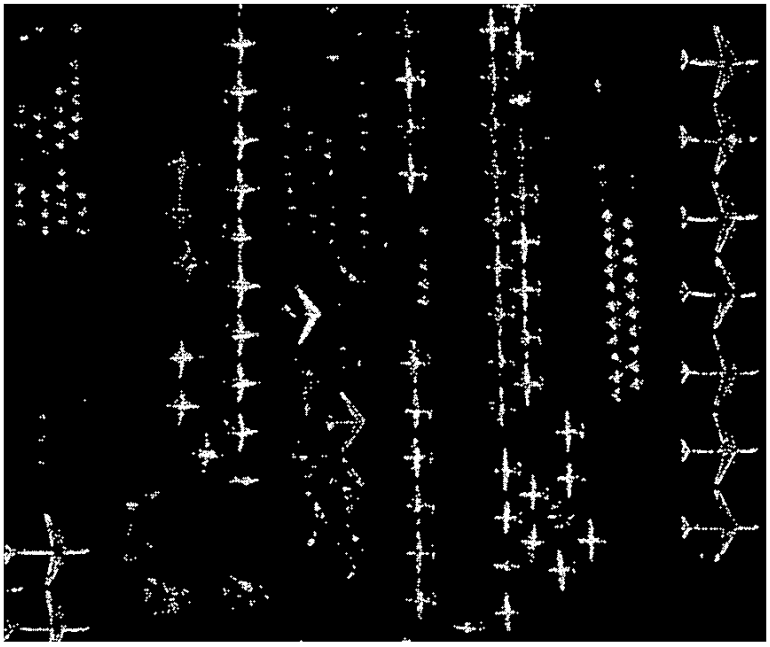


Then, the original image is divided into its red, green and blue bands to threshold them individually. By investigating the each plane, I decided to threshold the biggest planes into one image and the other ones into another to merge them afterwards. I checked every pixels' RGB values at the corresponding planes and came up with a most suitable interval. After I dilated these two images to make them more visible with the same structuring element that was used above.

The Results :

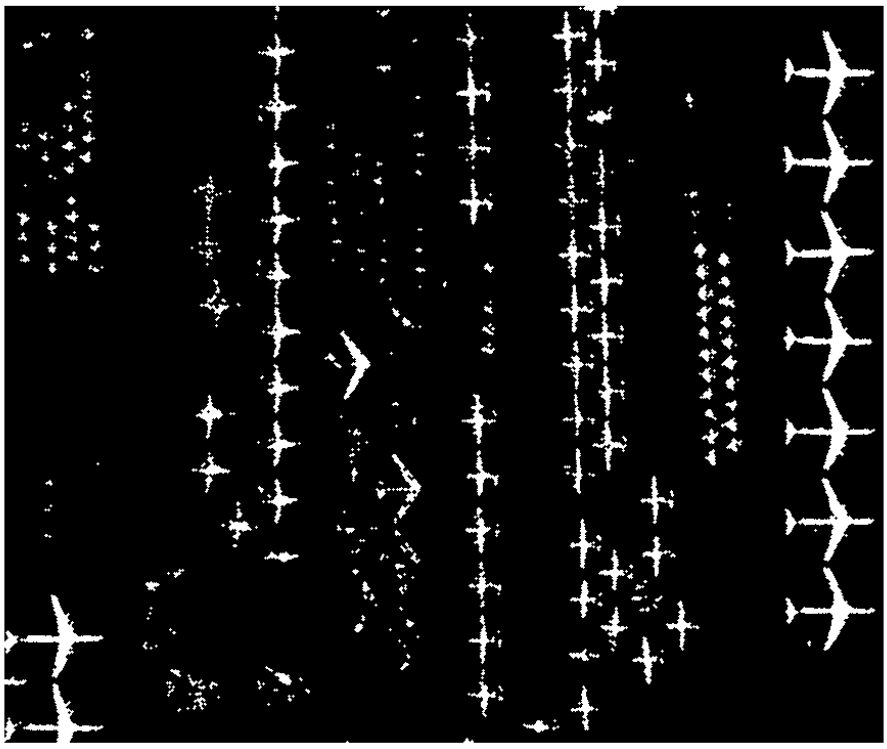


The threshold according to the biggest planes.(It covered another plane parts too)



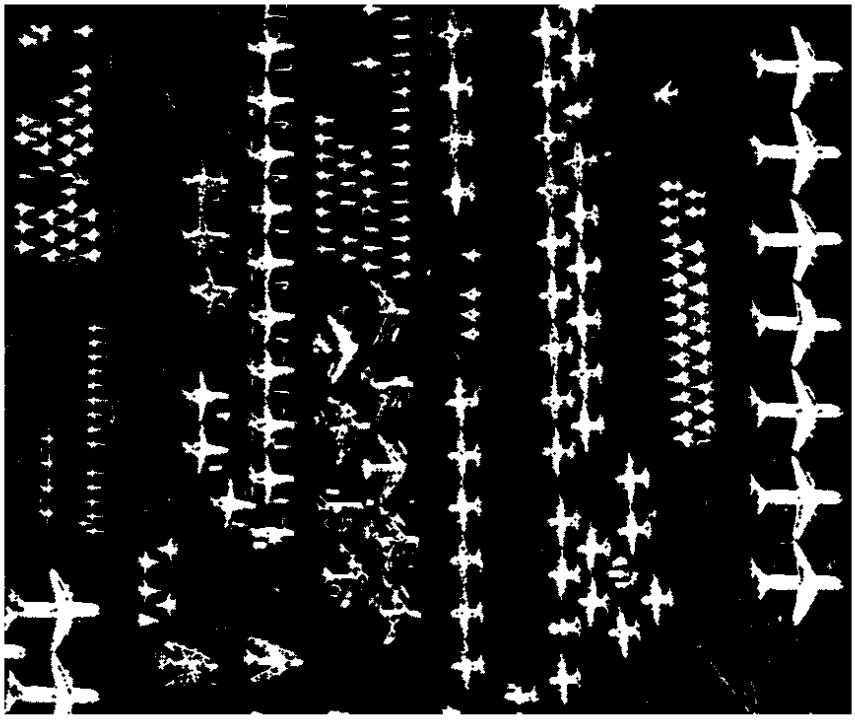
Selecting all the planes clearly was very challenging. I tried to threshold several times but none of the results were complete. So, I came up with an idea of selecting each types of planes as clearly as possible into one image then merge the results to output one single image that selects all individual elements. Therefore, I merged the above two results of the RGB thresholding of the original image into one and clear the noise with erosion followed by a dilation(closing).

The Result :



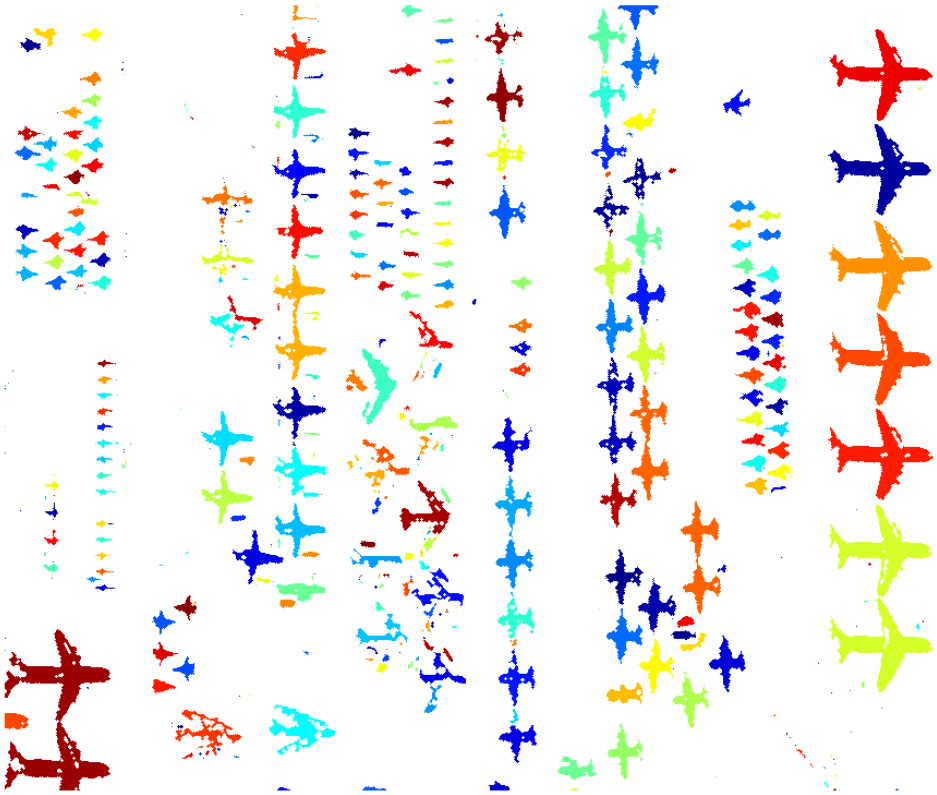
The above result does not include well several small planes at the left-most corner and some in the upper middle part. Therefore, I merged it with the first image which is the result of the grayscale thresholding and performed a closing operation in order to close the gaps because of merging the two images. However, I could not completely close all the gaps. The RGB thresholding results gave good shapes of several planes but lost a lot of the small planes. In order to include as much plane as possible, I corrupted the shapes of some planes slightly. Including all planes are challenging and I tried several methods to keep both their numbers and correct sizes. However, I concluded that a trade-off between the perfect shape versus exact number must be done and I chose to include as much plane as possible.

The Result :



At last, I used Matlab's built-in connected component labeling methods to label the individual components.

The Result :



Question 4)

Station Camera Frames :

The result of the background subtraction of the first image :

After that I used the Matlab's automatic binary thresholding function "imbinarize" to obtain a binary image and the result turns out to be quite good.

The Result :

Then, I applied an opening and closing operations with a disk structural elements that is obtained by “strel” function to clear the noises and fill the holes. Up to this point, the task was easy.

The Result :

At last, I label the connected components.

The Result :

The first frame was easier to analyze and I spent less time on that. For the second frame, the background subtraction result is :

At first I thresholded the image between [35,255] in order to obtain the person figures as much as possible. In this case, obtaining all points of interest without noise, shadow or illumination was impossible. So, I tried several thresholds to keep the noises as small as possible and chose the [35,255] experimentally. The hardest thing was if one wants to clear the shadow of the closest two person , the one with the backpack lost its several pixels and the hardly visible lady on the upper-left corner nearly disappears. The best result that I came up by using thresholding is subtracting the [0,65] intensity interval pixels from the [35,255] interval.

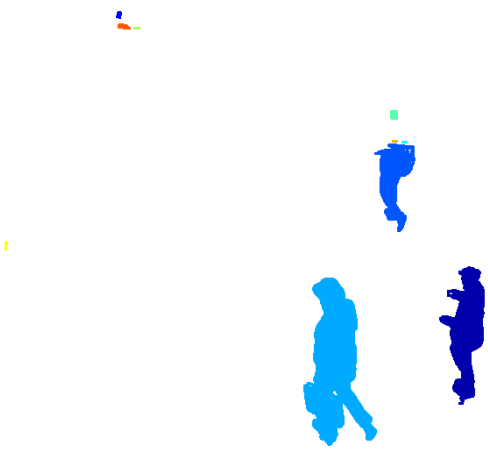
The Result :

I experimented several thresholding parameters and finding a one to fit all into the resulting image seemed impossible. The best result that I gathered is above. Since the grayscale images have nearly zero values on the back of the backpacked man, I could not extracted its all pixels. After that I applied an opening operation to clear out the noises but it did not enhance the quality very much. At this point, no morphological operation sequence resulted into a better image in terms of the recognition of the points of interest.

The result :

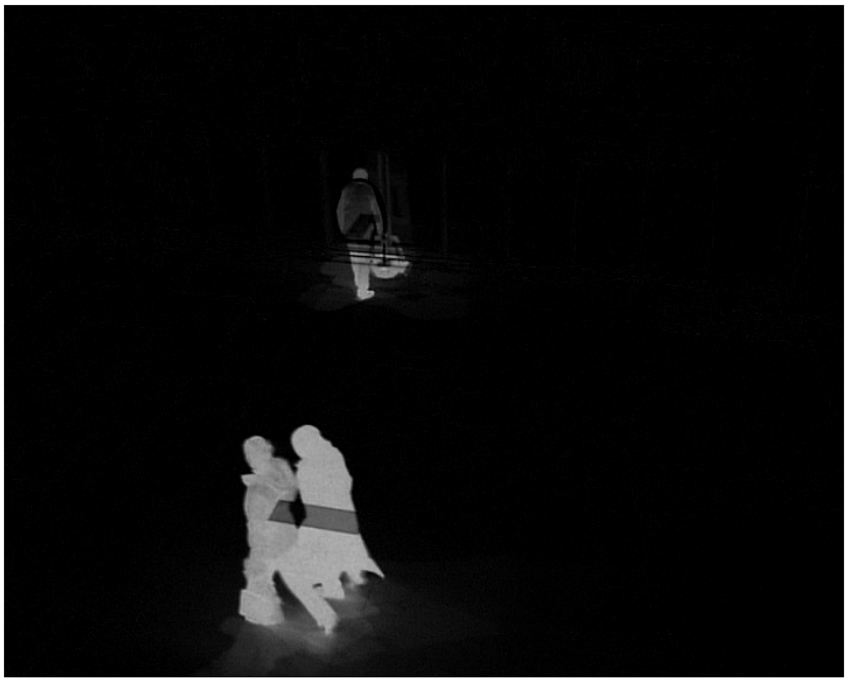
At last, connected component labeling is applied to the above image.

The Result :



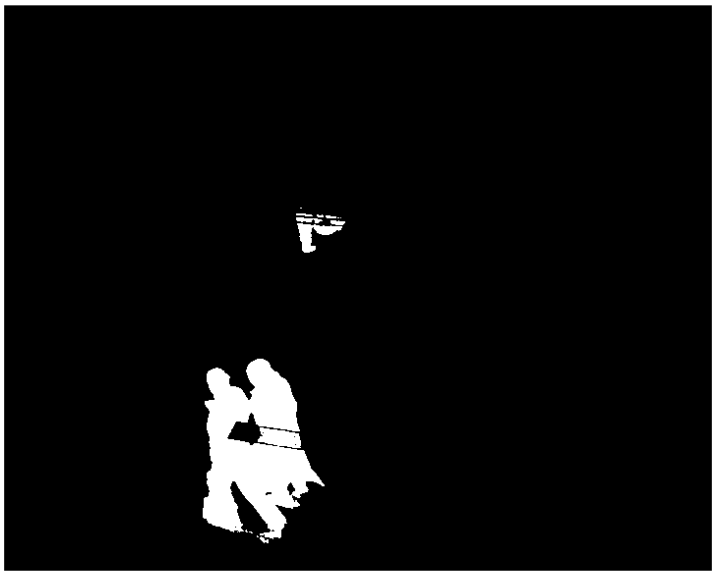
It can be seen that the upper body of the backpacked man lost. Also very few unconnected components of the lady on the upper left remains. Extracting the upper-left lady resulted into noises in terms of shadows and illumination and I could not get rid of these noises completely with morphological techniques.

For the third frame, the background subtraction result is :



This grayscale image has a lot of illumination and shadow errors. Trying to get rid of the shadows' of the two people in front makes the upper part of the man in the back disappear completely. I tried several thresholds for keeping the man but it seem it is not possible with a grayscale thresholding. Therefore, I tried RGB thresholding with 3 different bands but since the color of the man's coat is nearly same with the color of train's outer paintings, the RGB thresholding gave erroneous results. I tried several thresholds and pick up the [90,255] experimentally.

The Result :



I applied opening and closing operation consecutively to the above result and obtain this :

At last, connected component labeling is applied to the final result :

Copy Machine Camera Frames :

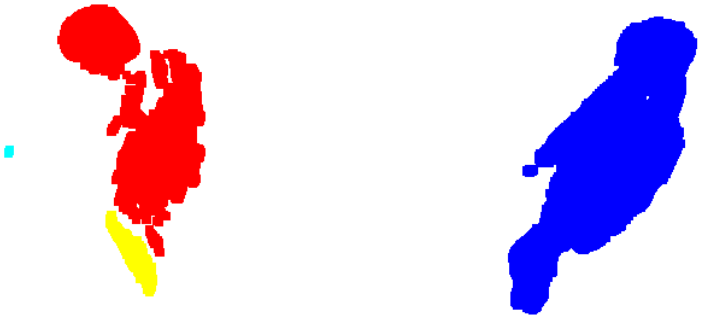
The result of the background subtraction of the first frame :

This subtracted image has a lot of difficulties when applying thresholding techniques. At first, the legs of the man in front of the copy machine have gray scale values [0,10] and it is impossible to threshold it. Moreover the copy machine has grayscale values very close to the mans upper body. Therefore, I found it very hard to threshold and acquire a reasonable image but I thresholded it with several values and combined those images into one by logical operations and the result is :

I thought that if I can manage to found the boundaries and most of the inner part of them, I can cover the holes and obtain the points of interests. However since copy machine and several noises existed, I could not find a way to obtain a perfect extractions. I tried opening and closing operations consecutively but the result had a lot of unconnected components. Therefore, I dilated it twice the result to obtain a better image but at this point I found it very hard to extract the points of interest perfectly because there are several near valued pixels exist in the image.

The Result :

At last, connected component labeling is applied :



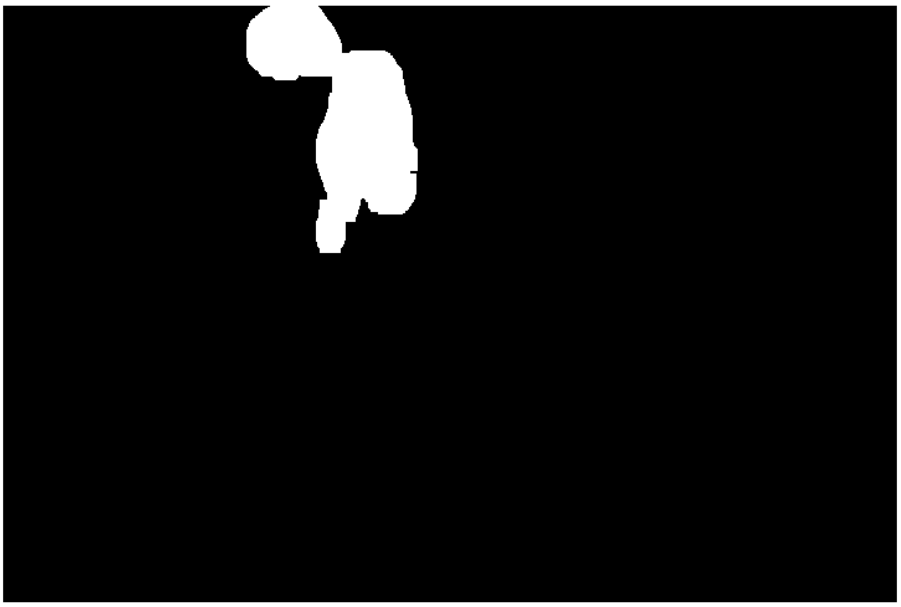
The background subtraction of the second frame is :

When the pixels of the person is analyzed, it is seen that his skin has nearly 0 values. Therefore, extracting his hands and necks are impossible with grayscale thresholding. Furthermore, I tried RGB thresholding but the floor of the area has nearly same RGB values with the person's skin color and therefore it created a lot of noise. The best interval I found is [80,255].

The Result :

The resulting image above has lack of considerable amount of pixels from the point of interest. I tried several morphological operations consecutively and the desired result cannot be reached. This step was quite hard because I blindly experiment sequences of morphological operations with several structuring element without any clear reason. Experimentally, I came up with a sequence of opening, closing, 3 times dilation and opening again.

The Result :



At last, connected component labeling is applied and the result is :

The background subtraction of the last frame is :

The main problem in this frame is, hairs of the person has grayscale values nearly as similar as his shadow. So, I first thresholded the person figure roughly and then merged it with another thresholded image which contains some missing part of his hairs and some noises.

The result :

The resulted image has missing shoes because they have 0 grayscale values. Closing the holes of this image without making noises bigger was hard. Even-though, I could not do it completely I tried several morphological operations. For smoothing the edges, I found disk with radius 3 is quite successful. Then, I applied opening, closing and 2 more dilation operations with that disk structural element.

The Result :

At last, connected component labeling is applied and the result is :