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CS 484
Homework 1

1. Question 2

1.1. Thresholding

Figure 1: Result of thresholding

I checked several thresholds to get enough but not much detailed image. I used 130 as a final threshold and selected that pixels.

1.2. Morphological Operations

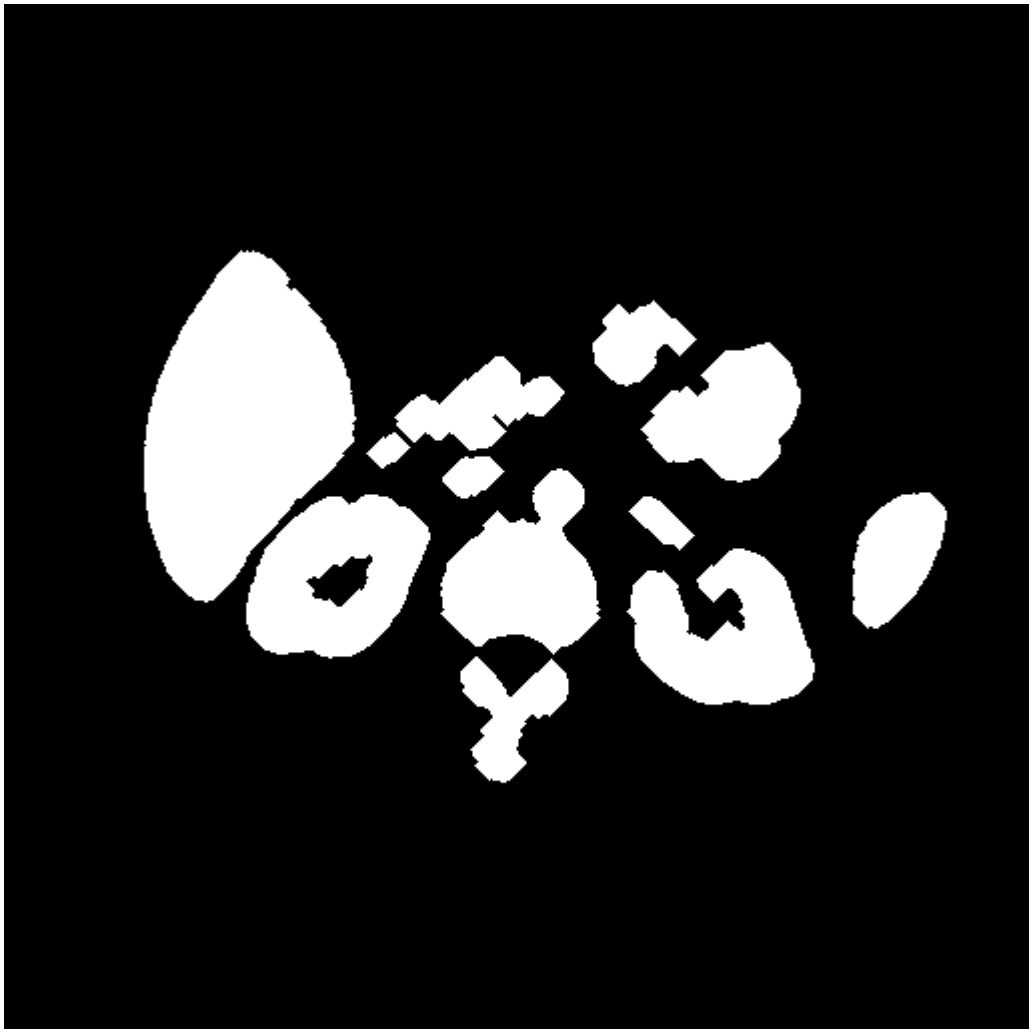

Figure 2: Result of morphological operations

I first fill gaps with closing. I tried several structuring elements to find best result. I used 3 by 3 diamond as final structuring element for closing. Then, I eliminated noise with opening. Again I tried several structuring elements. I used 15 by 15 diamond as final structuring element for opening.

1.3. Connected Components Labeling

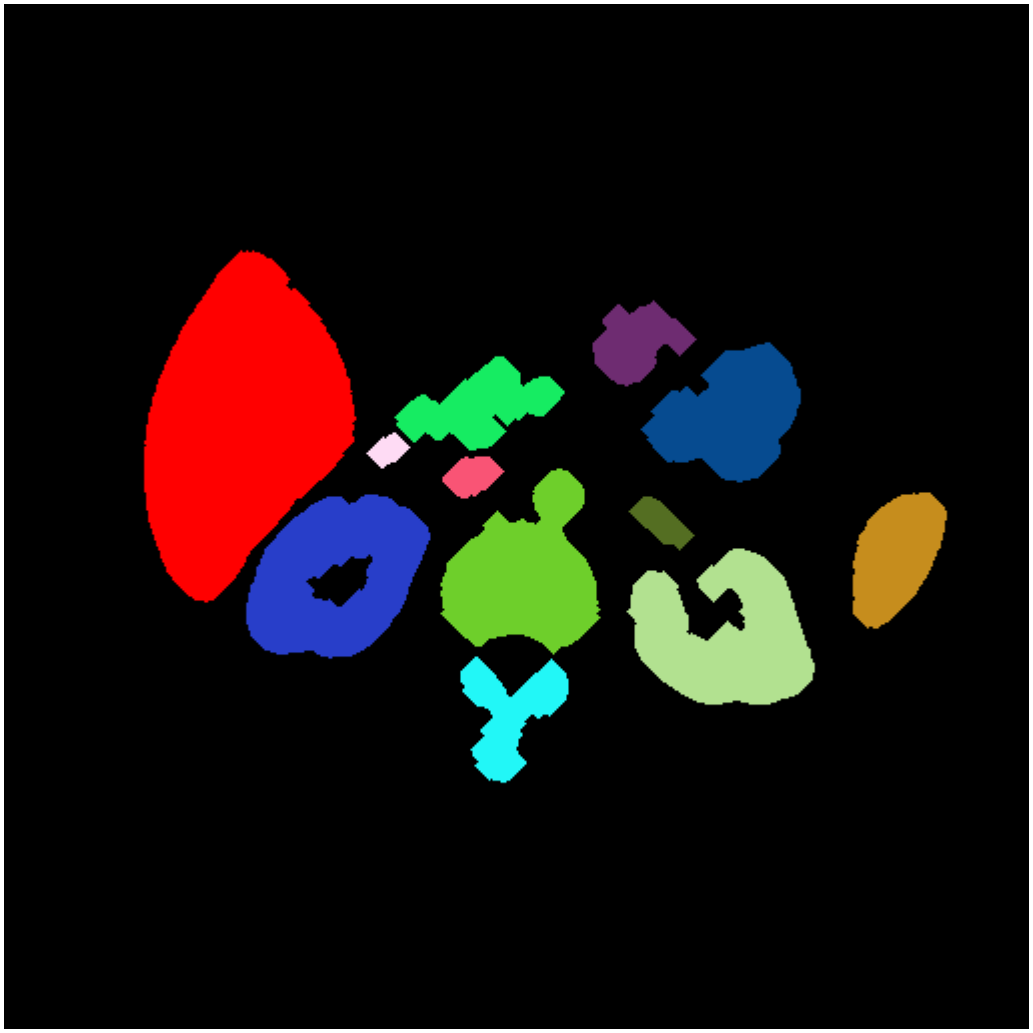

Figure 3: Result of connected components labeling

I used Matlab's "bwlabel" function to get labelled image. Then, I assigned colors to each label.

1.4. Result Analysis

I think finding a threshold and labelling the image was easy. The hardest part was finding appropriate structuring elements that fills the gaps but does not connect shapes, and eliminates the noise but keeps shapes as complete as possible. I spend most of my time by trying different structuring elements.

2. Question 3

For question 3, I wrote a function called “imageOperations”. This function takes background image, image, threshold, structuring element for closing, and structuring element for opening as parameters. First, the function subtracts the background image from the image and shows the result. For subtraction, I subtracted image from background and took absolute value of the result. After, I converted the result to grayscale and multiply by 255 since conversion gives values between 0 and 1. Then, the function thresholds the image with threshold parameter and shows the result. After that, the function fills the gaps by closing with closing structuring element parameter, and eliminates noise by opening with opening structuring element parameter, and shows the result. Finally, it labels connected components with Matlab’s “bwlabel” function, and assign colors to each component, and shows the result.

I read all images and convert them to grayscale. For each image I called this function optimal threshold and structuring elements.

2.1. Highway

2.1.1 Frame 1

Figure 4: Result of background subtraction

Figure 5: Result of thresholding

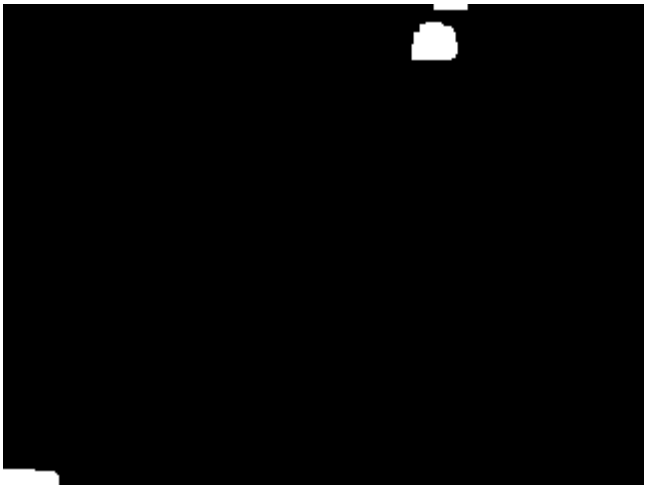

Figure 6: Result of morphological operations

Figure 7: Result of connected components labeling

I tried different thresholds. I think best result was given by threshold 40. I used different structuring elements. I used different sizes and shapes for structuring elements. I get final

result by 3 by 3 square structuring element for closing and 6 by 6 square structuring element for opening.

2.1.2 Frame 2

Figure 8: Result of background subtraction

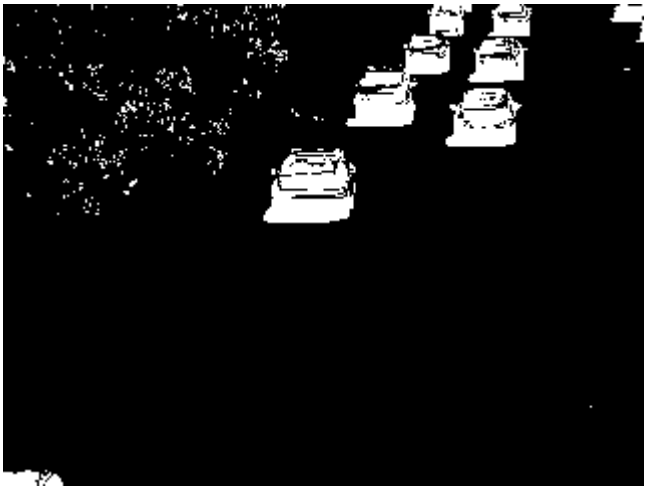

Figure 9: Result of thresholding

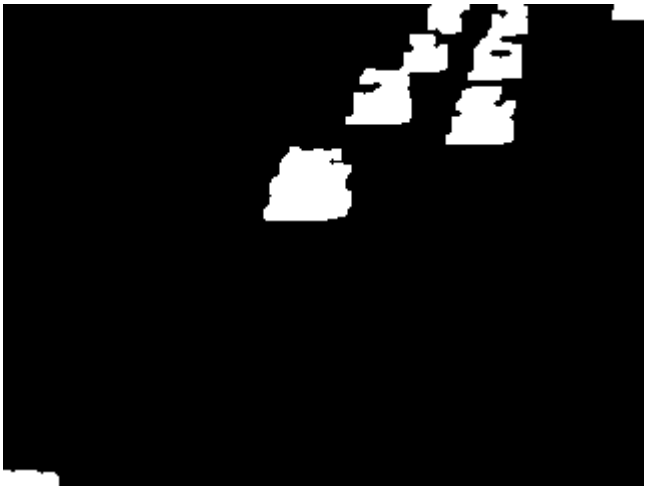

Figure 10: Result of morphological operations

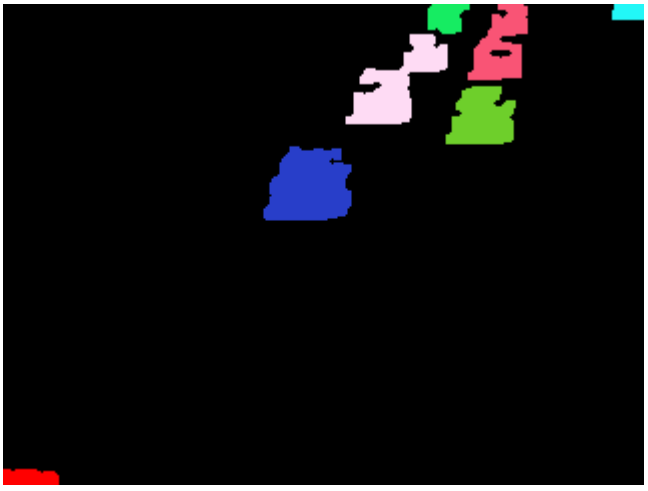

Figure 11: Result of connected components labeling

I tried different thresholds. I get best result with threshold 40. I used different structuring elements. I used different sizes and shapes for structuring elements. I get final result by 3 by 3 diamond structuring element for closing and 4 by 4 square structuring element for opening. The cars at top left (pink labelled) was connected with closing. I could not find any structuring element that fills the holes but does not connect cars since the gap between two cars was only 1 pixel.

2.1.3 Frame 3

Figure 12: Result of background subtraction

Figure 13: Result of thresholding

Figure 14: Result of morphological operations

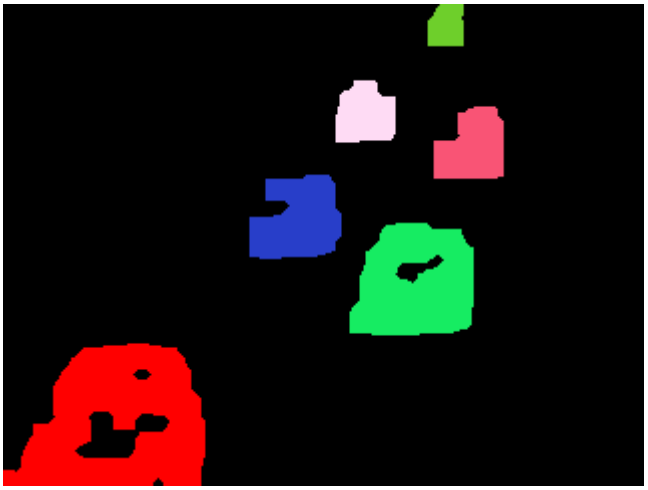

Figure 15: Result of connected components labeling

I tried different thresholds. I think best result was given by threshold 30. I used different structuring elements. I used different sizes and shapes for structuring elements. I get final result by 5 by 5 diamond structuring element for closing and 11 by 11 square structuring element for opening. It was hard to fill all the holes so I had to use bigger structuring element for closing. Since I used bigger structuring element for closing, I had to use bigger structuring element for opening which resulted some information loss (e.g. car labelled pink).

2.2. Pedestrians

2.2.1 Frame 1

Figure 16: Result of background subtraction

Figure 17: Result of thresholding

Figure 18: Result of morphological operations

Figure 19: Result of connected components labeling

I tried different thresholds. I get best with threshold 25. I used different structuring elements. I used different sizes and shapes for structuring elements. I get final result by 5 by 5

diamond structuring element for closing and 8 by 2 rectangle structuring element for opening. I could not keep the feet of the person since it was smaller than noise.

2.2.2 Frame 2

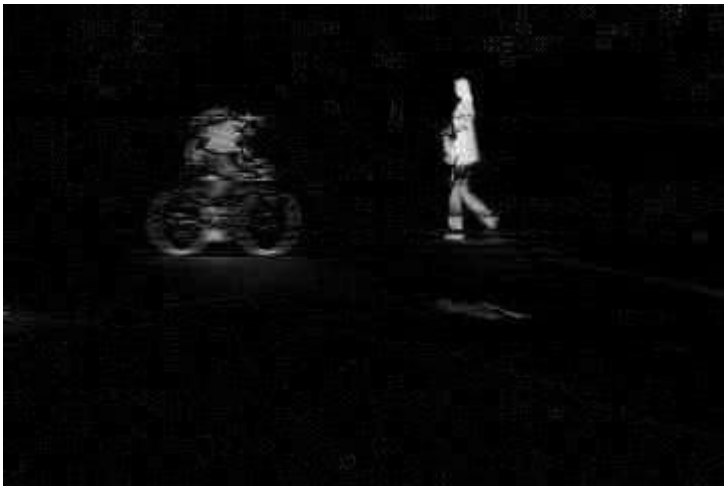

Figure 20: Result of background subtraction

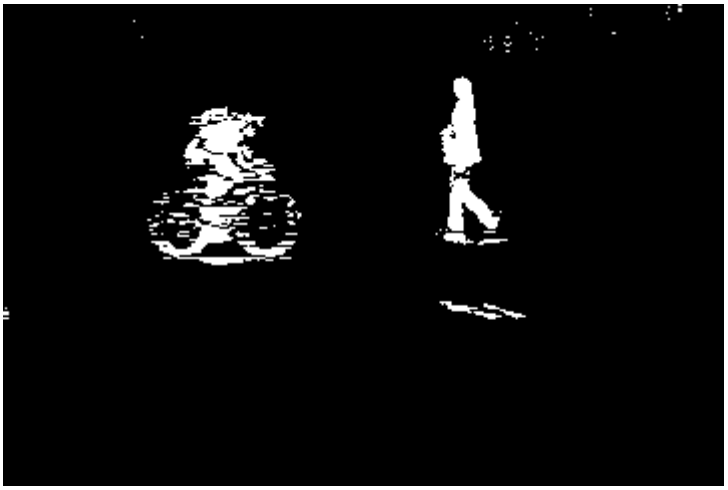

Figure 21: Result of thresholding

Figure 22: Result of morphological operations

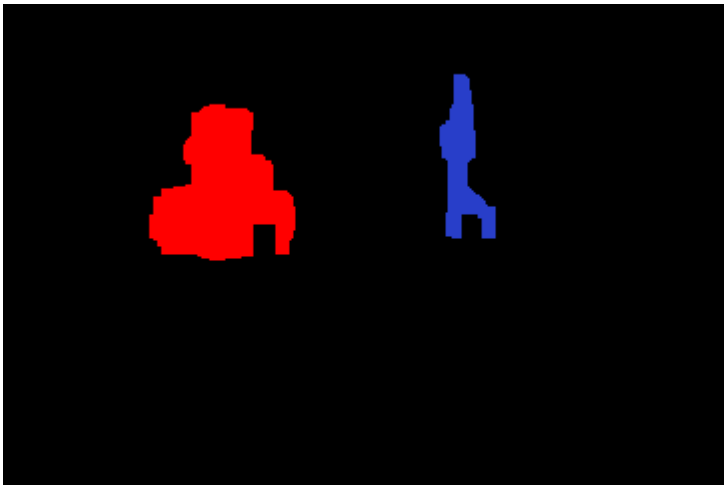

Figure 23: Result of connected components labeling

I tried different thresholds. I think best result was given by threshold 30. I used different structuring elements. I used different sizes and shapes for structuring elements. I get final result by 8 by 8 square structuring element for closing and 8 by 3 rectangle structuring element for opening. Since the bicycle and the person was blur and has lots of disconnected parts, I had used bigger structuring element for closing.

2.2.3 Frame 3

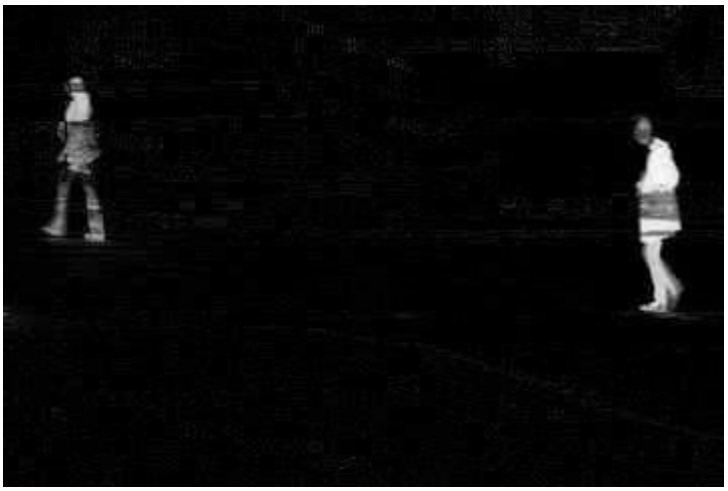

Figure 24: Result of background subtraction

Figure 25: Result of thresholding

Figure 26: Result of morphological operations

Figure 27: Result of connected components labeling

I tried different thresholds. I think best result was given by threshold 20. I used different structuring elements. I used different sizes and shapes for structuring elements. I get final result by 3 by 3 diamond structuring element for closing and 10 by 3 rectangle structuring element for opening.

2.3. Result Analysis

For highway, when objects have different sizes, it is hard to find structuring elements both for small objects and large objects. I think pedestrians was much harder than highway because of the organic shape (lots of curvy details) of the objects. Cars have much more geometric shapes than humans. Similar with question 2, the hardest thing was finding appropriate structuring element. I spent a lot of time to find structuring elements. I think it is impossible to get rid of noise without losing data of objects of interest.