

CS484 HW2 Report

Results for Canny Edge Detection part

In the canny edge detection part, I have used opencv's Canny function which takes 3 parameters; image, low_threshold and high_threshold. I found best threshold (most similar to example images in pdf) values by trial and error. In my experiment, I found low threshold as 42 and high threshold as 61. Following are the results.

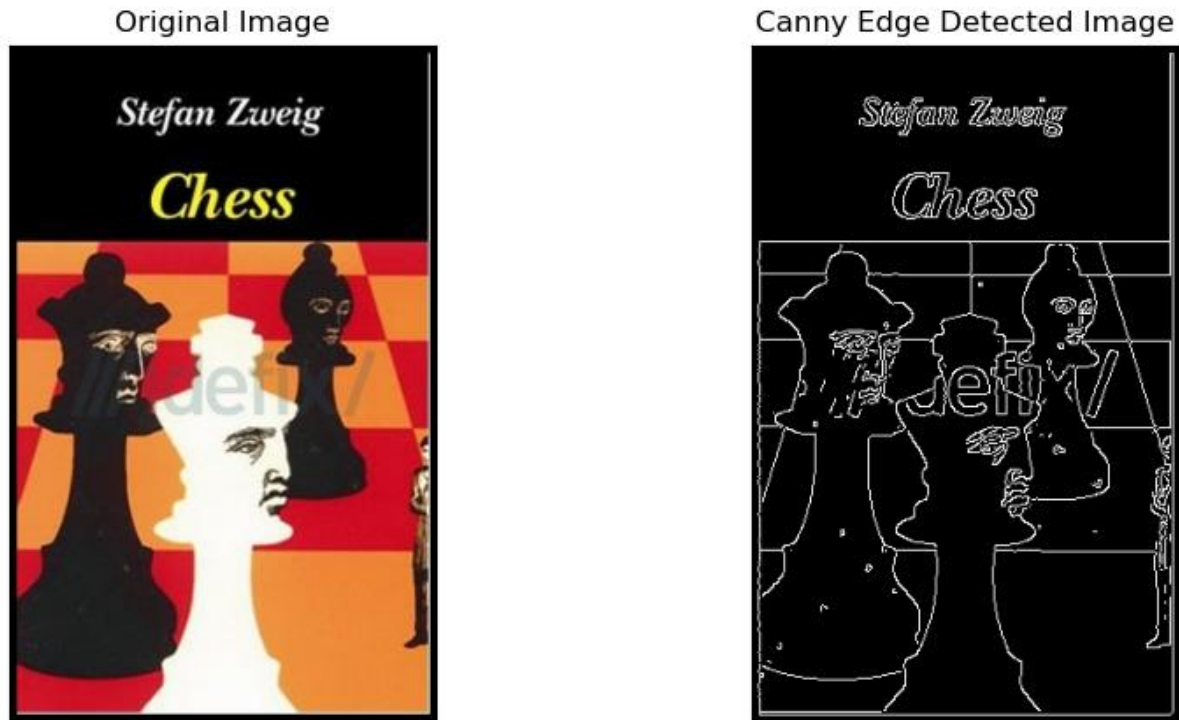


Figure 1: Result for template chess image and canny edge detected image where low=42, high=61

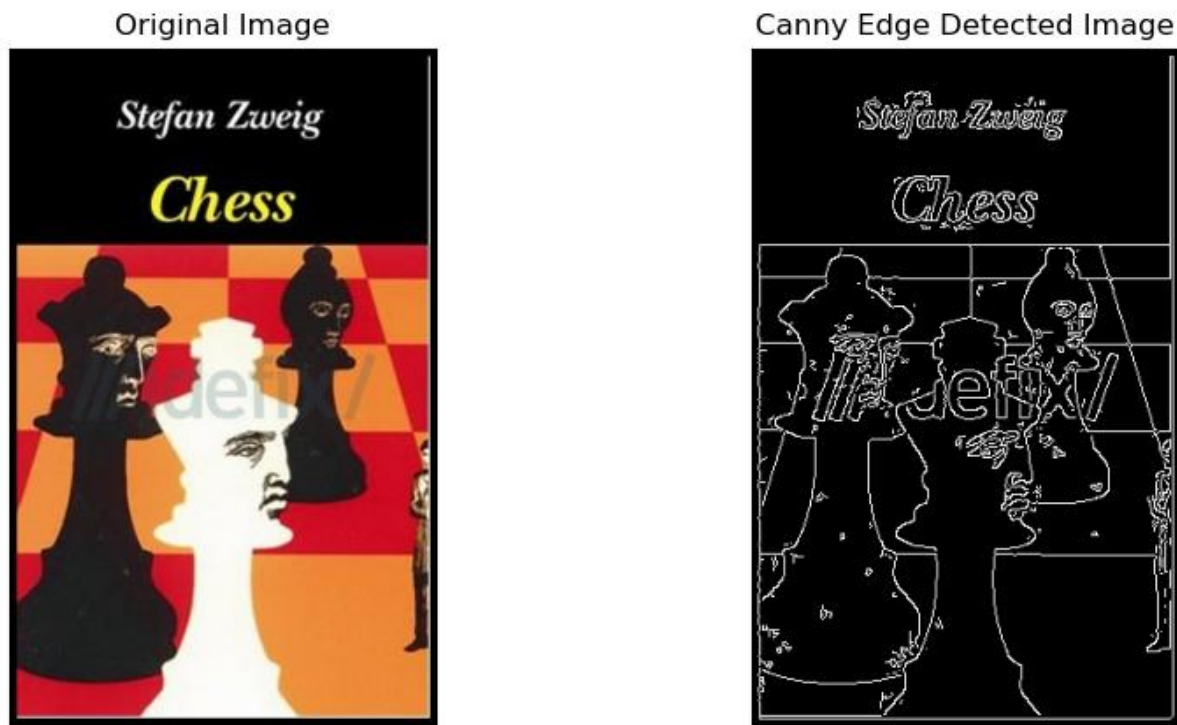


Figure 2: Results when low=15, high=45

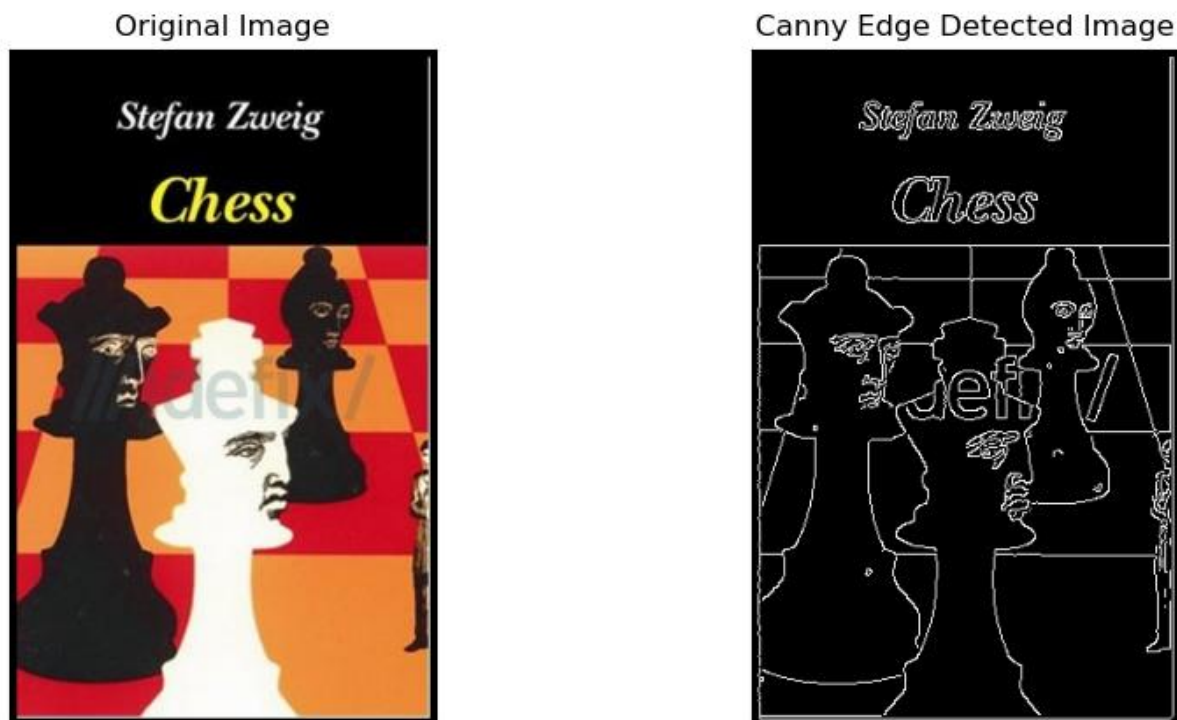


Figure 3: Results when low=50, high=100

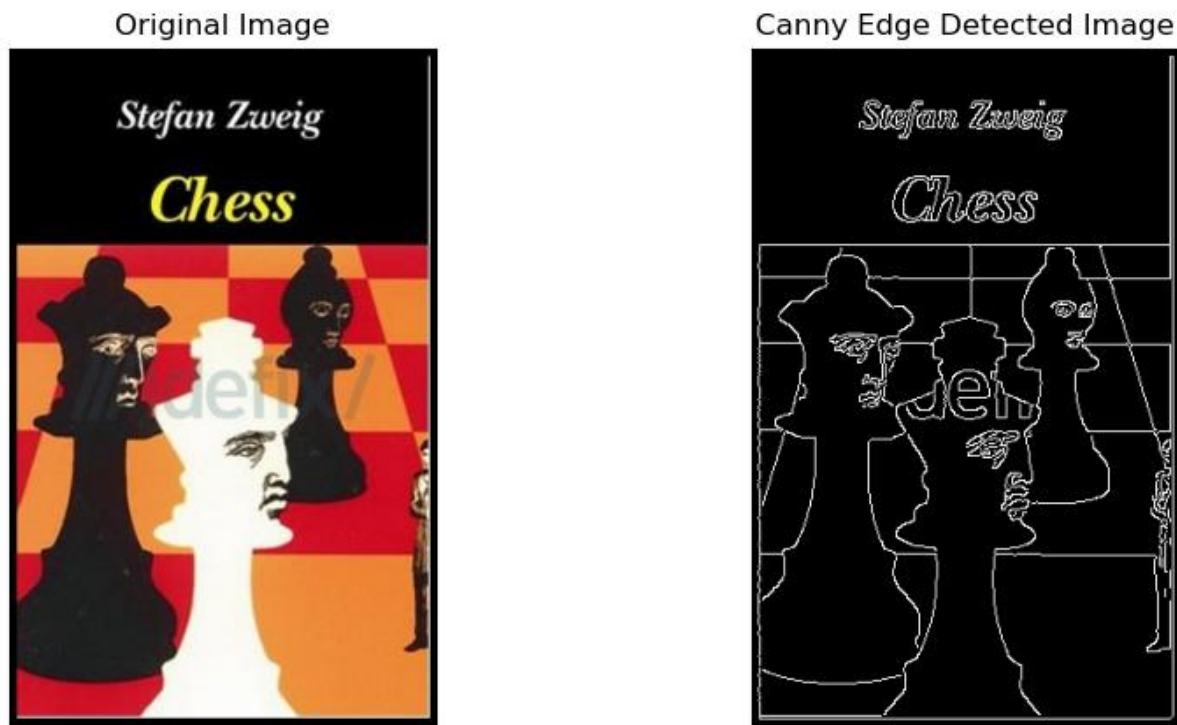


Figure 4: Results when low=100, high=200

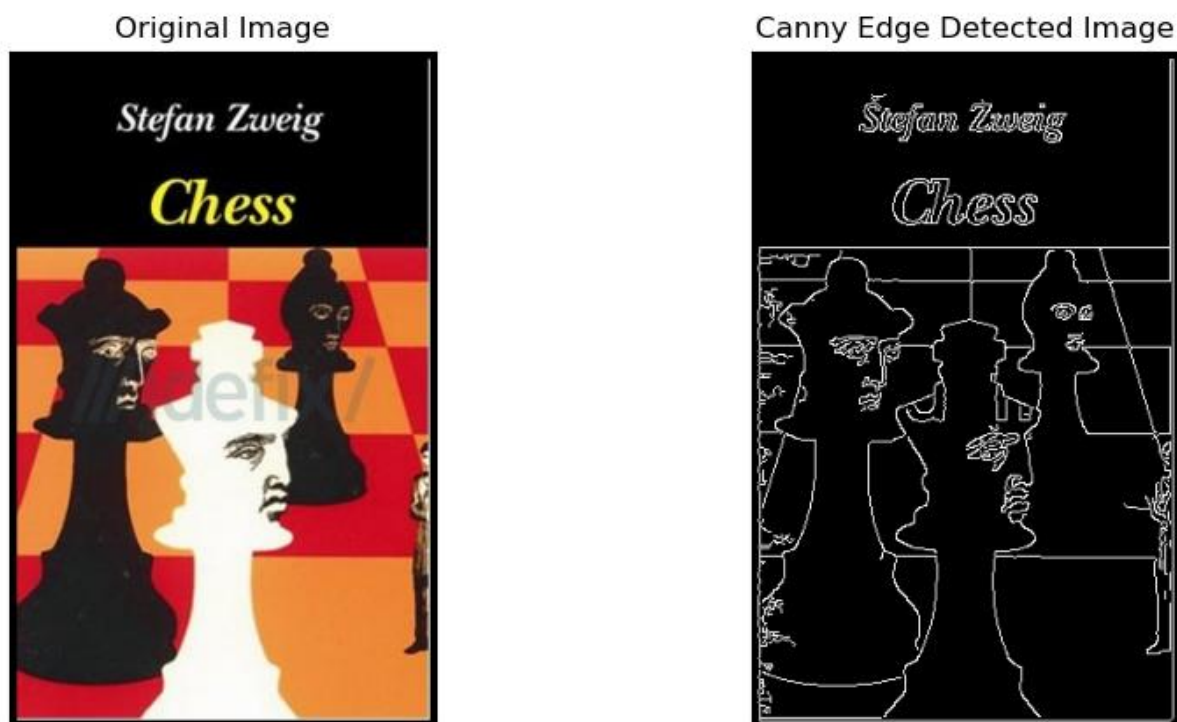


Figure 5: Results when low=0, high=255



Figure 6: Canny edge detected all original template images where low=42, high=61

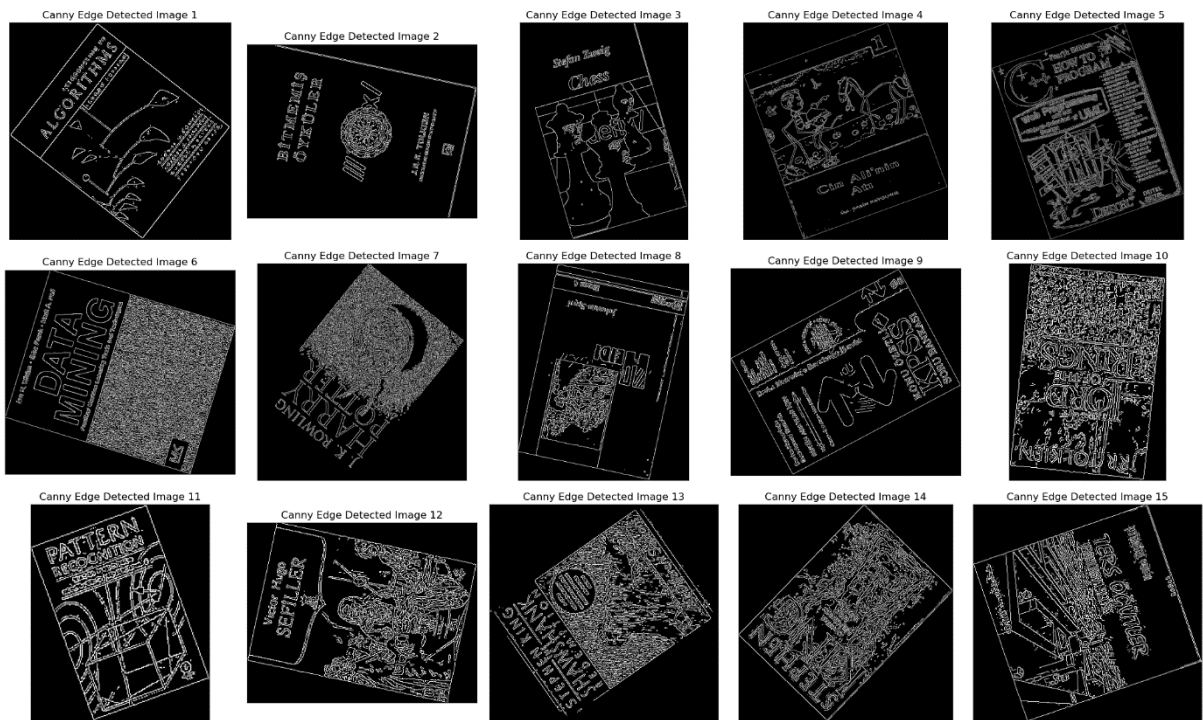


Figure 7: Canny edge detected all rotated images where low=42, high=61

Results for Hough Transform and line detection part

In Hough transform and line detection part, I have used opencv's HoughLinesP function which has rho, theta, threshold, min_line_length, max_line_gap as its parameters. Changing these values make

significant differences between images. I did this process for both rgb image(for better view) and gray scaled image you can see both results below.

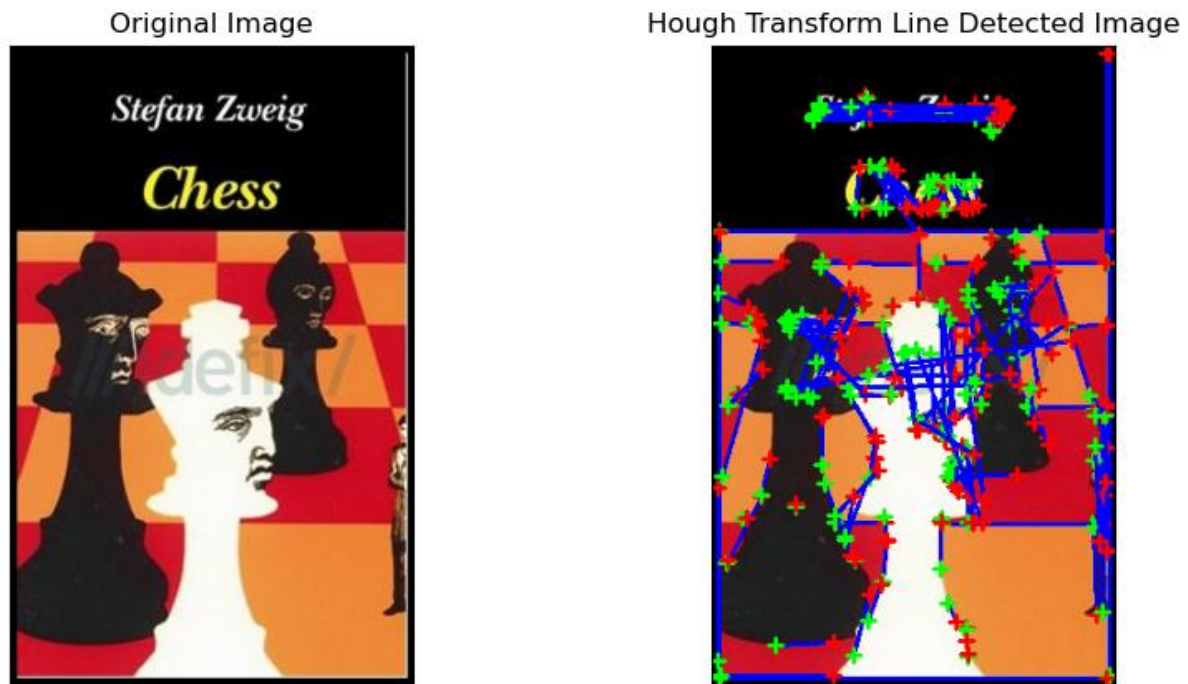


Figure 8: Result for template chess image and line detected image where parameters $\rho = 1$, $\theta = \text{np.pi}/180$, $\text{threshold} = 32$, $\text{min_line_length} = 22$, $\text{max_line_gap} = 16$

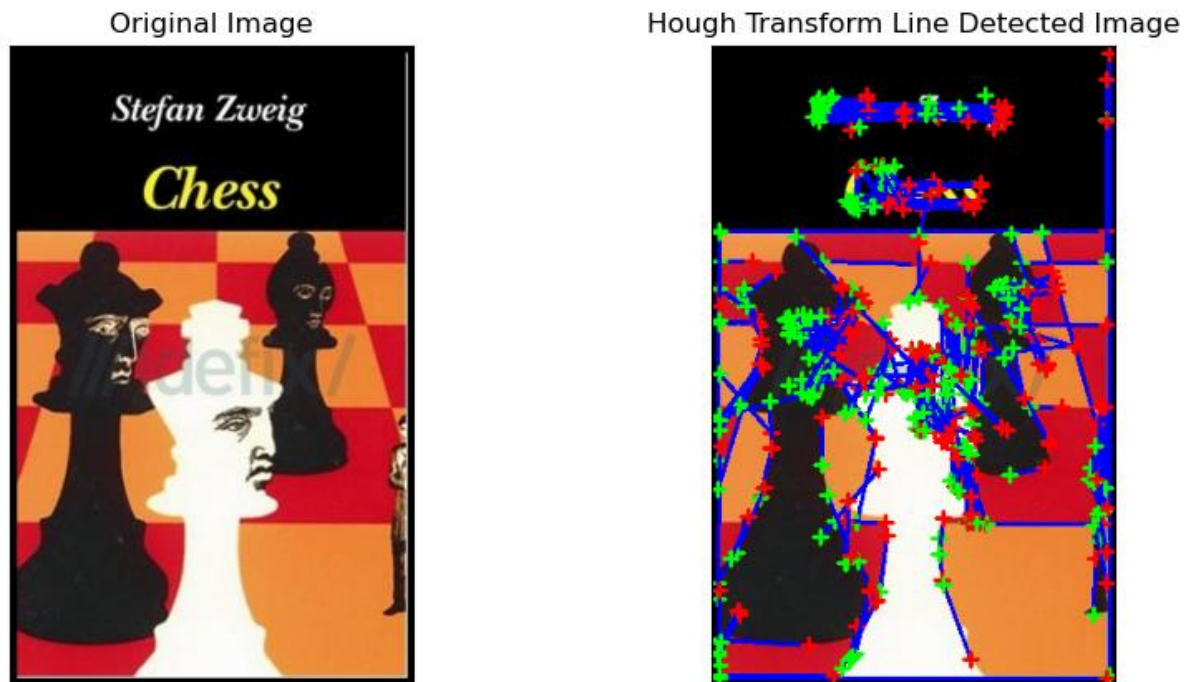


Figure 9: Result for template chess image and line detected image where parameters $\rho = 2$,

$\theta = \pi/180$, threshold = 32, min_line_length = 22, max_line_gap = 16

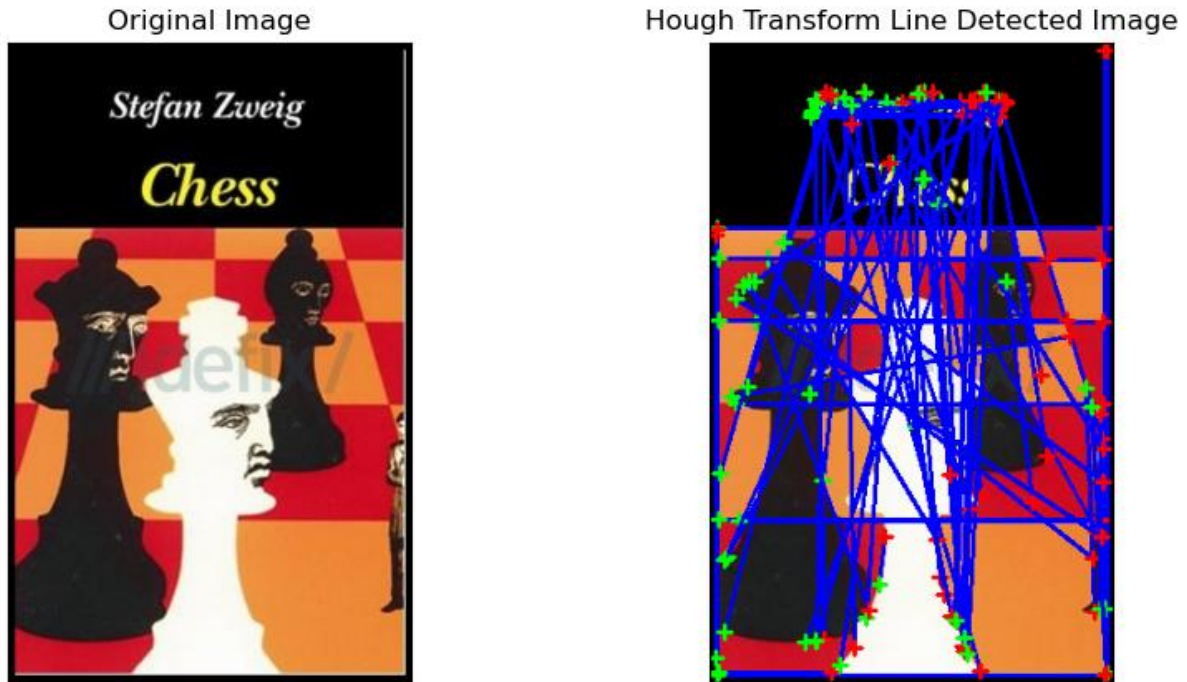


Figure 10: Result for template chess image and line detected image where parameters $\rho = 1$, $\theta = \pi/180$, threshold = 32, min_line_length = 22, max_line_gap = 100

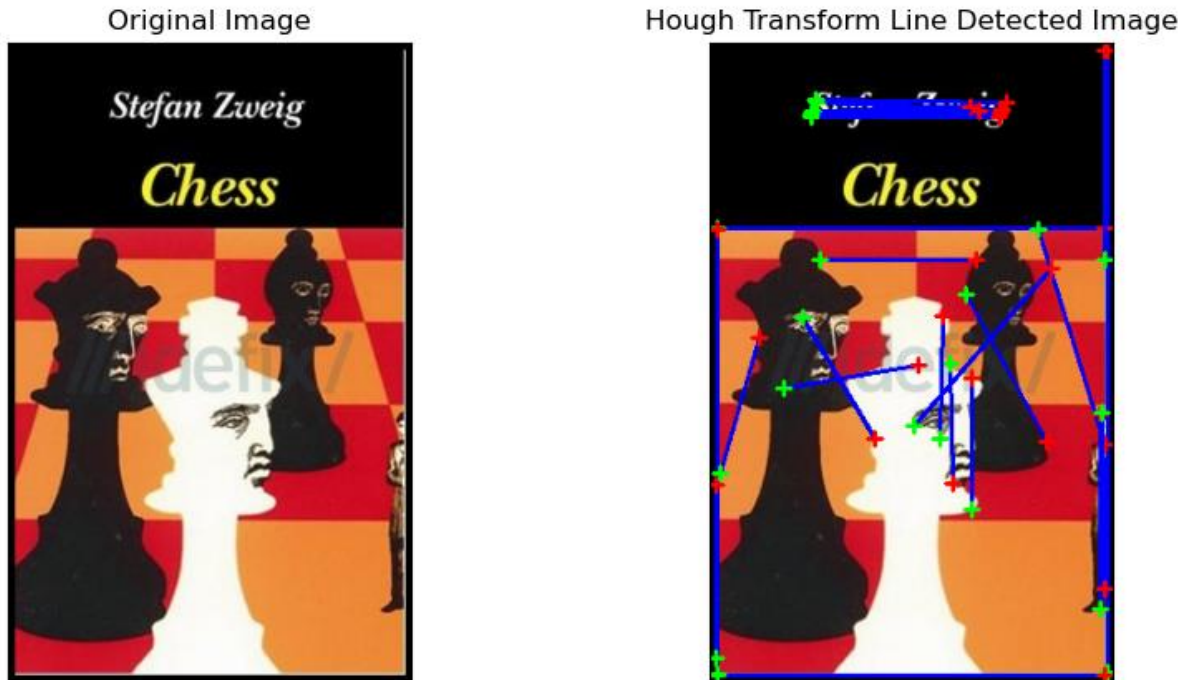


Figure 11: Result for template chess image and line detected image where parameters $\rho = 1$, $\theta = \pi/180$, threshold = 32, min_line_length = 80, max_line_gap = 16

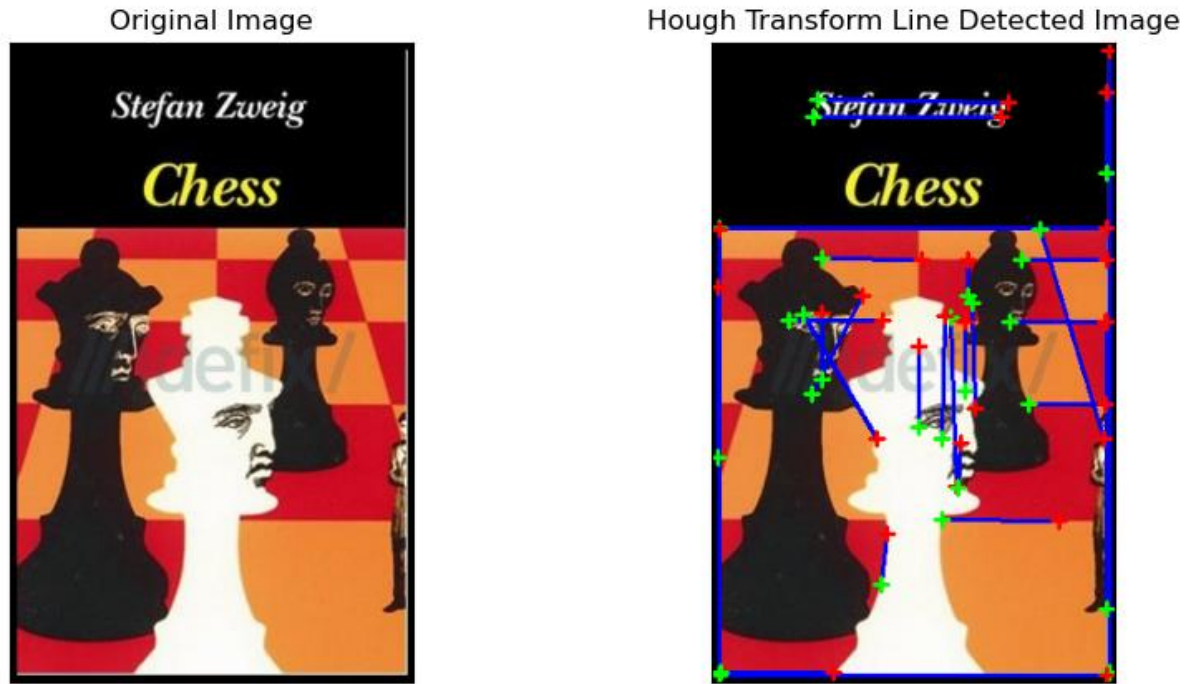


Figure 12: Result for template chess image and line detected image where parameters $\rho = 1$, $\theta = \text{np.pi}/180$, $\text{threshold} = 60$, $\text{min_line_length} = 22$, $\text{max_line_gap} = 16$

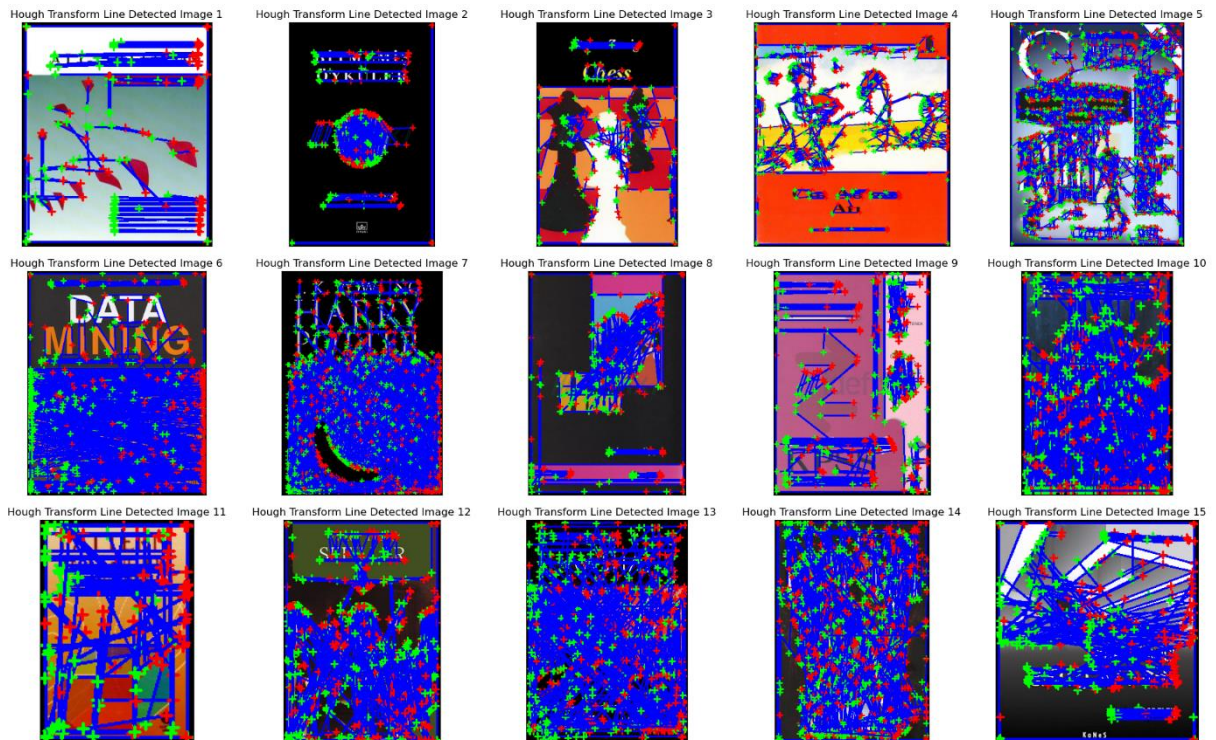


Figure 13: Result for all line detected template images where parameters $\rho = 1$, $\theta = \text{np.pi}/180$, $\text{threshold} = 60$, $\text{min_line_length} = 22$, $\text{max_line_gap} = 16$

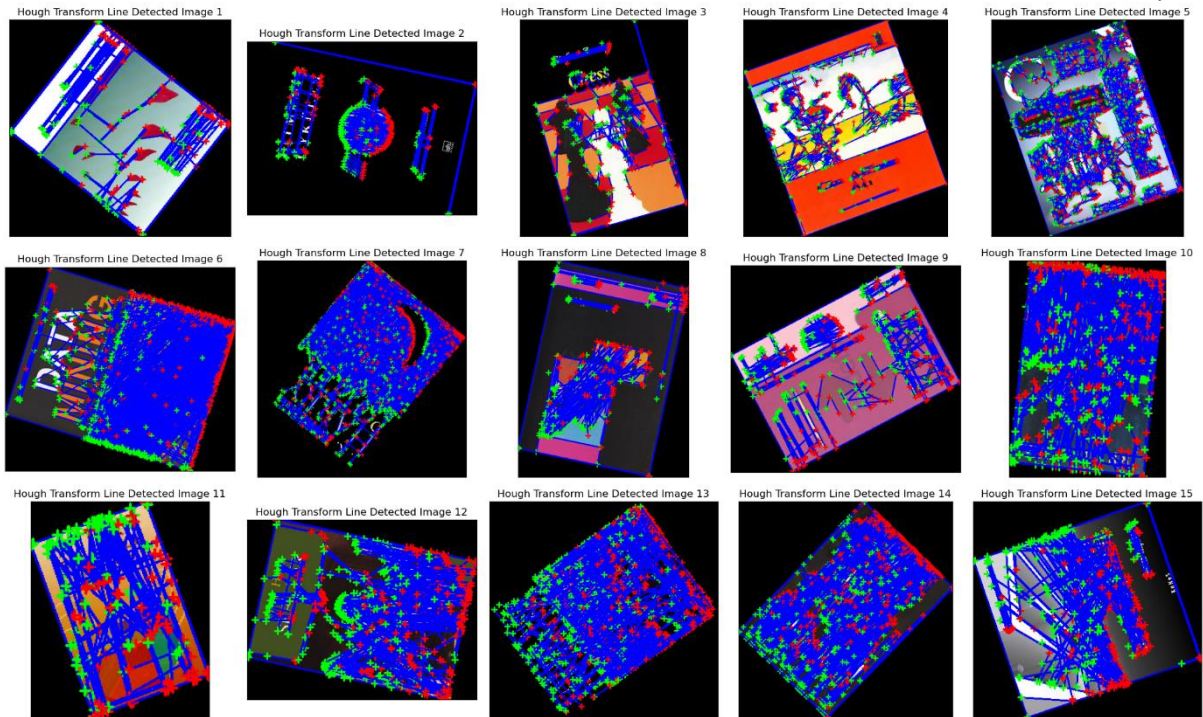


Figure 14: Result for all line detected rotated images where parameters $\rho = 1$,
 $\theta = \pi/180$, $\text{threshold} = 60$, $\text{min_line_length} = 22$, $\text{max_line_gap} = 16$

Hough Transform Line Detected Image

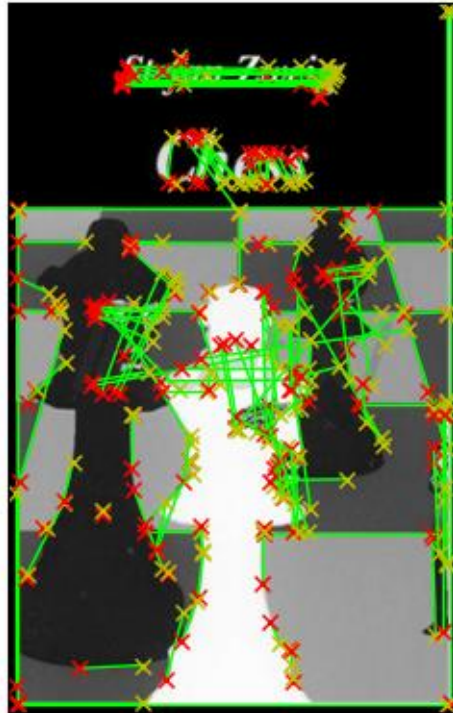


Figure 15: Result for template chess image and line detected image where parameters $\rho = 1$,
 $\theta = \pi/180$, $\text{threshold} = 32$, $\text{min_line_length} = 22$, $\text{max_line_gap} = 16$ (in gray scale format)

Hough Transform Line Detected Image

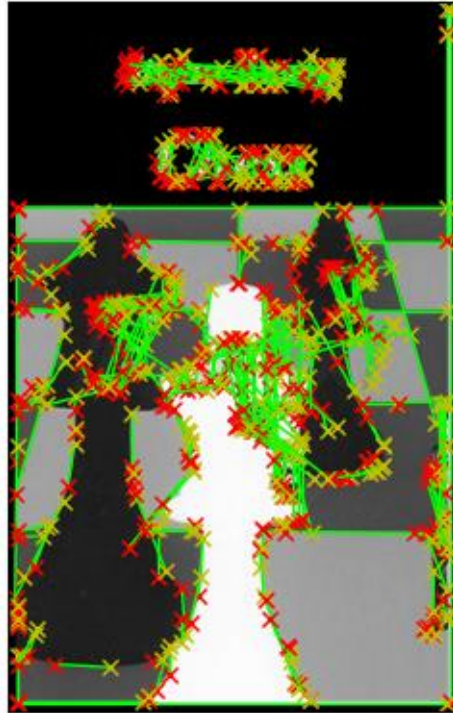


Figure 16: Result for template chess image and line detected image where parameters $\rho = 2$, $\theta = \text{np.pi}/180$, $\text{threshold} = 32$, $\text{min_line_length} = 22$, $\text{max_line_gap} = 16$ (in gray scale format)

Hough Transform Line Detected Image

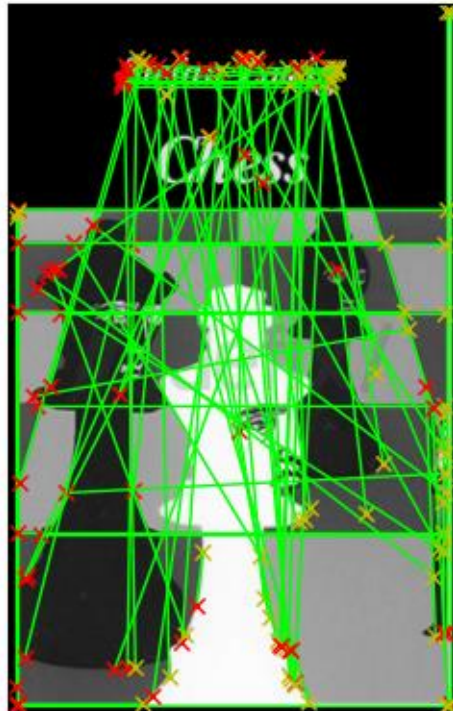


Figure 17: Result for template chess image and line detected image where parameters $\rho = 1$,

$\theta = \pi/180$, $\text{threshold} = 32$, $\text{min_line_length} = 22$, $\text{max_line_gap} = 100$ (in gray scale format)

Hough Transform Line Detected Image

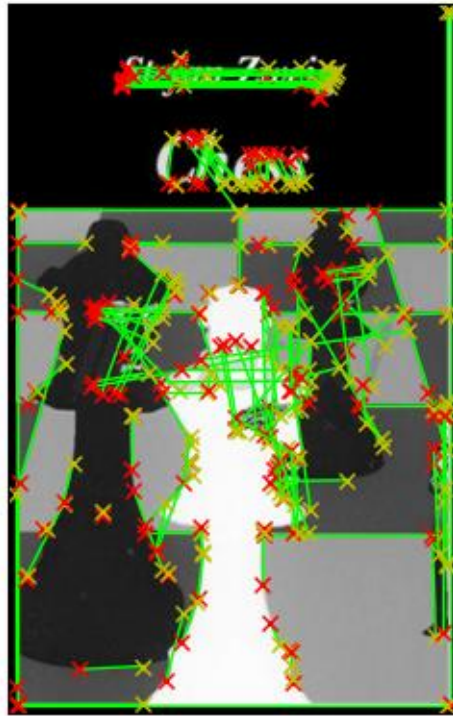


Figure 18: Result for template chess image and line detected image where parameters $\rho = 1$, $\theta = \pi/180$, $\text{threshold} = 32$, $\text{min_line_length} = 80$, $\text{max_line_gap} = 16$ (in gray scale format)

Hough Transform Line Detected Image

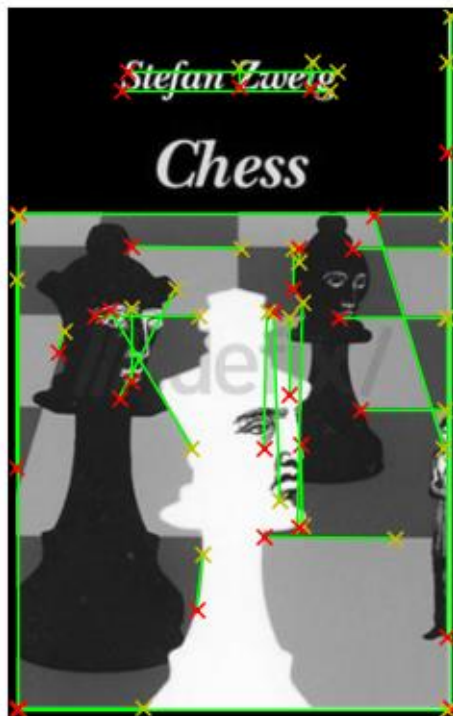


Figure 19: Result for template chess image and line detected image where parameters $\rho = 1$, $\theta = \pi/180$, threshold = 60, min_line_length = 22, max_line_gap = 16 (in gray scale format)

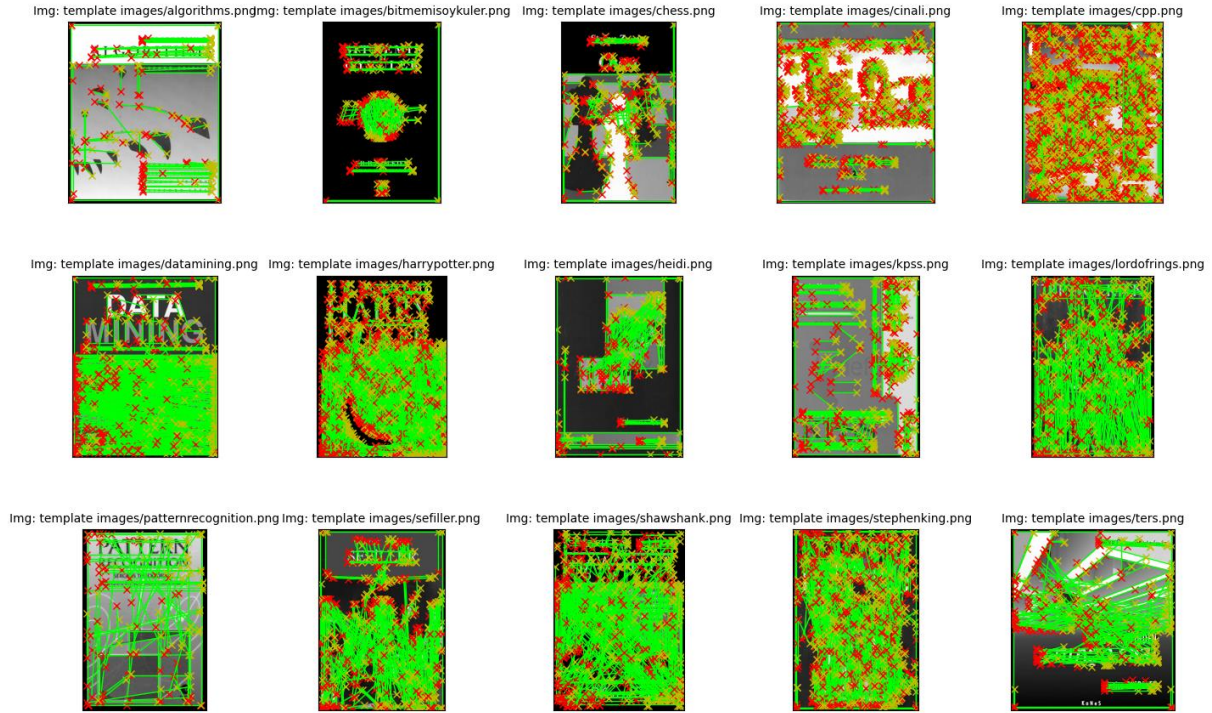


Figure 13: Result for all line detected template images where parameters $\rho = 1$, $\theta = \pi/180$, threshold = 60, min_line_length = 22, max_line_gap = 16 (in gray scale format)

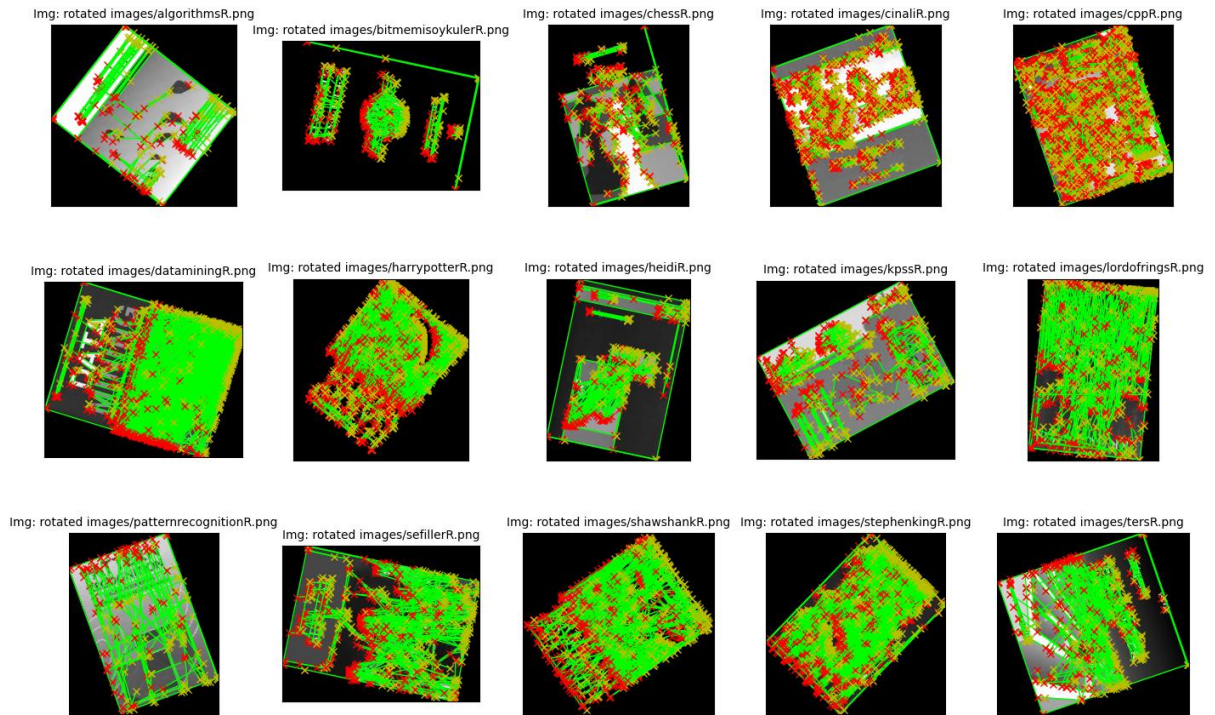


Figure 20: Result for all line detected rotated images where parameters $\rho = 1$, $\theta = \pi/180$, $\text{threshold} = 60$, $\text{min_line_length} = 22$, $\text{max_line_gap} = 16$ (in gray scale format)

Results for Line Orientation histogram part

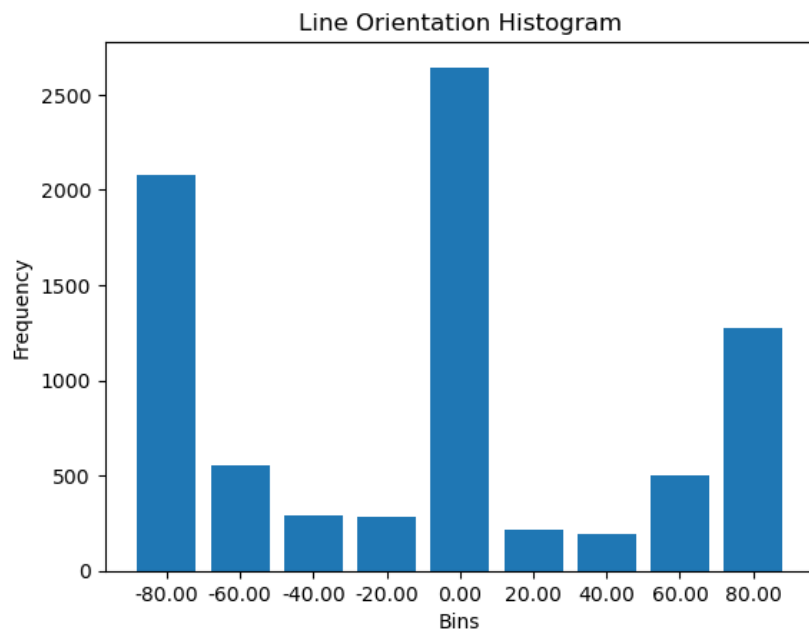


Figure 21: Result for template chess image images where $\text{bin_num} = 9$

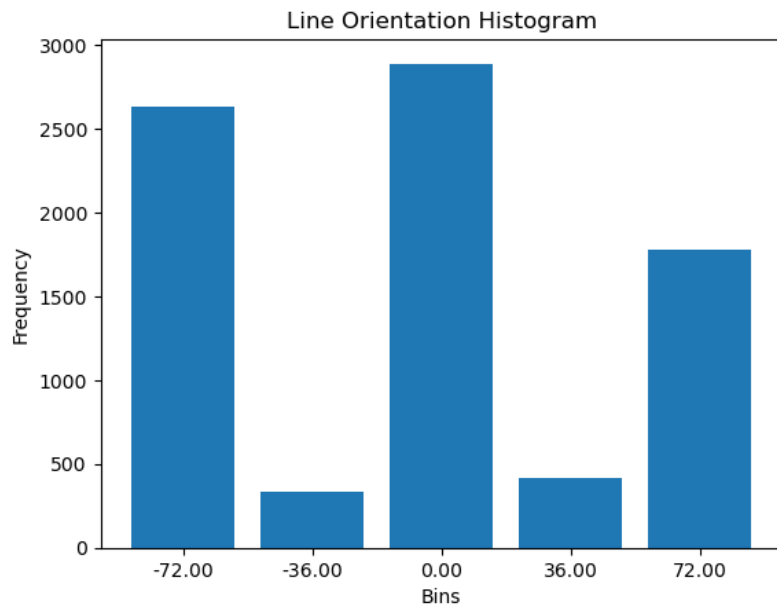


Figure 22: Result for template chess image images where bin_num = 5

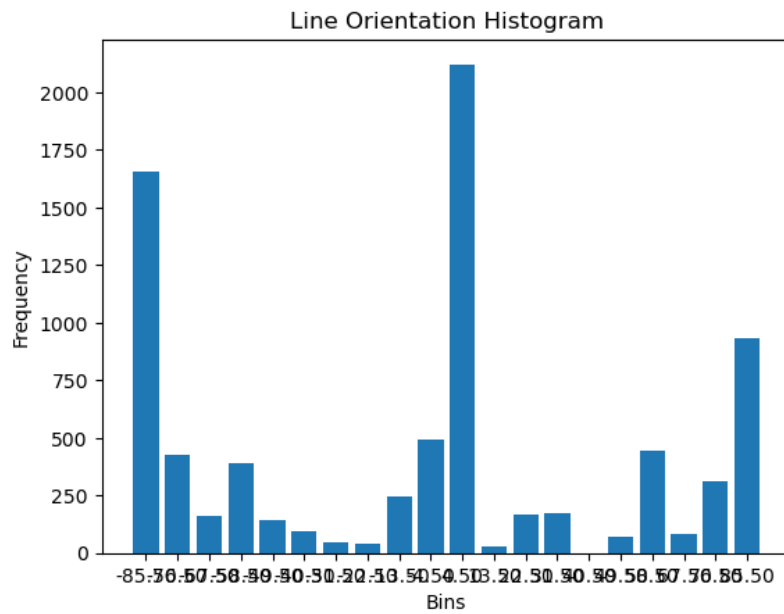


Figure 23: Result for template chess image images where bin_num = 20

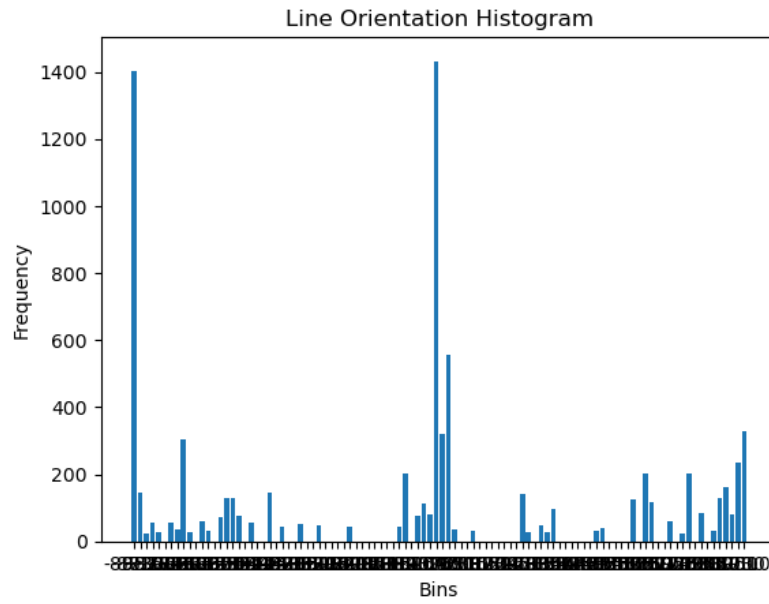


Figure 24: Result for template chess image images where bin_num = 100

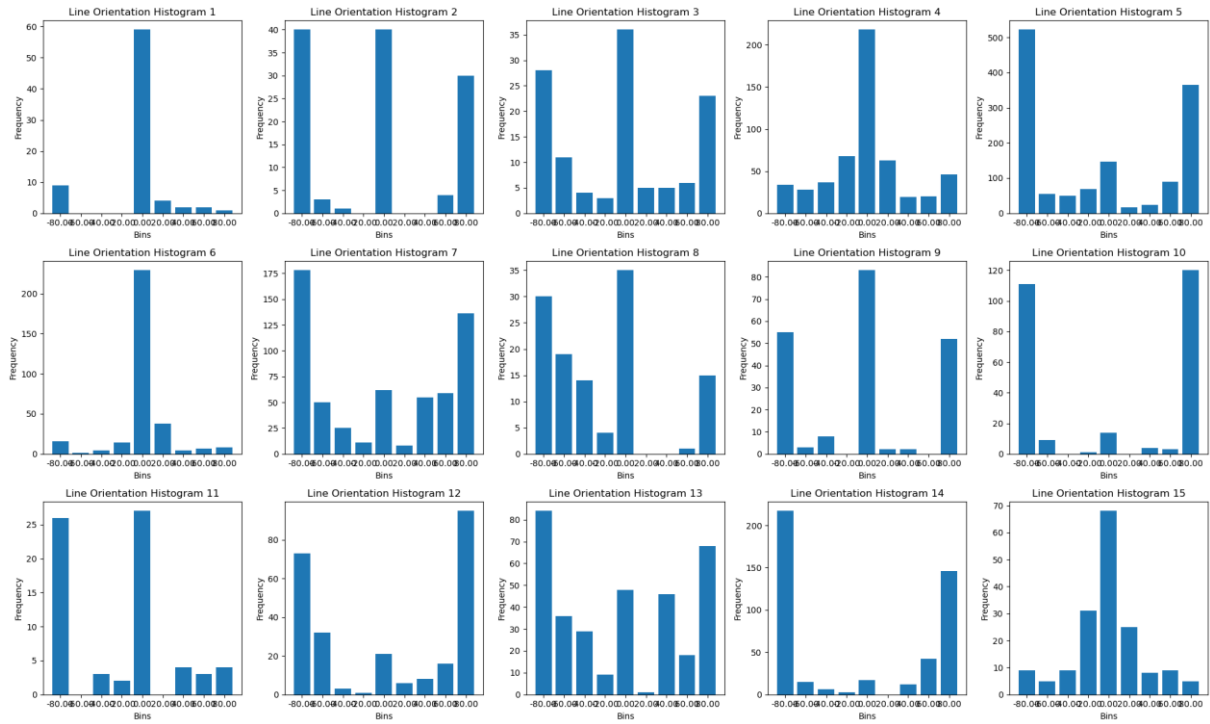


Figure 25: Result for all template images where bin_num = 9

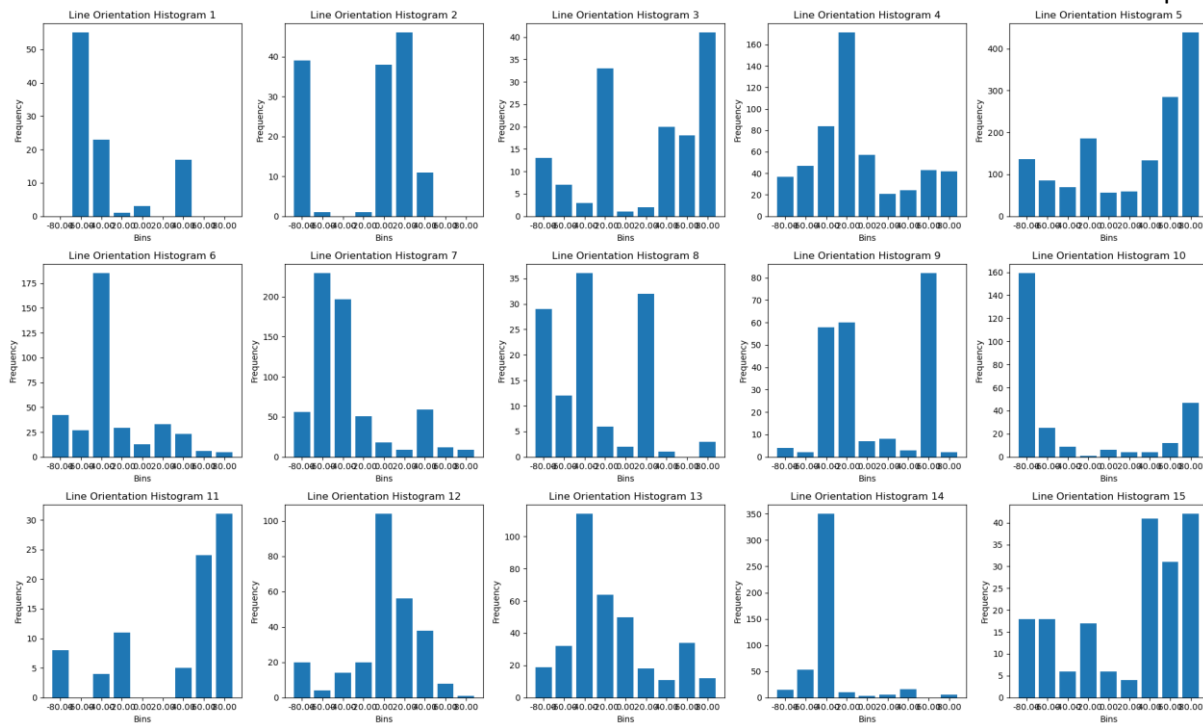


Figure 26: Result for all rotated images where bin_num = 9

Results for matching the rotated books to the original books

In the matching part, after a lot of time for trial and error process. I found %100 matching in these parameters:

```
# Best parameters for matching process

# Set parameters for Canny Edge detection
template_low_threshold = 42
template_high_threshold = 61
rotated_low_threshold = 42
rotated_high_threshold = 61

# Set the parameters for Hough Transform
rho = 1
theta = np.pi/180
threshold = 19
min_line_length = 55
max_line_gap = 27

# histogram parameters
num_bins = 9
```

Figure 27: Parameters for best matching

Here is the result:

```
Rotated Image: rotated images/algorithmsR.png, Matched Template: template images/algorithms.png, Rotation Angle: 60.00
Rotated Image: rotated images/bitmemisoykulerR.png, Matched Template: template images/bitmemisoykuler.png, Rotation Angle: 80.00
Rotated Image: rotated images/chessR.png, Matched Template: template images/chess.png, Rotation Angle: 20.00
Rotated Image: rotated images/cinaliR.png, Matched Template: template images/cinali.png, Rotation Angle: 20.00
Rotated Image: rotated images/cppR.png, Matched Template: template images/cpp.png, Rotation Angle: 20.00
Rotated Image: rotated images/dataminingR.png, Matched Template: template images/datamining.png, Rotation Angle: 80.00
Rotated Image: rotated images/harrypotterR.png, Matched Template: template images/harrypotter.png, Rotation Angle: 140.00
Rotated Image: rotated images/heidiR.png, Matched Template: template images/heidi.png, Rotation Angle: 160.00
Rotated Image: rotated images/kpssR.png, Matched Template: template images/kpss.png, Rotation Angle: 120.00
Rotated Image: rotated images/lordofringsR.png, Matched Template: template images/lordofrings.png, Rotation Angle: 0.00
Rotated Image: rotated images/patternrecognitionR.png, Matched Template: template images/patternrecognition.png, Rotation Angle: 20.00
Rotated Image: rotated images/sefillerR.png, Matched Template: template images/sefiller.png, Rotation Angle: 80.00
Rotated Image: rotated images/shawshankR.png, Matched Template: template images/shawshank.png, Rotation Angle: 120.00
Rotated Image: rotated images/stephenkingR.png, Matched Template: template images/stephenking.png, Rotation Angle: 140.00
Rotated Image: rotated images/tersR.png, Matched Template: template images/ters.png, Rotation Angle: 120.00
15
Accuracy of matching: 100.0 %
```

Figure 28: Best matching accuracy

Also other results for changing parameters can be seen below.

```
Rotated Image: rotated images/algorithmsR.png, Matched Template: template images/bitmemisoykuler.png, Rotation Angle: 67.50
Rotated Image: rotated images/bitmemisoykulerR.png, Matched Template: template images/bitmemisoykuler.png, Rotation Angle: 90.00
Rotated Image: rotated images/chessR.png, Matched Template: template images/heidi.png, Rotation Angle: 22.50
Rotated Image: rotated images/cinaliR.png, Matched Template: template images/cinali.png, Rotation Angle: 22.50
Rotated Image: rotated images/cppR.png, Matched Template: template images/cpp.png, Rotation Angle: 22.50
Rotated Image: rotated images/dataminingR.png, Matched Template: template images/datamining.png, Rotation Angle: 90.00
Rotated Image: rotated images/harrypotterR.png, Matched Template: template images/datamining.png, Rotation Angle: 67.50
Rotated Image: rotated images/heidiR.png, Matched Template: template images/heidi.png, Rotation Angle: 0.00
Rotated Image: rotated images/kpssR.png, Matched Template: template images/kpss.png, Rotation Angle: 135.00
Rotated Image: rotated images/lordofringsR.png, Matched Template: template images/lordofrings.png, Rotation Angle: 0.00
Rotated Image: rotated images/patternrecognitionR.png, Matched Template: template images/bitmemisoykuler.png, Rotation Angle: 112.50
Rotated Image: rotated images/sefillerR.png, Matched Template: template images/cinali.png, Rotation Angle: 0.00
Rotated Image: rotated images/shawshankR.png, Matched Template: template images/shawshank.png, Rotation Angle: 112.50
Rotated Image: rotated images/stephenkingR.png, Matched Template: template images/stephenking.png, Rotation Angle: 135.00
Rotated Image: rotated images/tersR.png, Matched Template: template images/ters.png, Rotation Angle: 112.50
10
Accuracy of matching: 66.66666666666666 %
```

Figure 29: After changing num_bins 9 to 8 accuracy drops to 66 %

```
Rotated Image: rotated images/algorithmsR.png, Matched Template: template images/algorithms.png, Rotation Angle: 60.00
Rotated Image: rotated images/bitmemisoykulerR.png, Matched Template: template images/bitmemisoykuler.png, Rotation Angle: 80.00
Rotated Image: rotated images/chessR.png, Matched Template: template images/chess.png, Rotation Angle: 20.00
Rotated Image: rotated images/cinaliR.png, Matched Template: template images/cinali.png, Rotation Angle: 20.00
Rotated Image: rotated images/cppR.png, Matched Template: template images/cpp.png, Rotation Angle: 20.00
Rotated Image: rotated images/dataminingR.png, Matched Template: template images/cpp.png, Rotation Angle: 140.00
Rotated Image: rotated images/harrypotterR.png, Matched Template: template images/datamining.png, Rotation Angle: 60.00
Rotated Image: rotated images/heidiR.png, Matched Template: template images/heidi.png, Rotation Angle: 160.00
Rotated Image: rotated images/kpssR.png, Matched Template: template images/kpss.png, Rotation Angle: 120.00
Rotated Image: rotated images/lordofringsR.png, Matched Template: template images/lordofrings.png, Rotation Angle: 0.00
Rotated Image: rotated images/patternrecognitionR.png, Matched Template: template images/patternrecognition.png, Rotation Angle: 20.00
Rotated Image: rotated images/sefillerR.png, Matched Template: template images/sefiller.png, Rotation Angle: 80.00
Rotated Image: rotated images/shawshankR.png, Matched Template: template images/shawshank.png, Rotation Angle: 120.00
Rotated Image: rotated images/stephenkingR.png, Matched Template: template images/cpp.png, Rotation Angle: 140.00
Rotated Image: rotated images/tersR.png, Matched Template: template images/sefiller.png, Rotation Angle: 20.00
11
Accuracy of matching: 73.33333333333333 %
```

Figure 30: After changing threshold value to 33 accuracy drops again 73 %

Note: Other parameters are same in the best result parameters.

```
Rotated Image: rotated images/algorithmsR.png, Matched Template: template images/algorithms.png, Rotation Angle: 60.00
Rotated Image: rotated images/bitmemisoykulerR.png, Matched Template: template images/bitmemisoykuler.png, Rotation Angle: 80.00
Rotated Image: rotated images/chessR.png, Matched Template: template images/chess.png, Rotation Angle: 20.00
Rotated Image: rotated images/cinaliR.png, Matched Template: template images/cinali.png, Rotation Angle: 20.00
Rotated Image: rotated images/cppR.png, Matched Template: template images/harrypotter.png, Rotation Angle: 20.00
Rotated Image: rotated images/dataminingR.png, Matched Template: template images/stephenking.png, Rotation Angle: 0.00
Rotated Image: rotated images/harrypotterR.png, Matched Template: template images/harrypotter.png, Rotation Angle: 160.00
Rotated Image: rotated images/heidiR.png, Matched Template: template images/heidi.png, Rotation Angle: 160.00
Rotated Image: rotated images/kpssR.png, Matched Template: template images/kpss.png, Rotation Angle: 120.00
Rotated Image: rotated images/lordofringsR.png, Matched Template: template images/cinali.png, Rotation Angle: 80.00
Rotated Image: rotated images/patternrecognitionR.png, Matched Template: template images/patternrecognition.png, Rotation Angle: 20.00
Rotated Image: rotated images/sefillerR.png, Matched Template: template images/sefiller.png, Rotation Angle: 80.00
Rotated Image: rotated images/shawshankR.png, Matched Template: template images/cinali.png, Rotation Angle: 40.00
Rotated Image: rotated images/stephenkingR.png, Matched Template: template images/stephenking.png, Rotation Angle: 140.00
Rotated Image: rotated images/tersR.png, Matched Template: template images/ters.png, Rotation Angle: 100.00
11
Accuracy of matching: 73.333333333333 %
```

Figure 31: After changing canny thresholds to 20, 80 accuracy changes again

Discussion about results

In the canny edge detection part, as it can be seen in the figures 1 to 7 each threshold values gives very different results. Changing parameter values brings out different results. In the figure 1, which is the most similar one to the example image in the pdf, it can be seen it is smoother than figure 2. But Figure 4 is the smoothest one with values low=100 and high=200, even though in the figure 5 values are low=0, high=255 which are the boundary numbers it can be seen in the left part of the figure there are some edges detected and it is less smooth than Figure 4. High threshold and low threshold values are very sensitive, so that even small changes demonstrate bigger differences.

In the hough line detection part, there are multiple parameters to change the figures. In canny edge part, we have 2 parameters but in hough line detection part we have 4 parameters and canny edge parameters also have an significant affect on the results. Comparing Figure 8 and Figure 9, changing rho value gives extra lines in some places and also cannot detect some lines in other places. This is the result of being at the core of hough transform, changing the value of rho can make figure completely different because it changes the transform. Comparing Figure 8 and 10, changing max_line_gap results much more lines than before. Comparing Figure 8 and 11, changing min_line_length, on the contrary, gives less lines detected. These are expected because if minimum line length increases or maximum line gap gets smaller the detected lines becomes less than before. There is also a threshold value which illustrates “minimum number of peaks”. If a bin's number of votes is below this threshold, it will not be considered a valid line. This helps eliminate false positives and retain only the most significant lines in the image. Therefore, as it can be seen in the figures 8 and 12 there are significant changes in the lines of image. Note that, I firstly wrote a code for illustrating the line images with rgb displaying, which is a better view in my opinion. But after I saw the pdf of assignment, I wrote another plotting code to show it in gray scale format. Both can be seen in the figures. They have no changes with regard to line number or orientation.

In the orientation histogram part, I assigned number of bins as 9 because in the pdf of assignment the figures used 9. Looking at figures 21 to 24, it can be understood that changing bin numbers changes the histograms significantly. Changing the bin number changes the distribution of line frequencies. Therefore, it have an immense affect on the histograms.

In the matching part, all the process before influences the result of matching and the angle detected. Thus, the values in the canny edge detection(low and high thresholds), parameters in the hough line transform(rho, theta, min line length, max line gap) and also number of bins affects the results. In my trial and error process, I could not see any explicit linear correlation between any

Atahan İyiekici

21801985

CS484-001

HW2 Report

features or parameters that we changed. Every parameters changes the results differently. In the parameters of figure 27, I managed to get 100 percent accuracy to match every template image with rotated one's.