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CS 484
Homework 3

1. Segmentation

I used SLIC0 algorithm to produce superpixels since SLIC0 chooses compactness parameter for each superpixel differently so that the algorithm produces more smooth and regular sized superpixels. After several trials with several images, I decided to use 1500 as number of labels in the image as parameter. You can see over segmentation results below. Superpixels showed with different colors on top of original image.

Results:

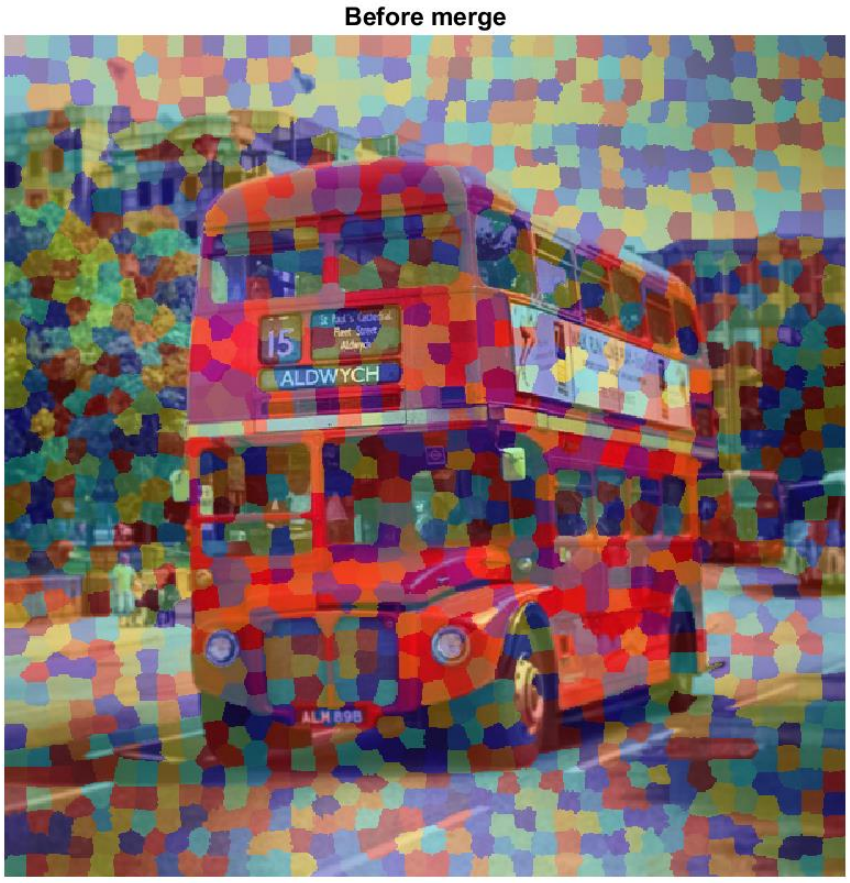

Figure 1: Image 1 over segmentation result

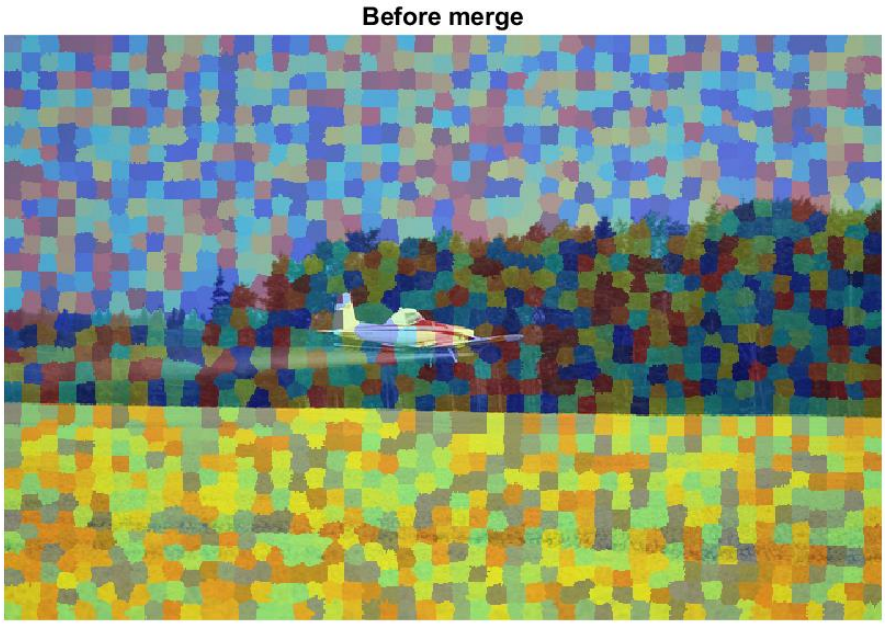

Figure 2: Image 2 over segmentation result

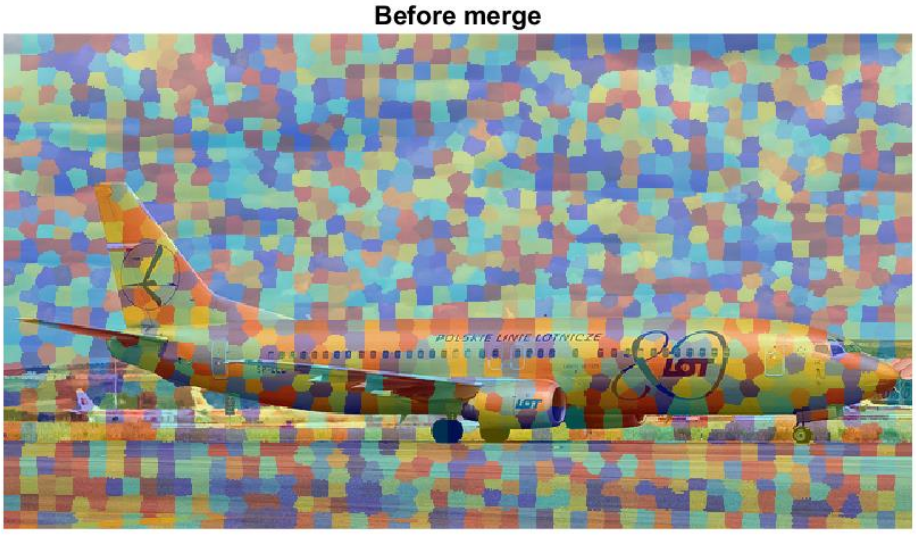

Figure 3: Image 3 over segmentation result

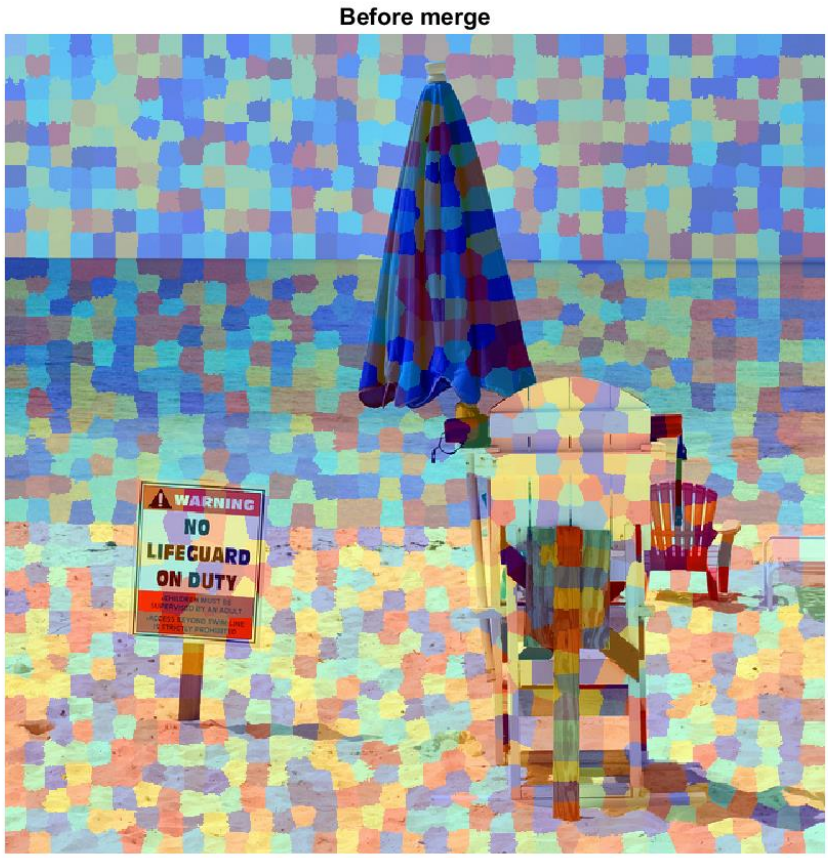

Figure 4: Image 4 over segmentation result

Figure 5: Image 5 over segmentation result

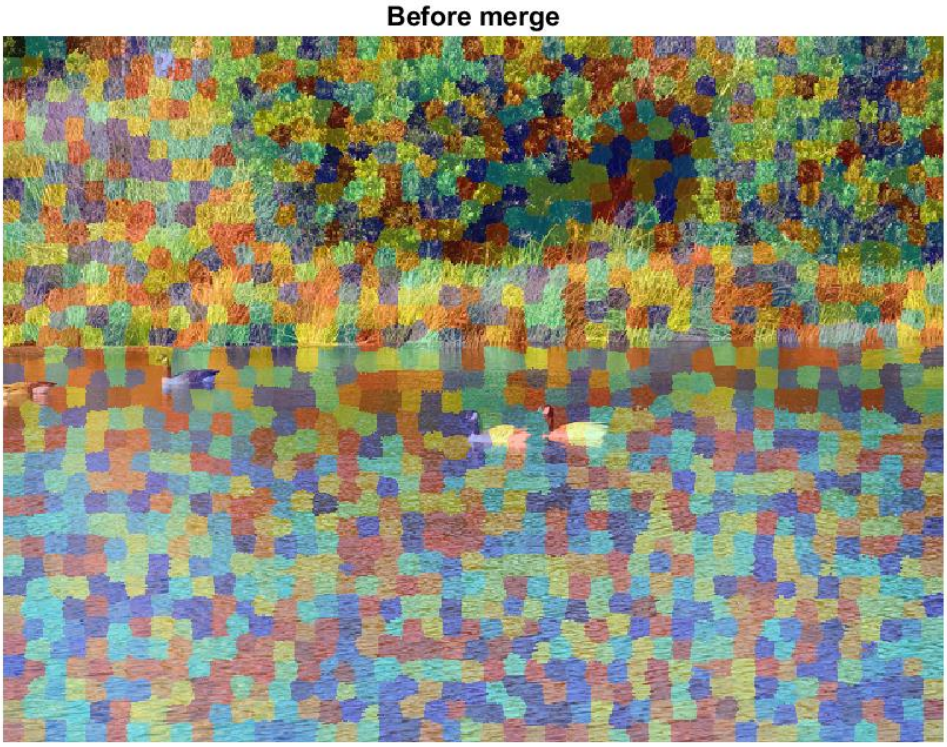

Figure 6: Image 6 over segmentation result

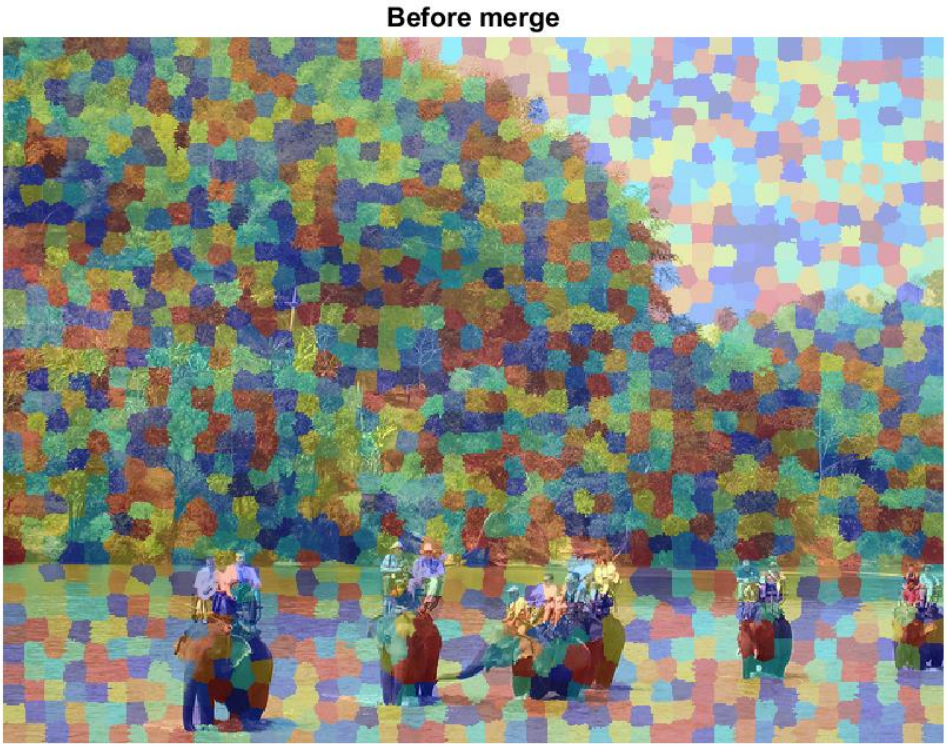

Figure 7: Image 7 over segmentation result

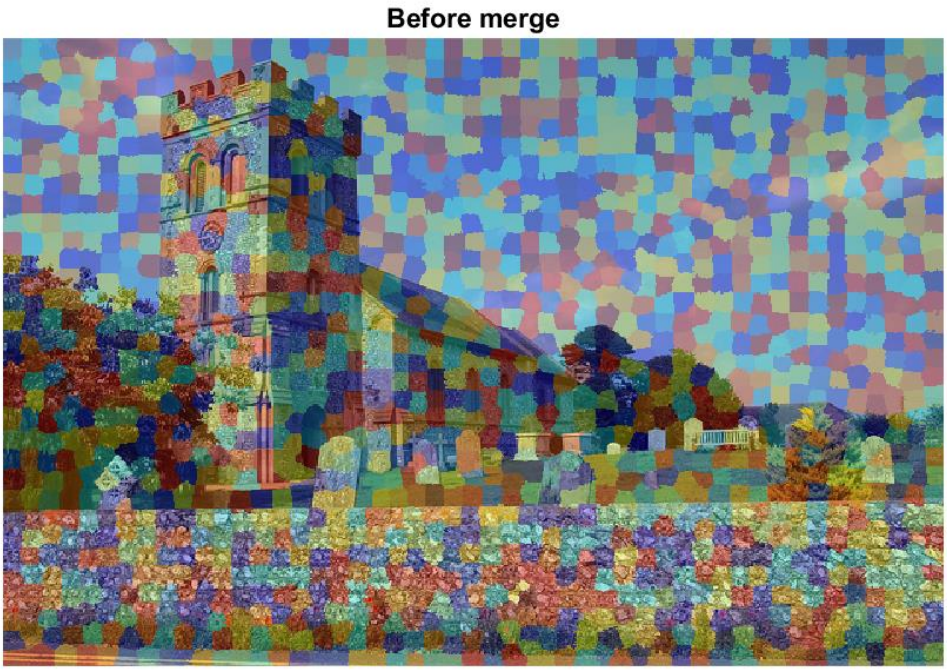

Figure 8: Image 8 over segmentation result

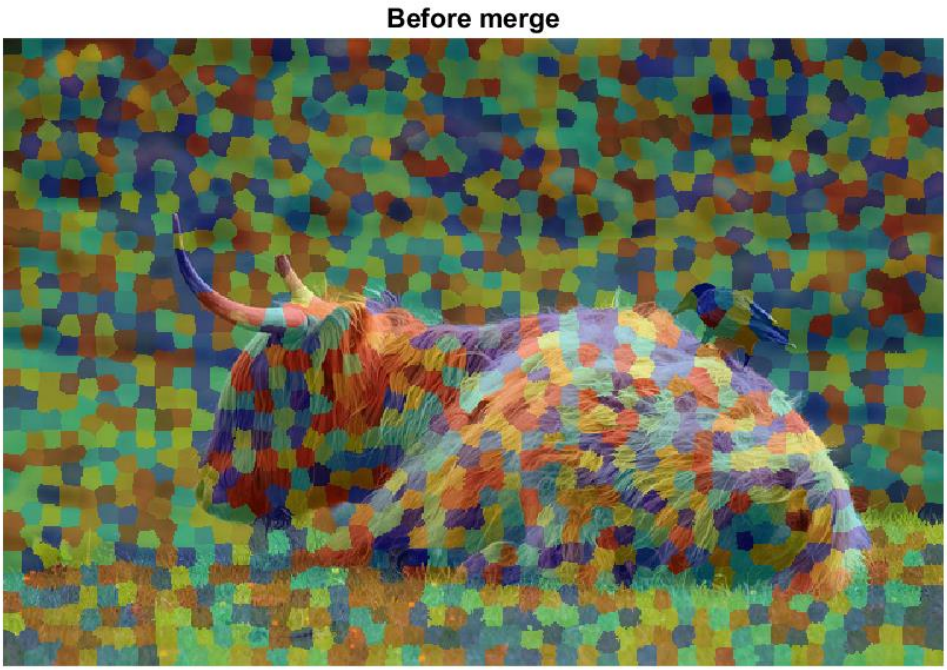

Figure 9: Image 9 over segmentation result

Figure 10: Image 10 over segmentation result

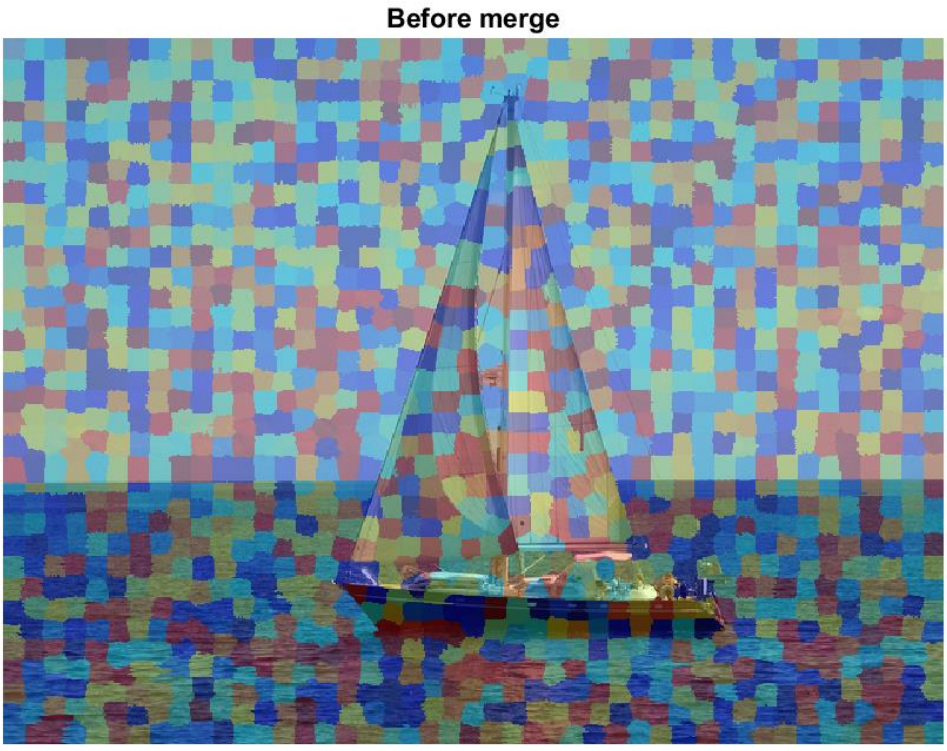

Figure 11: Image 11 over segmentation result

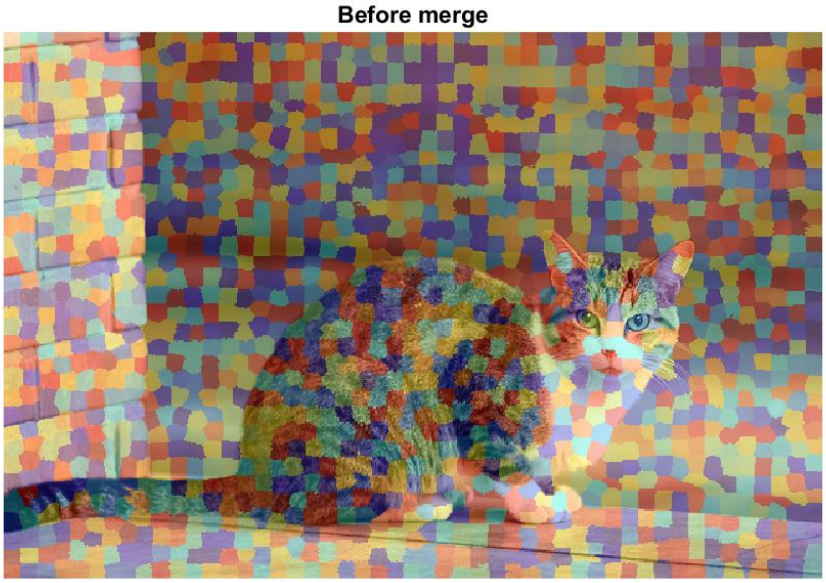

Figure 12: Image 12 over segmentation result

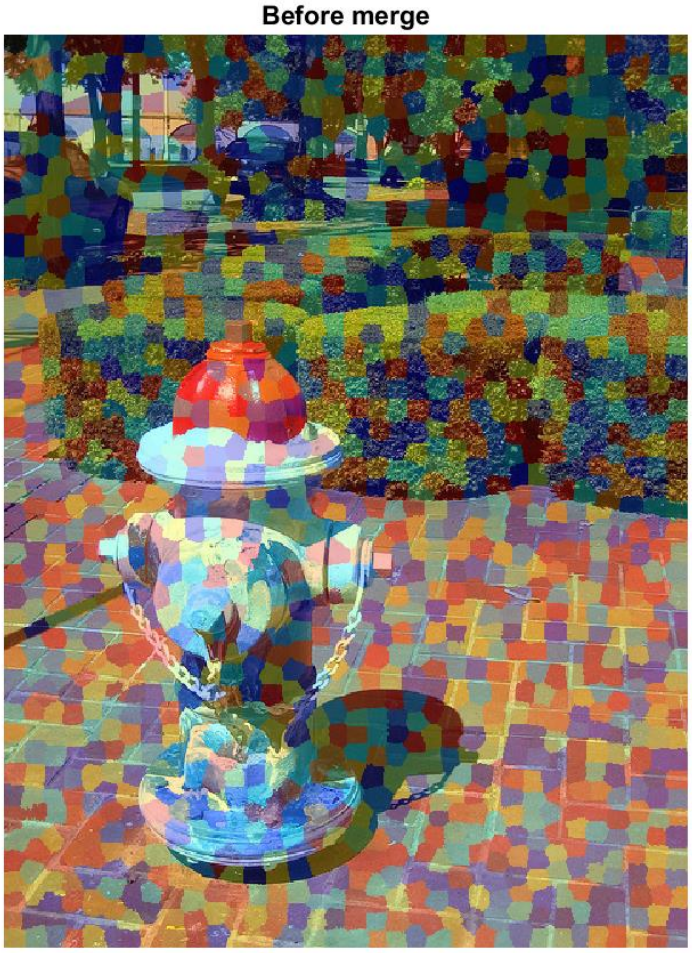

Figure 13: Image 13 over segmentation result

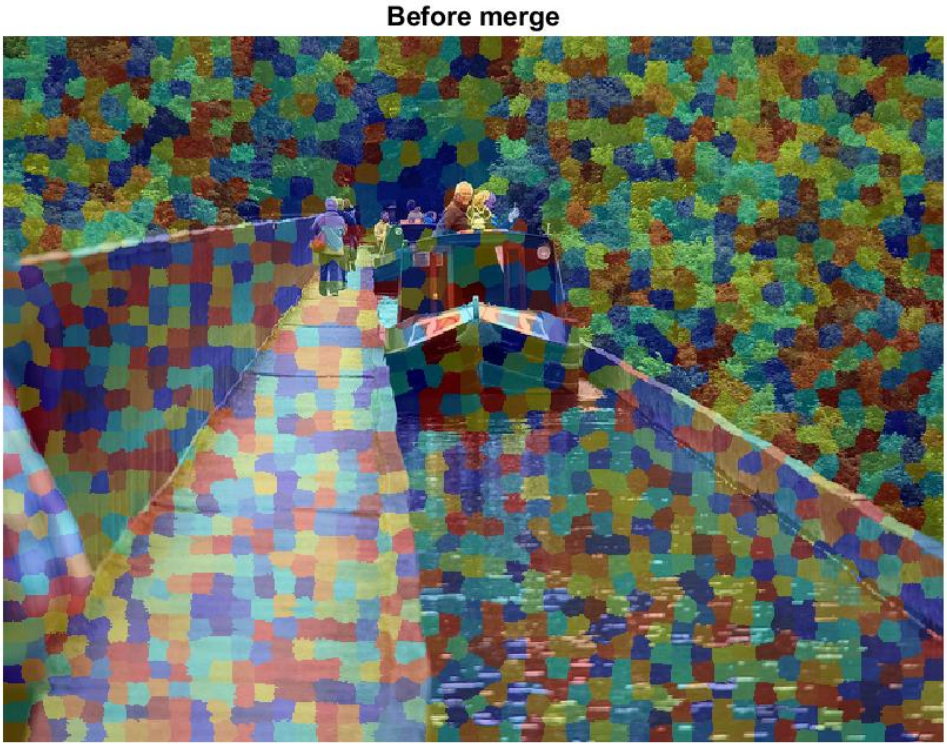

Figure 14: Image 14 over segmentation result

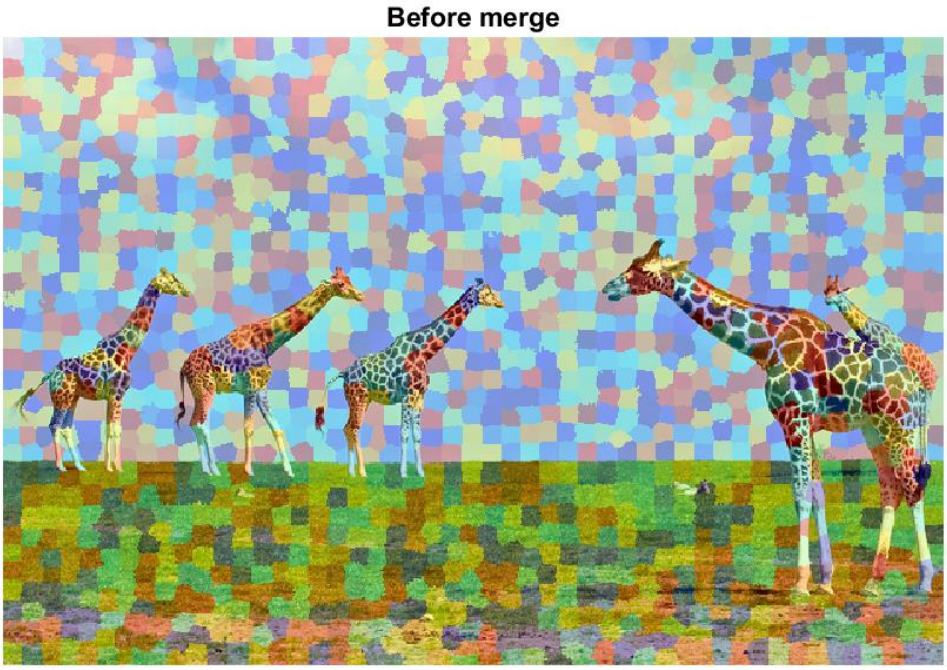

Figure 15: Image 15 over segmentation result

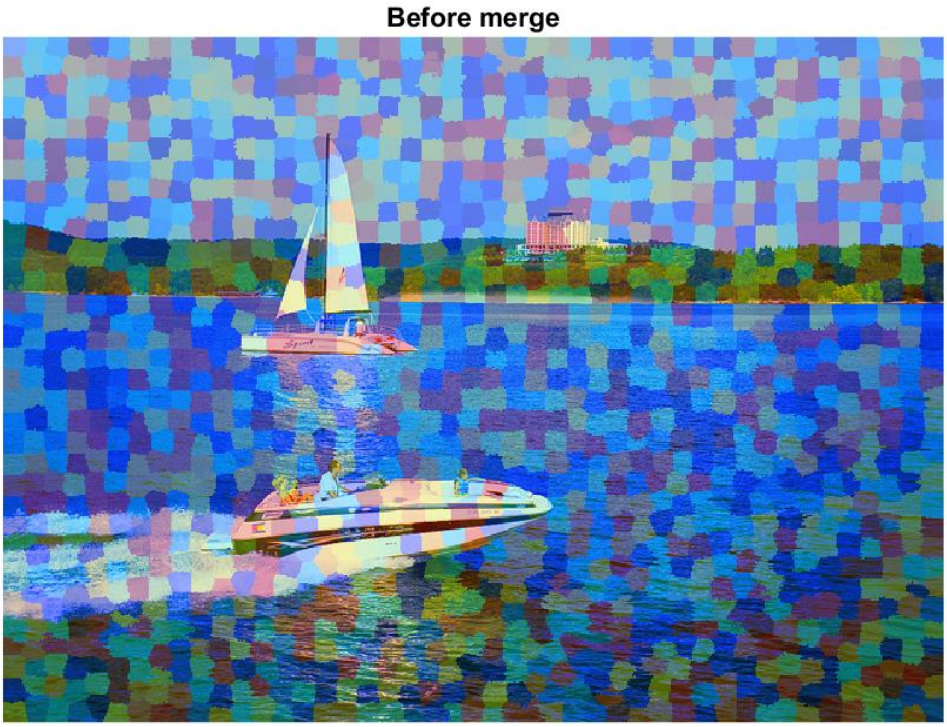

Figure 16: Image 16 over segmentation result

Figure 17: Image 17 over segmentation result

Figure 18: Image 18 over segmentation result

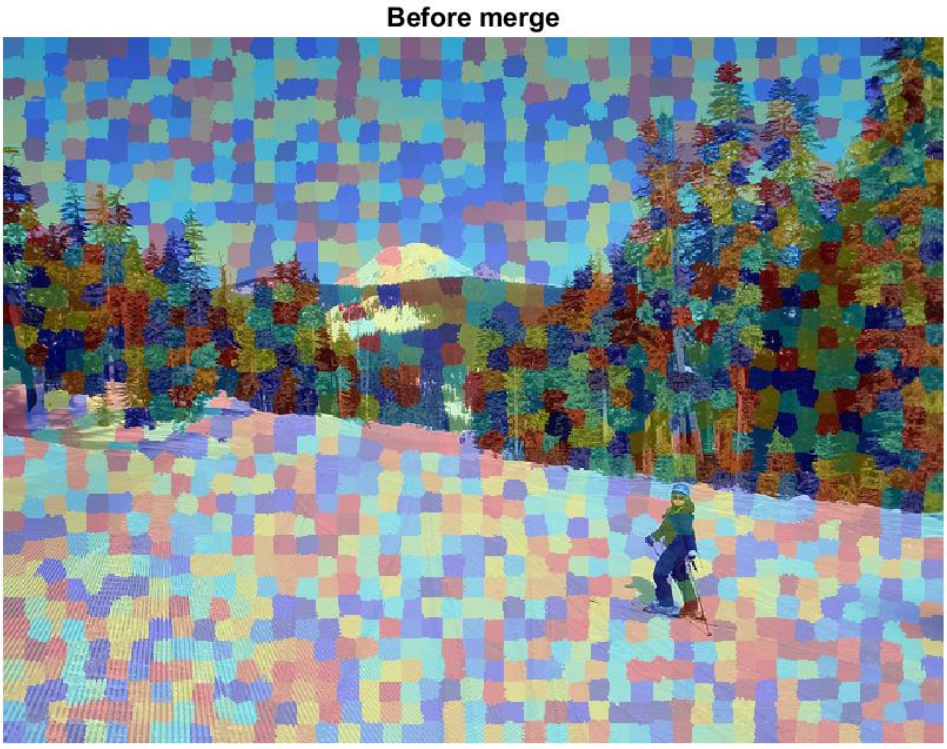

Figure 19: Image 19 over segmentation result

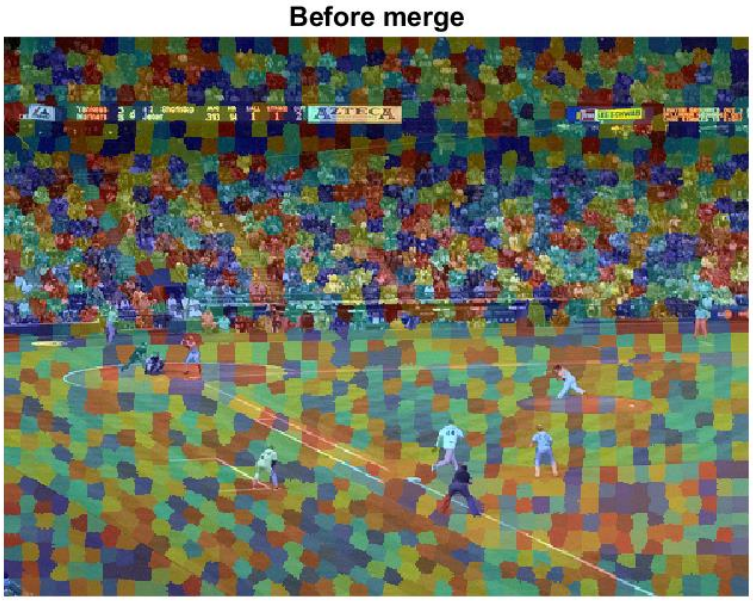

Figure 20: Image 20 over segmentation result

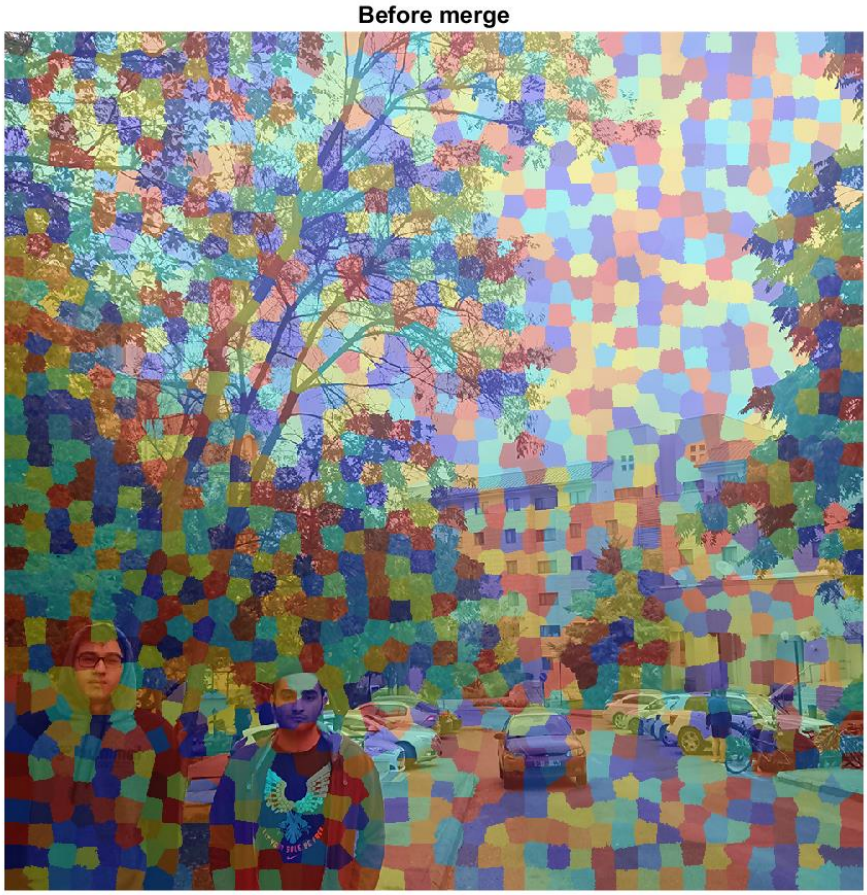

Figure 21: Image 21 over segmentation result

2. Gabor Texture Features

I created Gabor filter bank with 4 different orientations and 4 different wavelengths. In total, I created 16 filters. I choose 0, 45, 90 and 135 degrees as orientations and 2, 4, 8 and 16 as wavelengths. I calculated mean value for each superpixel for each Gabor pixel as Gabor feature.

Results:

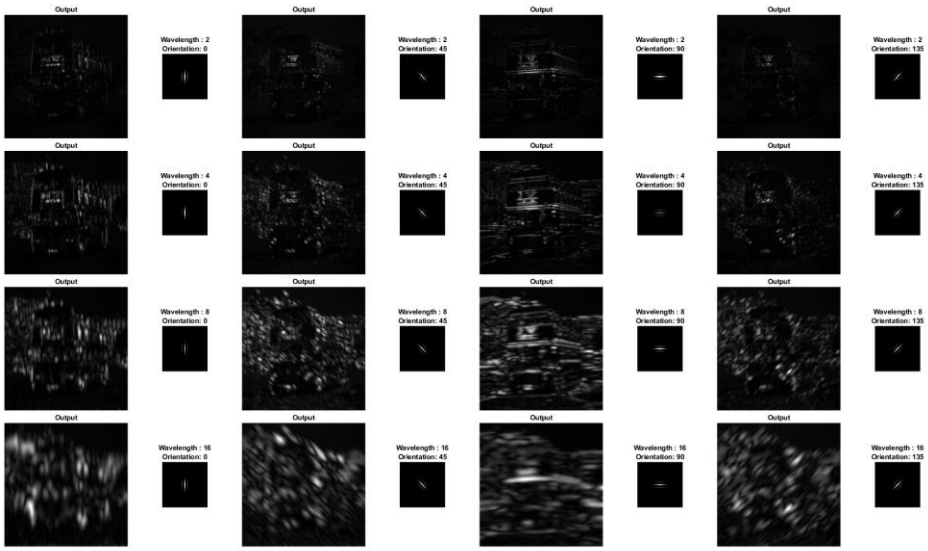

Figure 22: Image 1 Gabor texture features

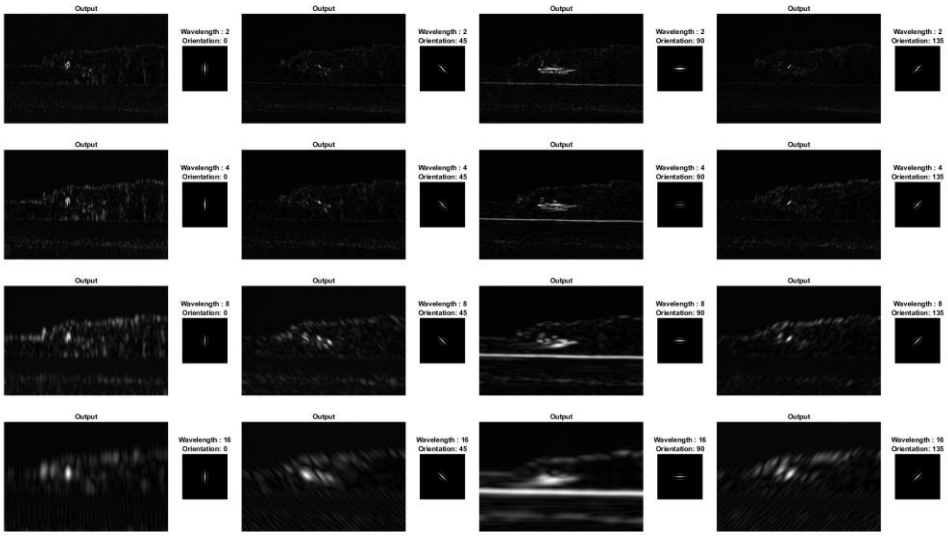

Figure 23: Image 2 Gabor texture features

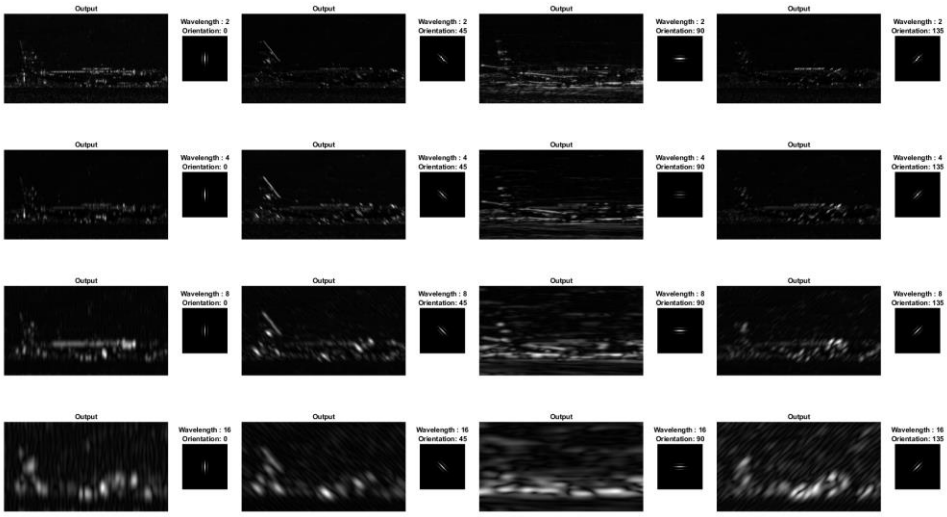

Figure 24: Image 3 Gabor texture features

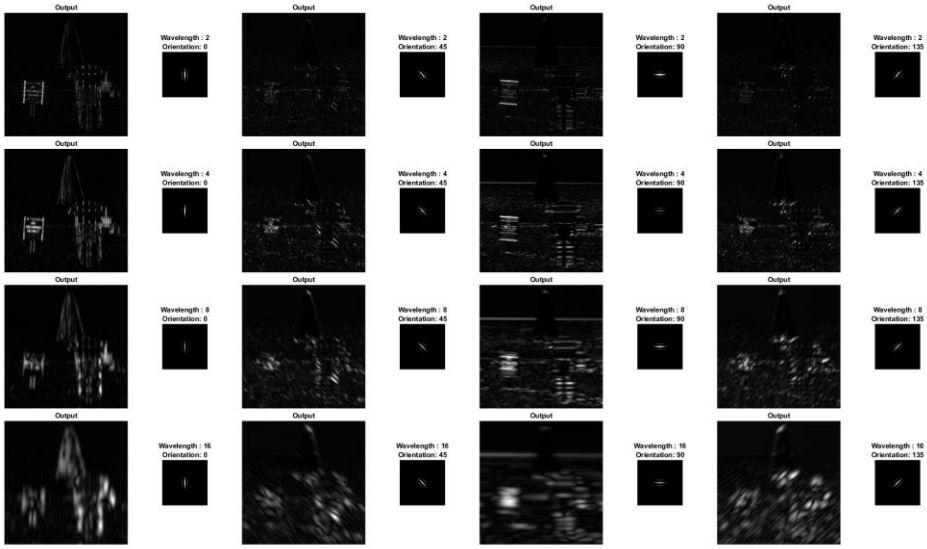

Figure 25: Image 4 Gabor texture features

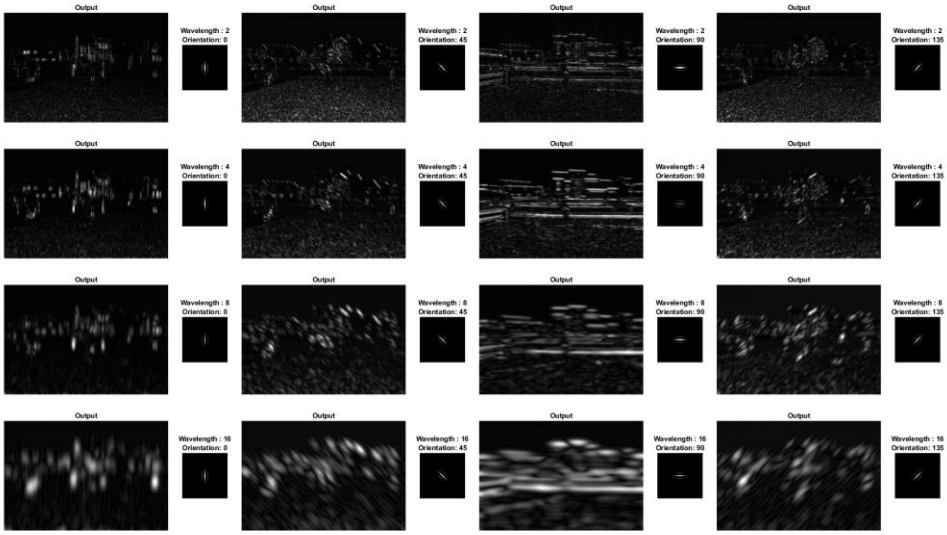

Figure 26: Image 5 Gabor texture features

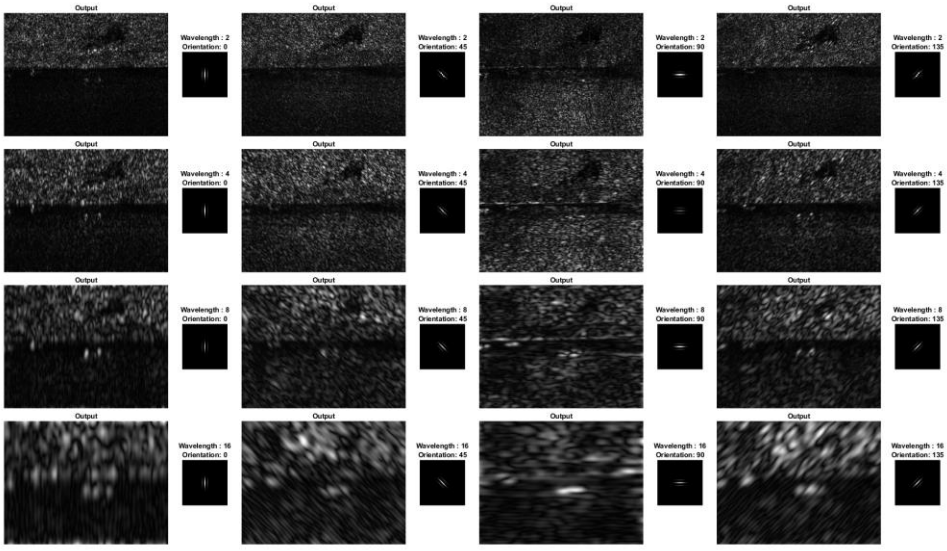

Figure 27: Image 6 Gabor texture features

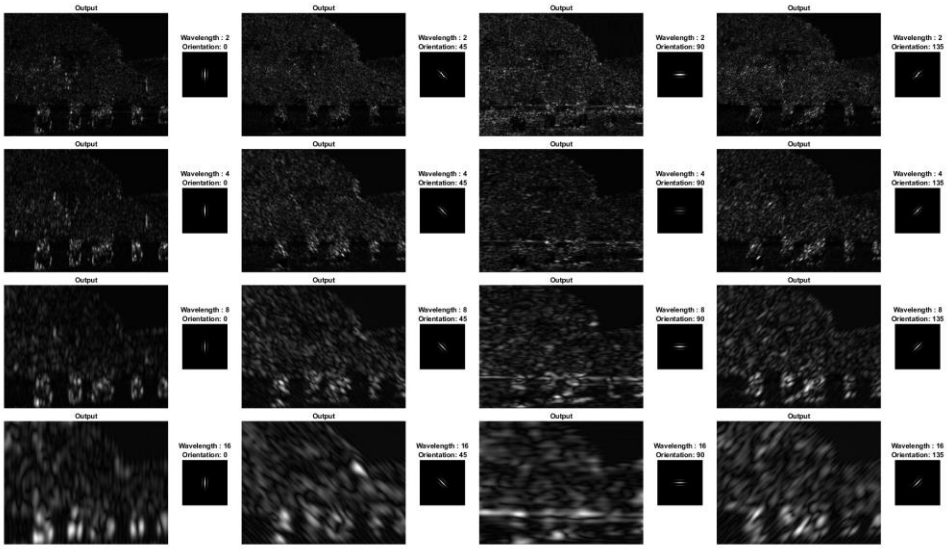

Figure 28: Image 7 Gabor texture features

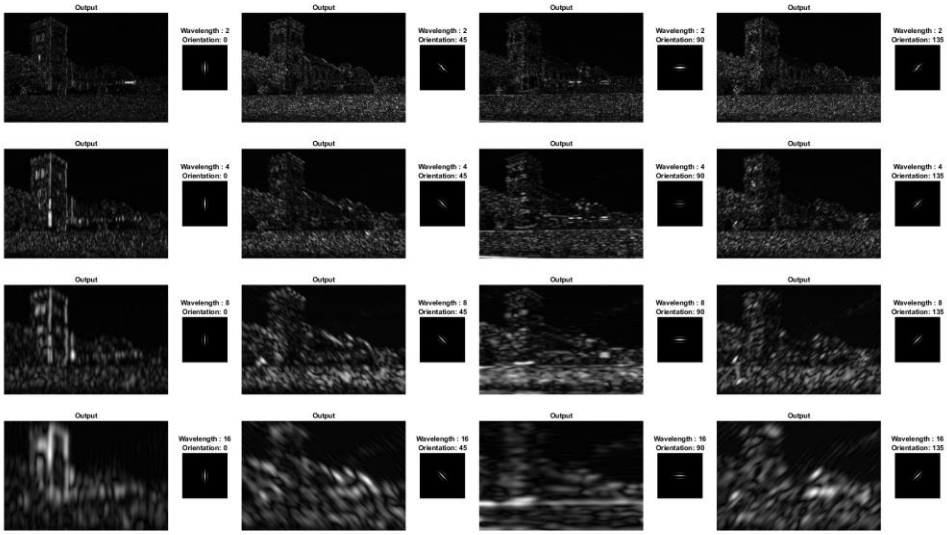

Figure 29: Image 8 Gabor texture features

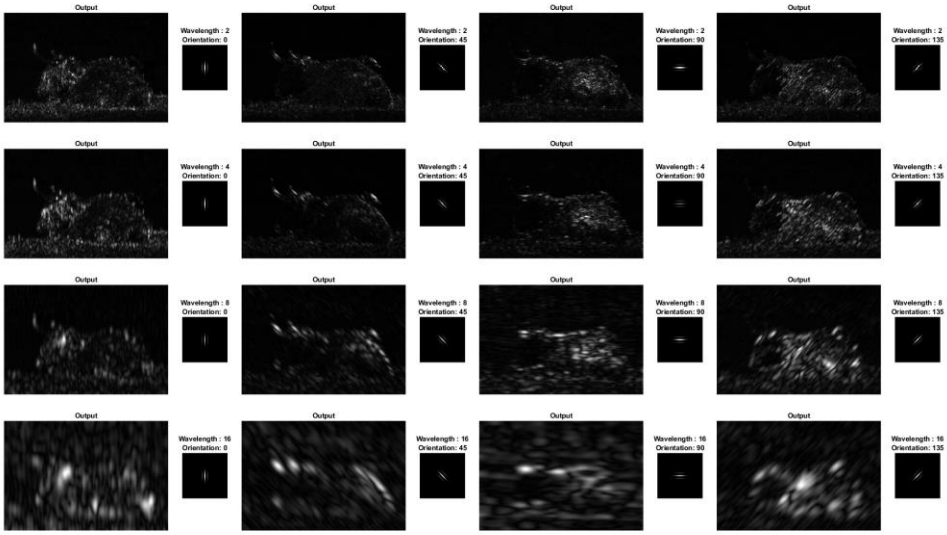

Figure 30: Image 9 Gabor texture features

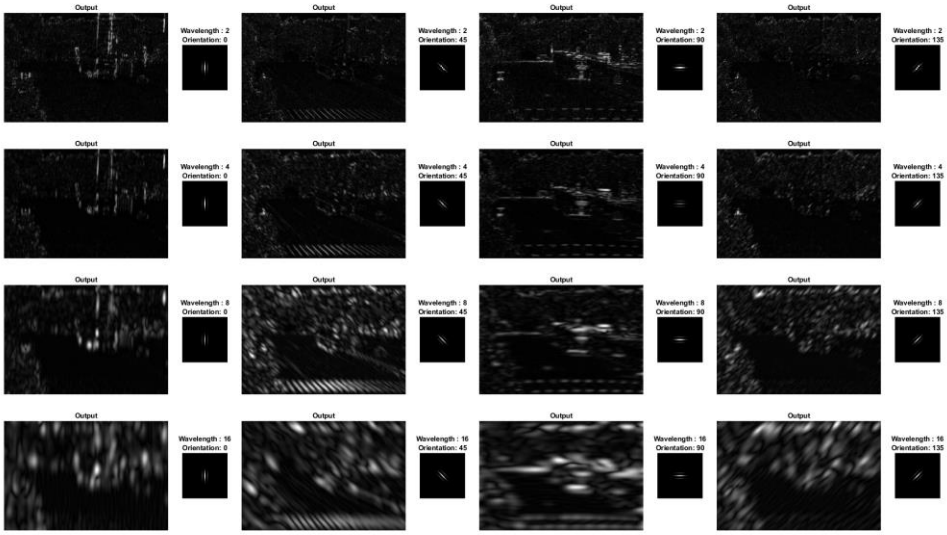

Figure 31: Image 10 Gabor texture features

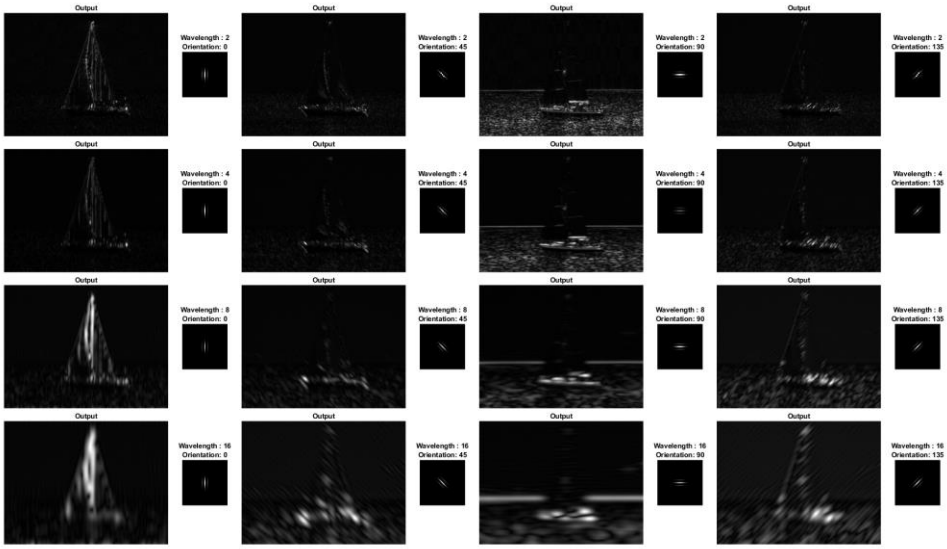

Figure 32: Image 11 Gabor texture features

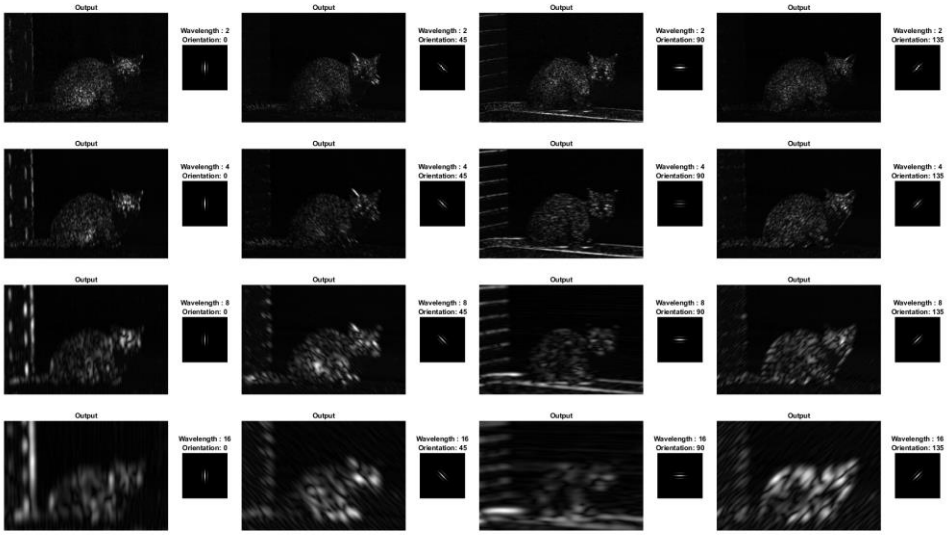

Figure 33: Image 12 Gabor texture features

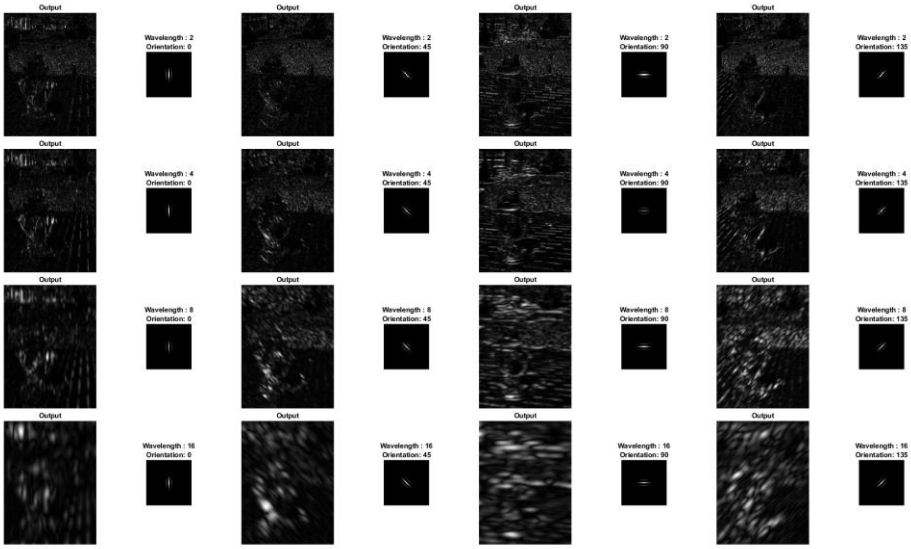

Figure 34: Image 13 Gabor texture features

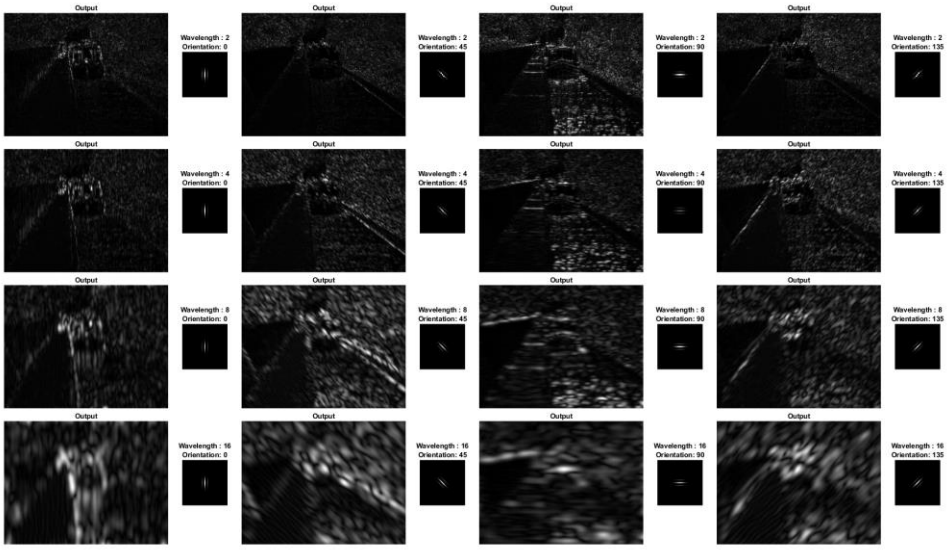

Figure 35: Image 14 Gabor texture features

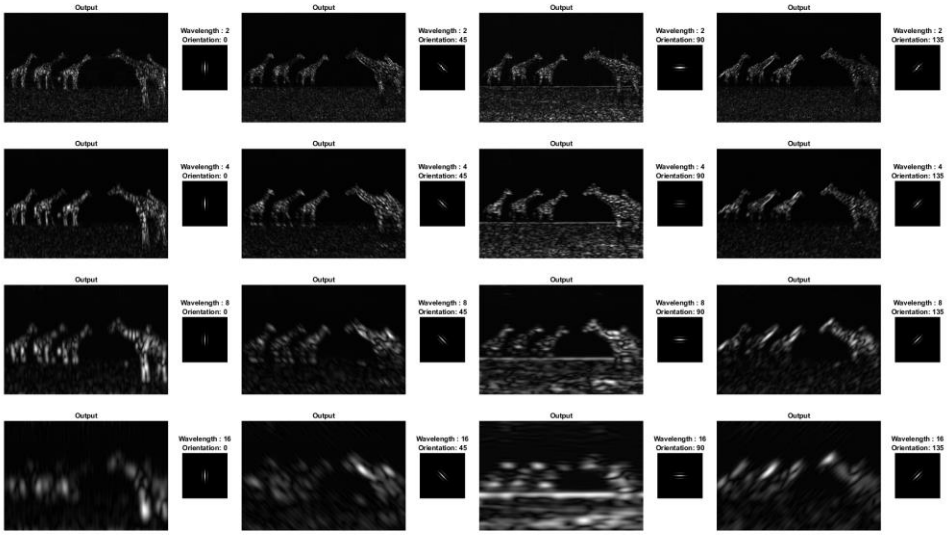

Figure 36: Image 15 Gabor texture features

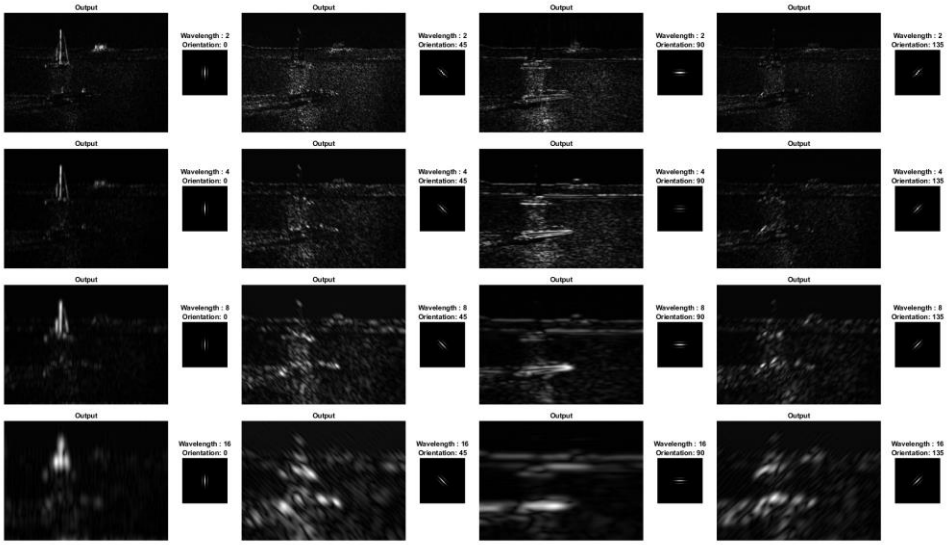

Figure 37: Image 16 Gabor texture features

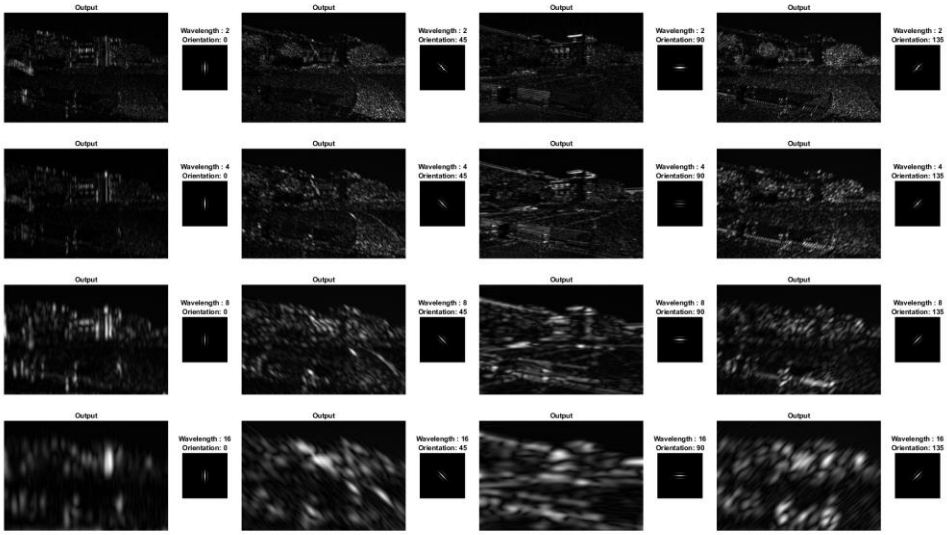

Figure 38: Image 17 Gabor texture features

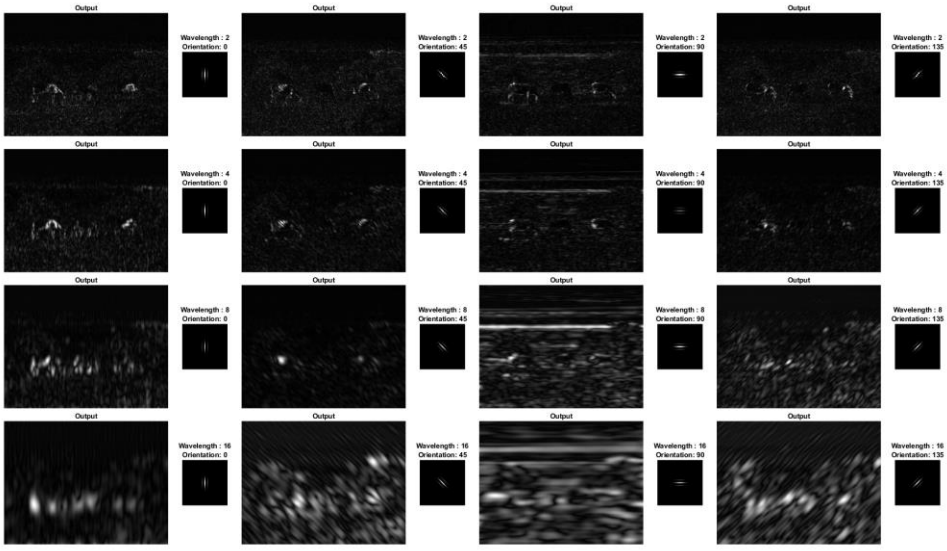

Figure 39: Image 18 Gabor texture features

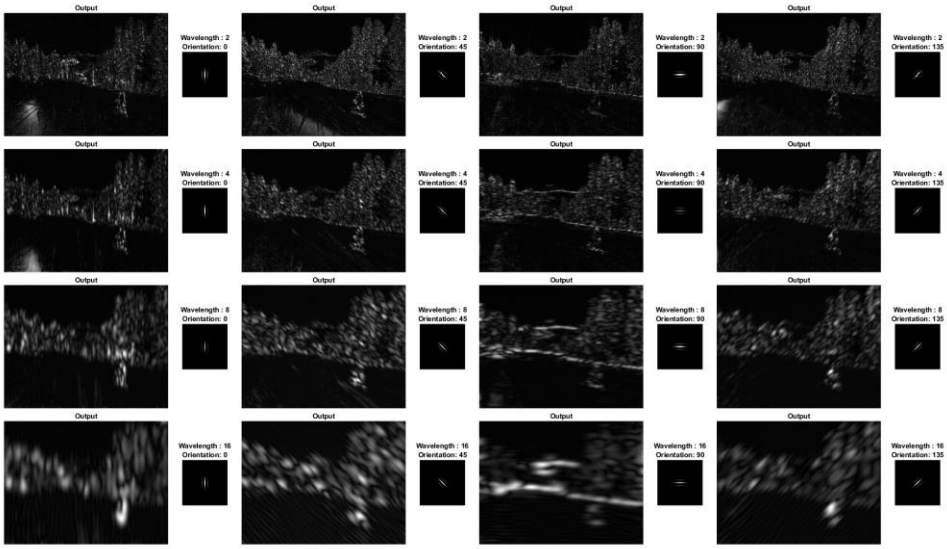

Figure 40: Image 19 Gabor texture features

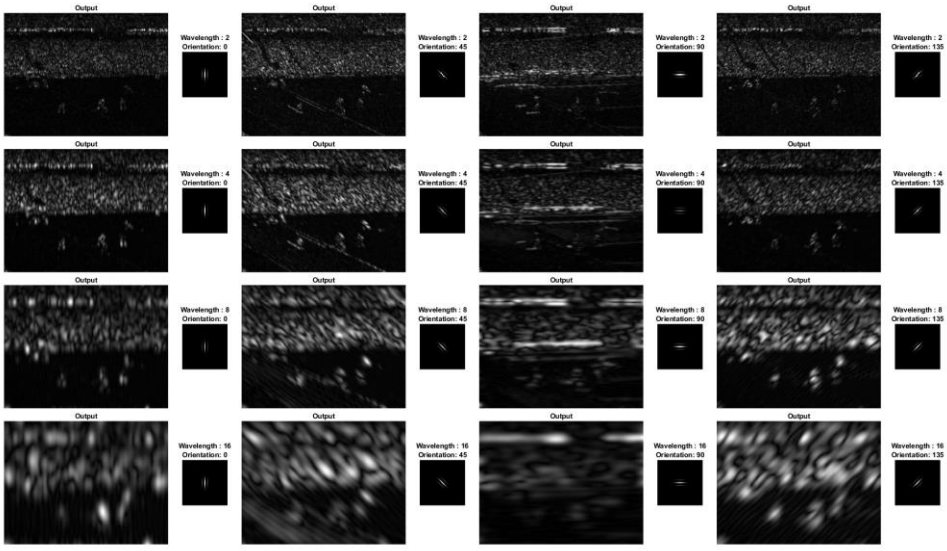

Figure 41: Image 20 Gabor texture features

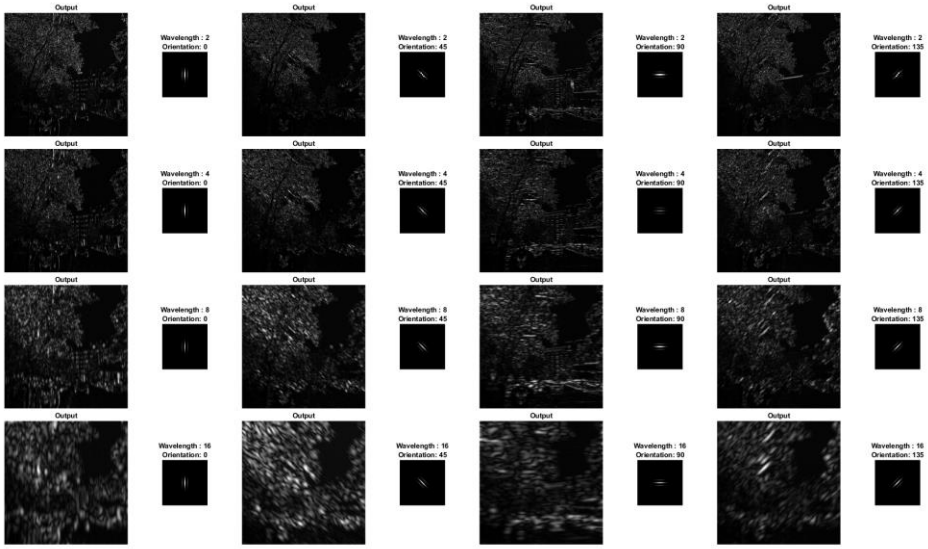

Figure 42: Image 21 Gabor texture features

3. Merging

I chose threshold for merging by narrowing a range. I chose a large value and a small value and then I increased the small value. I check different images and different merge methods. Finally, I chose 0.065 as threshold. You can see results from different merging methods below.

Results:

a. Merge with Color Features

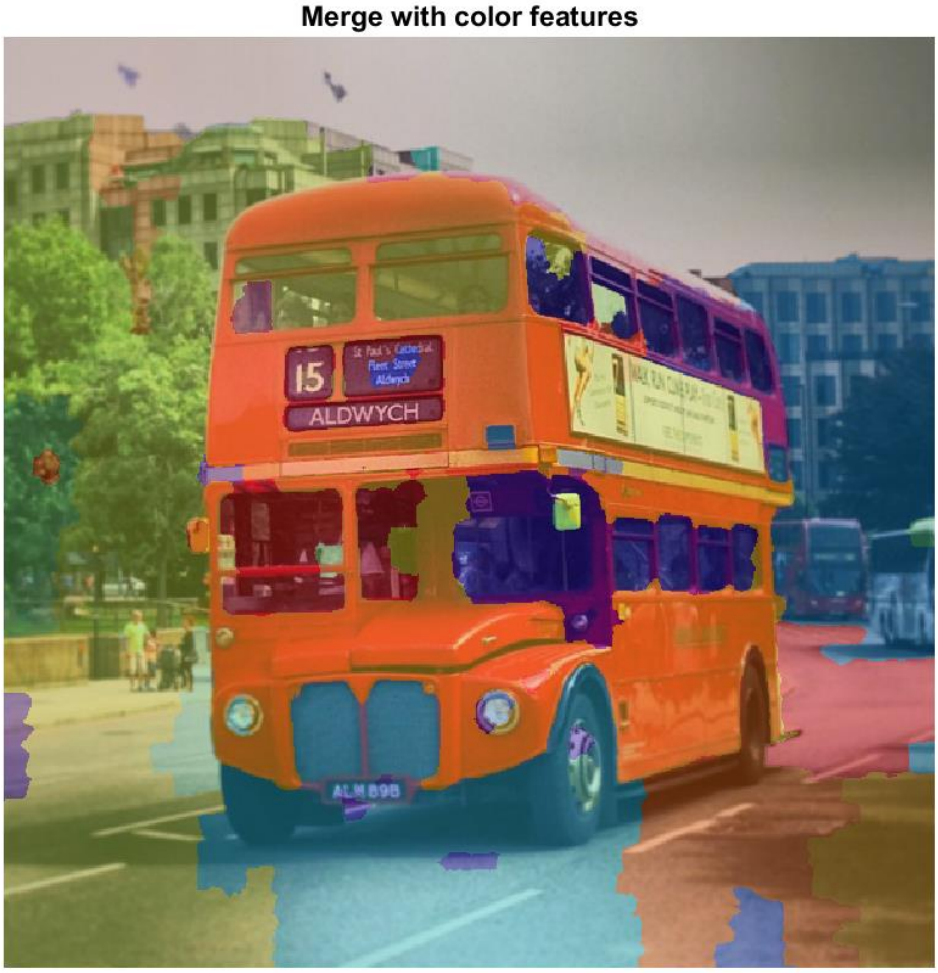

Figure 43: Image 1 merge with color features

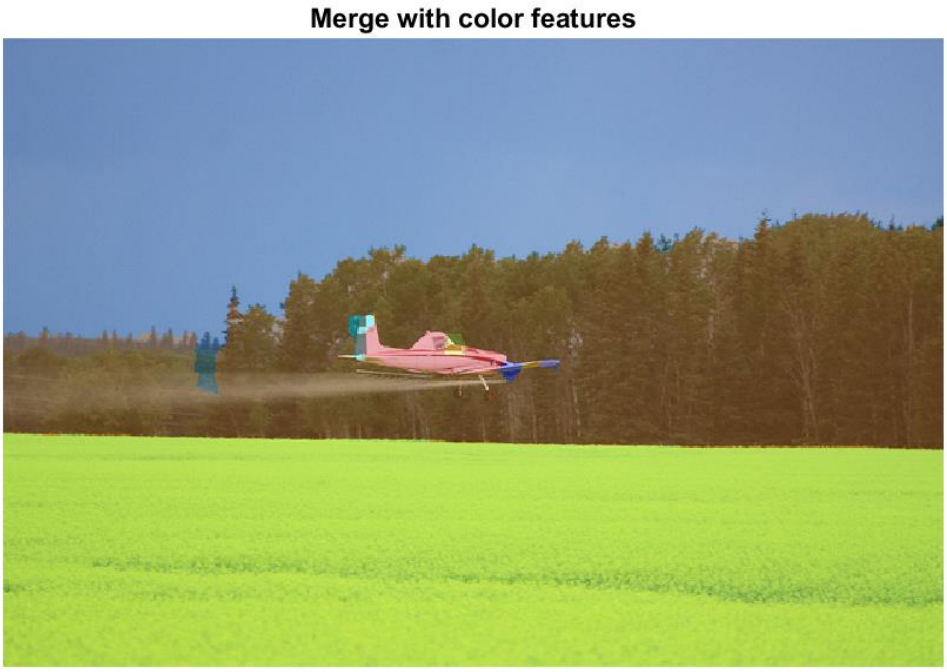

Figure 44: Image 2 merge with color features

Figure 45: Image 3 merge with color features

Figure 46: Image 4 merge with color features

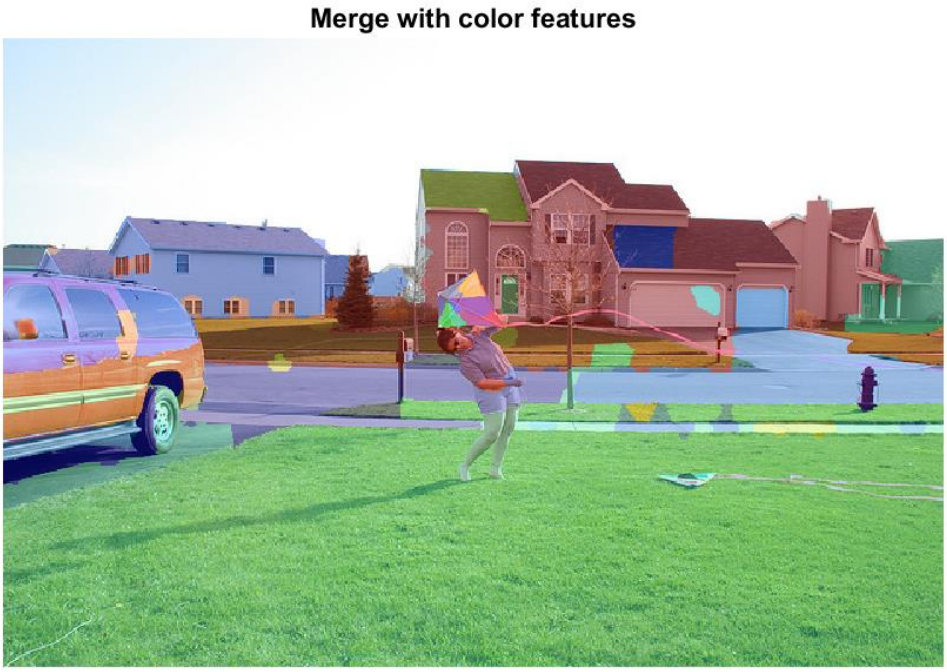

Figure 47: Image 5 merge with color features

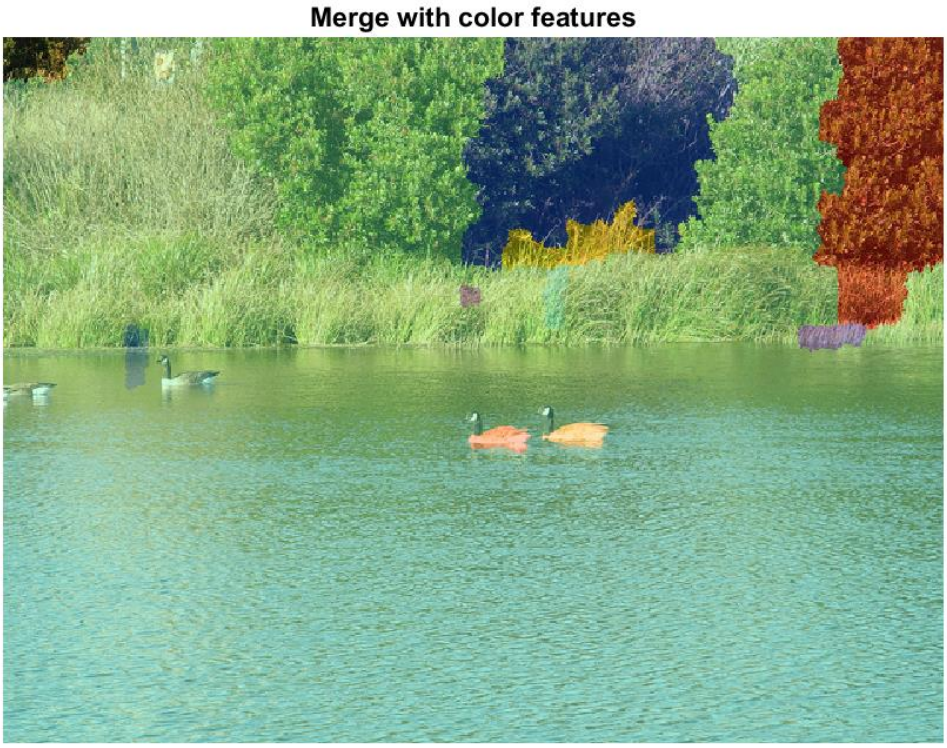

Figure 48: Image 6 merge with color features

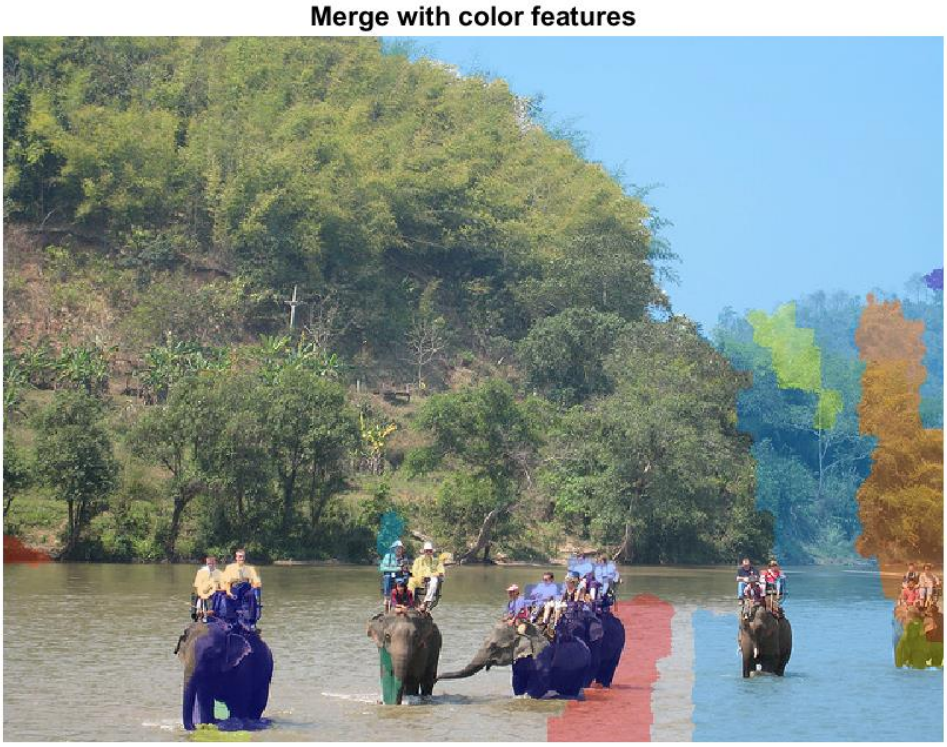

Figure 49: Image 7 merge with color features

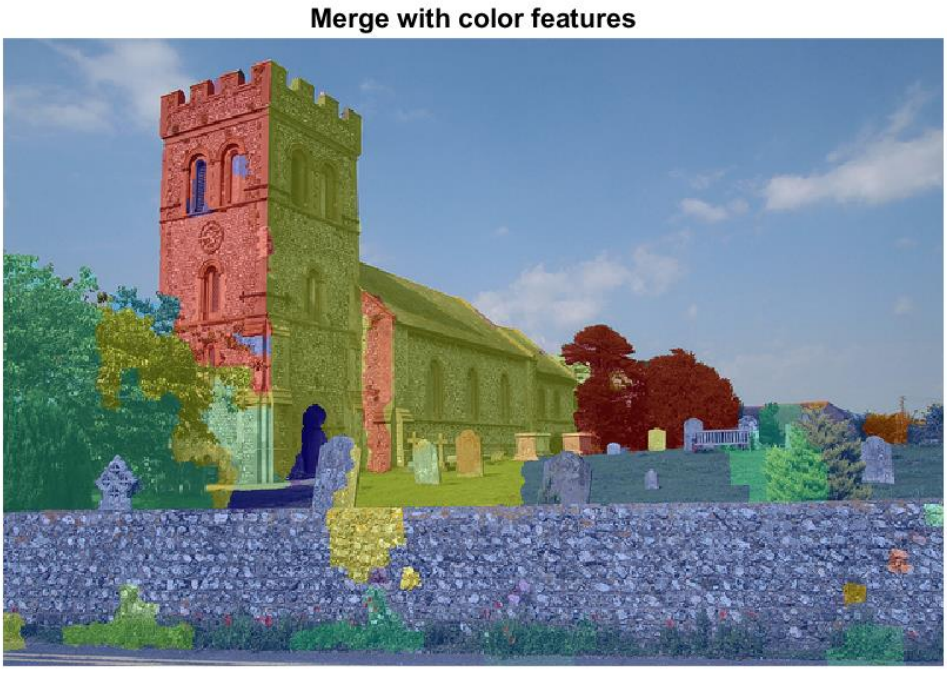

Figure 50: Image 8 merge with color features

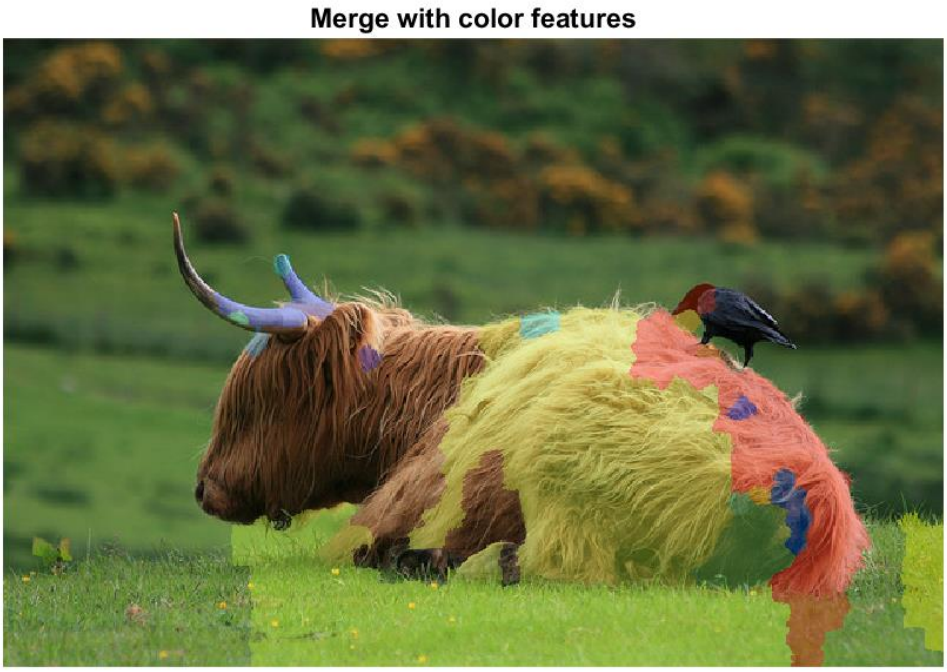

Figure 51: Image 9 merge with color features

Figure 52: Image 10 merge with color features

Figure 53: Image 11 merge with color features

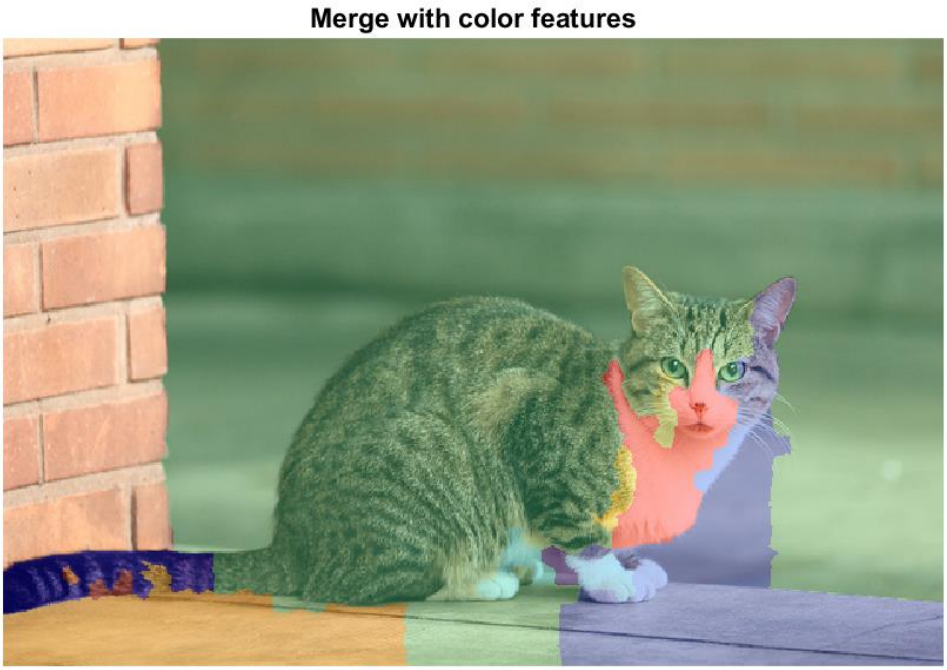

Figure 54: Image 12 merge with color features

Figure 55: Image 13 merge with color features

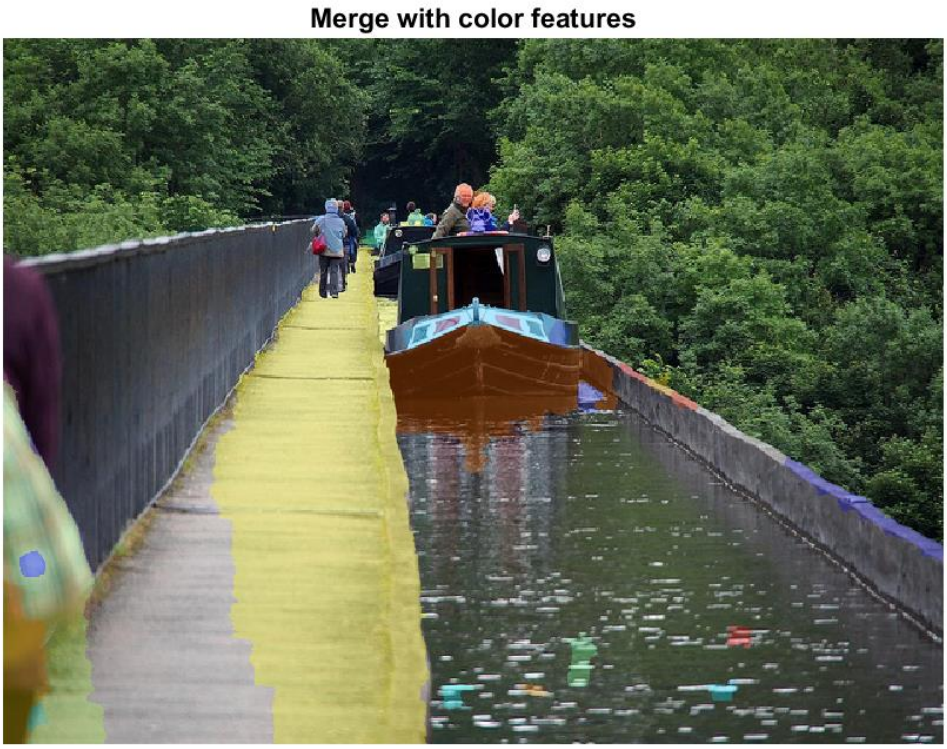

Figure 56: Image 14 merge with color features

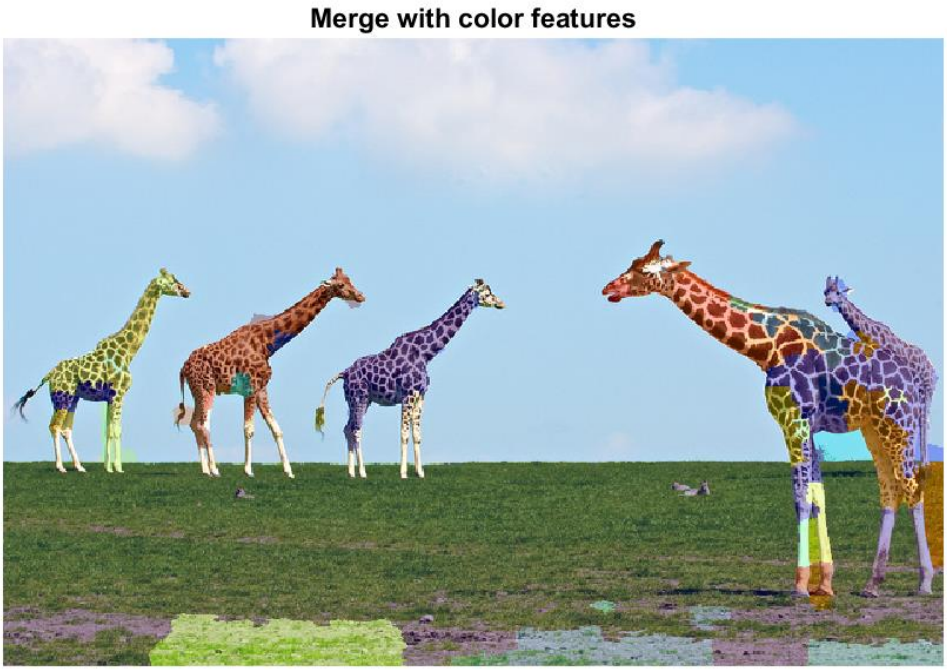

Figure 57: Image 15 merge with color features

Figure 58: Image 16 merge with color features

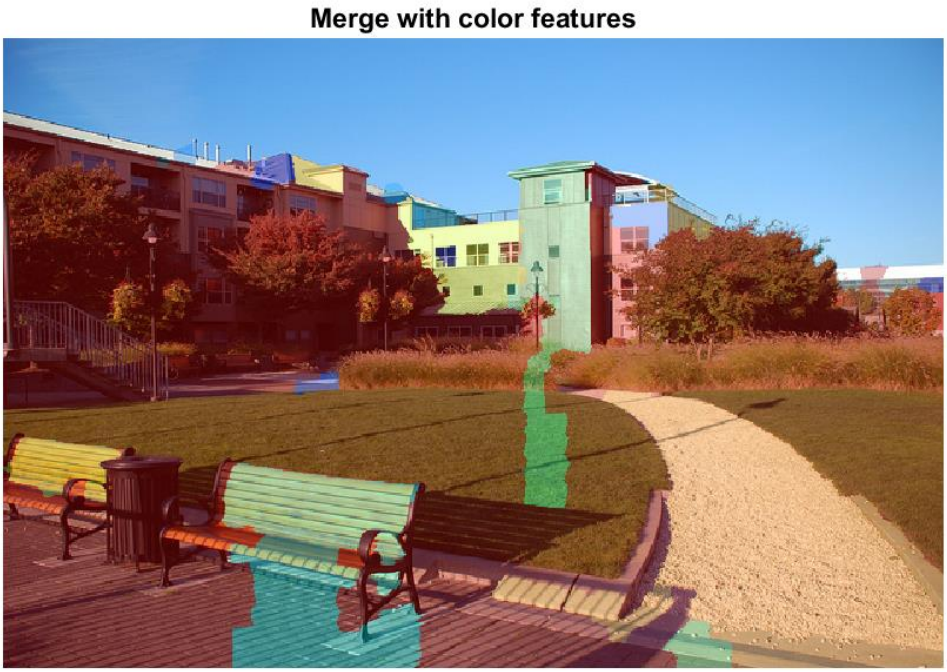

Figure 59: Image 17 merge with color features

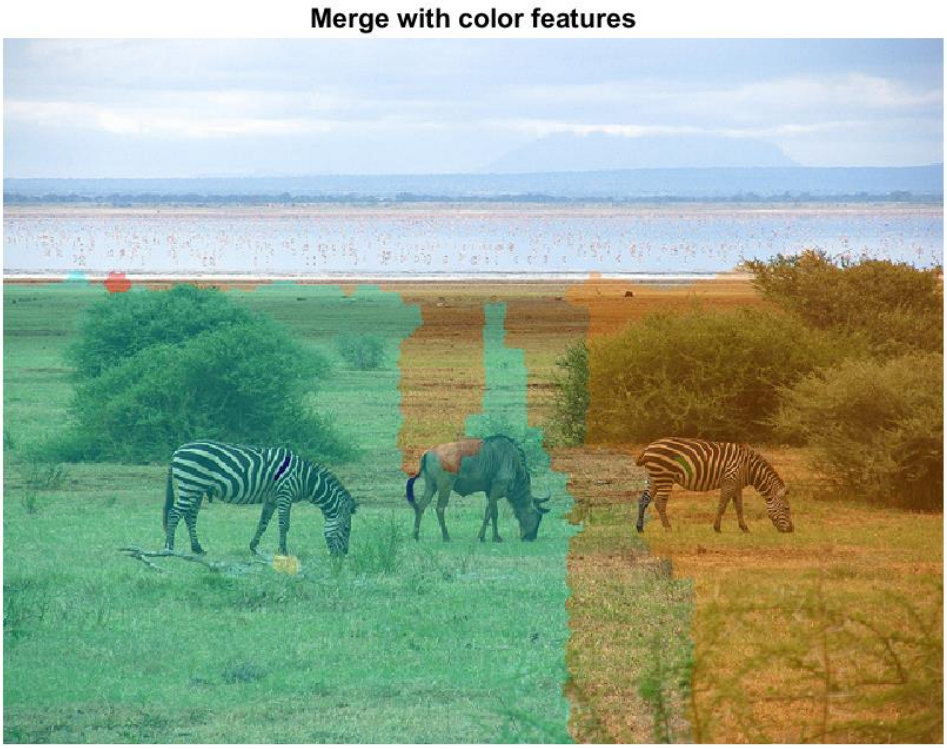

Figure 60: Image 18 merge with color features

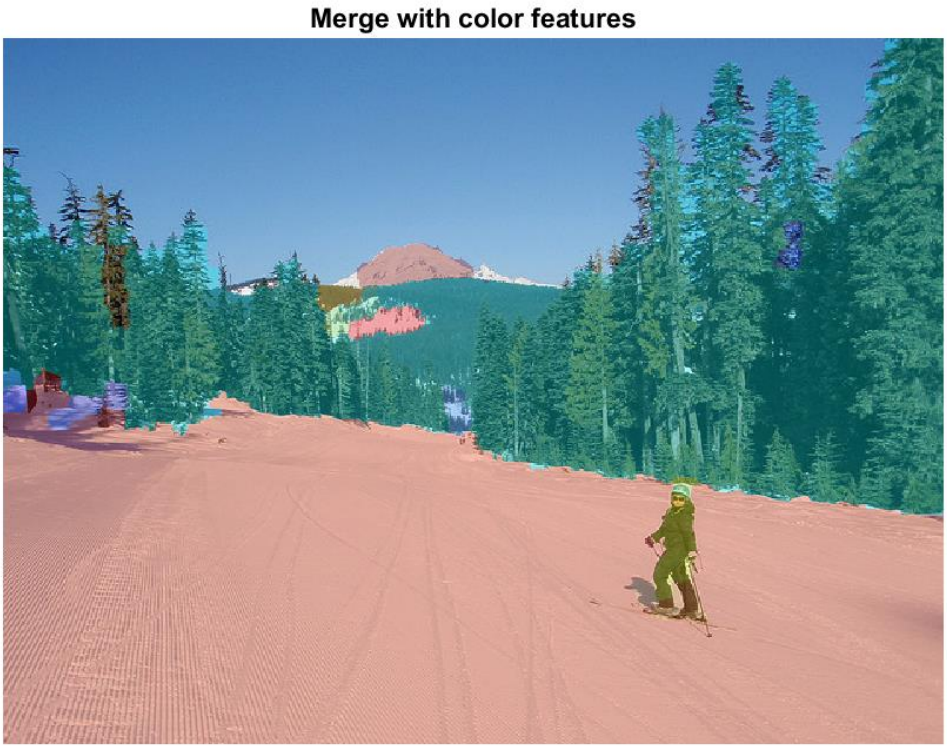

Figure 61: Image 19 merge with color features

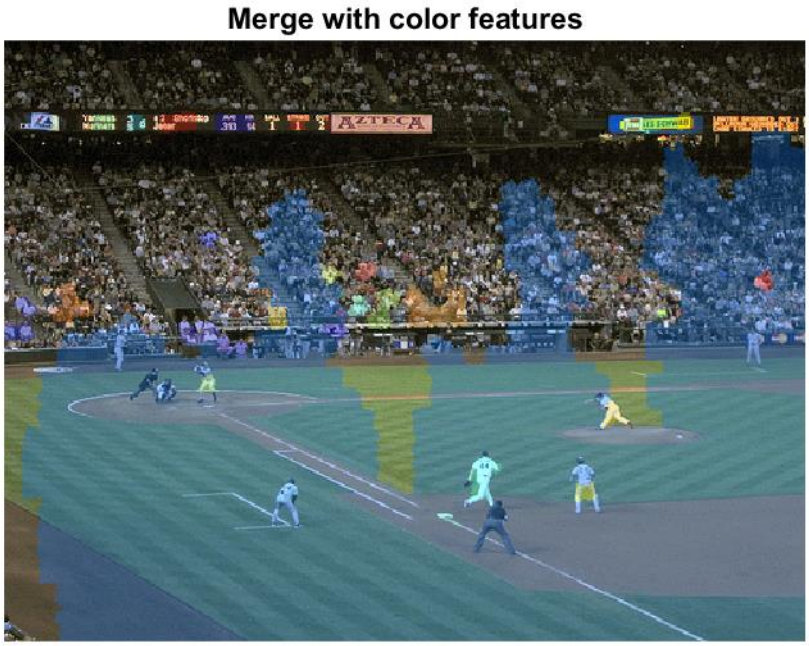

Figure 62: Image 20 merge with color features

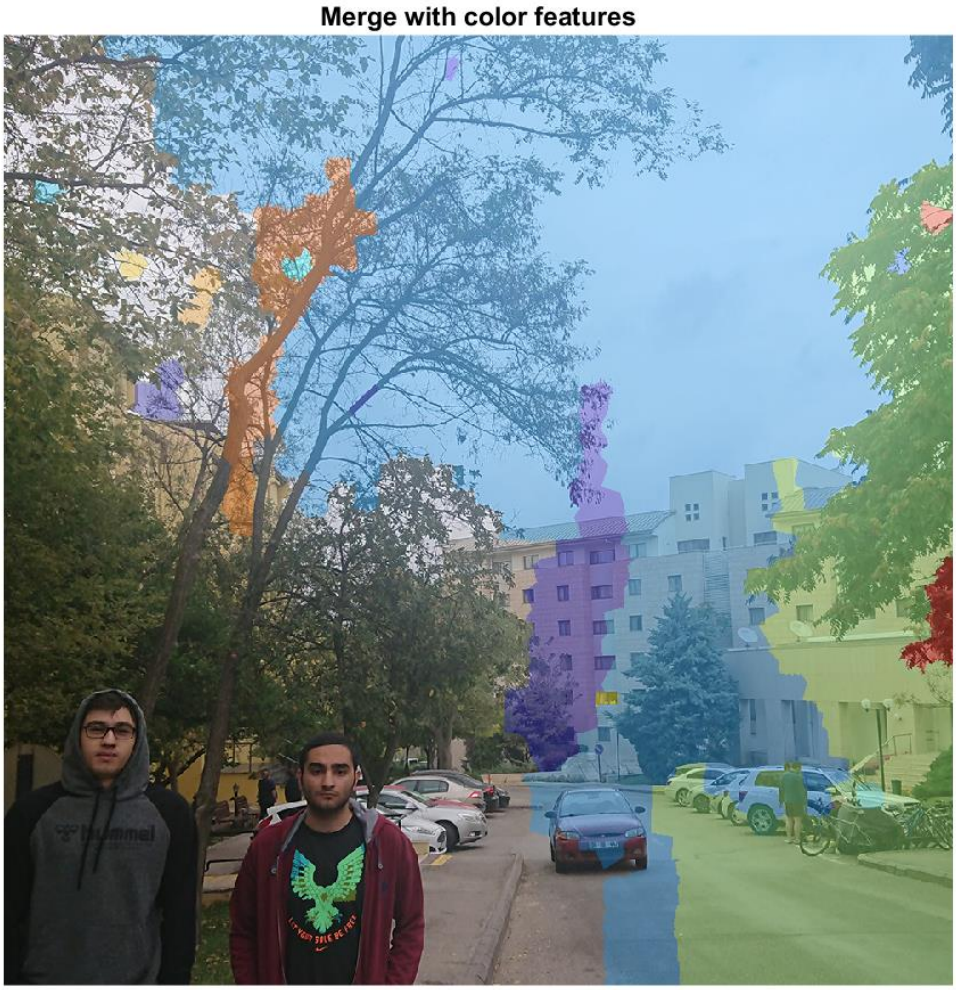

Figure 63: Image 21 merge with color features

b. Merge with Gabor Features

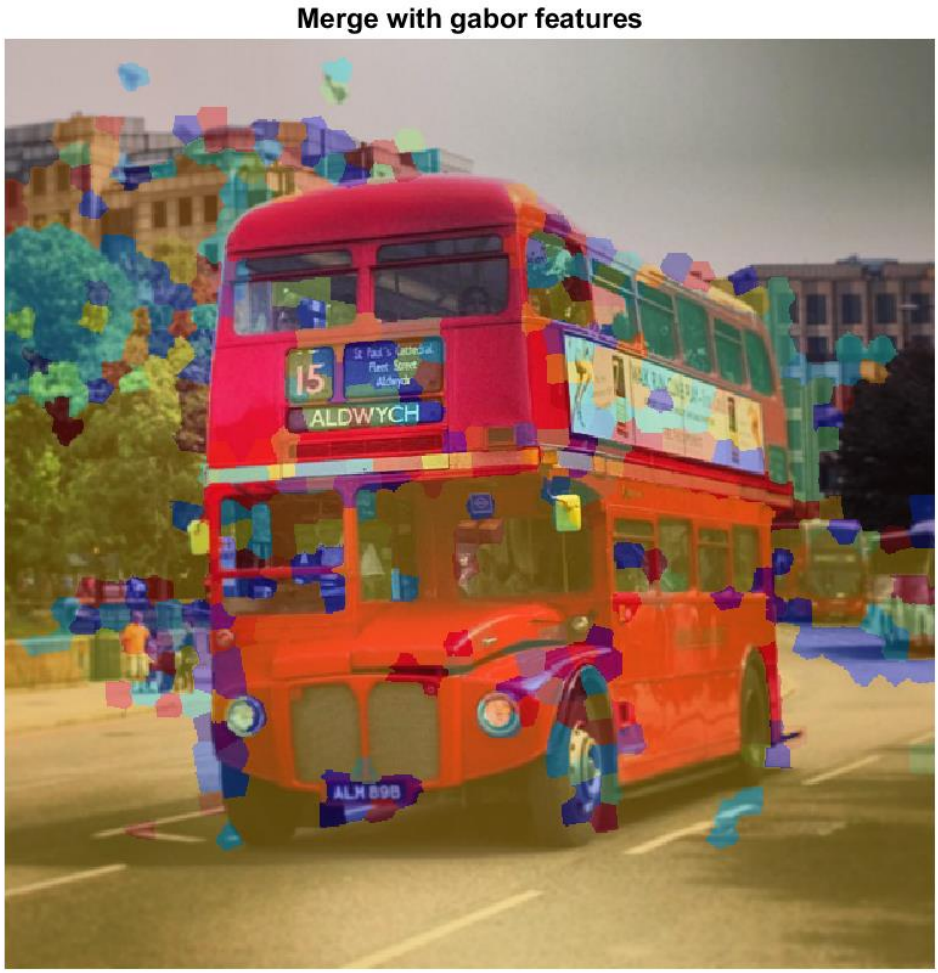

Figure 64: Image 1 merge with Gabor features

Figure 65: Image 2 merge with Gabor features

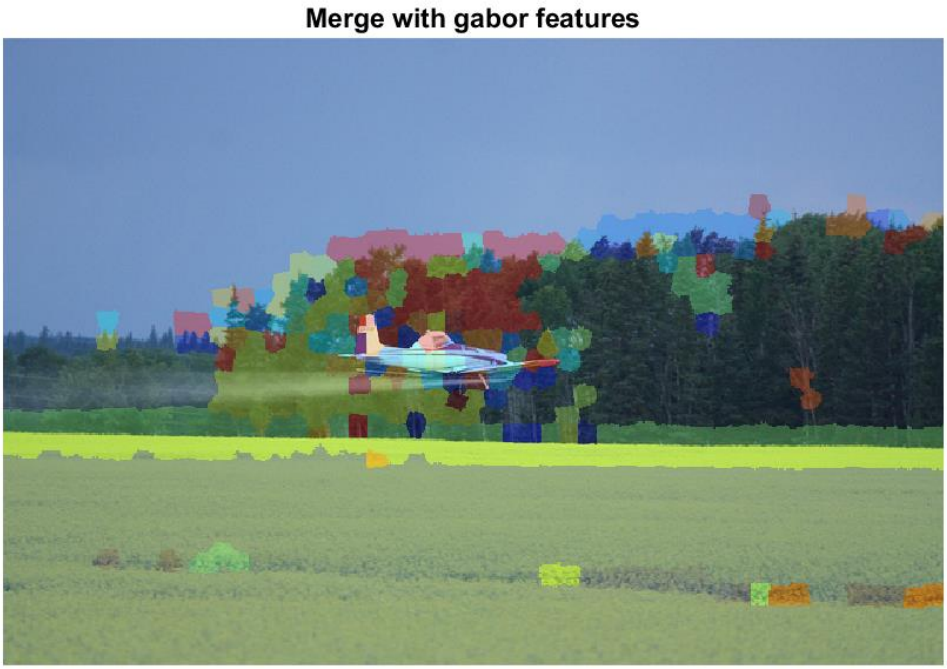

Figure 66: Image 3 merge with Gabor features

Figure 67: Image 4 merge with Gabor features

Figure 68: Image 5 merge with Gabor features

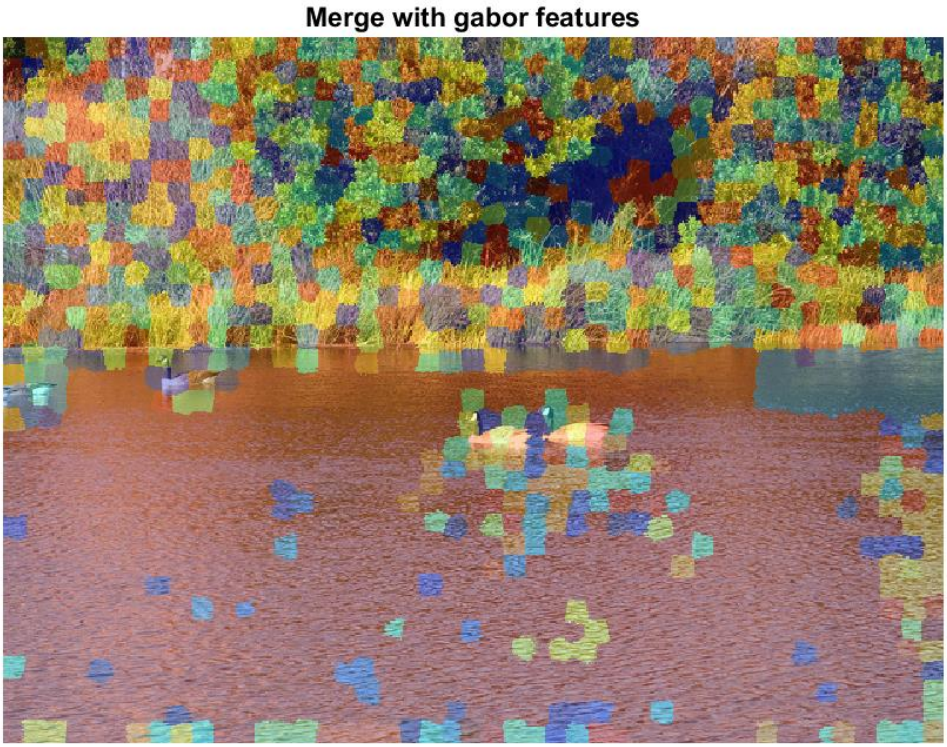

Figure 69: Image 6 merge with Gabor features

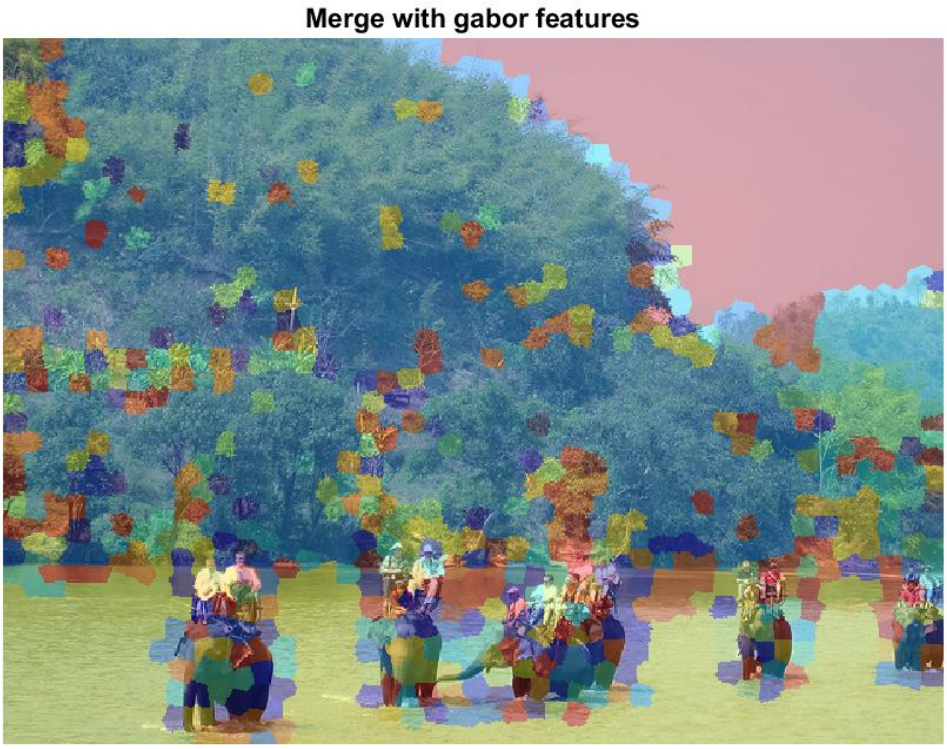

Figure 70: Image 7 merge with Gabor features

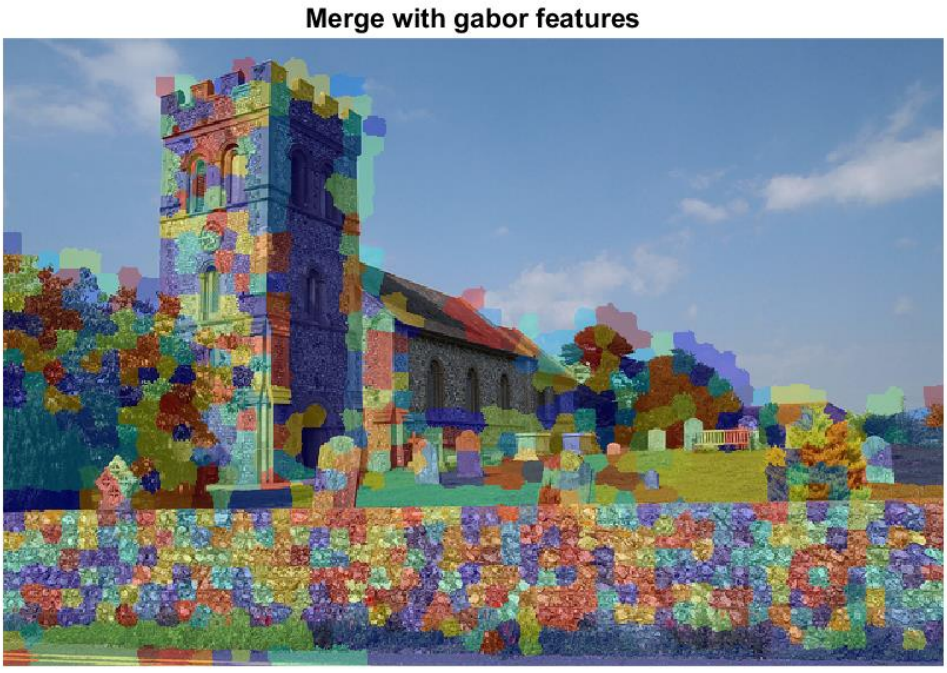

Figure 71: Image 8 merge with Gabor features

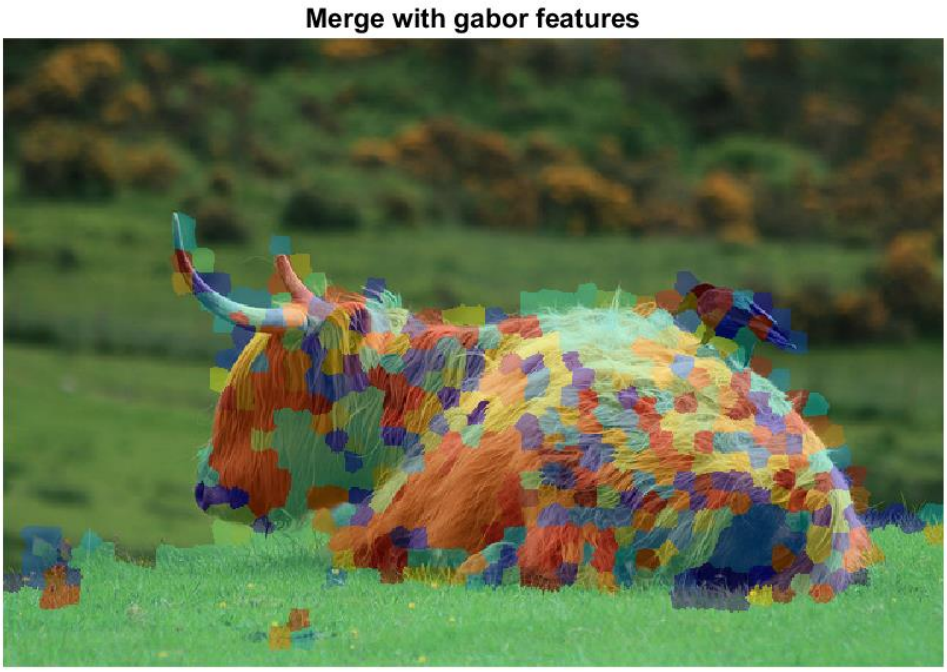

Figure 72: Image 9 merge with Gabor features

Figure 73: Image 10 merge with Gabor features

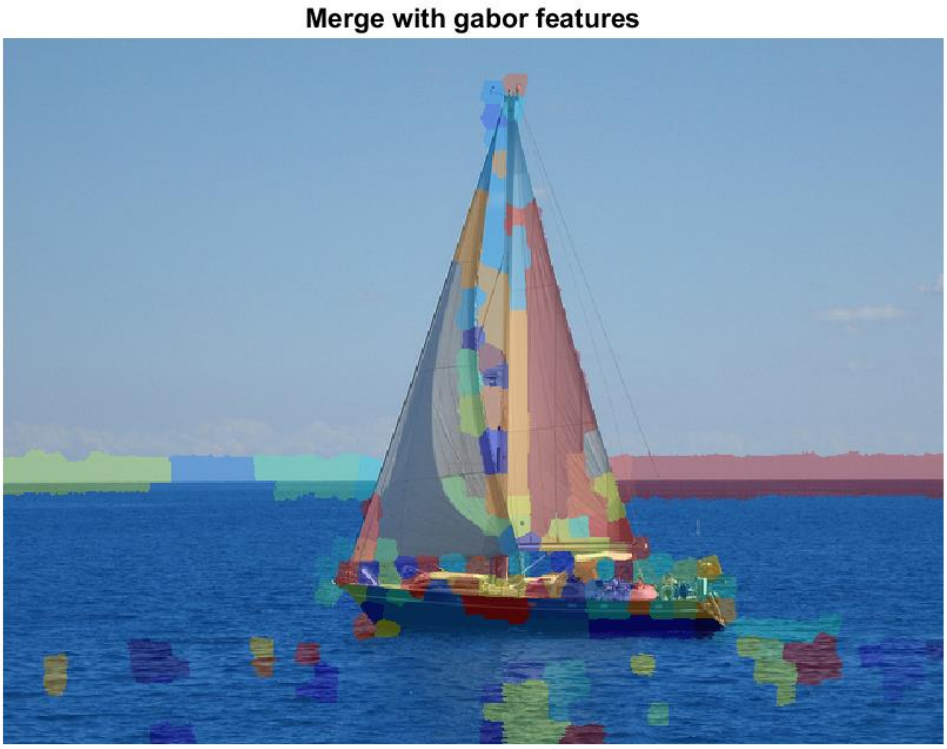

Figure 74: Image 11 merge with Gabor features

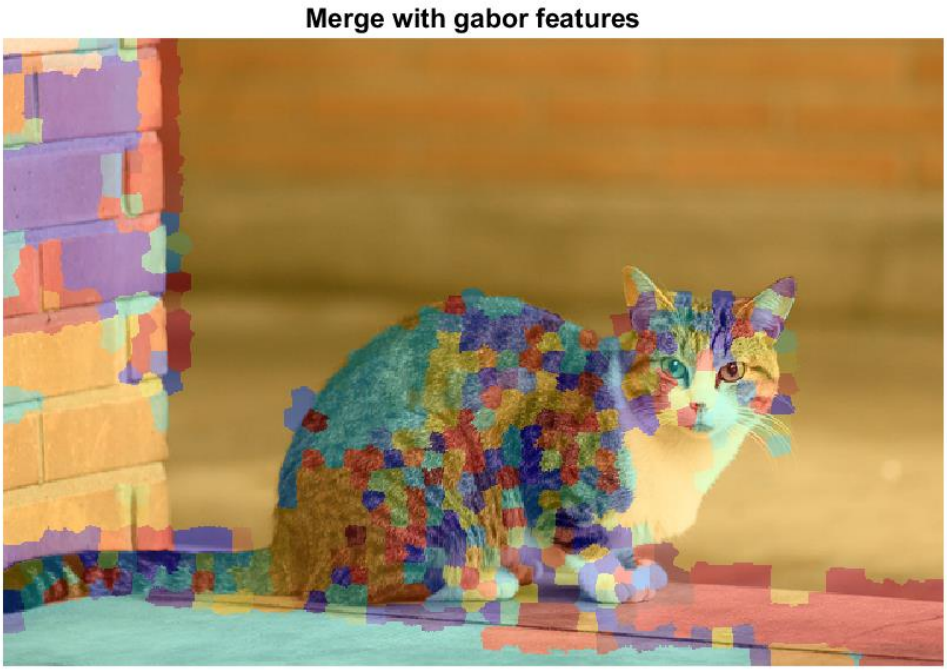

Figure 75: Image 12 merge with Gabor features

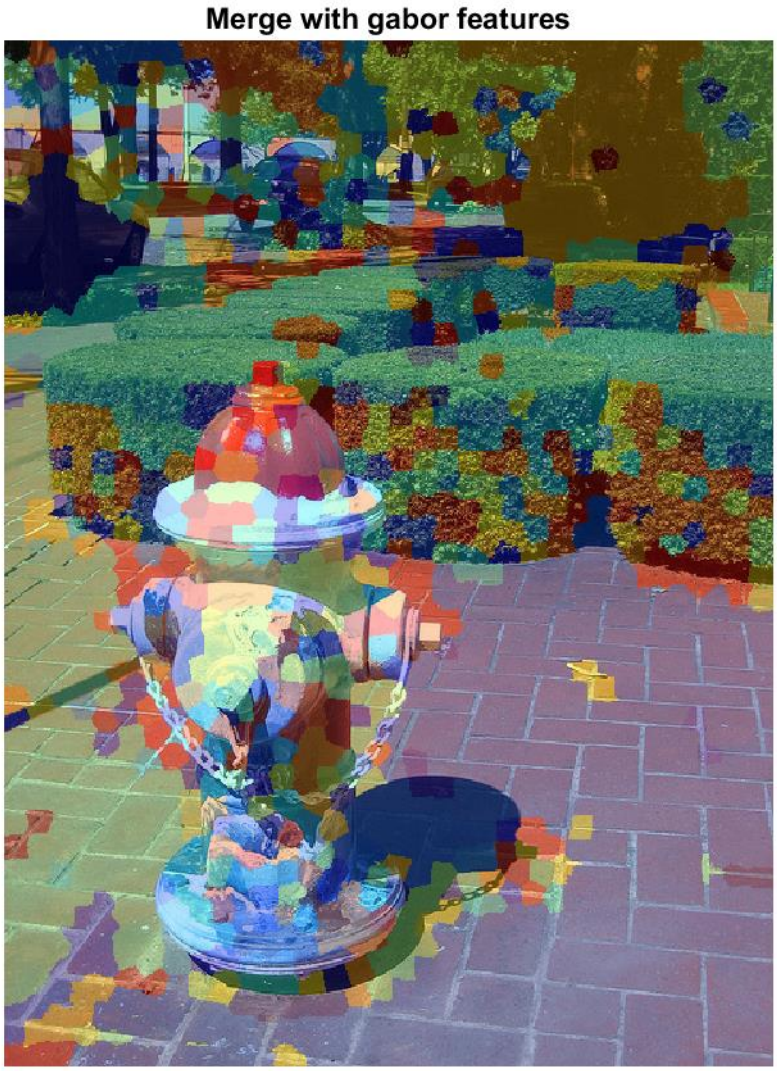

Figure 76: Image 13 merge with Gabor features

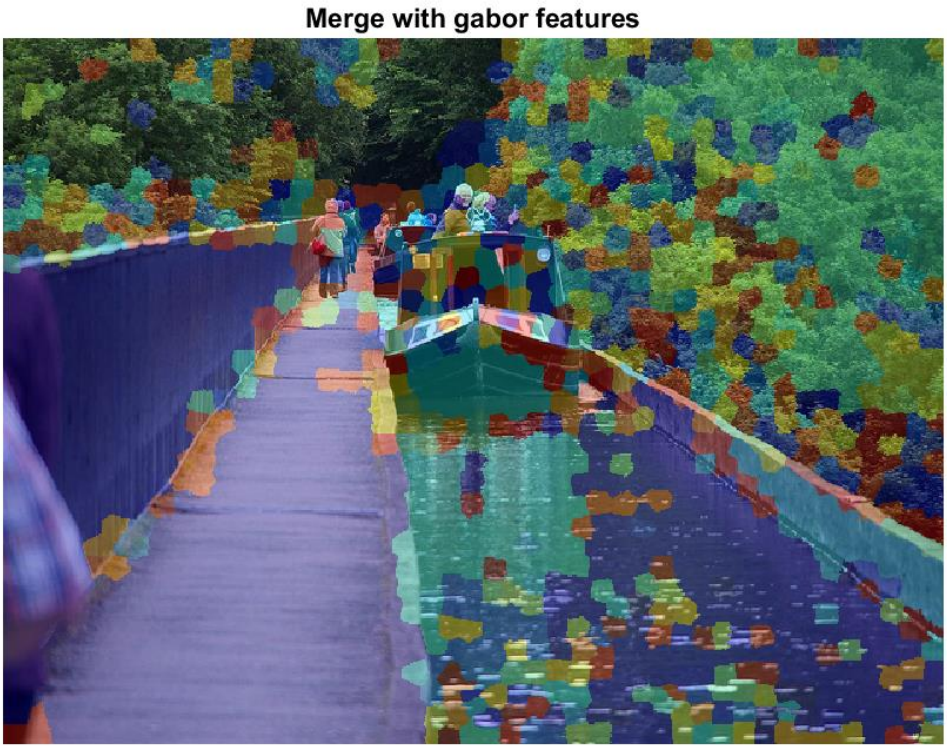

Figure 77: Image 14 merge with Gabor features

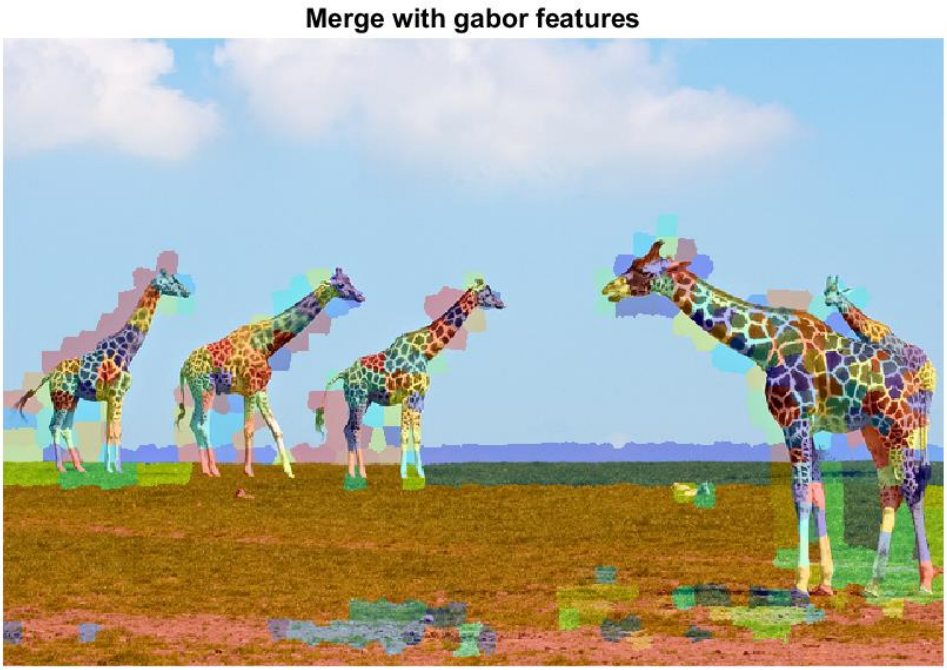

Figure 78: Image 15 merge with Gabor features

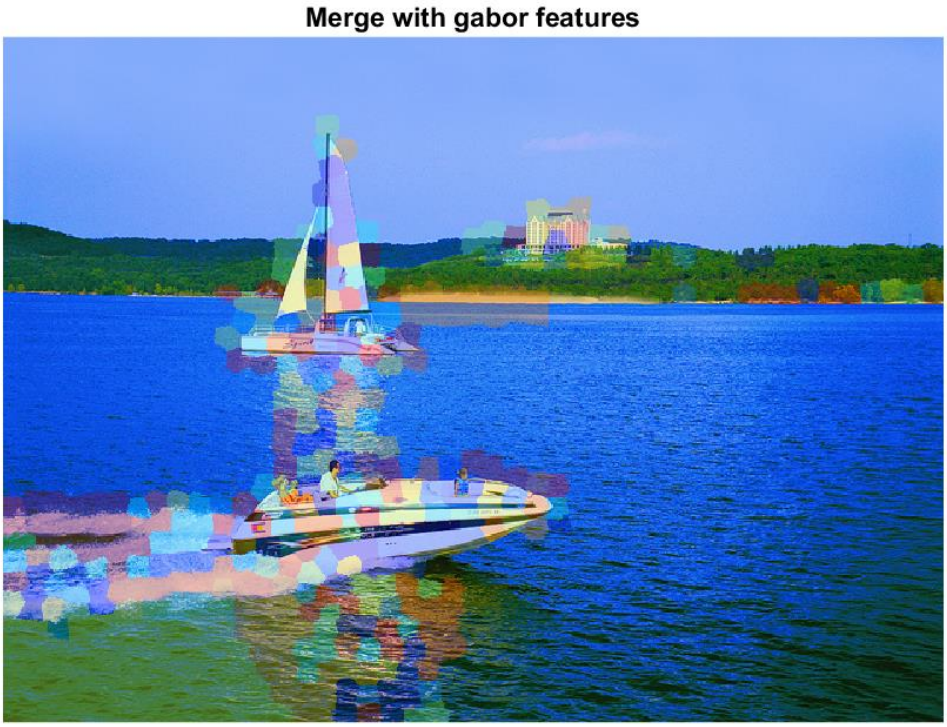

Figure 79: Image 16 merge with Gabor features

Figure 80: Image 17 merge with Gabor features

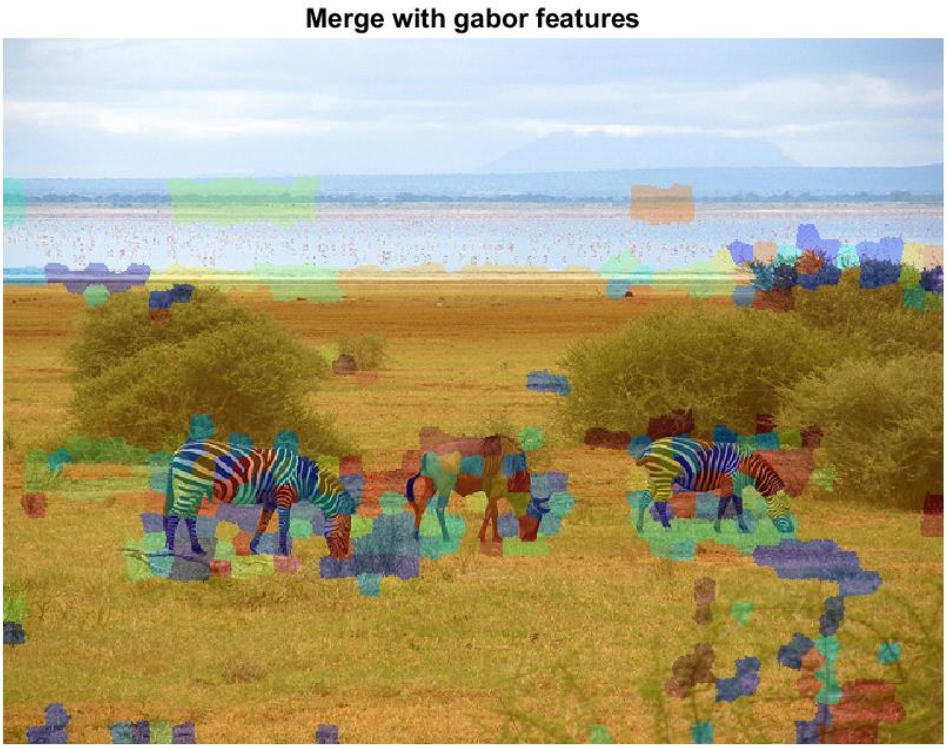

Figure 81: Image 18 merge with Gabor features

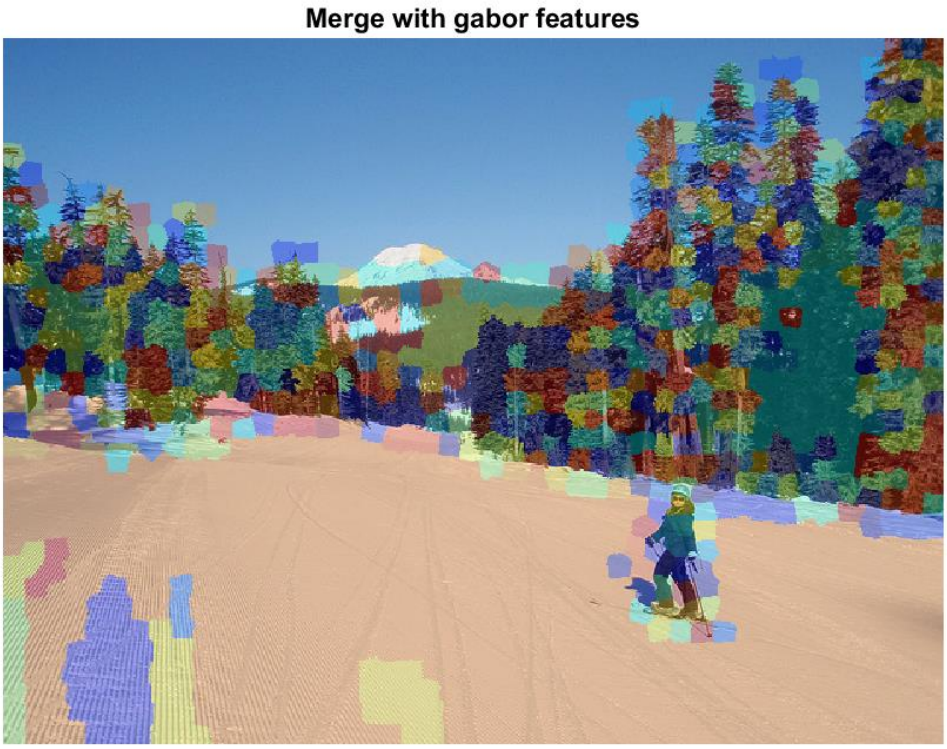

Figure 82: Image 19 merge with Gabor features

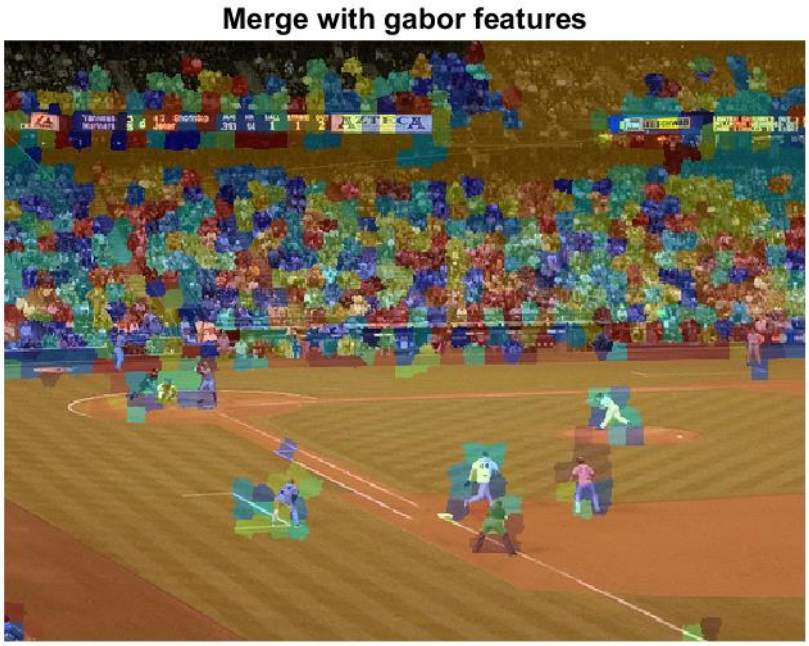

Figure 83: Image 20 merge with Gabor features

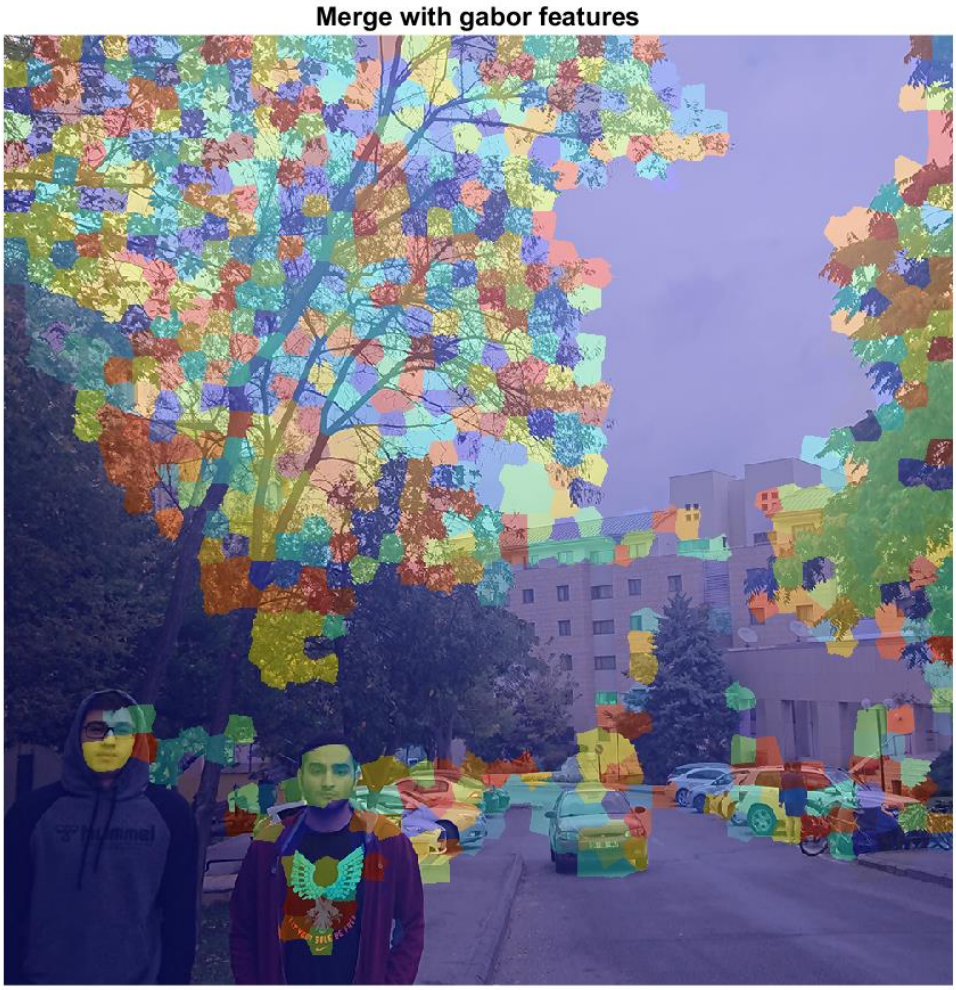

Figure 84: Image 21 merge with Gabor features

c. Merge with Combined Features

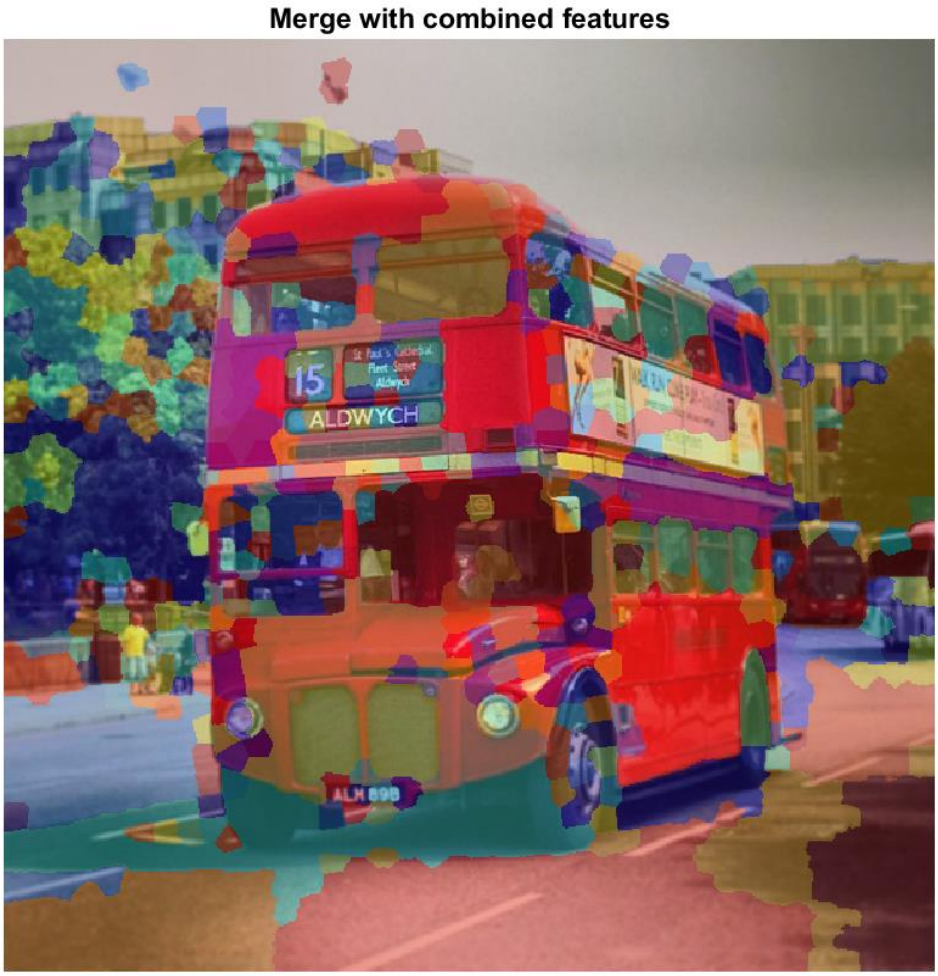

Figure 85: Image 1 merge with combined features

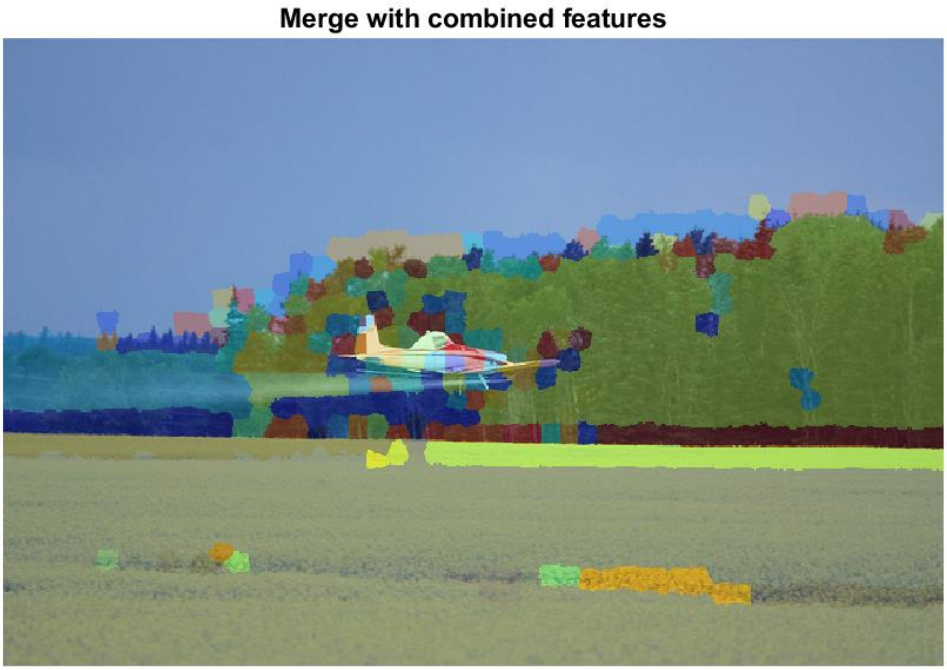

Figure 86: Image 2 merge with combined features

Figure 87: Image 3 merge with combined features

Figure 88: Image 4 merge with combined features

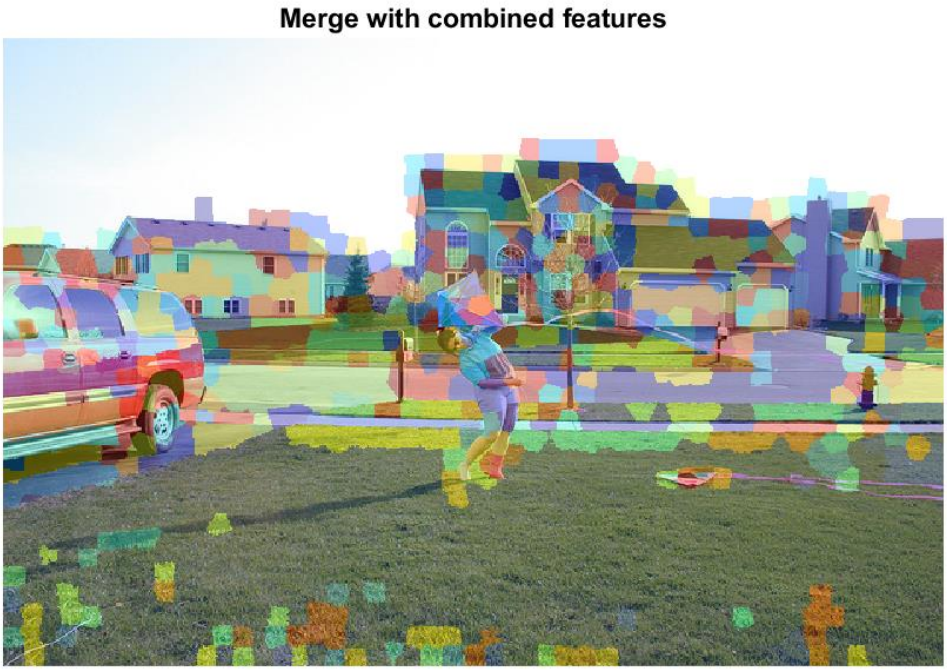

Figure 89: Image 5 merge with combined features

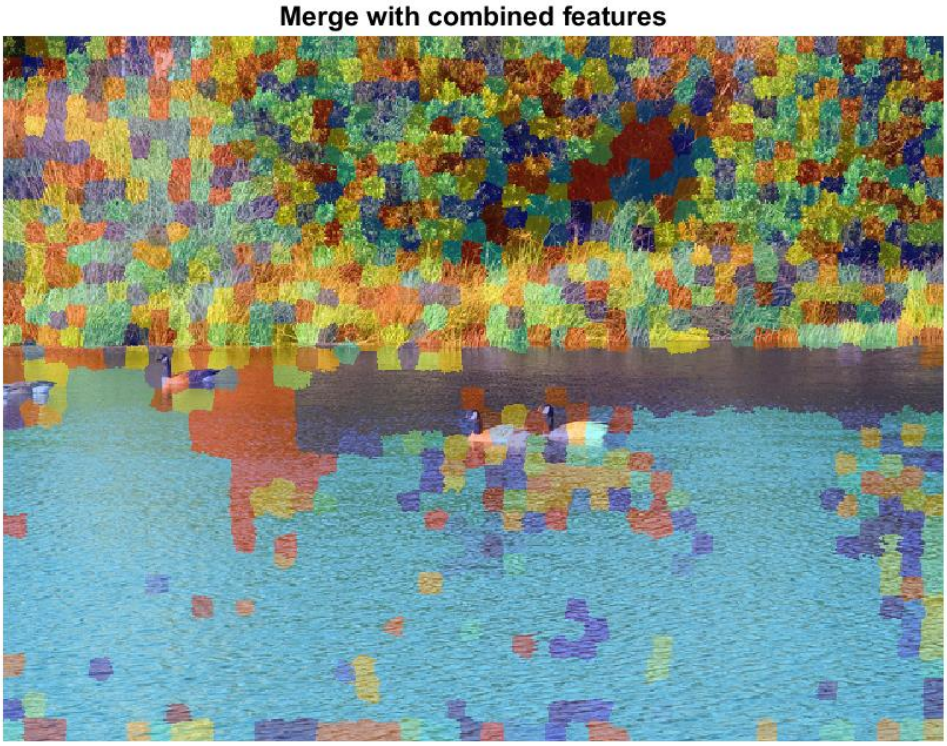

Figure 90: Image 6 merge with combined features

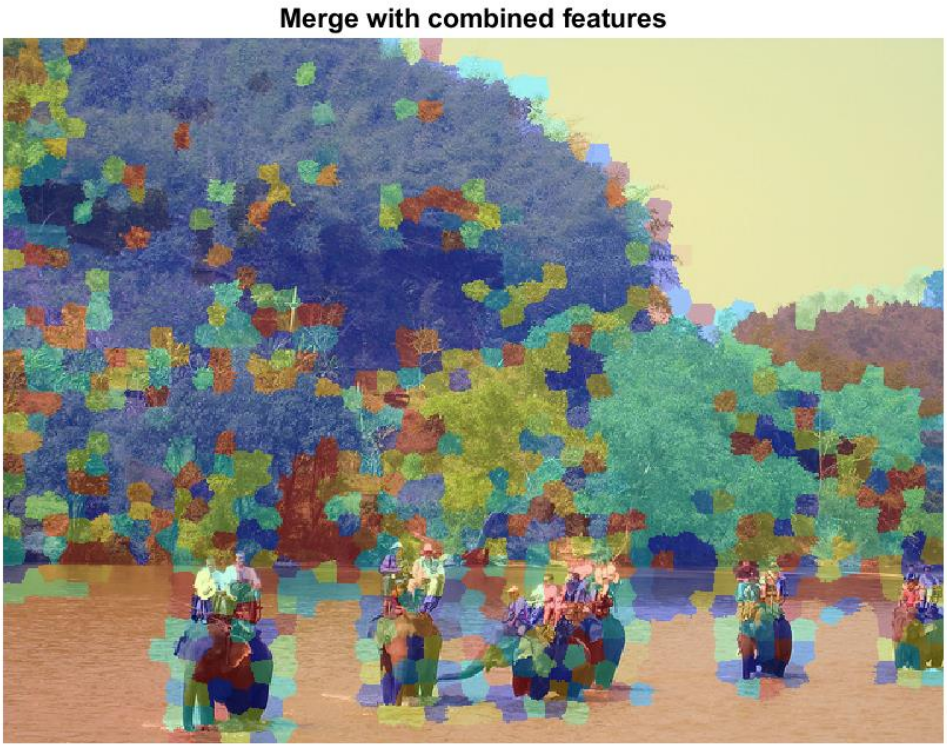

Figure 91: Image 7 merge with combined features

Figure 92: Image 8 merge with combined features

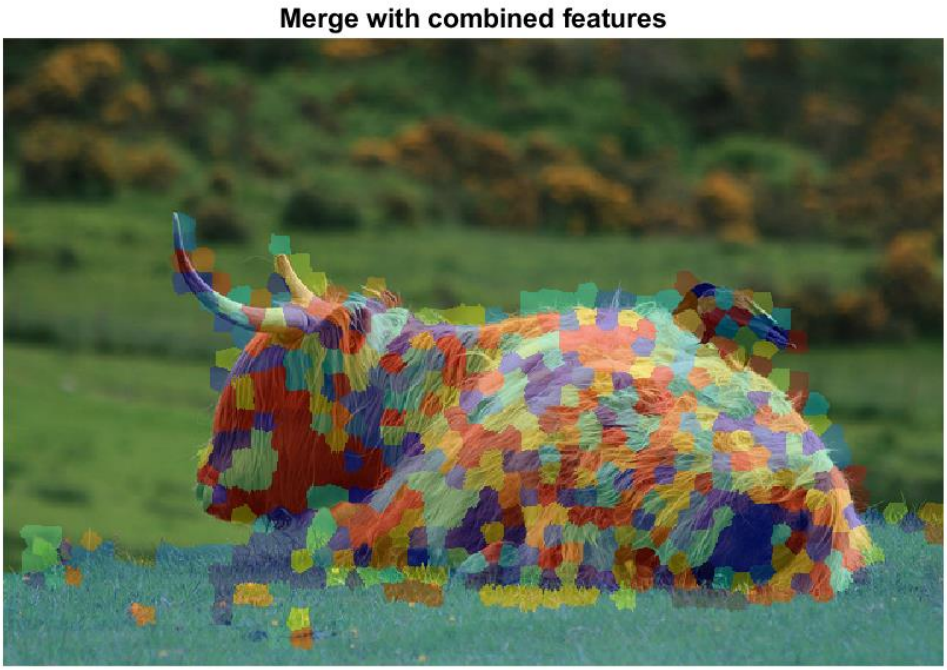

Figure 93: Image 9 merge with combined features

Figure 94: Image 10 merge with combined features

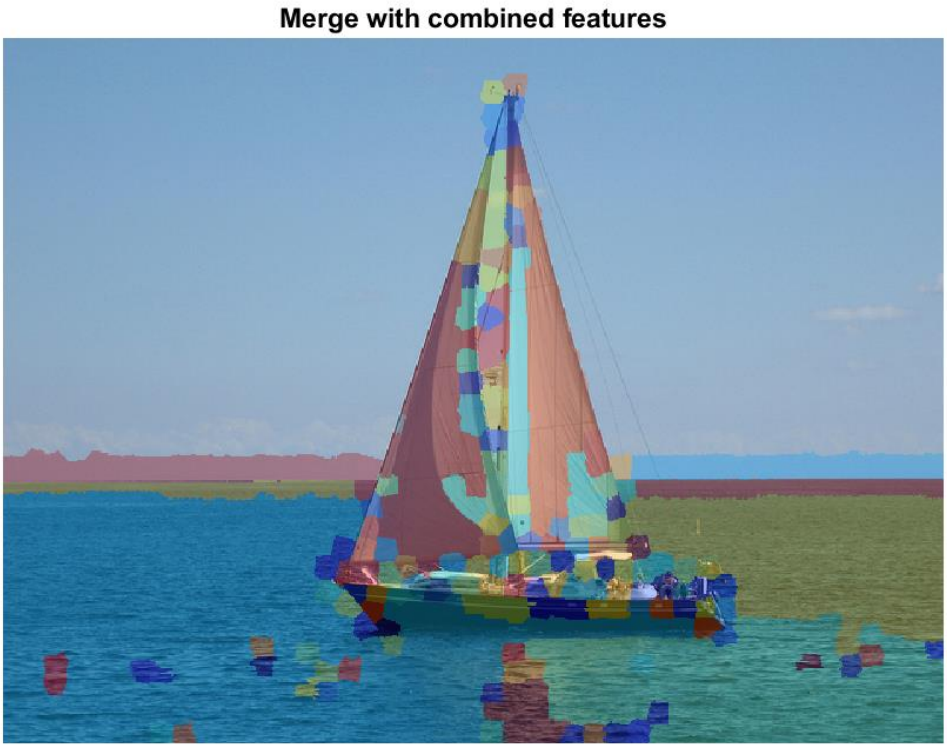

Figure 95: Image 11 merge with combined features

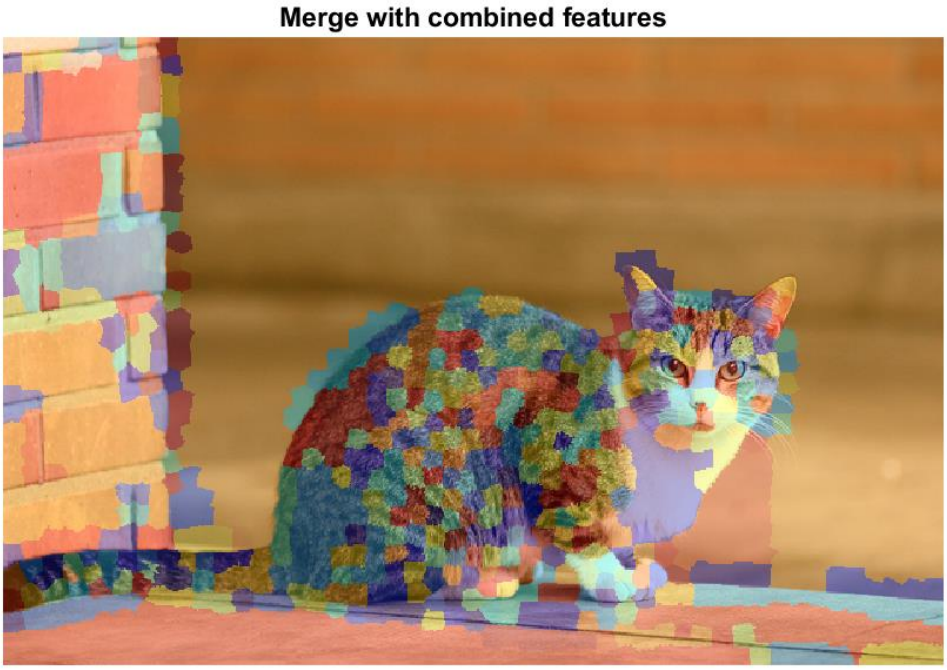

Figure 96: Image 12 merge with combined features

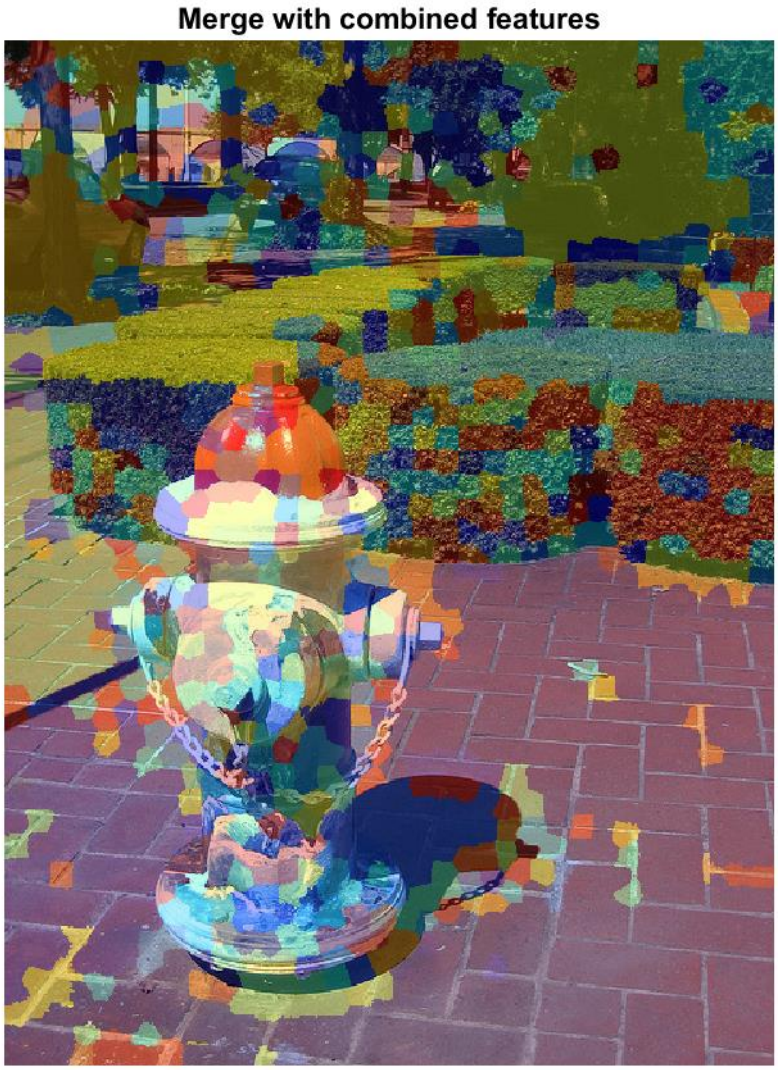

Figure 97: Image 13 merge with combined features

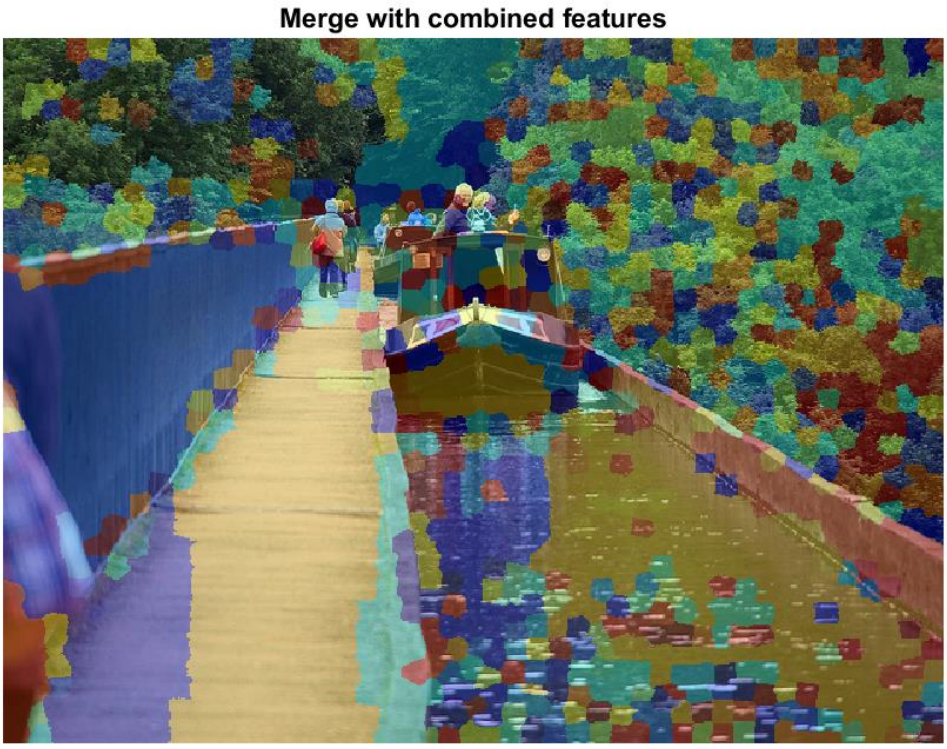

Figure 98: Image 14 merge with combined features

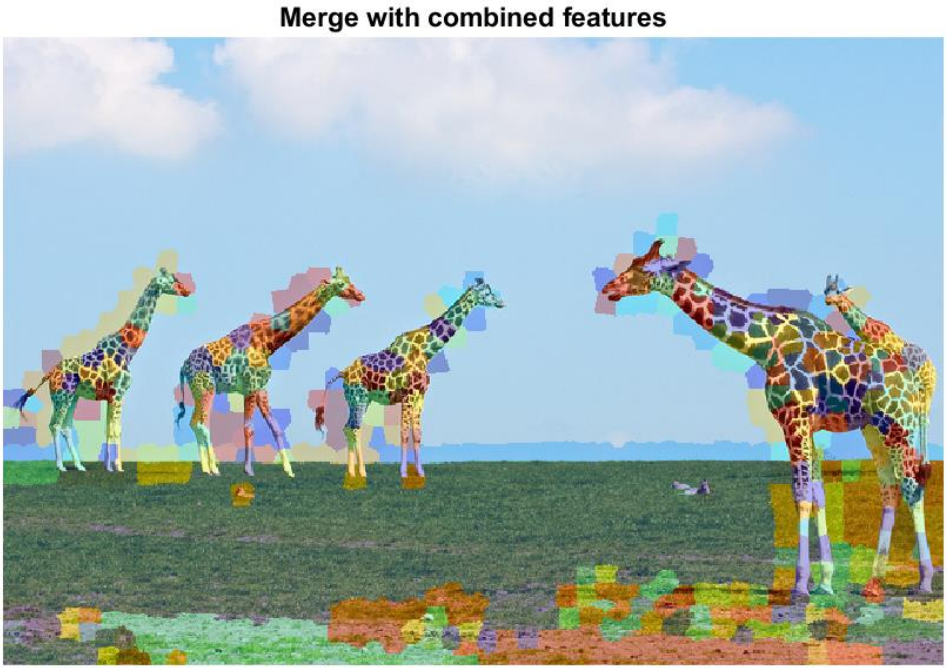

Figure 99: Image 15 merge with combined features

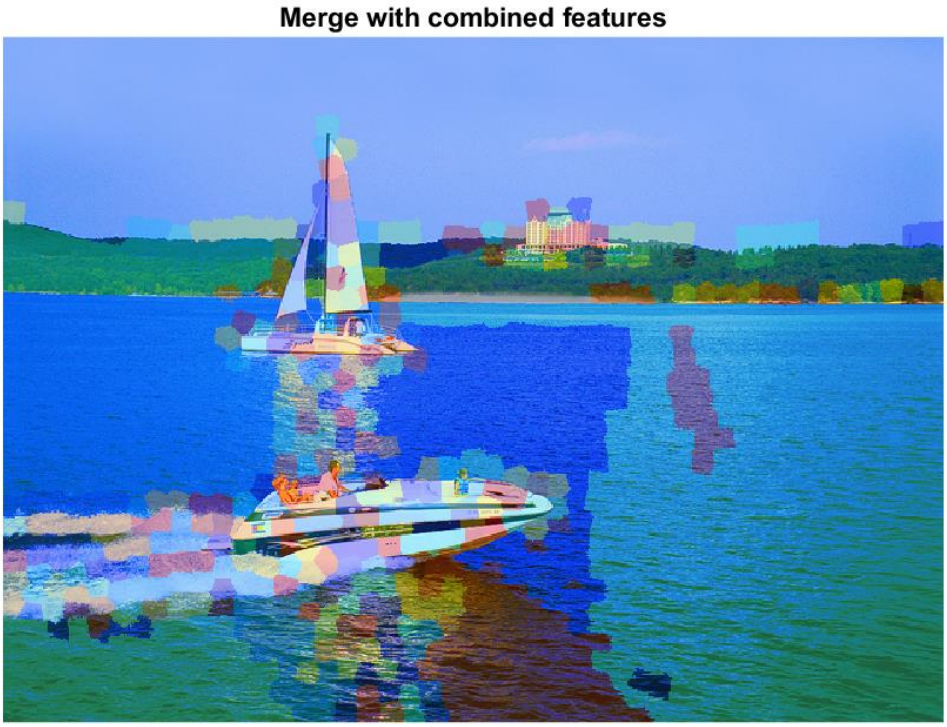

Figure 100: Image 16 merge with combined features

Figure 101: Image 17 merge with combined features

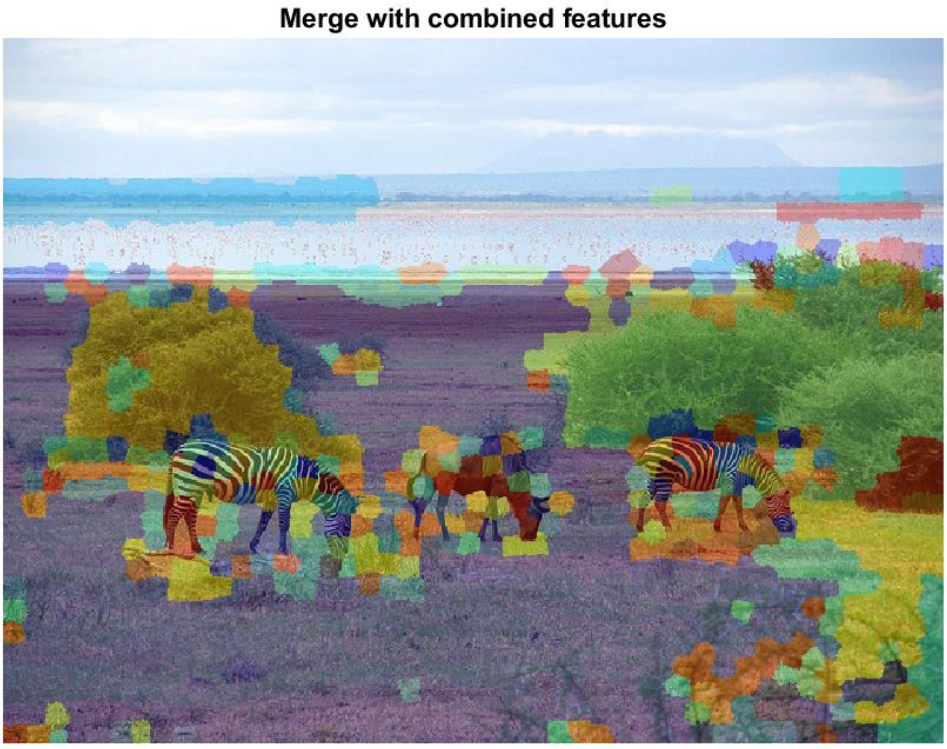

Figure 102: Image 18 merge with combined features

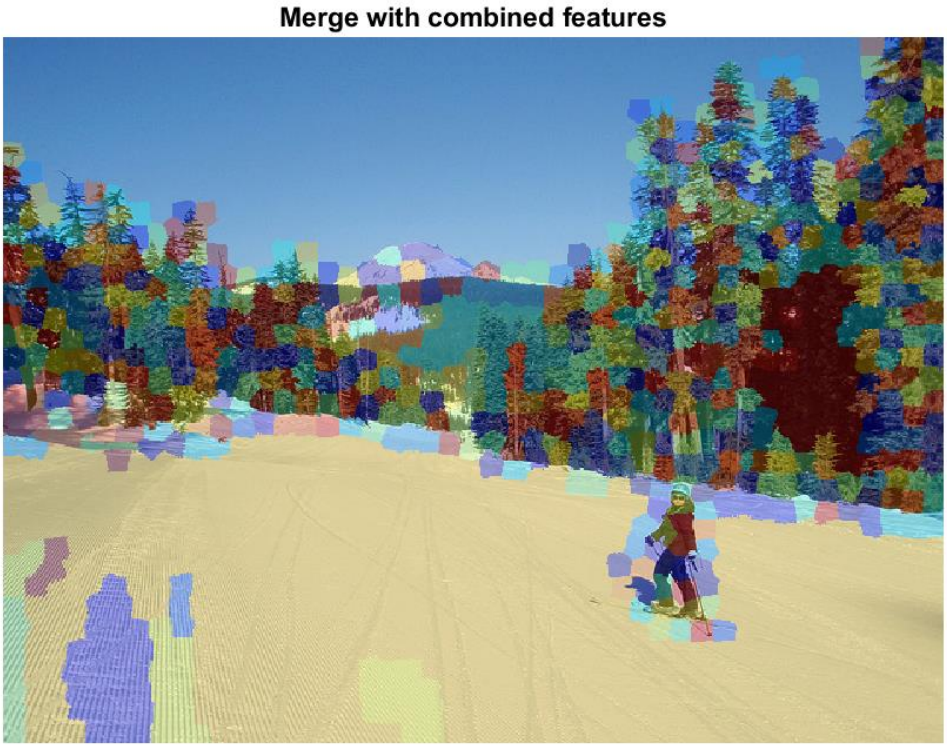

Figure 103: Image 19 merge with combined features

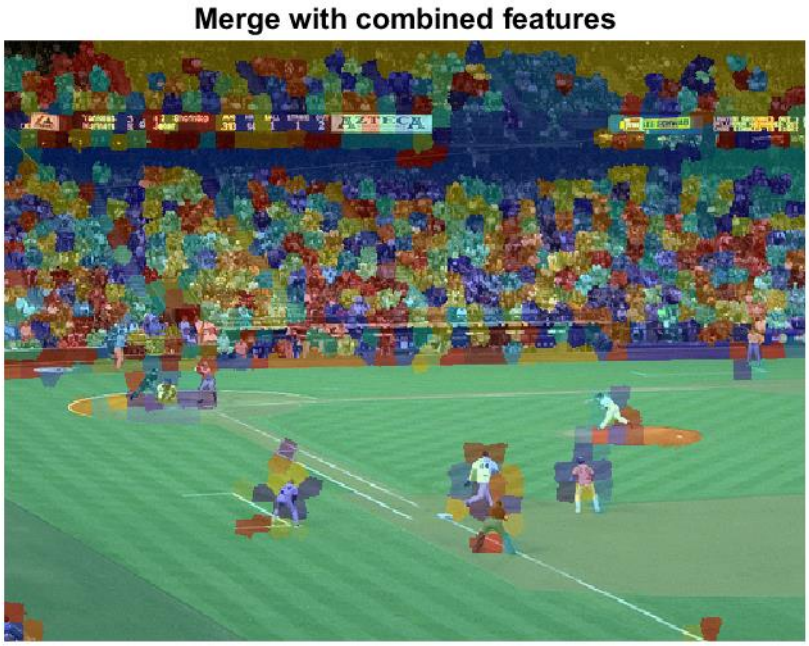

Figure 104: Image 20 merge with combined features

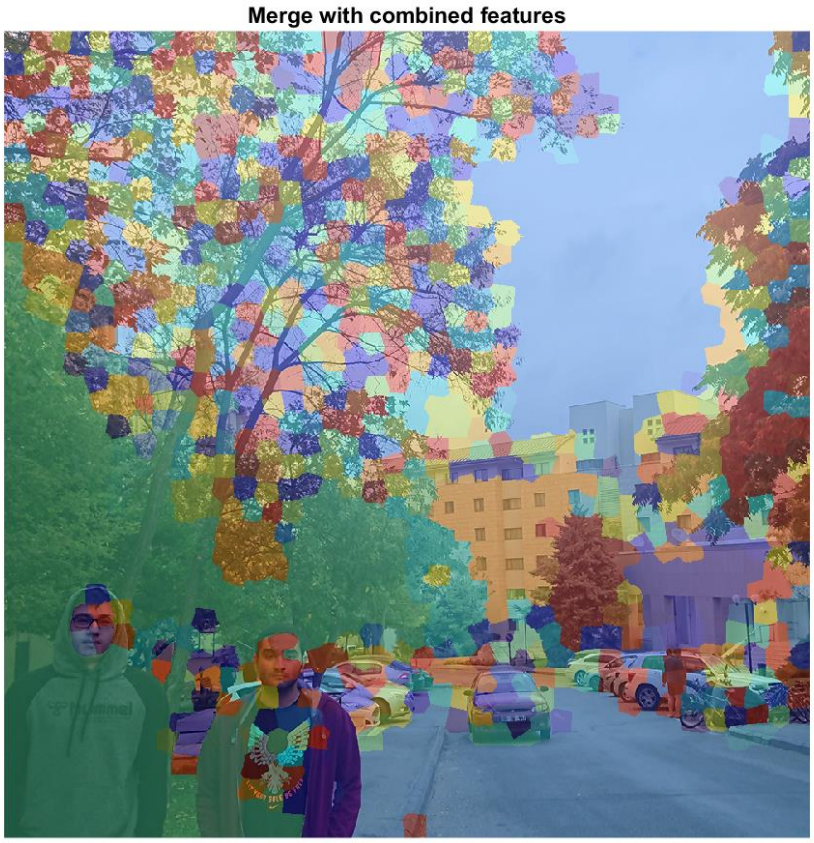

Figure 105: Image 21 merge with combined features

4. Discussion

I used a high value for over segmentation because I wanted better results after merging and I wanted merging results to wrap objects as much as possible. Finding a suitable threshold for every image and every feature type was hard. I used trial and error method to find the best threshold. Some thresholds were good for some images and some thresholds not. Also some thresholds worked better with a feature type but not with others. After a lot of trials, I find a threshold that I think it was the best. Merging with different feature types gave very different results. Using Gabor features gave good merging when there are similar and regular patterns like water waves, building, walls and grass but gave bad result when there are random patters like animal furs and leaves of trees. Using color features gave good result when there are areas with similar color like trees and sky but gave bad result when an object has similar color with background like animals in nature. Combination of Gabor and color features gave results somewhere between color and Gabor features. Good properties of both color and Gabor features became a little worse and bad properties became better. I think it is really hard to find a threshold and feature type for merging for general case (i.e. different type of images).