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HOMEWORK 2

Implementation

1. After getting inputs, reads class ids from the given text.
2. For each image, calculates gradient-based, color-based, mixed descriptors.
    a. During calculation of color-based descriptors, all pixels that are in rotated squares are figured out. During checking if the pixel is in or not, CCW method is used. One known application of it is Graham's Scan algorithm to Convex Hull problem. I look for 4 edges of the square. Each time, I construct 2 vectors where one of them corresponds to the edge and the other one corresponds to a vector from source of the edge to the pixel that I check. If I check edges in counter-clockwise order, then all 4 results of CCW should be '<= 0' that means the pixel is at the left of all edges. If I check edges in clockwise order, then all 4 results of CCW should be '>= 0' that means the pixel is at the right of all edges.
    b. I decreased number of descriptors for each image to 50 because of execution time issue. Since average number of interest points is about 200-250, there is some lose in data. However, the results are still meaningful. In total, there are 10*50*50=25000 interest points.
3. After calculation of each image's descriptors, I merged them into 3 matrices. I apply k-means for 2 k values. Therefore, in total, 6 normalized histograms are calculated.
4. Finally, t-SNE figures are shown for each 6 codebooks.

Note: I construct bar plots of intermediate steps by considering user's choice where there are 6 final t-SNE images.

Entry Points

The code gets 4 variables from user that are name of the text file listing a set of file names (a string like files.txt), name of the text file listing category ids of each image (a string like classes.txt), an integer that corresponds to type of local features descriptor (like 2 for color-based descriptor), an integer that corresponds to # of clusters (like 500 for k-mean step). These variables are got from the user from 4 different entry points.

```
promptDataFileName = 'Text file listing a set of file
names (files.txt): ';
dataFileName = input( promptDataFileName , 's' );
promptDataClassId = 'Text file listing a set of category
ids (classes.txt): ';
dataClassId = input( promptDataClassId , 's' );
promptDescriptorType = 'Choose descriptor type (Enter 1
for gradient, 2 for color, 3 for both): ';
userDescriptorType = input( promptDescriptorType );
promptCodebookSize = 'Choose codebook size (Enter 100 or
500): ';
userCodebookSize = input( promptCodebookSize );
```

Intermediate Outputs

Gradient-Based Descriptors

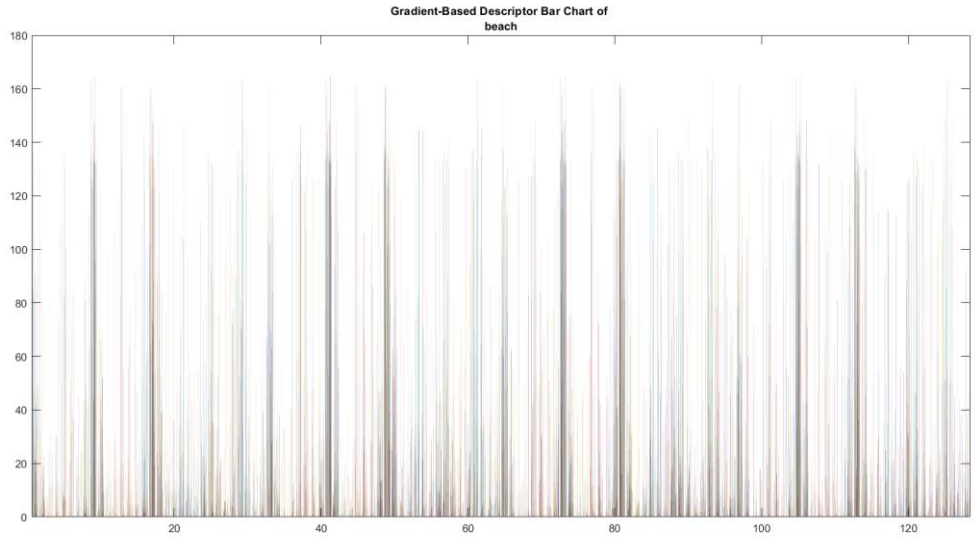

Figure 1. Gradient-based descriptor for beach where k=500

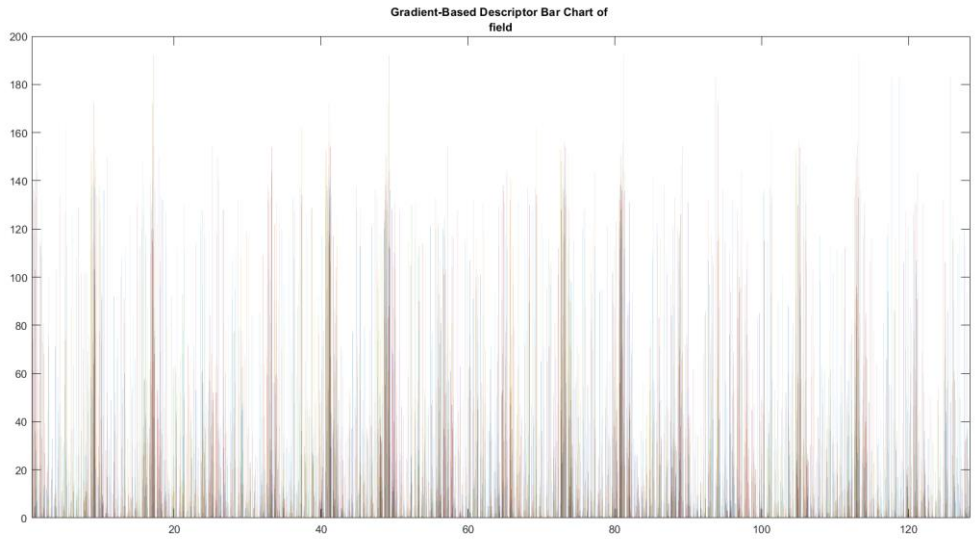

Figure 2. Gradient-based descriptor for field where k=500

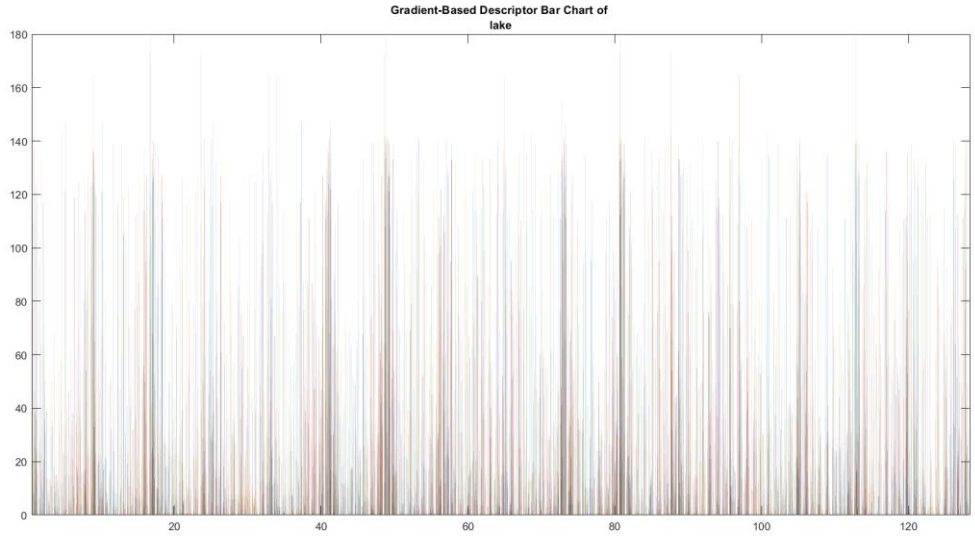

Figure 3. Gradient-based descriptor for lake where k=500

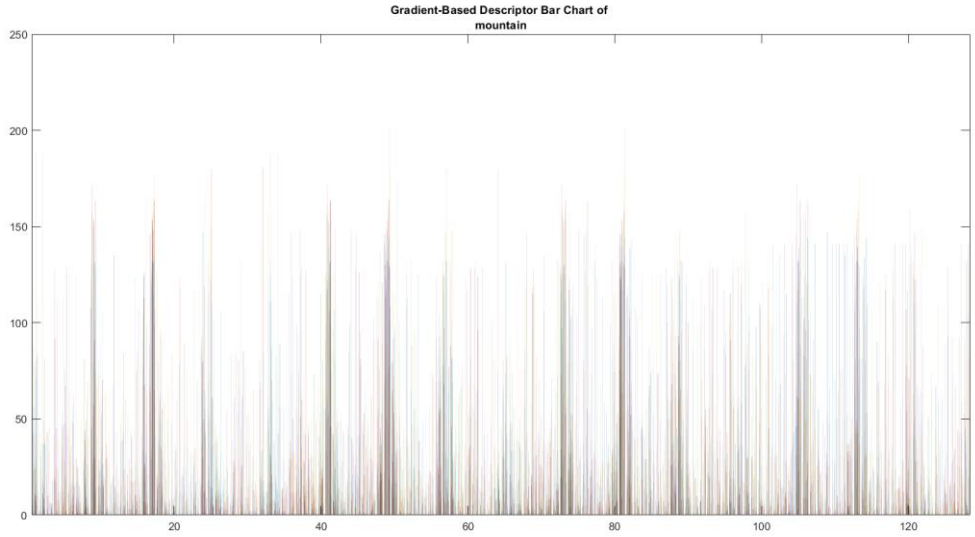

Figure 4. Gradient-based descriptor for mountain where k=500

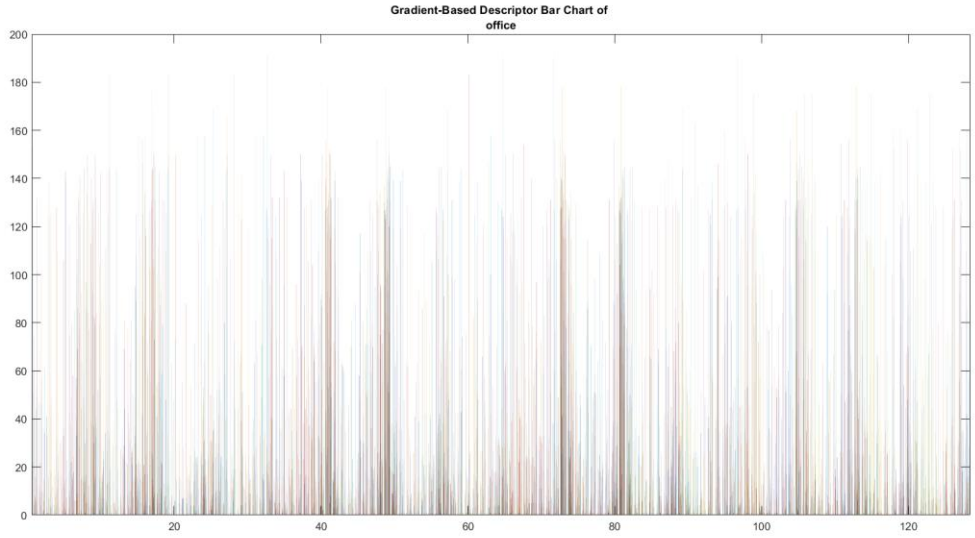

Figure 5. Gradient-based descriptor for office where k=500

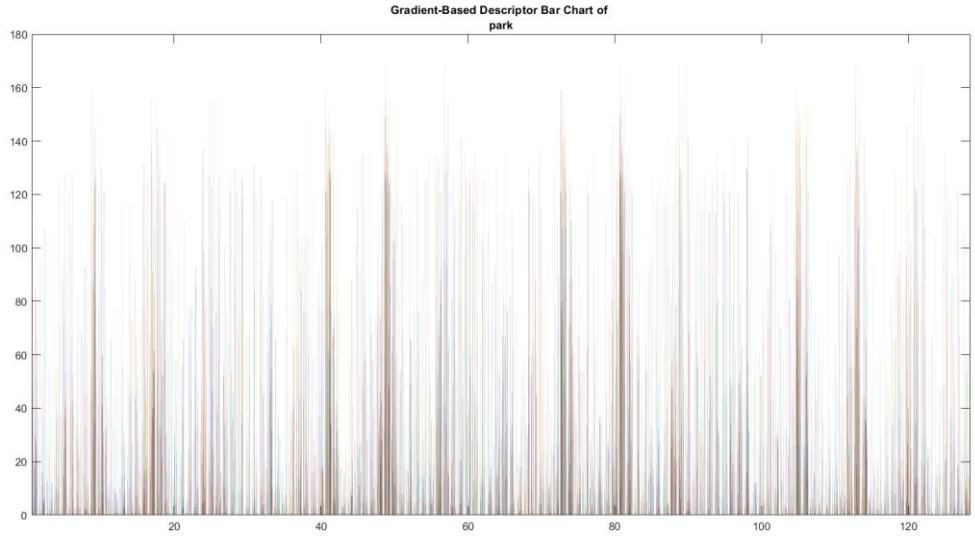

Figure 6. Gradient-based descriptor for park where k=500

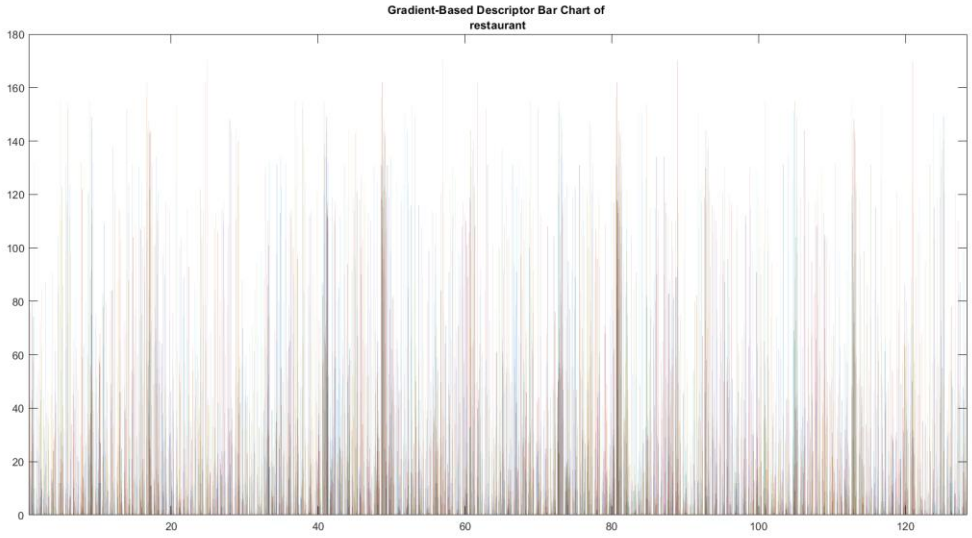

Figure 7. Gradient-based descriptor for restaurant where k=500

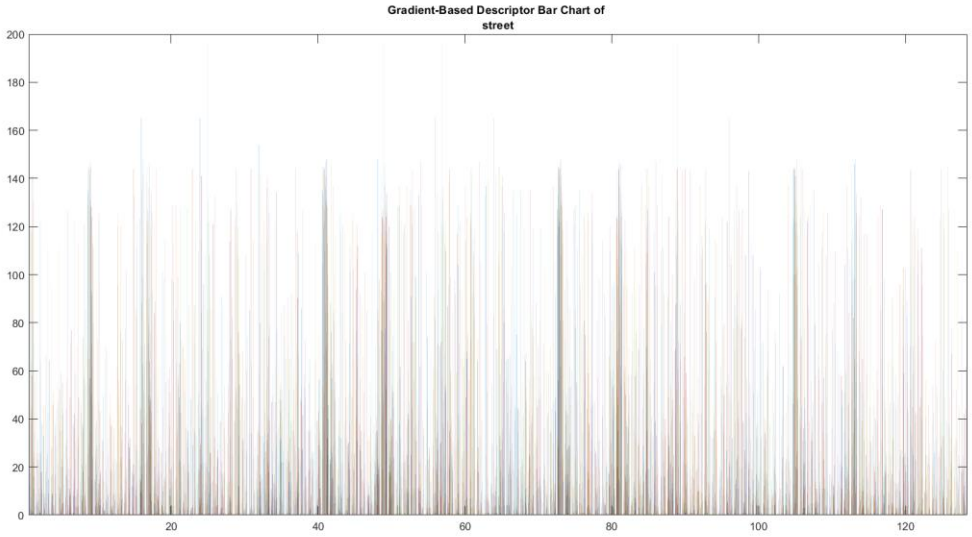

Figure 8. Gradient-based descriptor for street where k=500

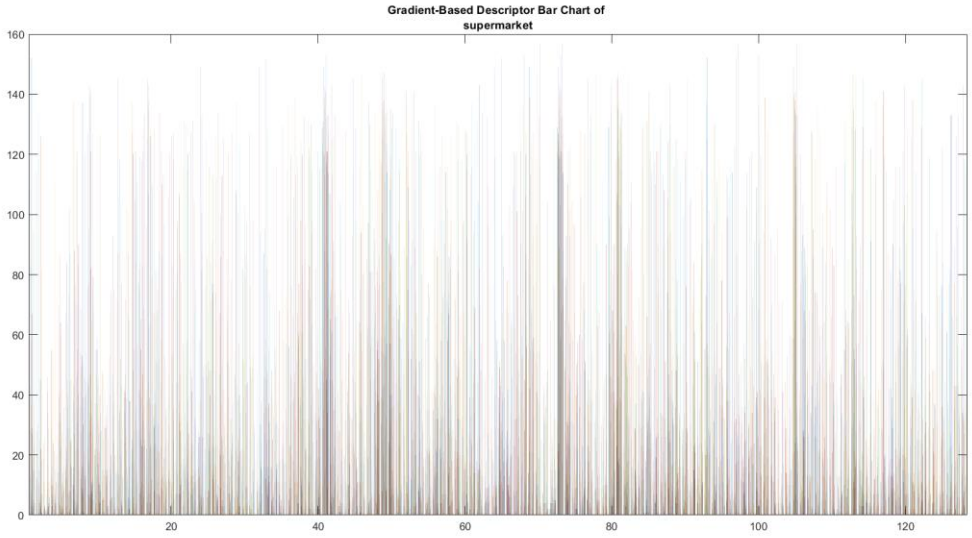

Figure 9. Gradient-based descriptor for supermarket where k=500

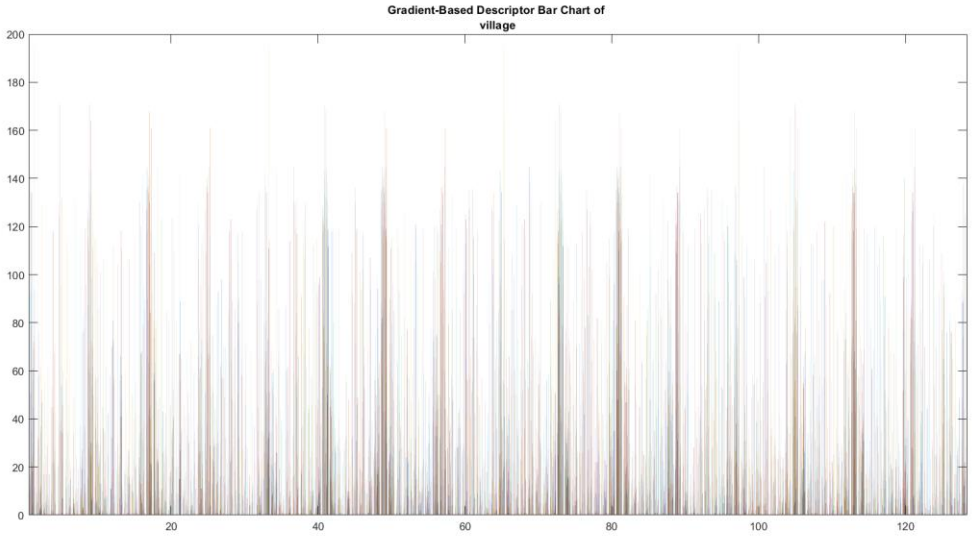

Figure 10. Gradient-based descriptor for village where k=500

Color-Based Descriptors

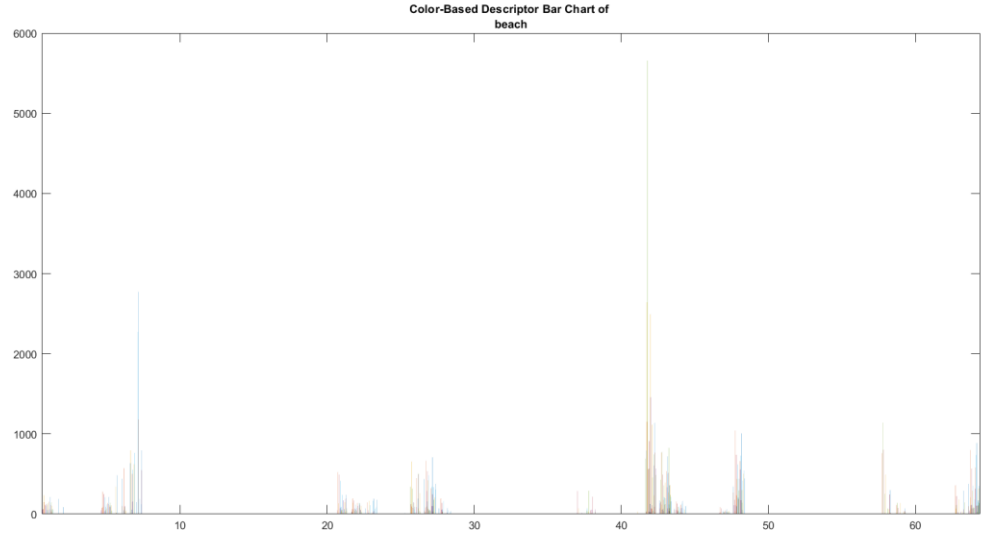

Figure 11. Color-based descriptor for beach where k=500

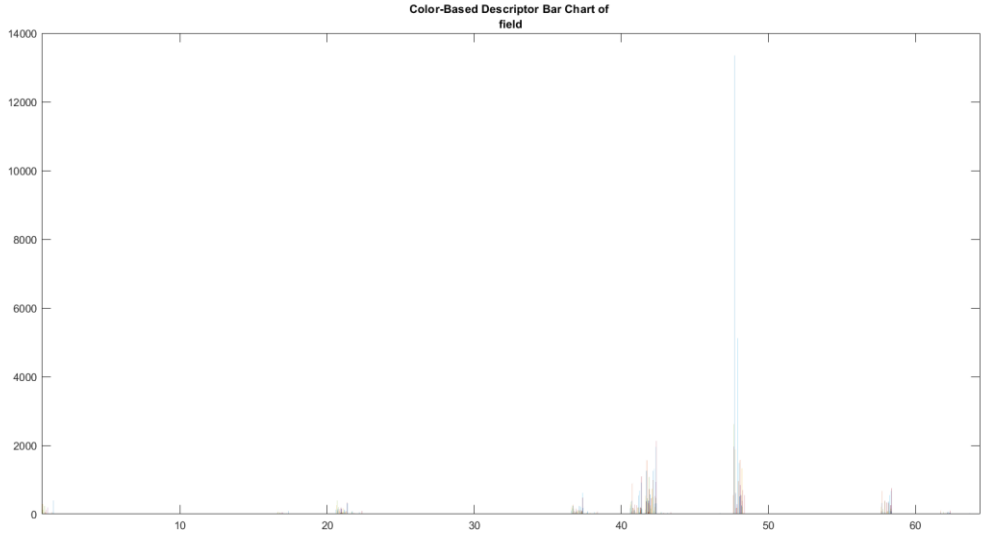

Figure 12. Color-based descriptor for field where k=500

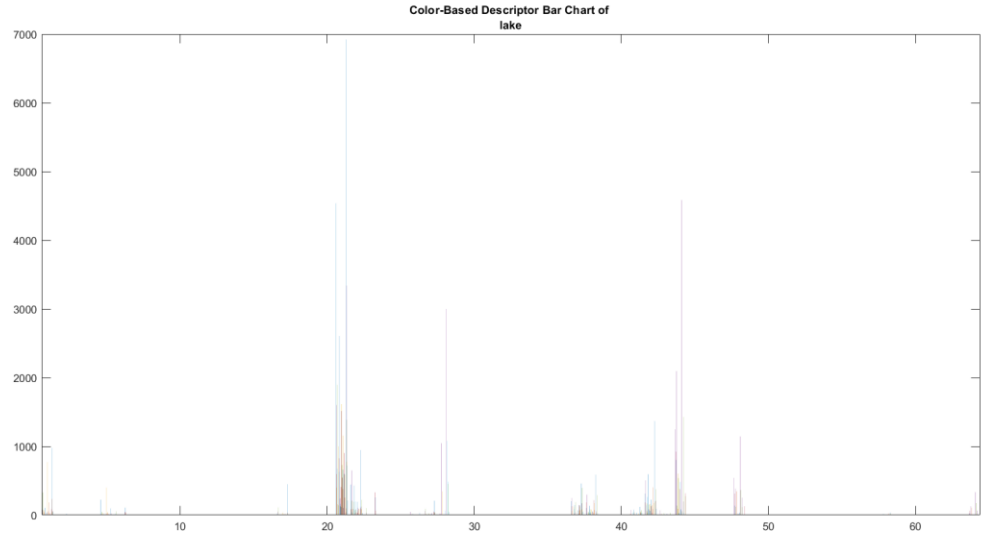

Figure 13. Color-based descriptor for lake where k=500

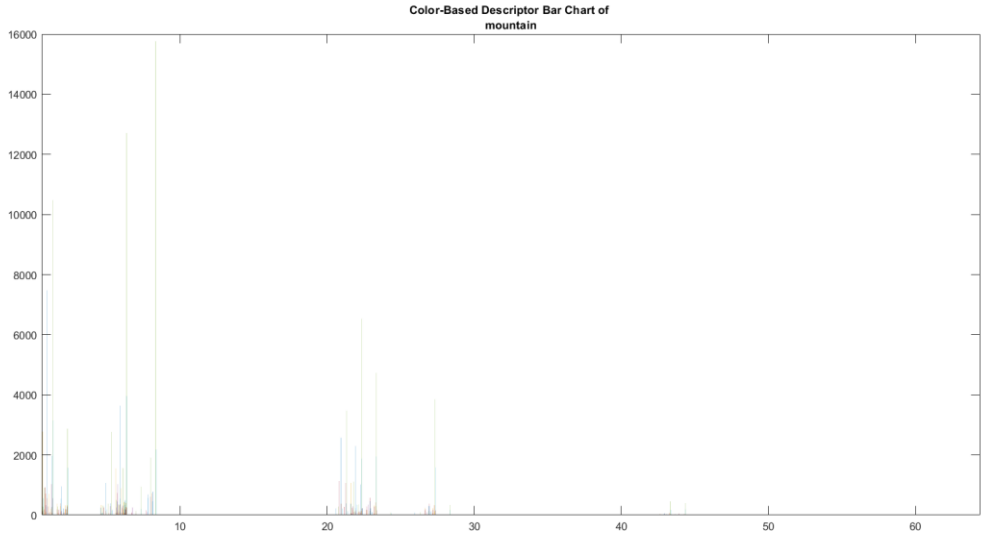

Figure 14. Color-based descriptor for mountain where k=500

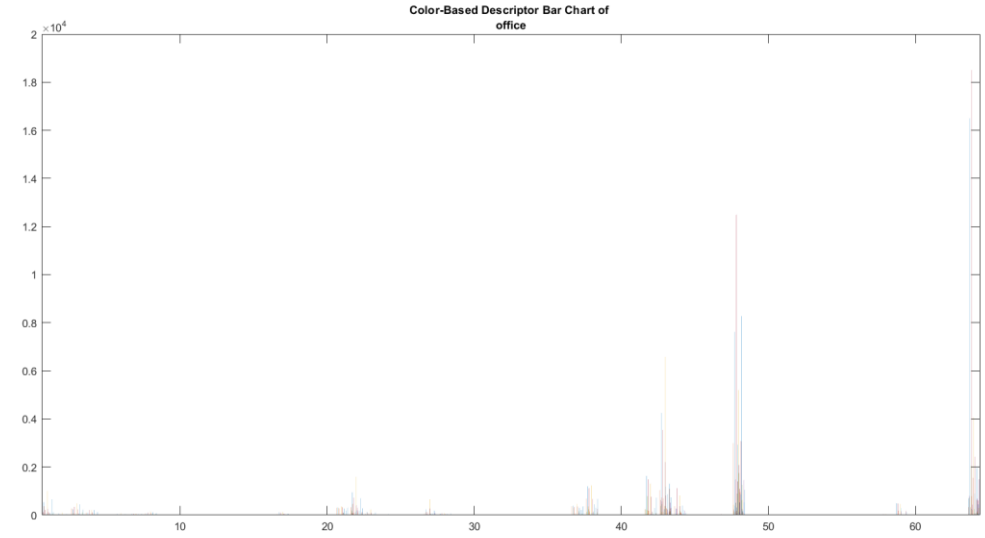

Figure 15. Color-based descriptor for office where k=500

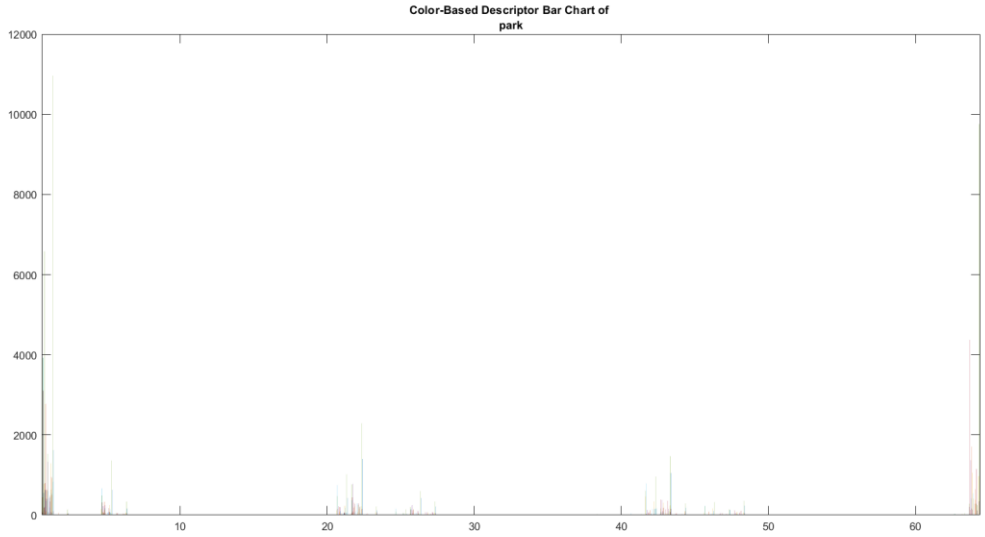

Figure 16. Color-based descriptor for park where k=500

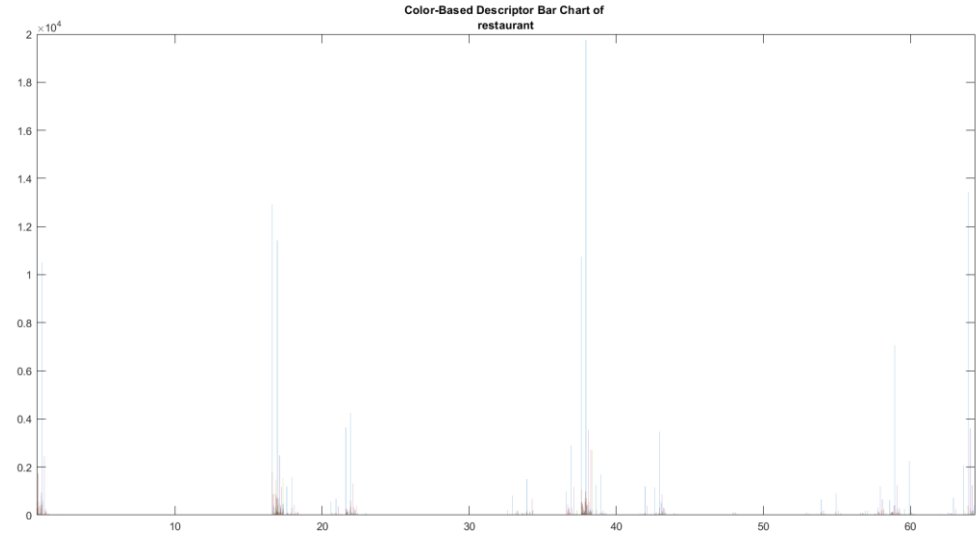

Figure 17. Color-based descriptor for restaurant where k=500

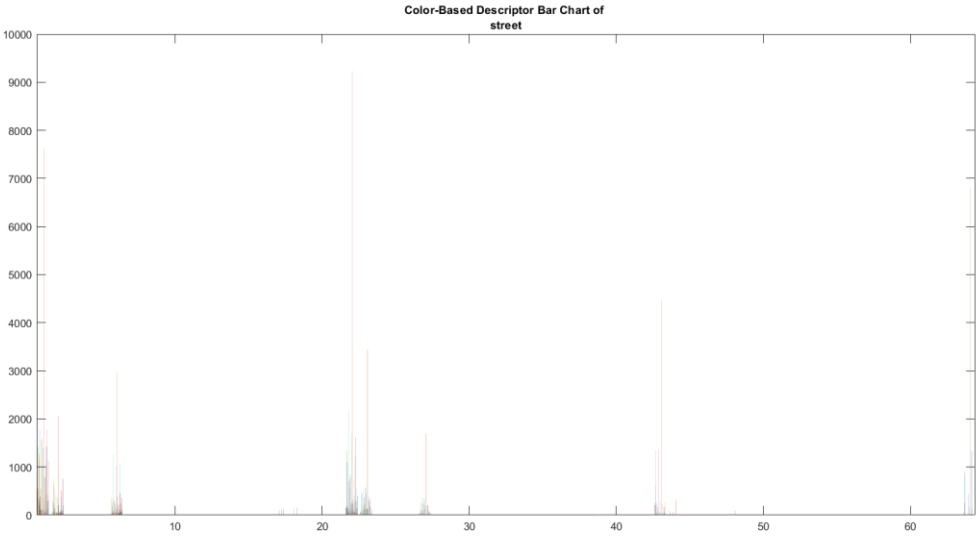

Figure 18. Color-based descriptor for street where k=500

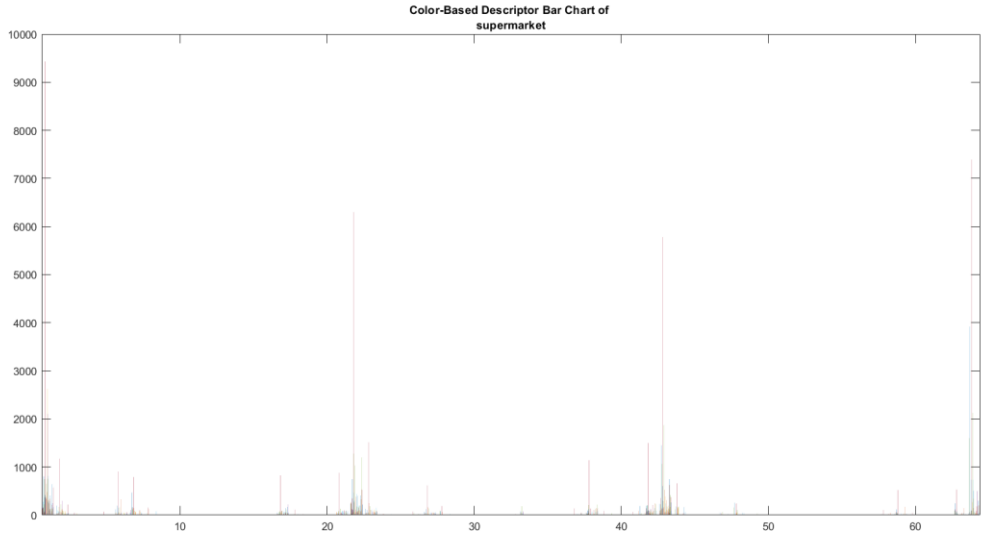

Figure 19. Color-based descriptor for supermarket where k=500

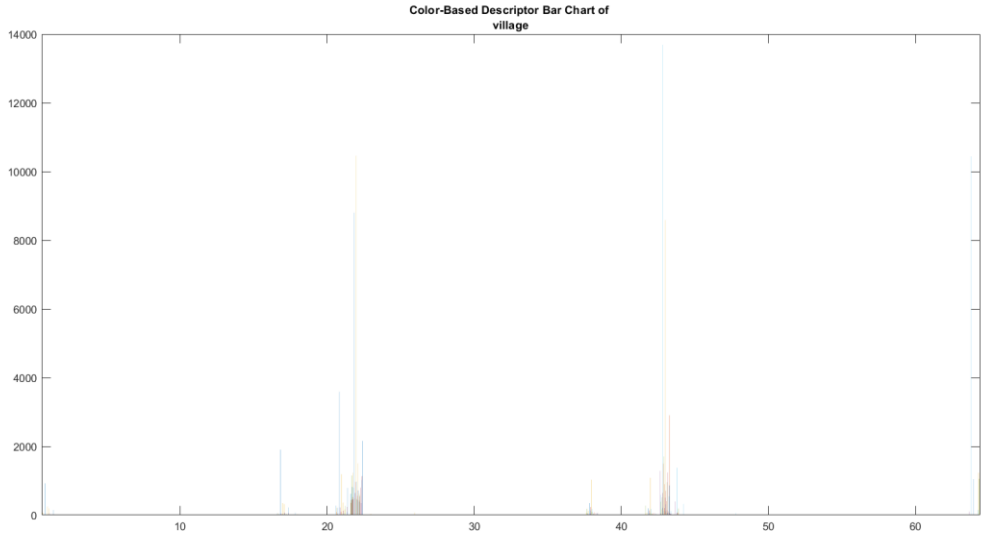

Figure 20. Color-based descriptor for village where k=500

Mixed Descriptors

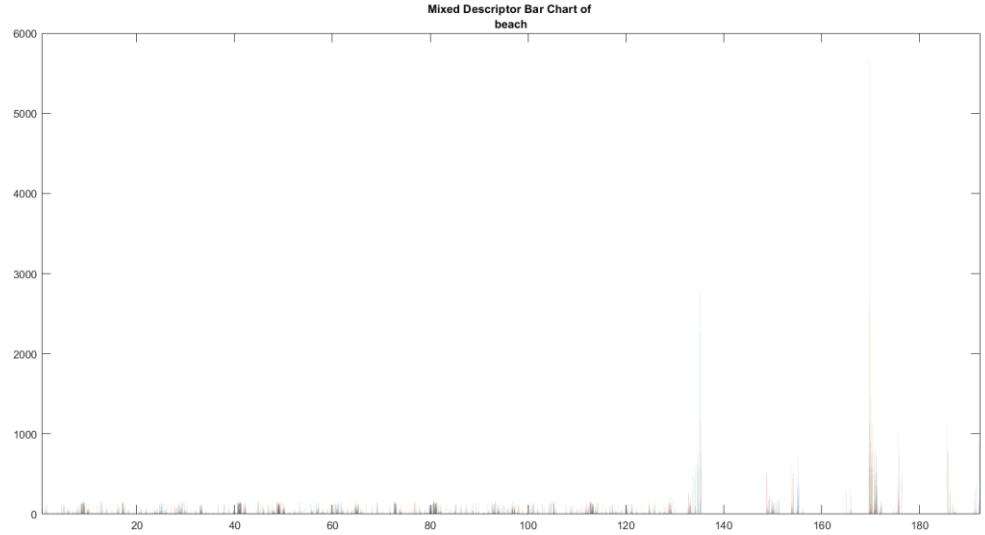

Figure 21. Mixed descriptor for beach where k=500

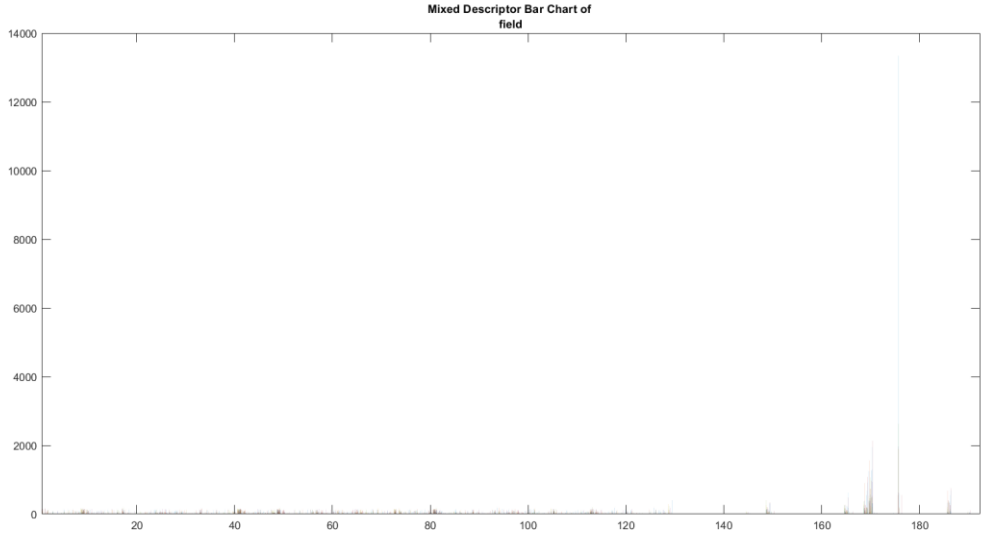

Figure 22. Mixed descriptor for field where k=500

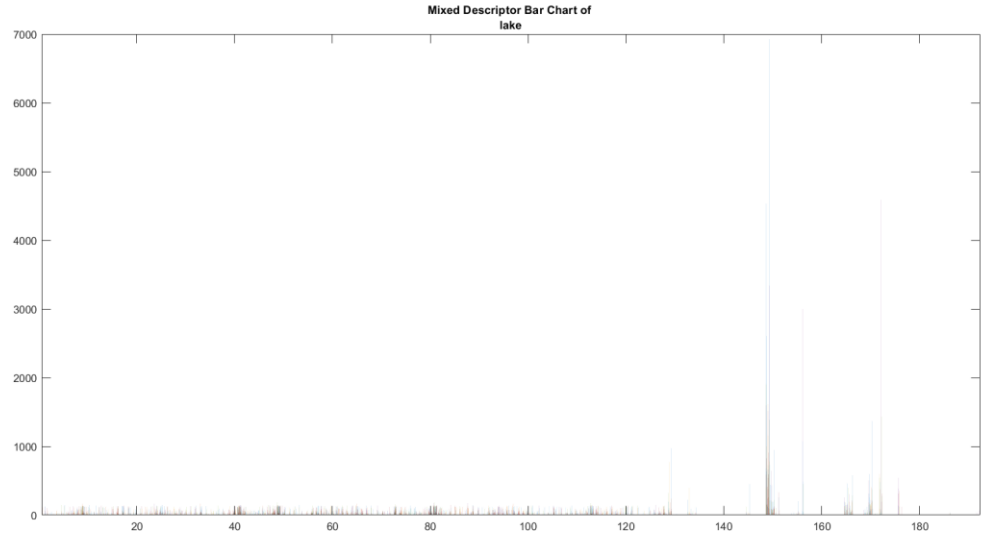

Figure 23. Mixed descriptor for lake where k=500

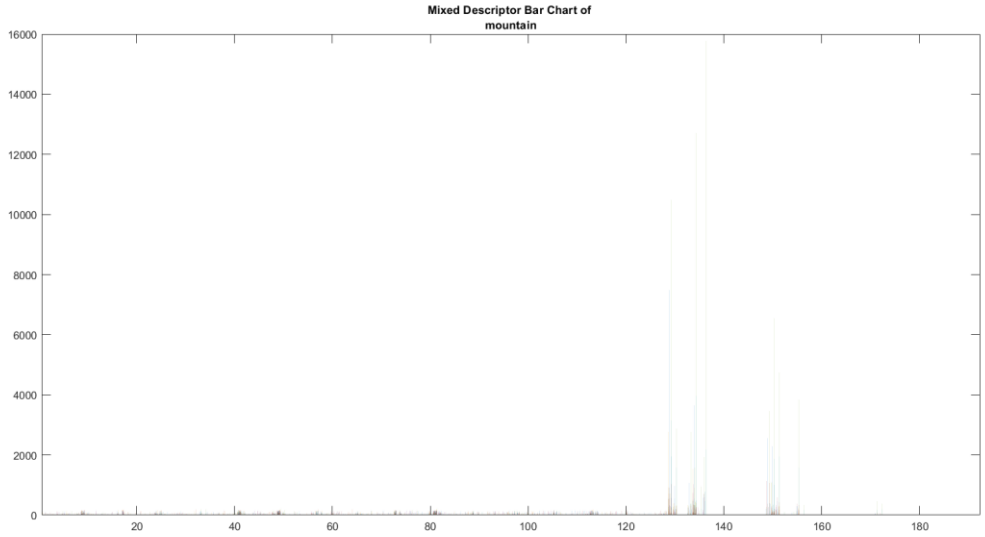

Figure 24. Mixed descriptor for mountain where k=500

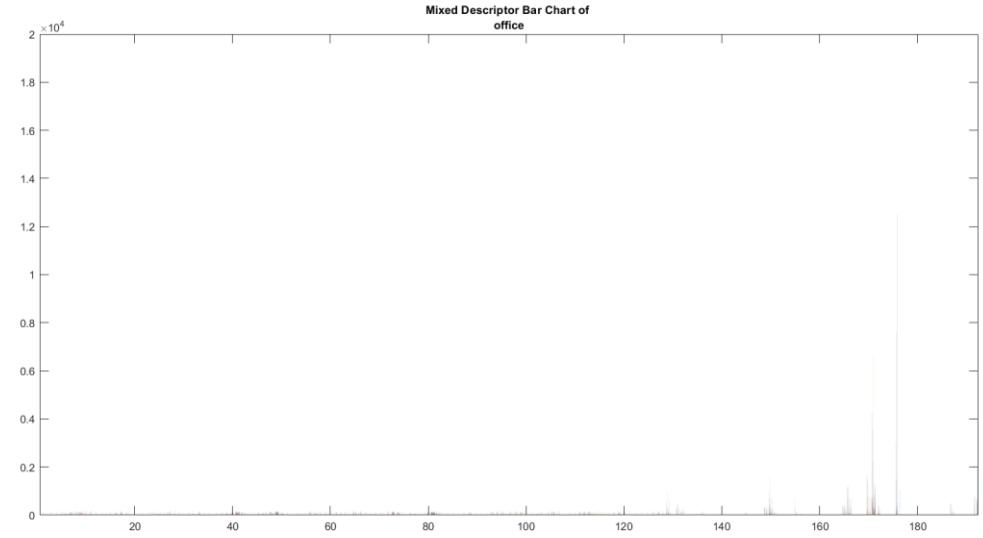

Figure 25. Mixed descriptor for office where k=500

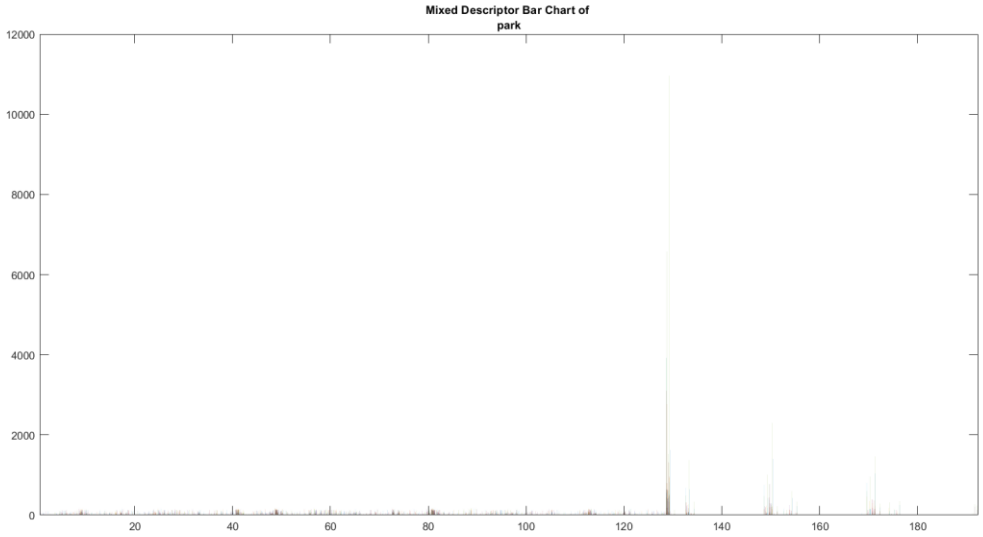

Figure 26. Mixed descriptor for park where k=500

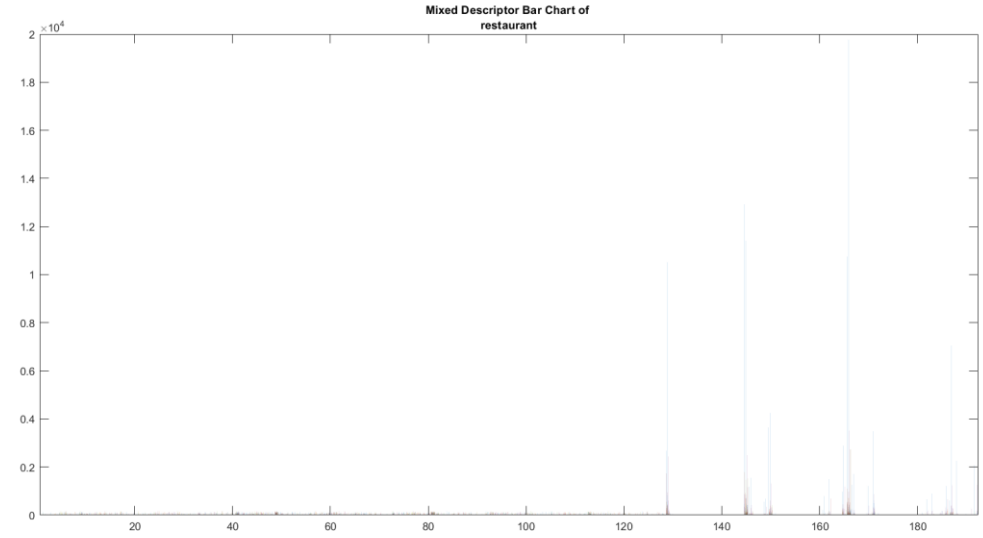

Figure 27. Mixed descriptor for restaurant where k=500

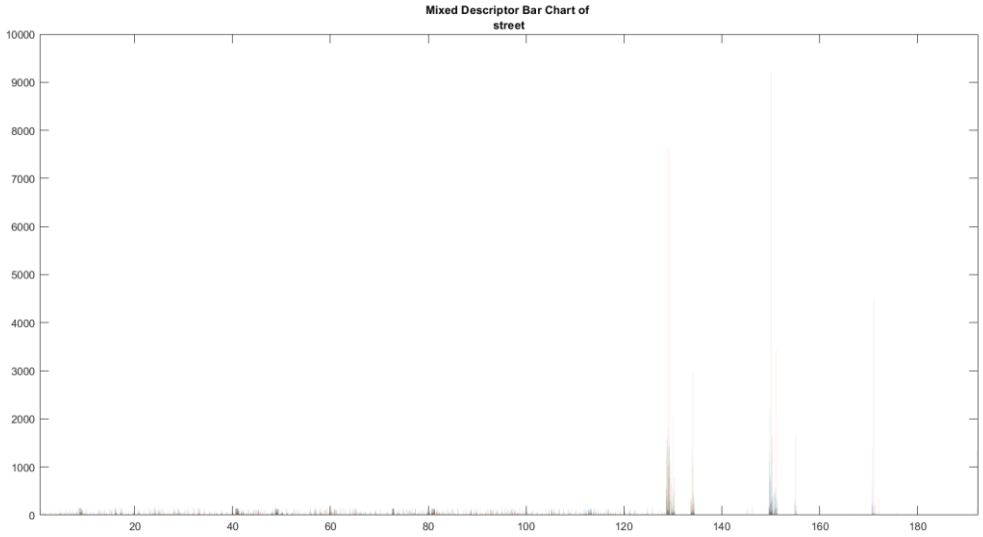

Figure 28. Mixed descriptor for street where k=500

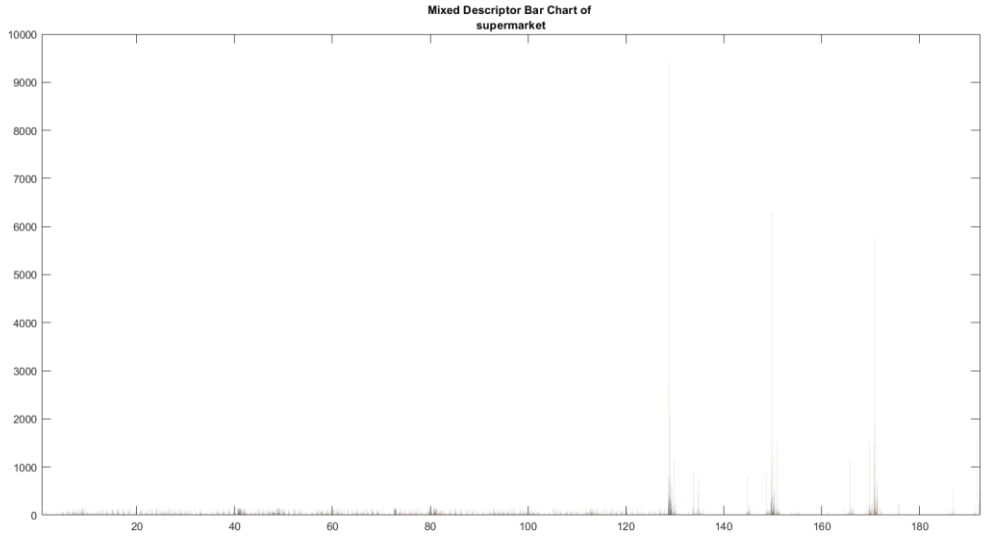

Figure 29. Mixed descriptor for supermarket where k=500

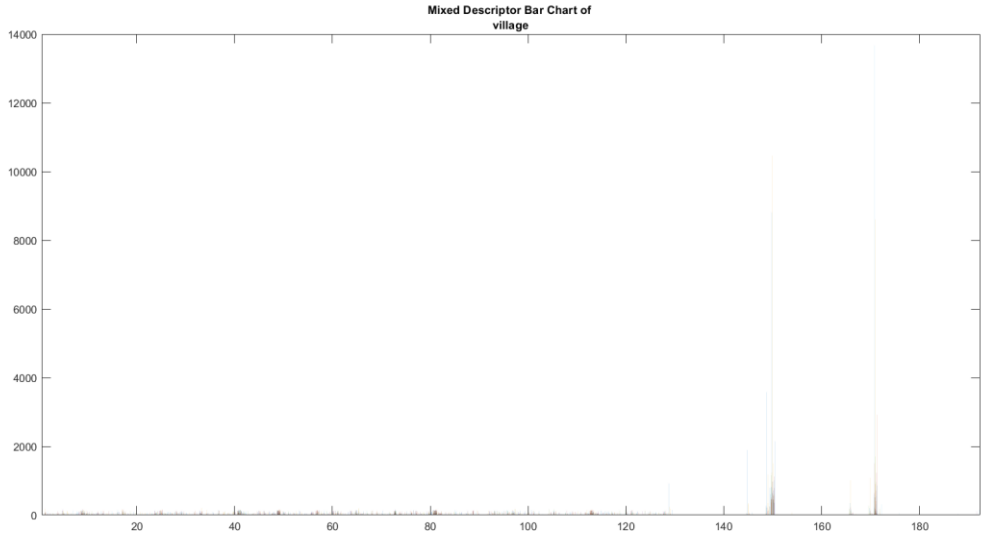

Figure 30. Mixed descriptor for village where k=500

Codebooks (Reverse)

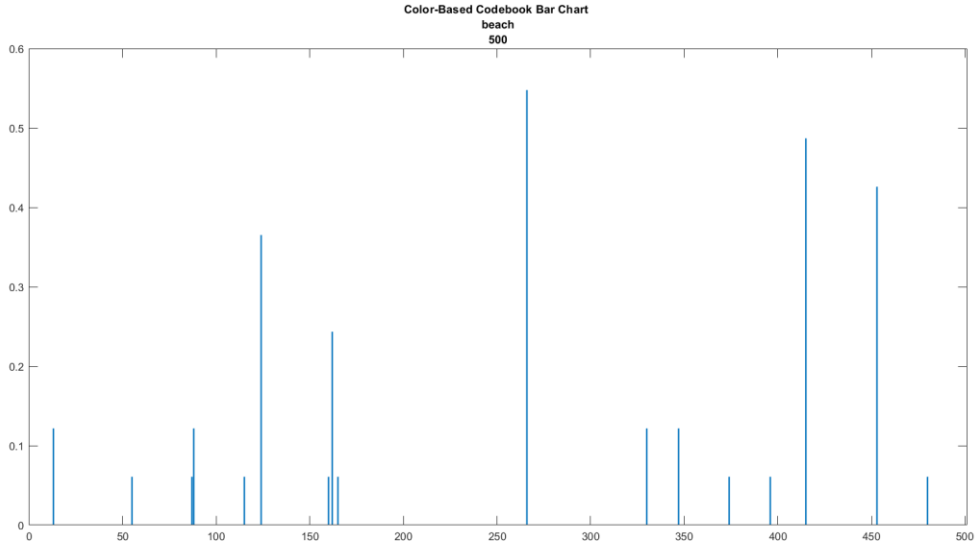

Figure 31. Codebook for beach according to color-based descriptor & k=500

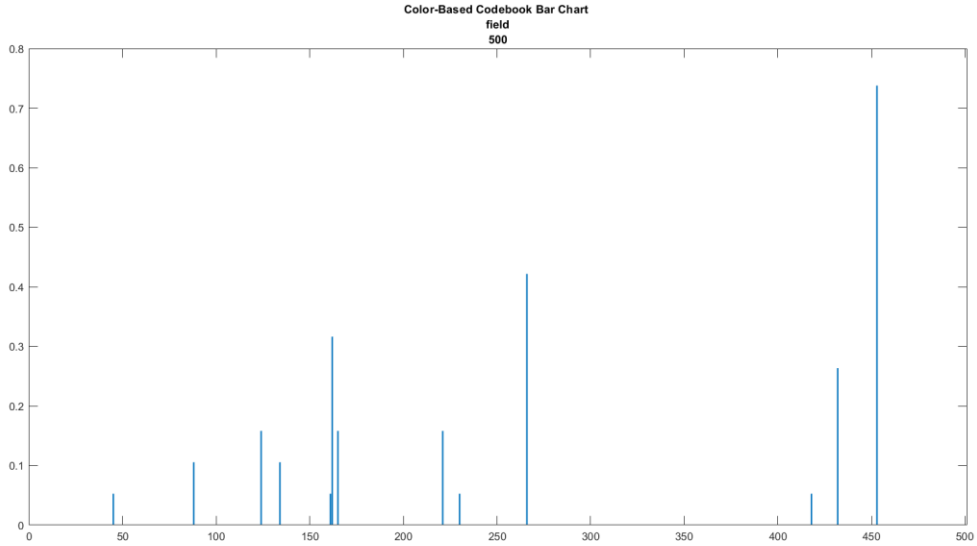

Figure 32. Codebook for field according to color-based descriptor & k=500

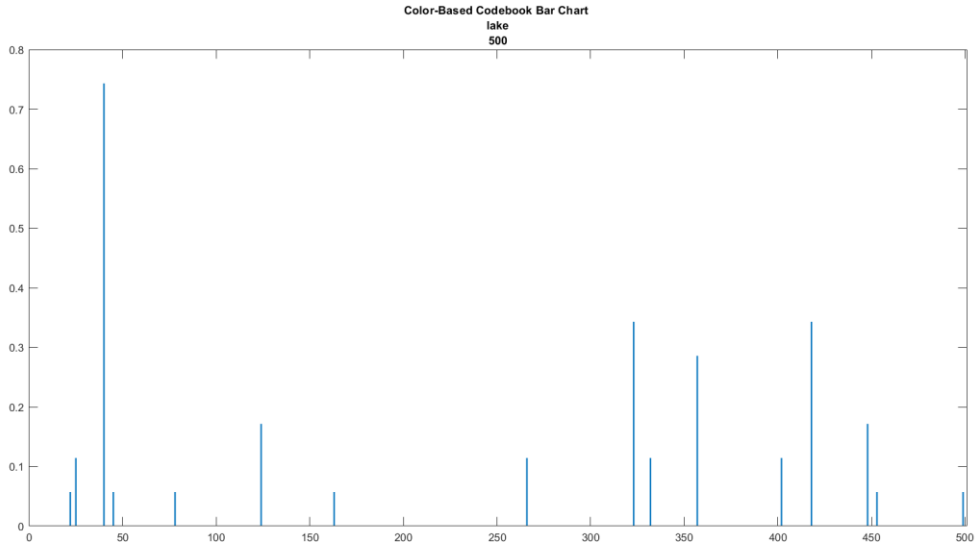

Figure 33. Codebook for lake according to color-based descriptor & k=500

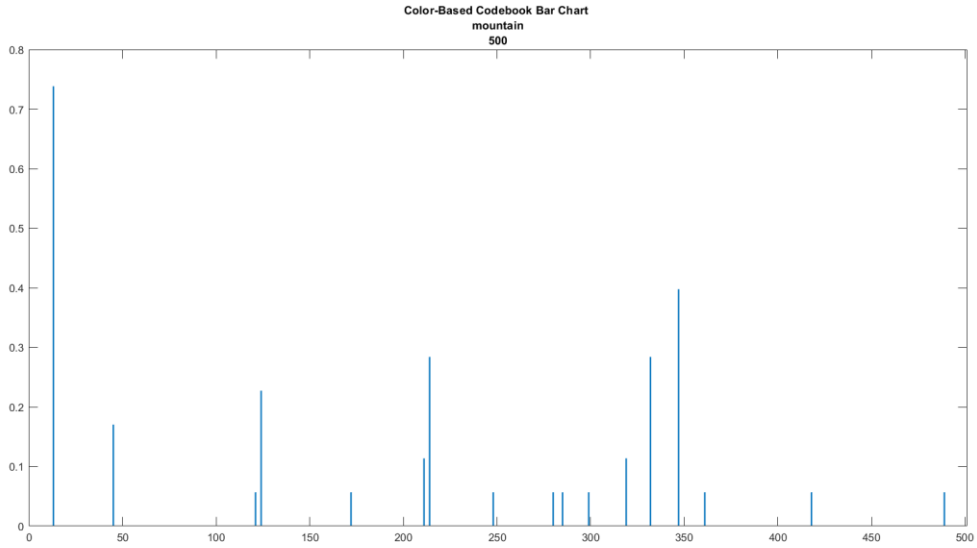

Figure 34. Codebook for mountain according to color-based descriptor & k=500

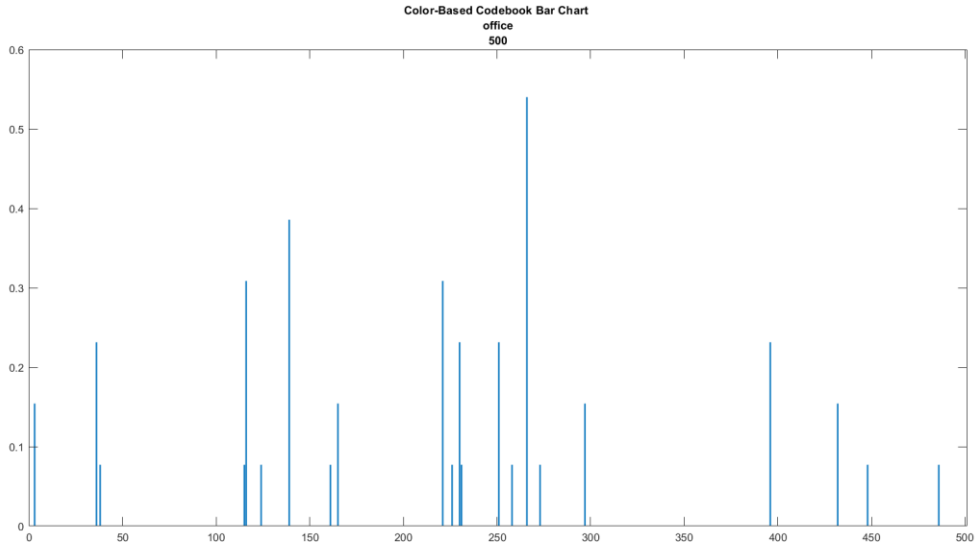

Figure 35. Codebook for office according to color-based descriptor & k=500

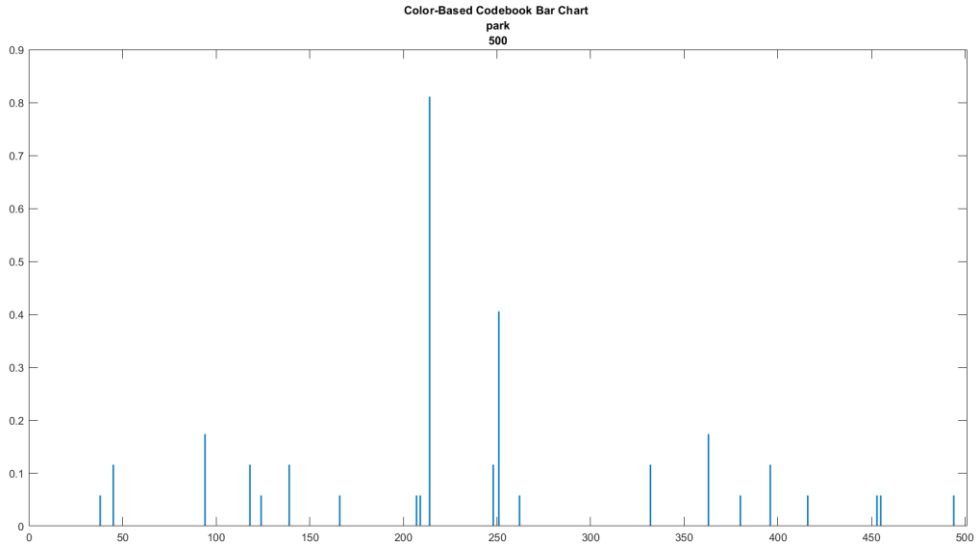

Figure 36. Codebook for park according to color-based descriptor & k=500

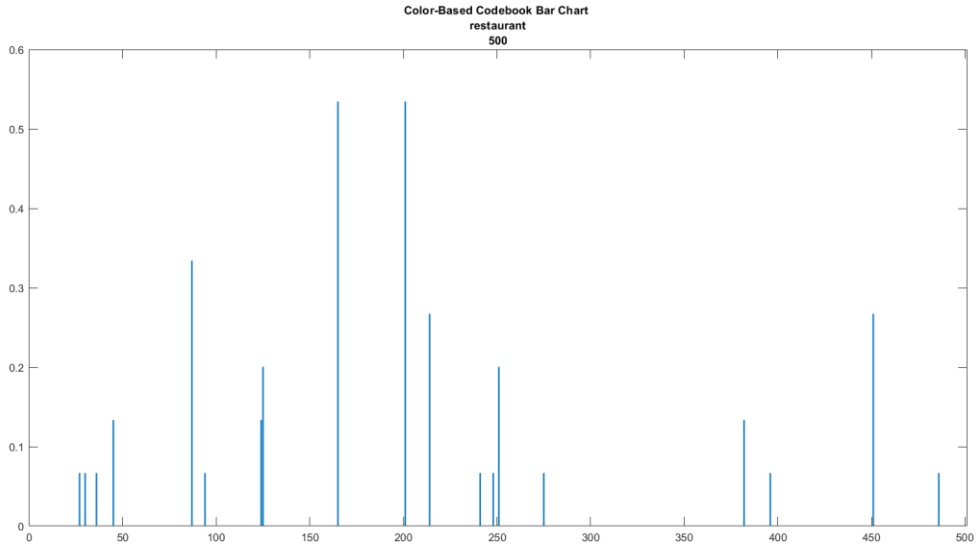

Figure 37. Codebook for restaurant according to color-based descriptor & k=500

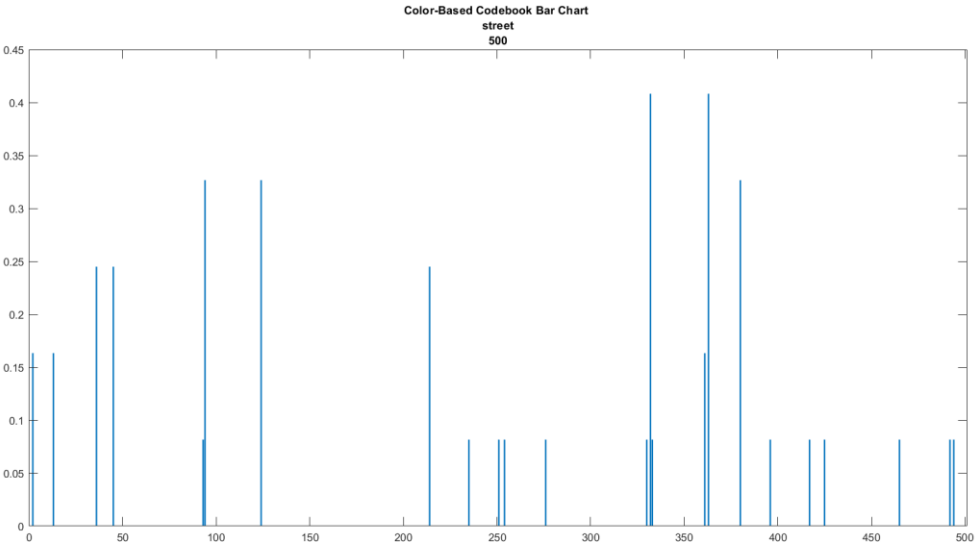

Figure 38. Codebook for street according to color-based descriptor & k=500

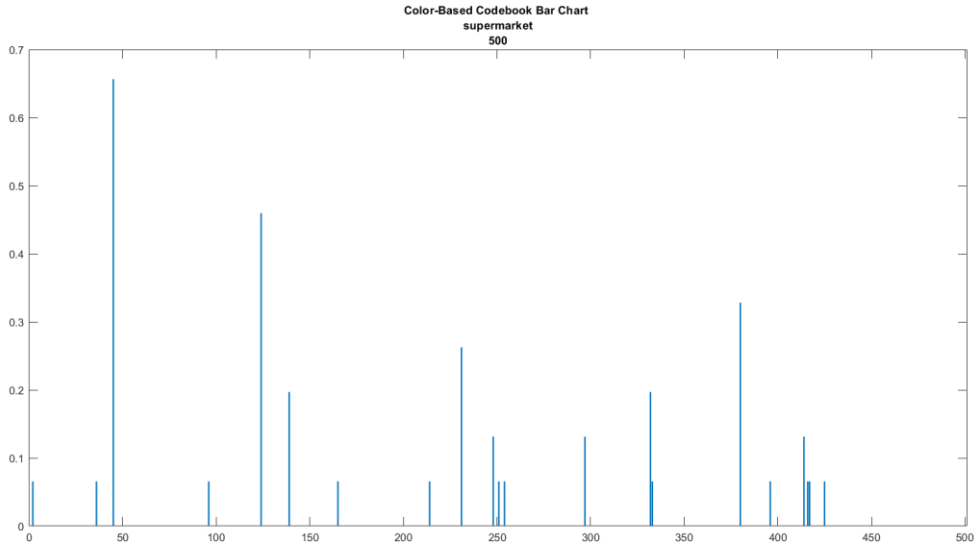

Figure 39. Codebook for supermarket according to color-based descriptor & k=500

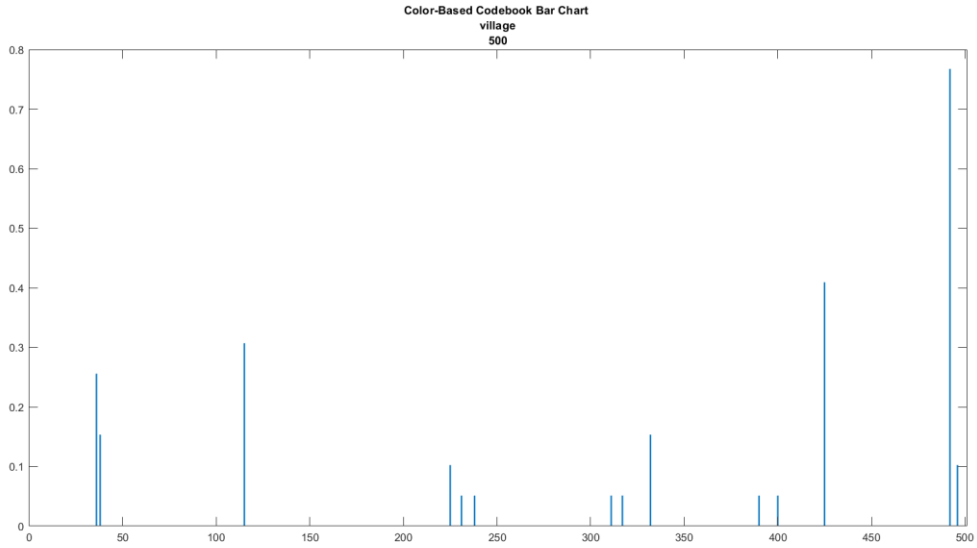

Figure 40. Codebook for village according to color-based descriptor & k=500

Final Outputs

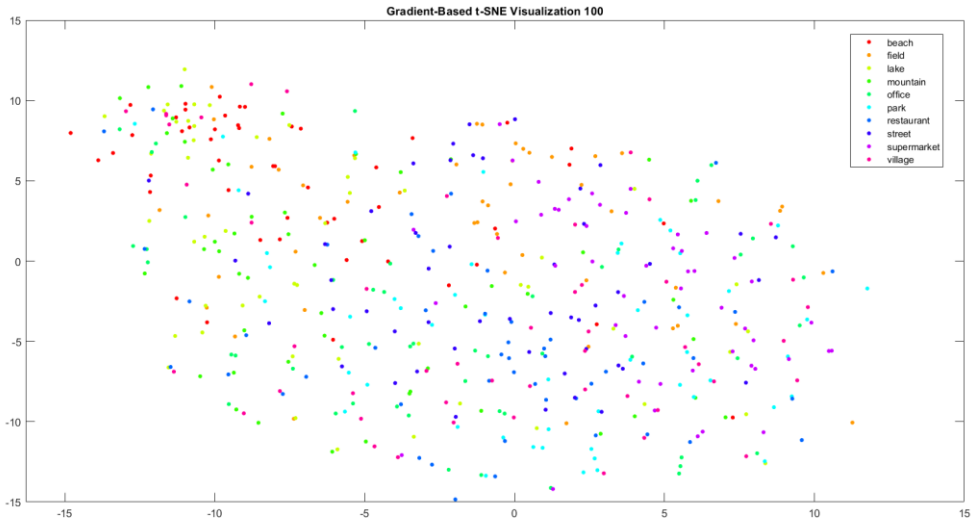

Figure 41. t-SNE results according to gradient-based descriptors and k=100

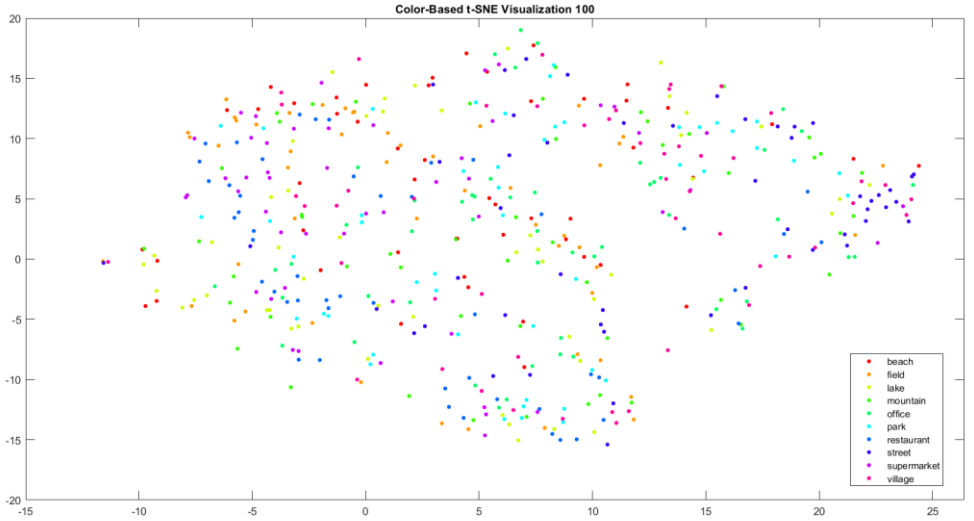

Figure 42. t-SNE results according to color-based descriptors and k=100

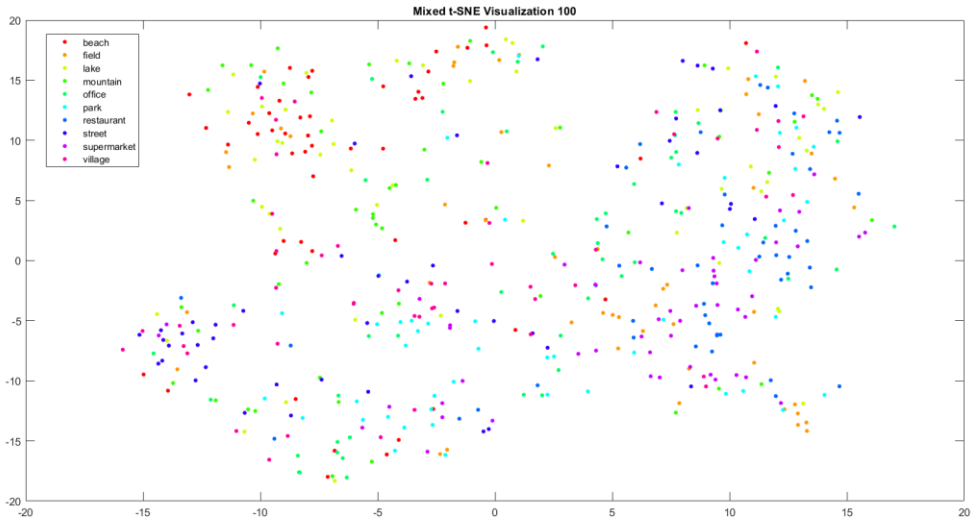

Figure 43. t-SNE results according to mixed descriptors and k=100

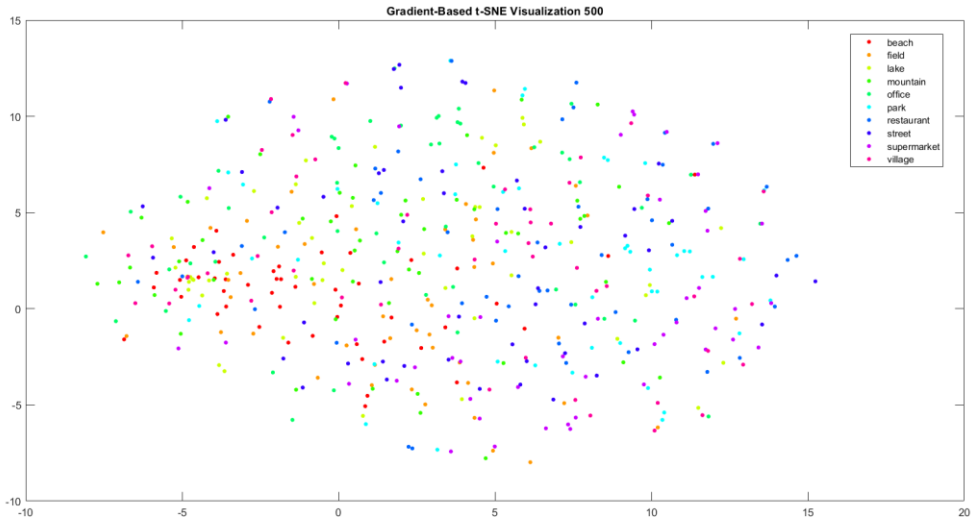

Figure 44. t-SNE results according to gradient-based descriptors and k=500

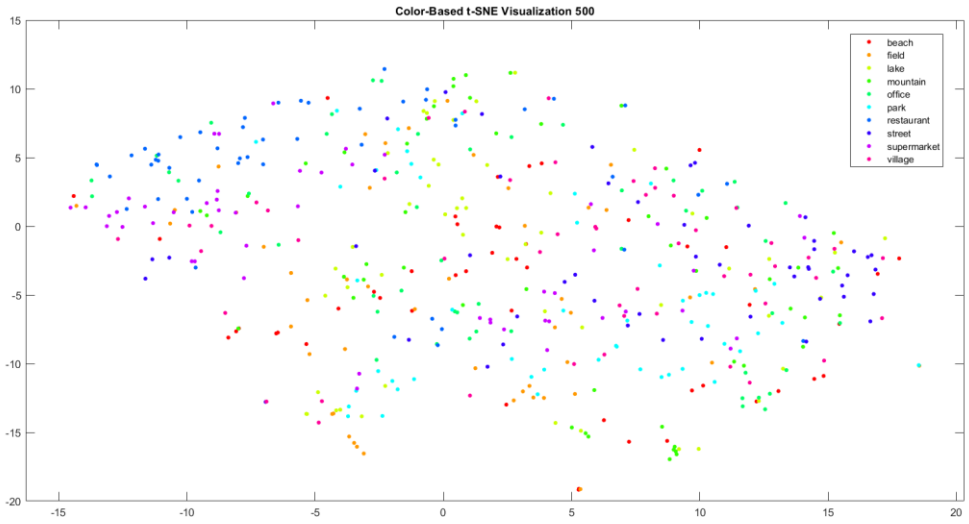

Figure 45. t-SNE results according to color-based descriptors and k=500

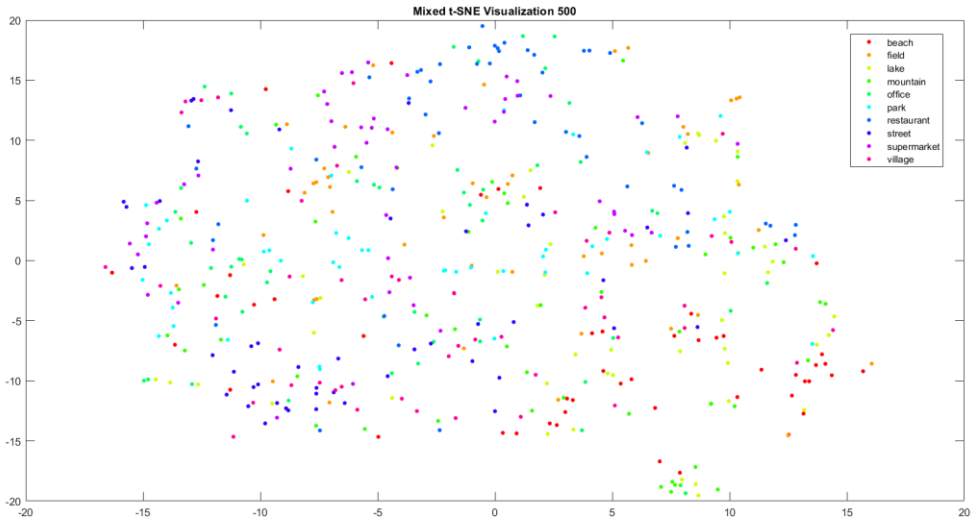

Figure 46. t-SNE results according to mixed descriptors and k=500

Discussion

The hardest step of the implementation was to calculate color-based descriptors since I did it without using a MATLAB function. I made approximations related to the pixels, and did not consider if a pixel's center or most of its area is in the square-region. If I did not make approximations, it would become harder to determine those pixels. Another issue is that I decreased the number of interest points that I consider for each image to 50 because of high execution time.

In general, it is easier to discriminate between categories that belong to the nature and locations like restaurant, supermarket, etc. by looking color-based and mixed descriptors. However, previous t-SNE plots are not clear since each of them show 10*50=500 points.

I used color-based descriptors in general because it is easier to make comparison in terms of color features. I realized that results of gradient-based descriptors are not so meaningful. According to

following 2 figures, it looks like points are distributed randomly. I guess, the results that use mixed descriptors may be worse than the ones that use color-based descriptors since they also consider gradient-based descriptors.

Since plots that show 50 points for each category are confusing, for the sake of clear comparison, I chose 3 categories where beach and lake are similar whereas restaurant is much different from others.

For a range of values of k, results are fine. However, when I decrease value of k too much, the points on the plot gets distributed. For instance, for k=500 and color-based descriptors, the t-SNE result is meaningful. When k becomes 100, the points correspond to the restaurant category gets distributed and it becomes harder to interpret the plot. When I set k to 25000 that is the number of total interests, 2 similar categories are collected in the center.

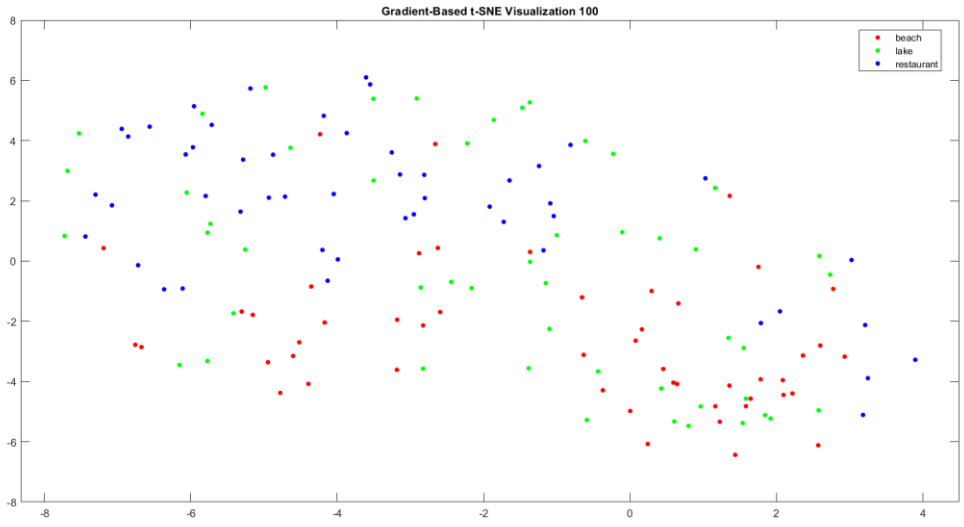

Figure 47. Final Result for 3 categories according to k=100 & gradient-based descriptors

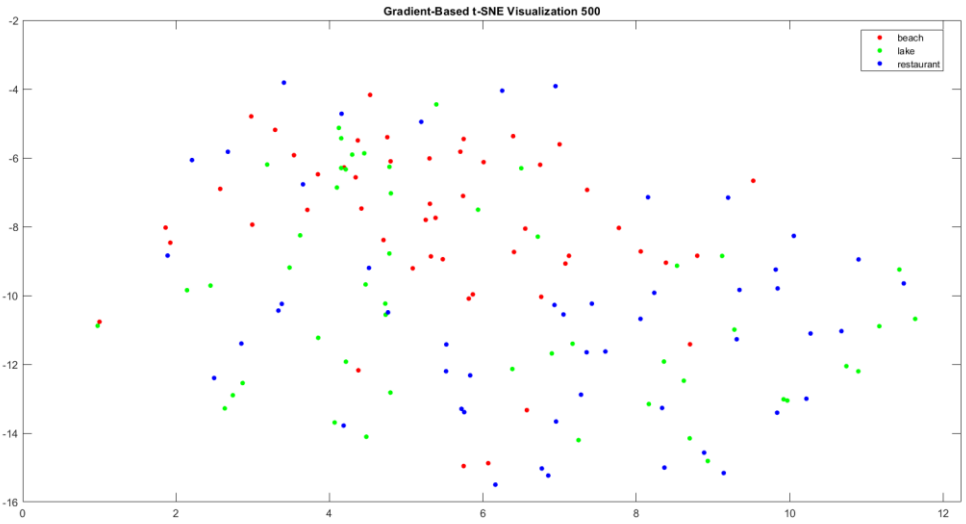

Figure 48. Final Result for 3 categories according to k=500 & gradient-based descriptors

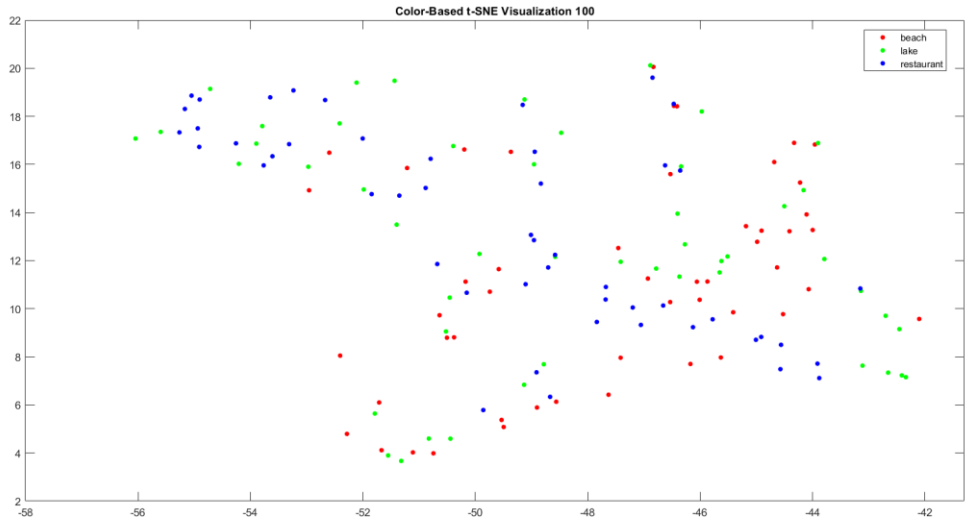

Figure 49. Final Result for 3 categories according to k=100 & color-based descriptors

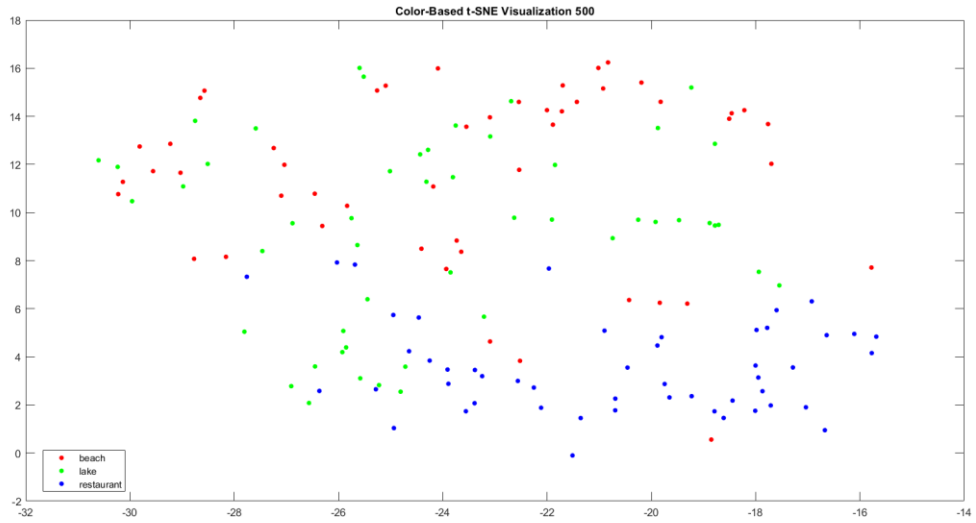

Figure 50. Final Result for 3 categories according to k=500 & color-based descriptors

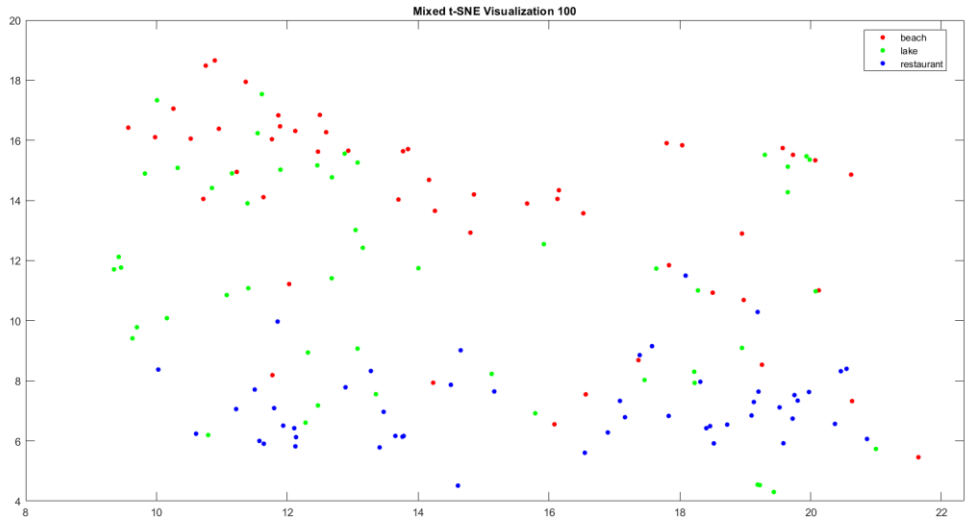

Figure 51. Final Result for 3 categories according to k=100 & mixed descriptors

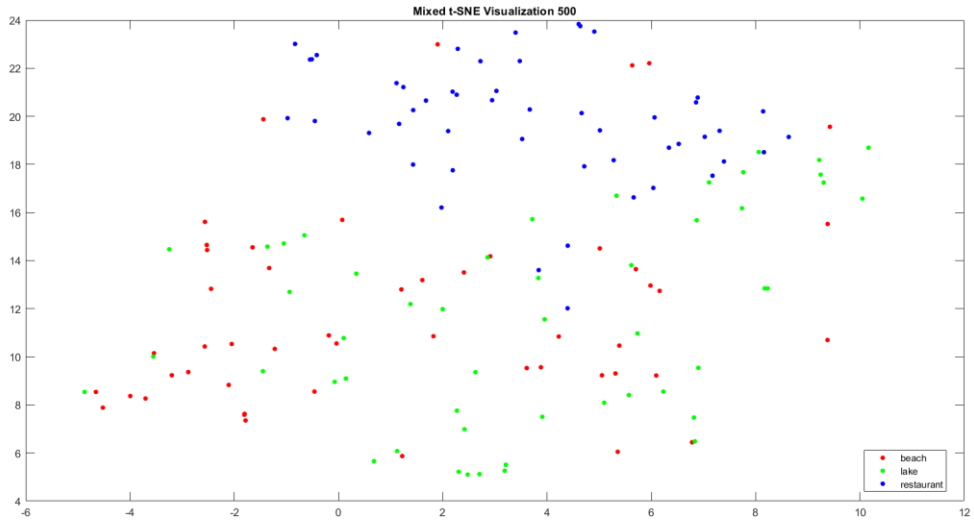

Figure 52. Final Result for 3 categories according to k=500 & mixed descriptors

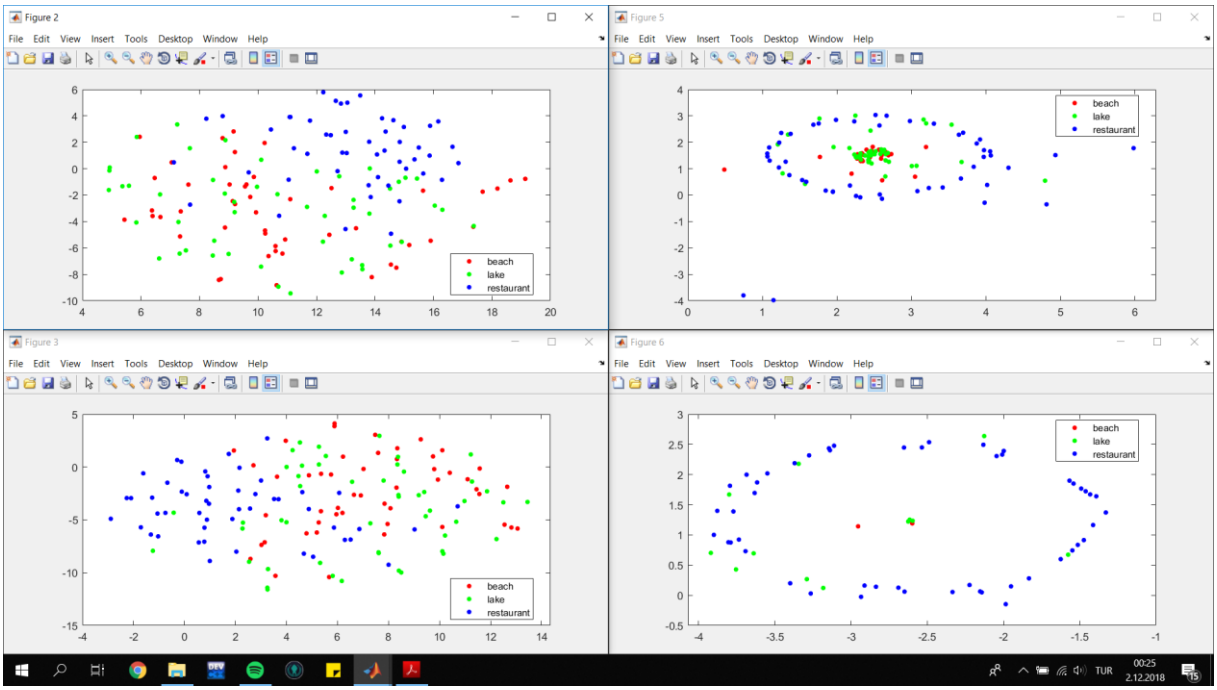

Figure 53. Final Result according to k=10000, 25000 and color-based, mixed descriptors