CENG 483

Introduction to Computer Vision

Fall 2021-2022

Take Home Exam 1

Instance Recognition with Color Histograms

Student ID: 2098705

Please fill in the sections below only with the requested information. If you have additional things you want to mention, you can use the last section. For all of the configurations make sure that your quantization interval is divisible by 256 in order to obtain equal bins.

1 3D Color Histogram

In this histogram, I used 4 different intervals which are 16, 8, 4, 2.In Query 1, images are more blur and resolution is lower but generally color distribution in the image are very similar to samples.We can see that at interval 2, top accuracy is a little bit lower from other intervals.We can conclude that in this observation, we should choose more detailed interval so that it can be obtained more information about the image.In Query 2, images are the same about clarity and resolution but some rotation operations were applied.With 3D color histogram, I obtained top accuracies as 1 at all intervals.Because 3D color histogram gives us color distribution on the all image, we detected all the images in the query with their corresponding samples due to no difference on color distribution.They were just rotated, no color intensity has changed in any pixels.In Query 3, no resolution or rotation were applied but in some images, colors on the background or on the object which is a bird, has totally changed.The color distribution in these images are totally different from the original ones.Therefore, this histogram gives us much lower top accuracies in Query 3 than other queries.

1.1 Query 1

Interval 16:

Number of correctly retrieved images: 200
Number of query images: 200
top-1 accuracy: 1.0

Interval 8:

Number of correctly retrieved images: 200
Number of query images: 200
top-1 accuracy: 1.0

Interval 4:

Number of correctly retrieved images: 200
Number of query images: 200
top-1 accuracy: 1.0

Interval 2:

Number of correctly retrieved images: 187
Number of query images: 200
top-1 accuracy: 0.935

1.2 Query 2

Interval 16:

Number of correctly retrieved images: 200
Number of query images: 200
top-1 accuracy: 1.0

Interval 8:

Number of correctly retrieved images: 200
Number of query images: 200
top-1 accuracy: 1.0

Interval 4:

Number of correctly retrieved images: 200
Number of query images: 200
top-1 accuracy: 1.0

Interval 2:

Number of correctly retrieved images: 200
Number of query images: 200
top-1 accuracy: 1.0

1.3 Query 3

Interval 16:

Number of correctly retrieved images: 22
Number of query images: 200
top-1 accuracy: 0.11

Interval 8:

Number of correctly retrieved images: 22

Number of query images: 200
top-1 accuracy: 0.11

Interval 4:

Number of correctly retrieved images: 24
Number of query images: 200
top-1 accuracy: 0.12

Interval 2:

Number of correctly retrieved images: 18
Number of query images: 200
top-1 accuracy: 0.09

2 Per Channel Color histogram

In this histogram, I used 5 different intervals which are 256, 128, 64, 32 and 16.In Query 1, we can observe that if we use same number of bins in Per Channel Color Histogram with 3D Color Histogram, we can detect less images in Per Channel Color Histogram.We can infer that color distribution in the Query 1 is more proportional but difference in the intensity values of R, G, B channels of a pixel is more problematic for Per Channel Color histogram due to applied filter to sample images.In Query 2, we say that no color distributions or pixel intensity has changed.Because Per Channel Color Histogram measures R, G, B intensity at each pixels on the whole image without dividing images into grids, we can expect that rotated images have the exact same intensity values with the samples.Thus, histogram detects all images in the Query 2 with the original ones.In Query 3, because in some images all the color distribution and intensity values has changed, this histogram is pretty ineffective to receive correct images.At interval 32, we obtained maximum top accuracy but then it decreased with lowering the interval.

2.1 Query 1

Interval 256:

Number of correctly retrieved images: 196
Number of query images: 200
top-1 accuracy: 0.98

Interval 128:

Number of correctly retrieved images: 196
Number of query images: 200
top-1 accuracy: 0.98

Interval 64:

Number of correctly retrieved images: 196
Number of query images: 200
top-1 accuracy: 0.98

Interval 32:

Number of correctly retrieved images: 196
Number of query images: 200
top-1 accuracy: 0.98

Interval 16:

Number of correctly retrieved images: 196
Number of query images: 200
top-1 accuracy: 0.98

2.2 Query 2

Interval 256:

Number of correctly retrieved images: 200
Number of query images: 200
top-1 accuracy: 1.0

Interval 128:

Number of correctly retrieved images: 200
Number of query images: 200
top-1 accuracy: 1.0

Interval 64:

Number of correctly retrieved images: 200
Number of query images: 200
top-1 accuracy: 1.0

Interval 32:

Number of correctly retrieved images: 200
Number of query images: 200
top-1 accuracy: 1.0

Interval 16:

Number of correctly retrieved images: 200
Number of query images: 200
top-1 accuracy: 1.0

2.3 Query 3

Interval 256:

Number of correctly retrieved images: 23
Number of query images: 200

top-1 accuracy: 0.115

Interval 128:

Number of correctly retrieved images: 23
Number of query images: 200
top-1 accuracy: 0.115

Interval 64:

Number of correctly retrieved images: 23
Number of query images: 200
top-1 accuracy: 0.115

Interval 32:

Number of correctly retrieved images: 25
Number of query images: 200
top-1 accuracy: 0.125

Interval 16:

Number of correctly retrieved images: 24
Number of query images: 200
top-1 accuracy: 0.12

Before starting the next section, please pick up the best configuration for two properties above and continue with them.

3 Grid Based Feature Extraction - Query set 1

Give your top-1 accuracy for all of the configurations below.

3.1 48×48 spatial grid

- 3d color histogram: 1.0
- per-channel histogram: 1.0

3.2 24×24 spatial grid

- 3d color histogram: 1.0
- per-channel histogram: 1.0

3.3 16×16 spatial grid

- 3d color histogram: 1.0
- per-channel histogram: 1.0

3.4 12×12 spatial grid

- 3d color histogram: 1.0
- per-channel histogram: 0.995

3.5 Questions

- What do you think about the cause of the difference between the results?

  There is no particularly difference between two histogram methods in this query set but we can say that if we inspect the image by dividing smaller grids, Per Channel Histogram begins to detect images in the wrong way because it becomes more distinct to detect color channel's density difference between a blurred version and normal version when grids become smaller.

- Explain the advantages/disadvantages of using grids in both types of histograms if there are any.

4 Grid Based Feature Extraction - Query set 2

Give your top-1 accuracy for all of the configurations below.

4.1 48×48 spatial grid

- 3d color histogram: 0.56
- per-channel histogram: 0.365

4.2 24×24 spatial grid

- 3d color histogram: 0.385
- per-channel histogram: 0.17

4.3 16×16 spatial grid

- 3d color histogram: 0.34
- per-channel histogram: 0.125

4.4 12×12 spatial grid

- 3d color histogram: 0.32
- per-channel histogram: 0.105

4.5 Questions

- What do you think about the cause of the difference between the results?

  In this query set, we divide sample image and this image's rotated version into grids and compare their KL divergences of histograms.Because the images in the query were rotated, we apply this comparison with different grids due to spatial grid technique so that top accuracies are much lower than without dividing.Grids do not correspond to each other due to rotation.Therefore, we tried to compute KL divergences between unlike grids.Also we can observe that while grids' dimension decreases, top accuracy decreases as well.

- Explain the advantages/disadvantages of using grids in both types of histograms if there are any.

  Spatial grid has a disadvantage in rotated images due to its nature.In rotated images, grids does not correspond to its original version or some similar version to its original.It constraints us to compare very different patches and that makes this technique inefficient with respect to other two types of histograms.

5 Grid Based Feature Extraction - Query set 3

Give your top-1 accuracy for all of the configurations below.

5.1 48×48 spatial grid

- 3d color histogram: 0.16
- per-channel histogram: 0.215

5.2 24×24 spatial grid

- 3d color histogram: 0.225
- per-channel histogram: 0.23

5.3 16×16 spatial grid

- 3d color histogram: 0.265
- per-channel histogram: 0.245

5.4 12×12 spatial grid

- 3d color histogram: 0.32
- per-channel histogram: 0.255

5.5 Questions

- What do you think about the cause of the difference between the results?

  In this query, when grid dimension decreases, accurate received images increases contrary to query 2 and also with spatial grid technique we obtain more accurate results than per color channel and 3d color histograms without dividing grids.When this query inspected with spatial grids, the algorithm finds similarities easily because the color distribution on the patches are very similar no matter how different color are used in the patches.The reason of getting more accurate results with smaller grids is that the probability of distribution of colors on different images decreases and therefore, the algorithm tends to match original image and its filtered version when using smaller grids.

- Explain the advantages/disadvantages of using grids in both types of histograms if there are any.

  If a filter is applied to an image that differs the image in color distribution, grids are more useful than other histogram to recognize images because it lowers the probability of matching with other different images because of its capability of minimize grids and comparing them.

6 Additional Comments and References

(if there any)