
CENG 483

Introduction to Computer Vision

Fall 2021-2022

Take Home Exam 1

Instance Recognition with Color Histograms

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1 3D Color Histogram

1.1 Query 1

- For interval = 16: top-1 accuracy = 1.0
- For interval = 32: top-1 accuracy = 1.0
- For interval = 64: top-1 accuracy = 1.0
- For interval = 128: top-1 accuracy = 0.935

1.2 Query 2

- For interval = 16: top-1 accuracy = 1.0
- For interval = 32: top-1 accuracy = 1.0
- For interval = 64: top-1 accuracy = 1.0
- For interval = 128: top-1 accuracy = 1.0

1.3 Query 3

- For interval = 16: top-1 accuracy = 0.115
- For interval = 32: top-1 accuracy = 0.105
- For interval = 64: top-1 accuracy = 0.115
- For interval = 128: top-1 accuracy = 0.085

Greater number for the interval means we divide colors into fewer bins, and hence it is prone to yield poorer results, as some number of bins below some threshold is probably not informative enough. This seems to be the cause of the poorer performance of the histogram with the last choice of intervals for query 1 and 2. Always 1.0 accuracy for query 2 demonstrates that this method is rotation invariant. And, the reason for poor performance for query set 3 is because the colors are altered, ie, some are with different effects, such as negative pictures or darker shades, etc. Even though there are other alternative choices for intervals to yield perfect accuracy; for query 1, interval = 64 and for query 2, interval = 128 are chosen for the sake of run time. And, for query 3, interval = 64 is chosen simply because it yields the best performance.

2 Per Channel Color histogram

2.1 Query 1

- For interval = 8: top-1 accuracy = 0.98
- For interval = 16: top-1 accuracy = 0.98
- For interval = 32: top-1 accuracy = 0.98
- For interval = 64: top-1 accuracy = 0.935
- For interval = 128: top-1 accuracy = 0.585

2.2 Query 2

- For interval = 8: top-1 accuracy = 1.0
- For interval = 16: top-1 accuracy = 1.0
- For interval = 32: top-1 accuracy = 1.0
- For interval = 64: top-1 accuracy = 1.0
- For interval = 128: top-1 accuracy = 0.995

2.3 Query 3

- For interval = 8: top-1 accuracy = 0.125
- For interval = 16: top-1 accuracy = 0.12
- For interval = 32: top-1 accuracy = 0.135
- For interval = 64: top-1 accuracy = 0.14
- For interval = 128: top-1 accuracy = 0.04

For Query1: intervals 8, 16, and 32 yield the highest results, however, 32 is chosen for the sake of run time. Moreover, having as many bins as possible do not yield the best result as can be seen from the following examples, as we do not generally try to find exactly the same image. (Choosing more bins than necessary therefore resembles to the problem of overfitting, as it fails to generalize, ie, fails to recognize similar images unless there are almost the same).

For Query2: For the same reasons stated for query 1, interval = 64 is chosen.

For Query3: Interval = 64 is chosen simply because it gives the best performance.

And, the reasons for poor performance in query 3 are as explained in the first section, 3D Color Histogram.

Chosen intervals for 3D Histogram:

Query 1: 32

Query 1: 64

Query 1: 64

Chosen intervals for Per-Channel Histogram:

Query 1: 64

Query 1: 128

Query 1: 64

3 Grid Based Feature Extraction - Query set 1

Top-1 accuracy results for all of the configurations below.

3.1 48×48 spatial grid

- 3d color histogram: top-1 accuracy = 1.0 (interval = 64)
- per-channel histogram: top-1 accuracy = 1.0 (interval = 32)

3.2 24×24 spatial grid

- 3d color histogram: top-1 accuracy = 0.99 (interval = 64)
- per-channel histogram: top-1 accuracy = 1.0 (interval = 32)

3.3 16×16 spatial grid

- 3d color histogram: top-1 accuracy = 0.965 (interval = 64)
- per-channel histogram: top-1 accuracy = 1.0 (interval = 32)

3.4 12×12 spatial grid

- 3d color histogram: top-1 accuracy = 0.965 (interval = 64)
- per-channel histogram: top-1 accuracy = 0.91 (interval = 32)

3.5 Questions

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

The accuracy is pretty high for query 1 for all configurations, as the images in this set are really similar to the ones in the support set.

There is no significant difference in the results.

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

Using grids do not seem to affect the performance too much for this set, and it is computationally more expensive.

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: top-1 accuracy = 0.45 (interval = 128)
- per-channel histogram: top-1 accuracy = 0.435 (interval = 64)

4.2 24×24 spatial grid

- 3d color histogram: top-1 accuracy = 0.31 (interval = 128)
- per-channel histogram: top-1 accuracy = 0.365 (interval = 64)

4.3 16×16 spatial grid

- 3d color histogram: top-1 accuracy = 0.28 (interval = 128)
- per-channel histogram: top-1 accuracy = 0.31 (interval = 64)

4.4 12×12 spatial grid

- 3d color histogram: top-1 accuracy = 0.26 (interval = 128)
- per-channel histogram: top-1 accuracy = 0.27 (interval = 64)

4.5 Questions

- What do you think about the cause of the difference between the results?
- Explain the advantages/disadvantages of using grids in both types of histograms if there are any.

We see a consistent fall in the performance of both types of histograms with more grids, which is as expected. That is, the images in the query 2 set are rotated, and comparing each grid against the corresponding one in the support image might yield extremely different results. Consider an image, tiled half vertically, with left-half red and right-half white. When rotated 90 degrees, each grid would be half red, half white, which are truly different than those of the original images. That's why using grids seem to be inconvenient with rotations, ie, this method is rotation-variant.

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: top-1 accuracy = 0.145 (interval = 64)
- per-channel histogram: top-1 accuracy = 0.255 (interval = 64)

5.2 24×24 spatial grid

- 3d color histogram: top-1 accuracy = 0.145 (interval = 64)
- per-channel histogram: top-1 accuracy = 0.285 (interval = 64)

5.3 16×16 spatial grid

- 3d color histogram: top-1 accuracy = 0.16 (interval = 64)
- per-channel histogram: top-1 accuracy = 0.29 (interval = 64)

5.4 12×12 spatial grid

- 3d color histogram: top-1 accuracy = 0.17 (interval = 64)
- per-channel histogram: top-1 accuracy = 0.295 (interval = 64)

5.5 Questions

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

The 3D histograms provide a way to represent the intermediate colors too, as for each bin there is the information of how much it contains red, green, and blue. That's why this method is more sensitive to the color information. And, hence the images in the query 3 set are different than their counterparts in the support set color-wise, ie, with some filters on them; the performance of 3D is poorer.

- Explain the advantages/disadvantages of using grids in both types of histograms if there are any.
Using grids seem to have a positive effect for the per channel histograms. When colors, although different, are together in a grid in a more compact form than for the whole image, comparison makes more sense.

6 Additional Comments and References