CENG 483

Introduction to Computer Vision

Fall 2021-2022

Take Home Exam 1

Instance Recognition with Color Histograms

Student ID:

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 section, give your results without dividing the images into grids. Your histogram must have at most 4096 bins. E.g. Assume that you choose 16 for quantization interval then you will have 16 bins for each channel and 4096 bins for your 3D color histogram.

- Pick 4 different quantization intervals and give your top-1 accuracy results for each of them on every query dataset.
- Explain the differences in results and possible causes of them if there are any.

Results					
Interval	Bins	Query-1	Query-2	Query-3	Support
16	16	1.0	1.0	0.11	1.0
32	8	1.0	1.0	0.11	1.0
64	4	1.0	1.0	0.12	1.0
128	2	0.935	1.0	0.085	1.0

Query-1 dataset includes the same images as in Support dataset, but it's scaled up (zoomed in), birds are larger in the pictures. Since scaling is not very extreme, histogram was sucessfull to capture the essential pixel distribution for matching the pictures. Query-1 is perfectly detected for all interval sizes except for (128x2) which has larger interval size corresponding to lower spatiality in terms of pixel values. However, 0.935 of accuracy is still successfull in Query-1.

Query-2 dataset also includes the same images, but with rotations (90, 180, 270 degrees). Since we are calculating histogram for the full image without any spatial partitions/grids and it only counts for the frequencies of pixel values, histogram is invariant to rotation in this case. Therefore, as expected Query-2 set perfectly matches to Support set.

Query-3 dataset is composed of same images as in Support dataset without rotation or scaling, but different transformations are applied on these images altering the pixel values. For example, American

Pipit turns into yellow from brown. Those transformations might be contrast and hue transformations which can change the pixel values. As it's clear from the Query-3 set, applying an entire histogram over images wouldn't be sufficient to capture its correspondance in Support set. Altough semantically the images correspond to the same entity, modified pixel values deviate/fool our full histogram approach resulting in poor accuracies for all interval sizes.

Additionally, I've included Support to Support matching for sanity check and comparison as a baseline. As it's clear, it perfectly matches with itself.

2 Per Channel Color histogram

In this section, give your results without dividing the images into grids.

- Pick 5 different quantization intervals and give your top-1 accuracy results for each of them on every query dataset.
- Explain the differences in results and possible causes of them if there are any.

Results					
Interval	Bins	Query-1	Query-2	Query-3	Support
8	32	0.98	1.0	0.125	1.0
16	16	0.98	1.0	0.12	1.0
32	8	0.98	1.0	0.135	1.0
64	4	0.935	1.0	0.14	1.0
128	2	0.585	0.995	0.04	1.0

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

Best Interval Configurations:

Configuration				
	Query-1	Query-2	Query-3	Support
3D	16	16	64	16
Color	8	8	64	8

3 Grid Based Feature Extraction - Query set 1

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

Results Spatial Grid: 3d histogram (intv=64)				
Grid	Query-1	Query-2	Query-3	Support
48 x 48	1.0	0.555	0.155	1.0
24 x 24	1.0	0.36	0.22	1.0
16 x 16	1.0	0.3	0.255	1.0
12 x 12	1.0	0.31	0.3	1.0

Results Spatial Grid: per-channel histogram (intv=32)				
Grid	Query-1	Query-2	Query-3	Support
48 x 48	1.0	0.36	0.22	1.0
24 x 24	1.0	0.205	0.26	1.0
16 x 16	1.0	0.13	0.27	1.0
12 x 12	0.995	0.1	0.265	1.0

3.1 48×48 spatial grid

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

3.2 24×24 spatial grid

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

3.3 16×16 spatial grid

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

3.4 12×12 spatial grid

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

3.5 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.

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:
- per-channel histogram:

4.2 24×24 spatial grid

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

4.3 16×16 spatial grid

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

4.4 12×12 spatial grid

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

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.

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:
- per-channel histogram:

5.2 24×24 spatial grid

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

5.3 16×16 spatial grid

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

5.4 12×12 spatial grid

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

5.5 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.

6 Additional Comments and References

Additional Grid Based Feature Extraction for different intervals besides the best pick.

3D - Histogram

Results 3D Grid histogram (intv=16)				
Grid	Query-1	Query-2	Query-3	Support
48 x 48	1.0	0.71	0.135	1.0
24 x 24	1.0	0.565	0.16	1.0
16 x 16	1.0	0.545	0.215	1.0
12 x 12	1.0	0.555	0.255	1.0
Results 3D Grid histogram (intv=32)				
Grid	Query-1	Query-2	Query-3	Support
48 x 48	1.0	0.655	0.15	1.0
24 x 24	1.0	0.425	0.155	1.0
16 x 16	1.0	0.4	0.22	1.0
12 x 12	1.0	0.39	0.245	1.0
Results 3D Grid histogram (intv=64)				
Grid	Query-1	Query-2	Query-3	Support
48 x 48	1.0	0.555	0.155	1.0
24 x 24	1.0	0.36	0.22	1.0
16 x 16	1.0	0.3	0.255	1.0
12 x 12	1.0	0.31	0.3	1.0

Results 3D Grid histogram (intv=128)				
Grid	Query-1	Query-2	Query-3	Support
48 x 48	0.995	0.28	0.15	1.0
24 x 24	1.0	0.195	0.24	1.0
16 x 16	0.995	0.14	0.285	1.0
12 x 12	1.0	0.145	0.34	1.0

Per-Channel Histogram

Results Per-Channel Grid histogram (intv=8)				
Grid	Query-1	Query-2	Query-3	Support
48 x 48	1.0	0.355	0.215	1.0
24 x 24	1.0	0.16	0.22	1.0
16 x 16	0.995	0.1	0.24	1.0
12 x 12	0.995	0.1	0.24	1.0

Results Per-Channel Grid histogram (intv=16)				
Grid	Query-1	Query-2	Query-3	Support
48 x 48	1.0	0.365	0.21	1.0
24 x 24	1.0	0.17	0.225	1.0
16 x 16	1.0	0.115	0.25	1.0
12 x 12	0.995	0.11	0.245	1.0

Results Per-Channel Grid histogram (intv=32)				
Grid	Query-1	Query-2	Query-3	Support
48 x 48	1.0	0.36	0.22	1.0
24 x 24	1.0	0.205	0.26	1.0
16 x 16	1.0	0.13	0.27	1.0
12 x 12	0.995	0.1	0.265	1.0

Results Per-Channel Grid histogram (intv=64)				
Grid	Query-1	Query-2	Query-3	Support
48 x 48	1.0	0.33	0.235	1.0
24 x 24	1.0	0.2	0.315	1.0
16 x 16	0.995	0.125	0.315	1.0
12 x 12	0.995	0.1	0.305	1.0

Results Per-Channel Grid histogram (intv=128)				
Grid	Query-1	Query-2	Query-3	Support
48 x 48	0.97	0.175	0.21	1.0
24 x 24	1.0	0.125	0.355	1.0
16 x 16	0.985	0.1	0.395	1.0
12 x 12	0.98	0.065	0.405	1.0