1. Introduction

In this Homework, we are given 180 classes having both test and train image sets. Using descriptors and nearest neighbor classifier (NN), we train our classifiers for each class and test over the given set.

Before applying descriptors to the images, we first normalize the size of the image with a 128x128 scale. Additionally, we create windowing options for the images with 1x1, 2x2 and 4x4 scales. This means that each image is chopped into small windows (for 2x2 and 4x4 case) and the descriptors are separately calculated for each window of the image.

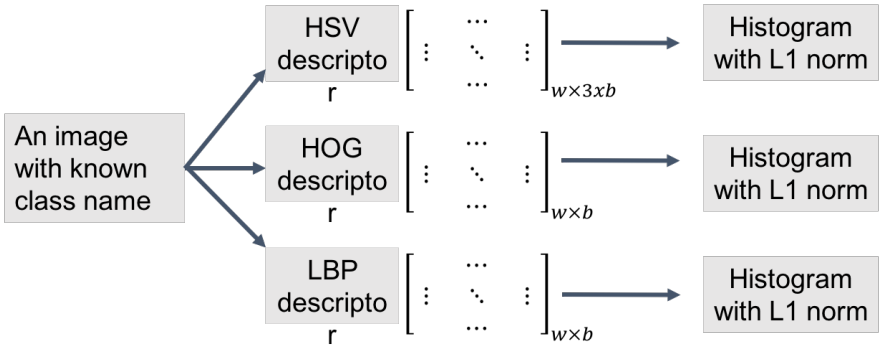
The descriptors are:

a. HSV (Hue-Saturation-Value)
b. Gradient Orientation (by taking the gradient orientation angle)
c. Local Binary Pattern (by computing the LBP code of each pixel with a predefined neighborhood pattern)

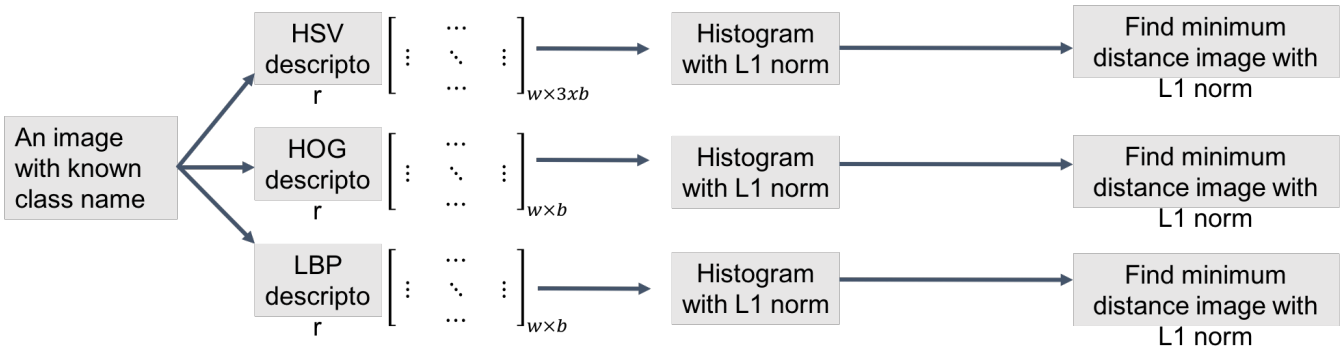
For each of these descriptors, the resulting vectors are normalized with L1 and mapped to a histogram with a parametric bin size. This concludes the creation of the training set.

Having the training set, we iterate over the test set and take each image from the test set and apply the same descriptors with the same parameters. We then search for the minimum distance of the given test image with an image from the train based on each descriptor separately as well as on their combination with equal weight and with HSV descriptor having twice the weight of LBP and HOG descriptors.

A schema of the training operations is given below (w being windows size and b being binning size):



Search operation schema is applying the same descriptors to test image and then searching for the minimum as mentioned above:



The search is done for each descriptor separately and with their combination as mentioned.

2. Results

All Averaged			
window_size/bin_size	8	16	32
1x1	0.63	0.67	0.69
2x2	0.66	0.65	0.62
4x4	0.71	0.72	0.68
Weighted Averaged			
window_size/bin_size	8	16	32
1x1	0.69	0.73	0.75
2x2	0.66	0.66	0.63
4x4	0.68	0.69	0.66
HSV			
window_size/bin_size	8	16	32
1x1	0.7	0.77	0.78
2x2	0.6	0.61	0.57
4x4	0.59	0.58	0.54
HOG			
window_size/bin_size	8	16	32
1x1	0.13	0.22	0.29
2x2	0.39	0.37	0.36
4x4	0.61	0.56	0.49
LBP			
window_size/bin_size	8	16	32
1x1	0.06	0.07	0.05
2x2	0.08	0.06	0.05
4x4	0.21	0.22	0.19

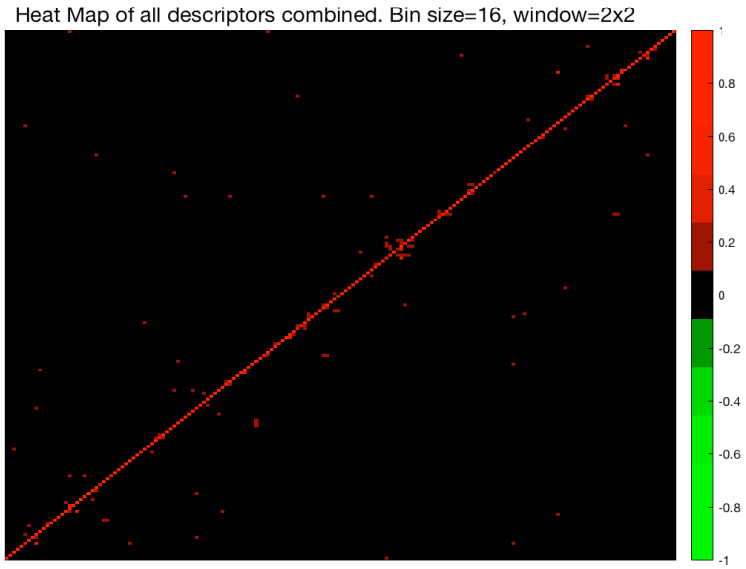
Notice that all averaged is obtained by simply averaging the distances coming from each of the descriptors whereas weighted average is obtained by assigning 0.5 weight to HSV and 0.25 to HOG and LBP descriptors. For both cases, the image providing the minimum norm of the distance for the given test image is searched. The norm of the distances of HSV, HOG and LBP descriptors are taken separately as well as averaged.

As it can be seen from the table above, HSV performs better than HOG and LBP in terms of accuracy given the same parameters. It's interesting to see that when window size is increased, HSV performance gets worse whereas LBP and HOG performs better.

The maximum accuracy points are marked on the table; when using descriptors without combining, HSV performs best with 1x1 window size and 32 bin histogram. HOG and performs best with 8 bin histogram and 4x4 window; LBP performs best with 16 bin histogram with 4x4 window. Their equally weighted combination performs best at 4x4 window size with 16 bin histogram, although 4x4 window with 8 bins as well as 1x1 window with 32 bins performs quite close. This is normal, because these points correspond the optimum

parameters for each of these descriptors. Finally, weighted average of these descriptors (in favor of the HSV descriptor as explained above) performs best at 32 bin histogram with 1x1 window size as expected; since this is the optimum point for HSV.

Heat map of the optimum point for all averaged:



Heat map of the optimum point for HSV descriptor: