IMAGE PROCESSING PROJECT 2

NIKHIL CHEZIAN|11027706

DATE OF SUBMISSION: 13-02-2023

PROFESSOR: milan.gnjatovic@kpu.edu.r

AIM

To develop object detection program based on the Histogram of gradients. This program should meet the following requirements:

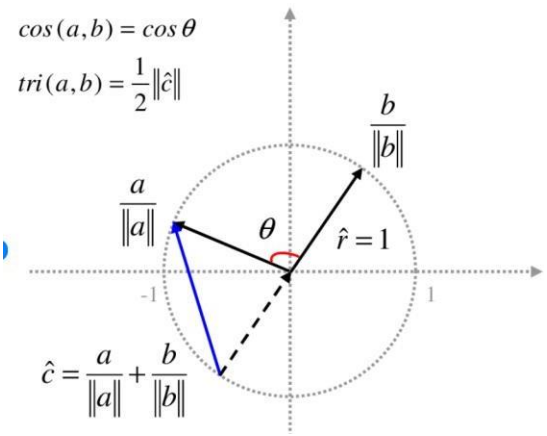
1. It computes a histogram of oriented gradients for a given image. The input parameters are: grayscale image, number of chain code directions, and grid dimension.

2. It estimates the similarity between two input grayscale images by calculating the cosine similarity between their histograms of oriented gradients.

3. It reads an object represented in image A and detects its occurrences in image B.

INTRODUCTION:

Cosine Similarity isa measure of similarity between two non-zero vectors of an inner product space and the cosine of the trigonometric angle between two vectors. It is the inner product of two vectors normalized to length 1.It is applied to vectors of low and high dimensionality.



Cosine similarity between the gradient histograms conveys an idea of how similar two images are in terms of their texture or edge characteristics. The orientation gradient histogram (HOG) is a widely used characteristic description for images that capture the distribution of the local gradient orientation in the image. The HOG character descriptor represents an image as a gradient orientation histogram at each pixel location. The concept behind the HOG characteristic character generator is to characterize the appearance of local objects and textures by distributing gradient orientations within small sub-areas of the image. The cosine similarity of the gradient histograms of two images measures the similarity or

inconsistency of the gradient orientation distribution between the two images. Cosine similarity is a measure of the angle of the cosine between the two vectors, and the vector represents the gradient histogram of the two images. If the gradient histograms of the two images are similar, the similarity of the cosine is close to 1. If the gradient histograms of the two images differ, cosine similarities are close to 0. Cosine similarity is a common distance metric used to compare features in many computer vision applications such as object recognition, image retrieval, and face recognition.

The cosine similarity of two gradient histograms can be calculated using the following formula: cosine similarity = dot (H1, H2) / (norm(H1) * norm(H2))

If H1 and H2 are the two histograms to compare, dot (H1, H2) are the two histograms products, whose result is calculated by multiplying the corresponding cylinders of the histograms and by combining the results. The result of the cosine similarity formula is a scale value between -1 and 1, where values closer to 1 indicate higher similarity between the gradient histograms of the two images. If the two histograms are identical, the similarity ofcosineis1. If both histograms are completely different, the cosine similarityis-1.

CODE EXPLANATION:

This code loads two images, resizes them to the same size, converts them to grayscale, computes Histogram of Oriented Gradients (HOG) features for each image, calculates the cosine similarity between the two HOG feature vectors, and visualizes the HOG images.

1. The code first imports the necessary libraries: skimage.feature for HOG feature extraction, skimage.color for colour conversion, numpy for array manipulation, matplotlib.pyplot for plotting, cv2 for image loading and resizing, and os for setting the working directory.

2. The working directory is set to where the images are stored.

3. The two sample images are loaded using cv2.imread() function and stored as image1 and image2.

4.The images are resized to 400x400 pixels using cv2.resize() function.

5. The images are converted to grayscale using color.rgb2gray() function from skimage.

6. HOG features are computed for each image using hog() function from skimage.feature. The parameters orientations, pixels_per_cell, and cells_per_block are set to 8, (16,16), and (1,1), respectively. This results in a 1D array of HOG feature vectors.

7. Cosine similarity between two HOG feature vectors, fd1 and fd2, using the cosine_similarity() function.

8. The HOG images are visualized using matplotlib.pyplot.imshow() function. The visualize parameter in hog () function is set to True to return the HOG image and the [1] index is used to extract it. Two subplots are created for the two images using plt.subplots() function and the images are plotted using imshow() function on each subplot.

7.Visualizes the HOG images using skimage.feature.hog() method with visualize=True parameter and matplotlib. pyplot.imshow() method.

RESULTS:

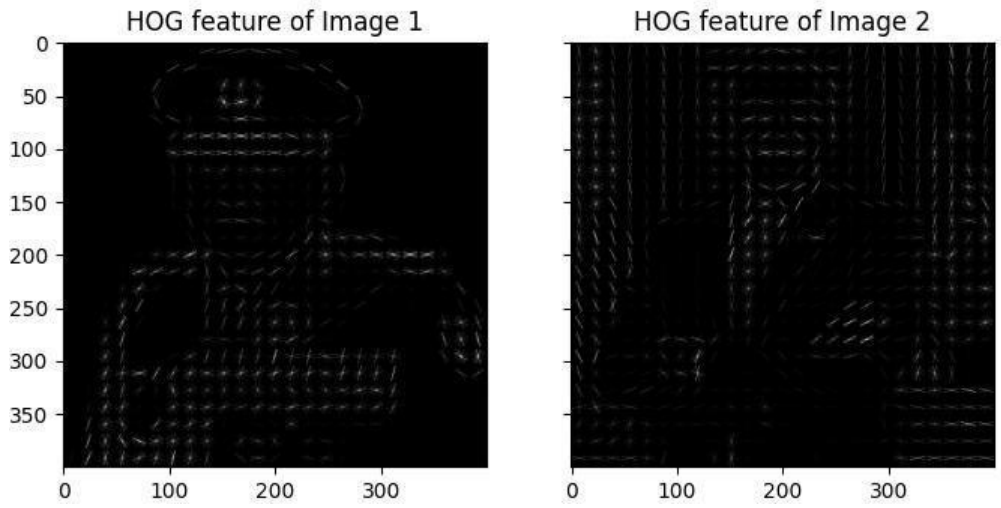
PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL

```
3.64622957e-01 3.55123395e-01 3.64622957e-01 2.76021685e-01
3.64622957e-01 3.64622957e-01 3.64622957e-01 3.64622957e-01
7.06733177e-01 1.64222308e-02 6.37443367e-03 0.00000000e+00
1.96061838e-02 3.88843199e-03 1.86168589e-02 7.06733177e-01
3.70064223e-01 3.70064223e-01 3.70064223e-01 2.89549897e-01
3.70064223e-01 3.70064223e-01 3.07368966e-01 3.70064223e-01
3.69789152e-01 3.69789152e-01 3.43824502e-01 3.69789152e-01
2.57878637e-01 3.62716465e-01 3.69789152e-01 3.69789152e-01
3.67136047e-01 3.38925867e-01 3.67136047e-01 3.67136047e-01
2.76398252e-01 3.67136047e-01 3.67136047e-01 3.67136047e-01
7.06939532e-01 0.00000000e+00 0.00000000e+00 0.00000000e+00
0.00000000e+00 0.00000000e+00 2.17484470e-02 7.06939532e-01
6.97983263e-01 7.88581274e-02 2.30101724e-02 0.00000000e+00
1.40435112e-02 9.25784927e-03 1.36410145e-01 6.97983263e-01
7.06789040e-01 2.90863726e-02 2.32010526e-03 2.87513744e-03
0.00000000e+00 0.00000000e+00 6.23208797e-03 7.06789040e-01
7.05395866e-01 5.71092378e-02 1.19704616e-02 0.00000000e+00
3.57604112e-03 7.63649379e-03 3.68440290e-02 7.05395866e-01
3.69545198e-01 3.68579025e-01 3.69545198e-01 3.69545198e-01
3.69545198e-01 2.11583508e-01 3.69545198e-01 3.69545198e-01
2.72331237e-01 3.44910655e-01 2.40203771e-01 3.87085129e-01
3.87085129e-01 3.87085129e-01 3.87085129e-01 3.87085129e-01
3.54195035e-01 3.54195035e-01 3.54195035e-01 3.54195035e-01
3.49028854e-01 3.54195035e-01 3.54195035e-01 3.54195035e-01
4.76857791e-02 4.86955820e-01 4.86955820e-01 3.39157545e-01
2.90627802e-01 4.43123721e-01 3.52756170e-01 5.64465904e-02
2.06365532e-01 4.53520411e-01 4.53520411e-01 4.53520411e-01
4.53520411e-01 2.86021981e-01 2.14668821e-01 8.24556793e-02
1.25132673e-01 2.72117218e-01 4.28744957e-01 4.28744957e-01
4.28744957e-01 4.28744957e-01 4.05017204e-01 1.04719372e-01
7.08910399e-02 1.73234041e-01 2.37964393e-01 4.70433891e-01
4.70433891e-01 4.70433891e-01 4.70433891e-01 1.52003915e-01
4.07728355e-01 2.38448675e-01 2.13031642e-01 2.57968390e-01
4.07728355e-01 4.07728355e-01 4.07728355e-01 4.07728355e-01
3.65218838e-01 3.65218838e-01 2.57500299e-01 3.65218838e-01
3.65218838e-01 3.65218838e-01 3.65218838e-01 3.65218838e-01
3.64051322e-01 3.64051322e-01 3.64051322e-01 3.64051322e-01
3.51922405e-01 2.84517892e-01 3.64051322e-01 3.64051322e-01
7.06881296e-01 2.00333012e-02 2.87470740e-03 0.00000000e+00
0.00000000e+00 0.00000000e+00 1.51019019e-02 7.06881296e-01
7.06982586e-01 1.32256008e-02 0.00000000e+00 1.03448400e-03
2.50138332e-03 8.44951173e-03 9.87968874e-03 7.06982586e-01
6.20970258e-01 1.28507829e-02 3.76398533e-03 1.96450979e-03
0.00000000e+00 2.80171941e-03 3.25063790e-02 7.83037836e-01
7.06896706e-01 1.97510089e-02 8.75391569e-03 1.12843259e-03
```

PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL

```
7.06896706e-01 1.97510089e-02 8.75391569e-03 1.12843259e-03
8.96142270e-03 4.15940347e-03 5.33662520e-03 7.06896706e-01
6.62957463e-01 2.24289787e-01 1.05074061e-01 6.35385426e-02
3.68043612e-02 1.05979196e-01 2.07376564e-01 6.62957463e-01
3.60014667e-01 3.60014667e-01 3.60014667e-01 3.60014667e-01
3.04509565e-01 3.60014667e-01 3.60014667e-01 3.60014667e-01
3.54900409e-01 3.54900409e-01 3.43976595e-01 3.54900409e-01
3.54900409e-01 3.54900409e-01 3.54900409e-01 3.54900409e-01
7.05519670e-01 2.68722281e-02 1.96599881e-02 1.34238993e-02
3.22633001e-02 6.54795845e-03 4.59495264e-02 7.05519670e-01
3.92874116e-01 3.92874116e-01 3.92874116e-01 2.55127163e-01
3.92874116e-01 1.78182765e-01 3.62506108e-01 3.92874116e-01
3.62006010e-01 3.62006010e-01 3.61310951e-01 3.62006010e-01
3.06289714e-01 3.46985953e-01 3.62006010e-01 3.62006010e-01
3.57191213e-01 3.26957277e-01 3.57191213e-01 3.57191213e-01
3.57191213e-01 3.57191213e-01 3.57191213e-01 3.57191213e-01
7.06996424e-01 1.64927871e-02 0.00000000e+00 2.24545227e-03
8.03208156e-04 2.50858218e-03 5.30269434e-03 7.06996424e-01
7.05145072e-01 1.14194692e-02 0.00000000e+00 0.00000000e+00
0.00000000e+00 0.00000000e+00 7.35557516e-02 7.05145072e-01
7.06934452e-01 2.30347107e-03 0.00000000e+00 0.00000000e+00
0.00000000e+00 0.00000000e+00 2.19557470e-02 7.06934452e-01
7.06708278e-01 9.39235020e-03 9.20070024e-03 0.00000000e+00
9.40112829e-03 4.48356022e-03 2.90768869e-02 7.06708278e-01
4.04035674e-01 2.92051381e-01 3.20981746e-01 4.04035674e-01
2.96953544e-01 3.18400150e-01 3.63843605e-01 4.04035674e-01
2.73815996e-01 3.67280079e-01 3.67280079e-01 3.67280079e-01
3.67280079e-01 3.62759696e-01 3.67280079e-01 3.44901318e-01
3.69755955e-01 2.89561208e-01 3.09576341e-01 3.69755955e-01
3.69755955e-01 3.69755955e-01 3.69755955e-01 3.69755955e-01
4.40751931e-01 3.20137186e-01 2.27889725e-01 1.81336668e-01
2.50158095e-01 4.09059409e-01 4.40751931e-01 4.40751931e-01
1.86384903e-01 1.55475885e-01 3.46732756e-01 4.57252807e-01
4.57252807e-01 4.57252807e-01 3.07114395e-01 3.15126438e-01
1.06912961e-01 1.89551700e-01 4.76144034e-01 4.76144034e-01
4.76144034e-01 4.76144034e-01 1.74590466e-01 1.23714893e-01
3.01773478e-01 4.41705251e-01 4.41705251e-01 4.41705251e-01
4.41705251e-01 1.12255577e-01 1.54415930e-01 3.03435425e-01
6.19167793e-01 6.19167793e-01 2.98426596e-01 1.06896140e-01
1.39035536e-01 1.09187391e-01 2.01106595e-01 2.47144975e-01
3.71559288e-01 3.71559288e-01 3.71559288e-01 3.71559288e-01
3.71559288e-01 1.92529670e-01 3.66871230e-01 3.71559288e-01
4.43663752e-01 4.43663752e-01 2.59381427e-01 3.52970660e-01
3.34788961e-01 1.68351249e-01 2.77839200e-01 4.43663752e-01
7.04839008e-01 6.80746542e-02 7.32338062e-03 8.54752205e-03
```

Cosine similarity of the two HOG feature vectors: 0.2602400014966881



REFERENCES:

1. Sources of input images

I/P Image-1 https://en.wikipedia.org/wiki/Bipin_Rawat#/media/File:Bipin_Rawat_Chief_of_Defence_Staff_(CDS).jpg

I/P Image-2 https://en.wikipedia.org/wiki/Barack_Obama#/media/File:President_Barack_Obama.jpg

2. https://chat.openai.com/chat

3. https://www.analyticsvidhya.com/blog/2019/09/feature-engineering-images-introduction-hog-feature-descriptor/

4. https://github.com/arcticpenguin/ObjectDetection

5. https://www.youtube.com/watch?v=thcB1NcorV8