Histogram of Oriented Gradients

Object classification and detection is one of the major tasks in computer vision. One of very successful methods is call Histogram of Oriented Gradients (HOG) [1]. It's a method that computes features for sought objects based on their gradients. As you may guess, gradients are computed to form a histogram, based on which objects are classified/detected.

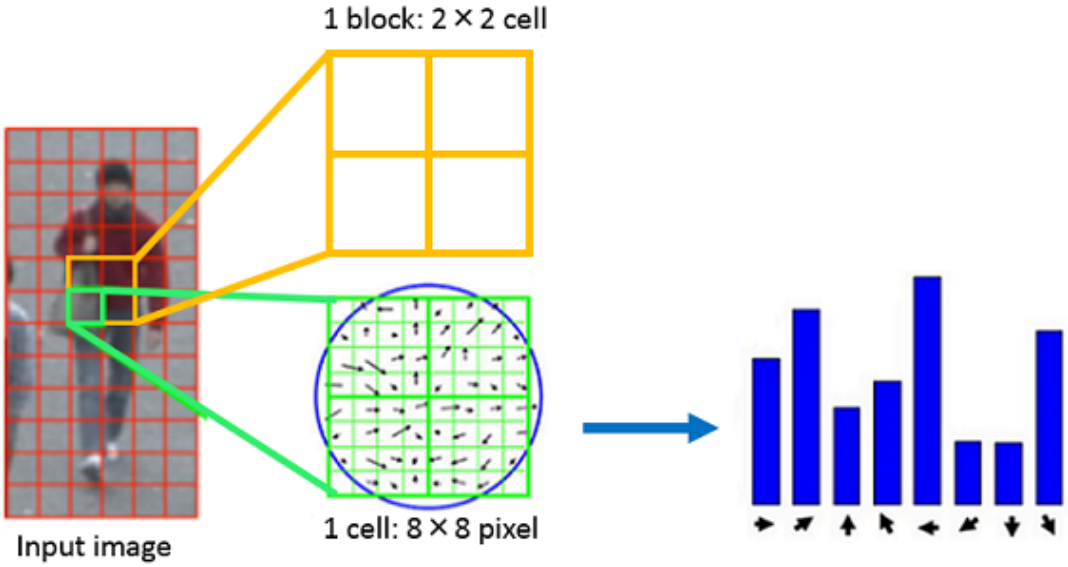

Figure 1: HOG Illustration [2]

Step 1: Compute the Gradient Image

For each image pixel (x, y), compute the orientation of gradient as

$$\varphi(x, y) = \arctan\left(\frac{f_y(x, y)}{f_x(x, y)}\right), \tag{1}$$

and the size of gradient as

$$e(x, y) = \sqrt{f_x^2(x, y) + f_y^2(x, y)}\,, \tag{2}$$

where $f_x(x, y)$ and $f_y(x, y)$ are the differences of brightness in the x and y direction, respectively. For their computing, we can use the following equations:

$$f_x(x, y) = f(x + 1, y) - f(x, y)\,, \tag{3}$$
$$f_y(x, y) = f(x, y + 1) - f(x, y)\,. \tag{4}$$

Step 2: Create the Histograms

Let the image be split into blocks of size $B_x \times B_y$, and let the blocks be split into cells of size $C_x \times C_y$ (see Fig. 1). Create a histogram of gradient orientations in each cell. Divide the range of orientations ($0 - 180$ or $0 - 360$ degrees) into N bins (for example, with the step 20 degrees that leads to 9 bins for the interval $0 - 180$ degrees). For each image pixel, add its gradient size into the bin representing the angle interval in which the gradient orientation of the pixel belongs. Create such a histogram for each cell, and normalize the histograms within the blocks.

As a result of this method, we get a feature vector with the histogram values. The size of the feature vector depends on the number of bins and on the number of cells in the image.

References

[1] Dalal, Navneet and Triggs, Bill: Histograms of Oriented Gradients for Human Detection, Proceedings of the 2005 IEEE Computer Society Conference on Computer Vision and Pattern Recognition (CVPR'05) - Volume 1, pp. 886–893,(2005)

[2] `http://www.lsi-contest.com/2017/shiyou_3-1e.html`