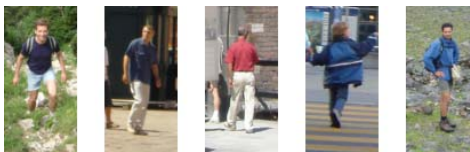


# HOG Feature

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## HOG Feature

- HOG = Histograms of Oriented Gradients
- Proposed by Dalal & Triggs in CVPR 2005 for detecting human in 2D images
- One of the most widely used feature descriptor for detecting human in 2D images
  - descriptor = a feature representation computed from the images



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## HOG Feature



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## HoG: Basic Steps

- A detection window is placed at different locations on an image
- Divide detection window into small non-overlapping regions called cells
- Compute local intensity gradient orientation histograms in cells
  - Human shapes can be described by local gradient orientations; local histograms insensitive to small variations in translations and pose.



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## HoG: Basic Steps

- Normalize local gradient orientation histograms over larger local regions called blocks
  - For handling variations in illuminations and image contrast
  - Blocks are made up of cells and overlapping blocks are typically used in HOG
- The normalized histograms from the individual blocks are concatenated together to form the final HoG descriptor

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## HoG: Implementation Details

- Assume detection window size = 128 x 64 pixels (rows x columns), cell size = 8 x 8 pixels, block size = 16 x 16 pixels (or 2 x 2 cells), block overlap step size = 8 pixels (or 1 cell).
- Window divided into 16 x 8 non-overlapping cells of 8 x 8 pixels each.
- Group of 4 cells form a block.
- There are 15 x 7 overlapping blocks in window.
- Can use other values for window, cell, block and step sizes.

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## HoG: Implementation Details

- Local gradient orientation histograms for cells
  - Quantize gradient angles into bins: 9 bins (unsigned) or 18 bins (signed)
  - Histogram is formed by weighted vote of individual edge pixels
  - Gradient magnitude used as weight and vote is split between two closest bins based on distance to bin center.
    - e.g., for an edge with gradient angle = 85 degrees, add  $\frac{1}{4}$  of its magnitude to the bin centered at 75 degrees, and add  $\frac{3}{4}$  of its magnitude to the bin centered at 90 degrees.

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## HoG: Implementation Details

- Normalization over blocks
  - Group of 4 cells form a block.
  - Concatenate histograms from the 4 cells to form a long vector.
    - For 9 bin (unsigned) histograms, dimension of vector =  $9 \times 4 = 36$ .
    - Normalize vector by its L2-norm, L2-hys, L1-norm, or L1-sqrt.
    - L2-norm of a vector is defined as

$$|V| = \sqrt{v_1^2 + v_2^2 + v_3^2 + \dots + v_n^2}$$

- Concatenate vectors from all blocks to form final descriptor
  - Dimension of descriptor =  $36 \times 105 \text{ blocks} = 3,780$ .
- A SVM (support vector machine) or other types of classifier can be trained to classify windows into *human* or *non-human*.

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