
Histogram of Oriented Gradients (HOG)

CVPR '05 Dalal and Triggs

Introduction

- Global features
- Sliding window
- Image subsampled to multiple sizes
- Normalized histograms

Steps

- Find horizontal and vertical gradients
- Gradient Magnitude and orientations
- Use a patch of 64 x 128
- Divide the image into blocks of 8 x 8 cells
- Slide over 2 x 2 block cells
- Quantize the gradient orientation into 9 bins by gradient magnitude
- Concatenate histograms into a feature of : $15 \times 7 \times 4 \times 9 = 3780$ dimensions.

Gradients

$$\nabla f(x, y) = \begin{bmatrix} g_x \\ g_y \end{bmatrix} = \begin{bmatrix} \frac{\partial f}{\partial x} \\ \frac{\partial f}{\partial y} \end{bmatrix} = \lim_{d \rightarrow 0} \frac{f(x + d) - f(x - d)}{2d}$$

Filter Masks:

-1	0	1	-1
			0
			1

Gradient Magnitude: $g = \sqrt{g_x^2 + g_y^2}$

Gradient Orientation: $\theta = \tan^{-1}\left(\frac{g_y}{g_x}\right)$

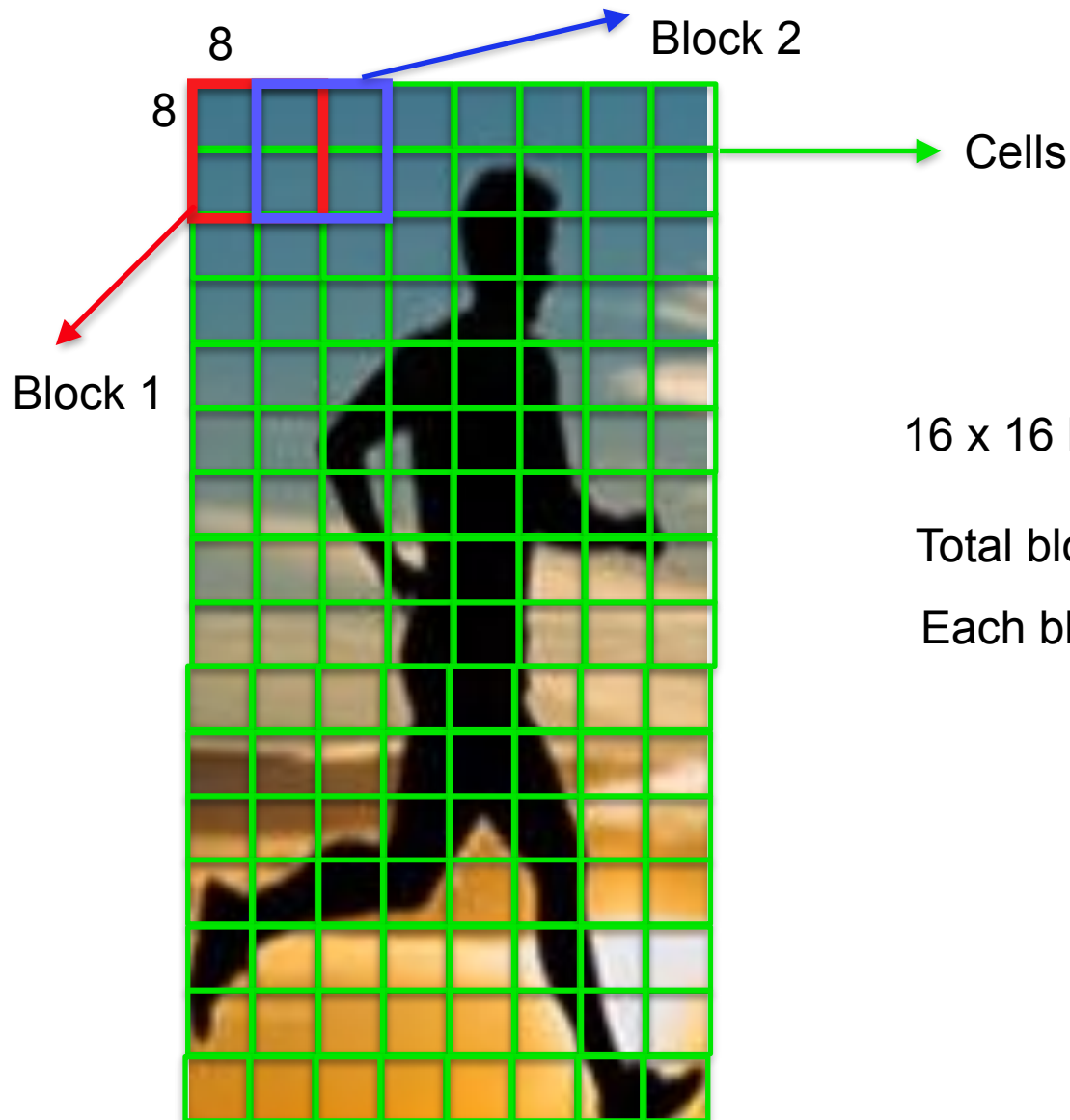
Blocks and Cells



128

64

Blocks and Cells



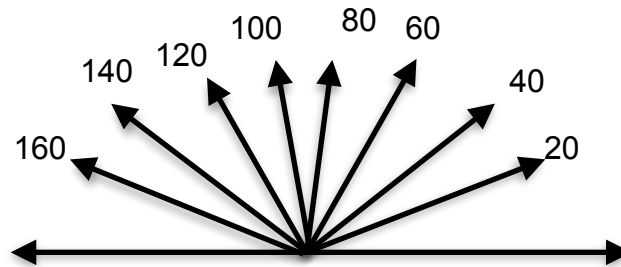
16 x 7 blocks with an overlap

Total blocks: 15 x 7

Each block is 2 x 2 of 8x8 cells

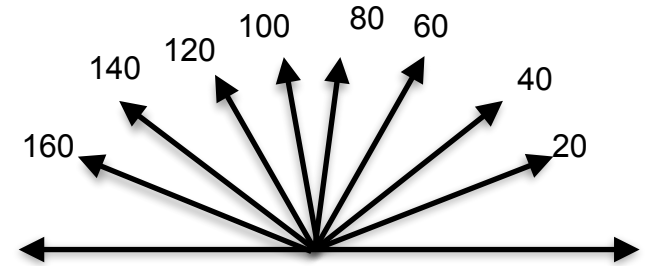
Histogram bins

Quantize gradient orientations into 9 bins



Histogram bins

Quantize gradient orientations into 9 bins

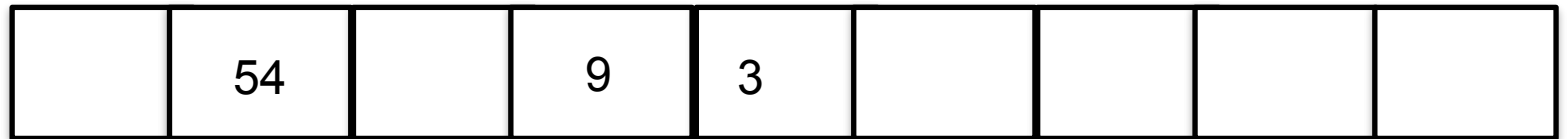


70	35	5	10	64	0
57	85	160	0	120	65
22	45	90	145	30	18
12	4	134	6	75	57
43	30	23	5	119	14
67	57	98	11	9	77
3	11	23	54	78	90

Gradient direction

2	5	4	85	2	0
106	12	13	77	3	6
37	86	48	180	12	37
108	3	87	33	81	27
23	54	11	186	19	114
7	210	19	33	24	12
112	4	34	9	3	12

Gradient Magnitude



0 20 40 60 80 100 120 140 160 180

Concatenate Histograms

$$15 \times 7 \times 9 \times 4 = 3780$$

