

Extracting Image Features



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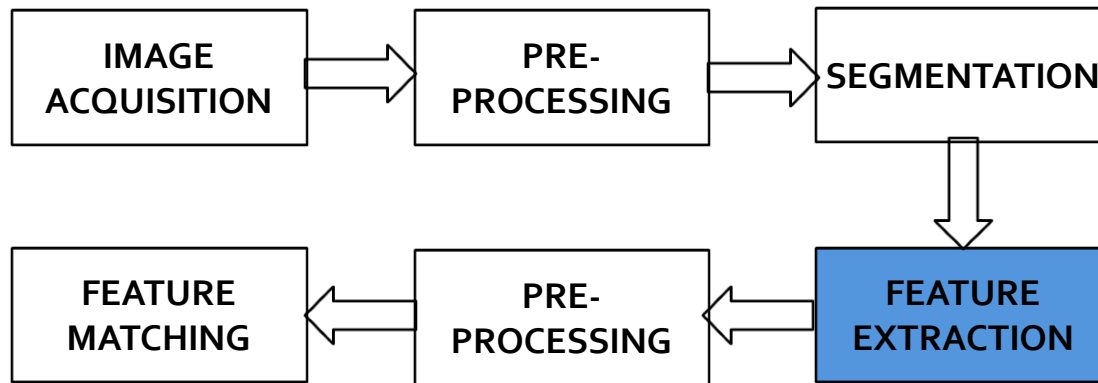
Outline of Lecture11

- ❑ Image feature
- ❑ Feature extraction
- ❑ Feature extraction method
- ❑ Histogram of Oriented Gradients (HOG)

Image Feature

- ❑ An *image feature* is a **distinguishing primitive characteristic or attribute** of an image which can distinguish one object from other objects. Features are specific patterns which are unique, which can be easily tracked and easily compared.
- ❑ Some features are **natural** features which are defined by the visual appearance of an image, while other, **artificial features** result from specific manipulations of an image.
- ❑ Natural features include the **luminance of a region of pixels and gray scale textural regions**.
- ❑ Image amplitude **histograms and spatial frequency spectra** are examples of artificial features.
- ❑ *It is a simplified representation of the image that contains only the most important information about the image.*

Stages in Image Processing

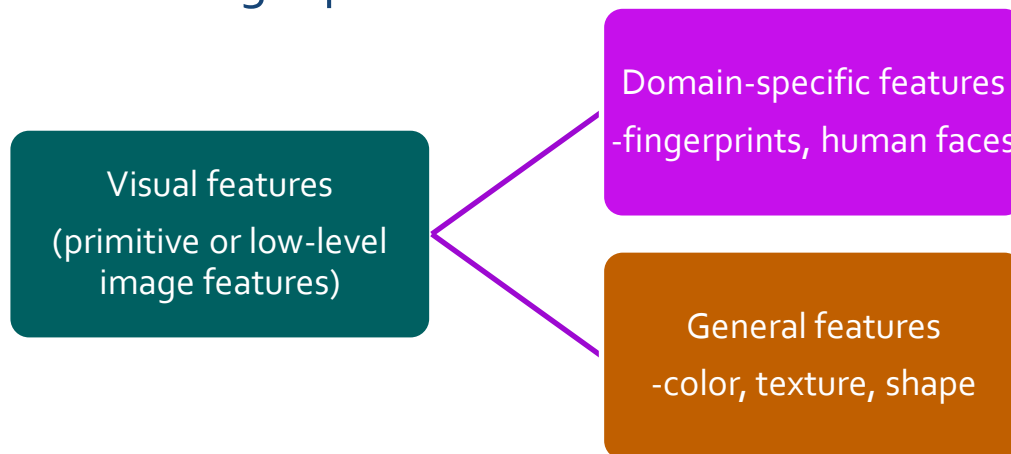


Feature extraction

- ❑ Feature Extraction - method of capturing **visual content** of Feature.
- ❑ Feature extraction describes the relevant shape information contained in a pattern so that the task of **classifying the pattern** is made easy by a formal procedure.
- ❑ In pattern recognition and in image processing, feature extraction is a special form of **dimensionality reduction**. When the **input** data be redundant (much data, but not much information) then the input data will be transformed into a **reduced representation set of features** (also named features vector).
- ❑ feature extraction techniques are applied to get features that will be useful in classifying and recognition of images. For various image processing applications e.g. character recognition, script recognition etc.

Feature extraction method

- ❑ Image features can be classified as
 - ❑ General features
 - ❑ Domain specific features
- ❑ The former include color, texture, and shape features, while the latter are application-dependent and may include, features of human faces or finger prints.



Histogram of Oriented Gradients (HOG)

- ❑ **Histogram of Oriented Gradients**, is a feature descriptor, used to extract features from image data. It is widely used in computer vision tasks for object detection.
- ❑ The HOG feature descriptor counts the **occurrences of gradient orientation** in localized portions of an image.
- ❑ The HOG descriptor focuses on **the structure or the shape** of an object. HOG is able to provide the **edge direction** as well. This is done by extracting the gradient and orientation (or magnitude and direction) of the edges.

HOG (cont.)

- ❑ Additionally, the image is broken down into **smaller regions** and for each region, the gradients and orientation are calculated in '**localized**' portions..
- ❑ Finally the HOG would generate a **Histogram** for each of these regions separately. The histograms are created using the gradients and orientations of the pixel values, hence the name 'Histogram of Oriented Gradients'.
- ❑ The image is divided into 8×8 cells, and the histogram of oriented gradients is computed for each cell. If we divide the image into 8×8 cells and generate the histograms, we will get a **9×1 matrix** for each cell.

HOG (cont.)

- ❑ **Gradients** are the small change in the x and y directions.
- ❑ To determine the gradient (or change) in **the x-direction**, we need to **subtract** the value on the **left** from the pixel value on the **right**. Similarly, to calculate the gradient in **the y-direction**, we will subtract the pixel value **below** from the pixel value **above** the selected pixel.
- ❑ This process will give us two new matrices – one storing gradients in the x-direction and the other storing gradients in the y direction. This is similar to using a Sobel Kernel of size 1. The same process is repeated for all the pixels in the image.

HOG (cont.)

The following are equation to calculate the magnitude and direction for each pixel value.

Gradient computation

$$G_x = I \otimes [-1 \ 0 \ 1]$$

$$G_y = I \otimes [-1 \ 0 \ 1]^T$$

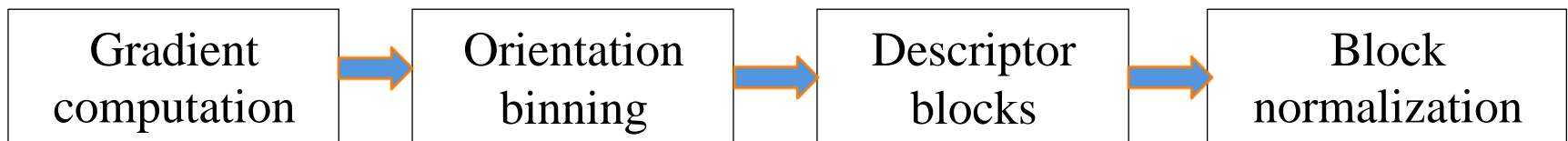
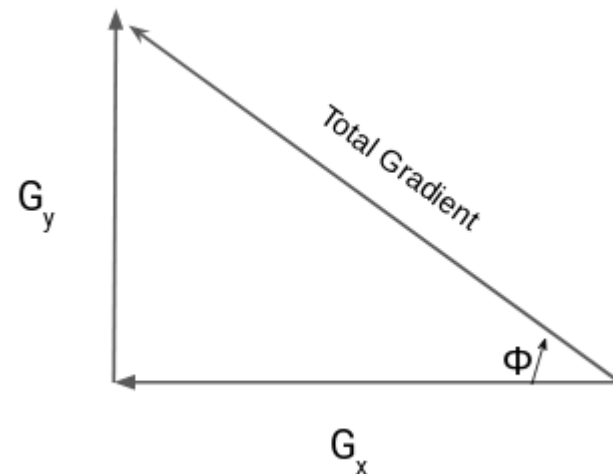
Gradient Magnitude

$$G = \sqrt{[(G_x)^2 + (G_y)^2]}$$

Orientation or Direction(Angle)

$$\tan(\Phi) = G_y / G_x$$

$$\Phi = \text{atan}(G_y / G_x)$$



HOG (cont.)

61	64	146	74	69	72
117	111	211	140	111	92
107	133	214	254	148	158
176	254	168	254	254	190
193	254	255	231	187	201
193	234	255	195	126	204

G_x

G_y

3	85	10	-77	-2	3
-6	94	29	-100	-48	-19
26	107	121	-66	-96	10
78	-8	0	86	-64	-64
61	62	-23	-68	-30	14
41	62	-39	-129	9	78

56	47	65	66	42	20
46	69	68	180	79	86
59	143	-43	114	143	98
86	121	41	-23	39	43
17	-20	87	-59	-128	14
0	-20	0	-36	-61	3

Change in X direction(G_x) = $254 - 133 = 121$

Change in Y direction(G_y) = $41 - 68 = -43$

Total Gradient Magnitude = $\sqrt{[(G_x)^2 + (G_y)^2]}$

Total Gradient Magnitude = $\sqrt{[(121)^2 + (-43)^2]} = 128$

HOG (cont.)

Computing histogram of gradient based on gradients and orientation
(Using unsigned of orientation (0-180°) and 9 bins)

Gradient (Magnitude)


56	97	66	101	42	20
46	117	74	206	92	88
64	179	128	132	172	99
116	121	41	89	75	77
63	65	90	90	131	20
41	65	39	134	62	78

Orientation (Angle)

87	29	81	139	93	81
97	36	67	119	121	102
66	53	20	120	124	84
48	94	90	15	149	146
16	18	105	139	103	45
1	18	180	164	82	2

Magnitude = 128

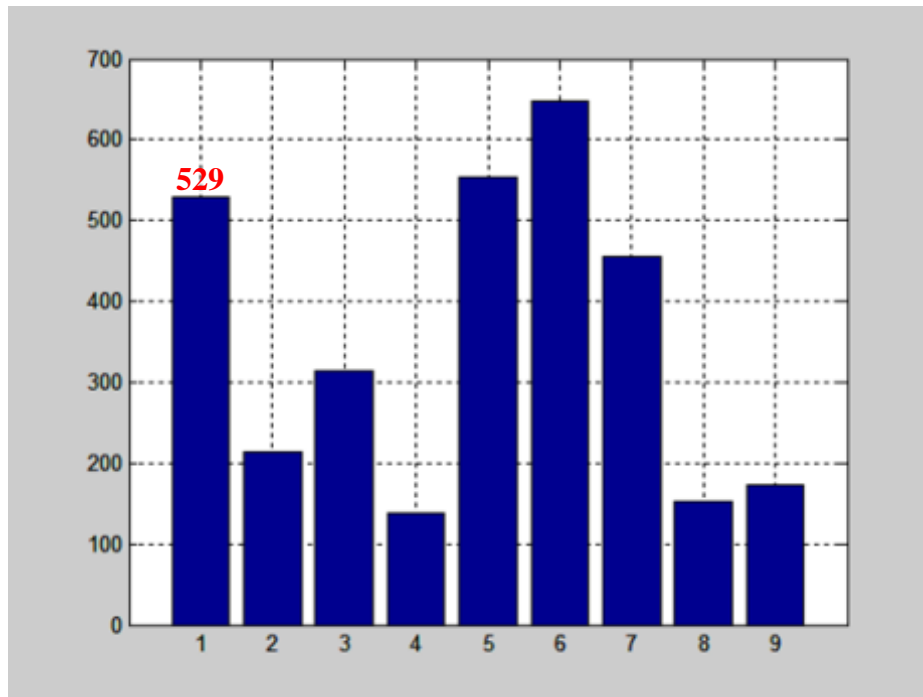
Angle = 20



Magnitude	128								
Bin	0-20	21-40	41-60	61-80	81-100	101-120	121-140	141-160	161-180

Calculating Histogram of Gradients

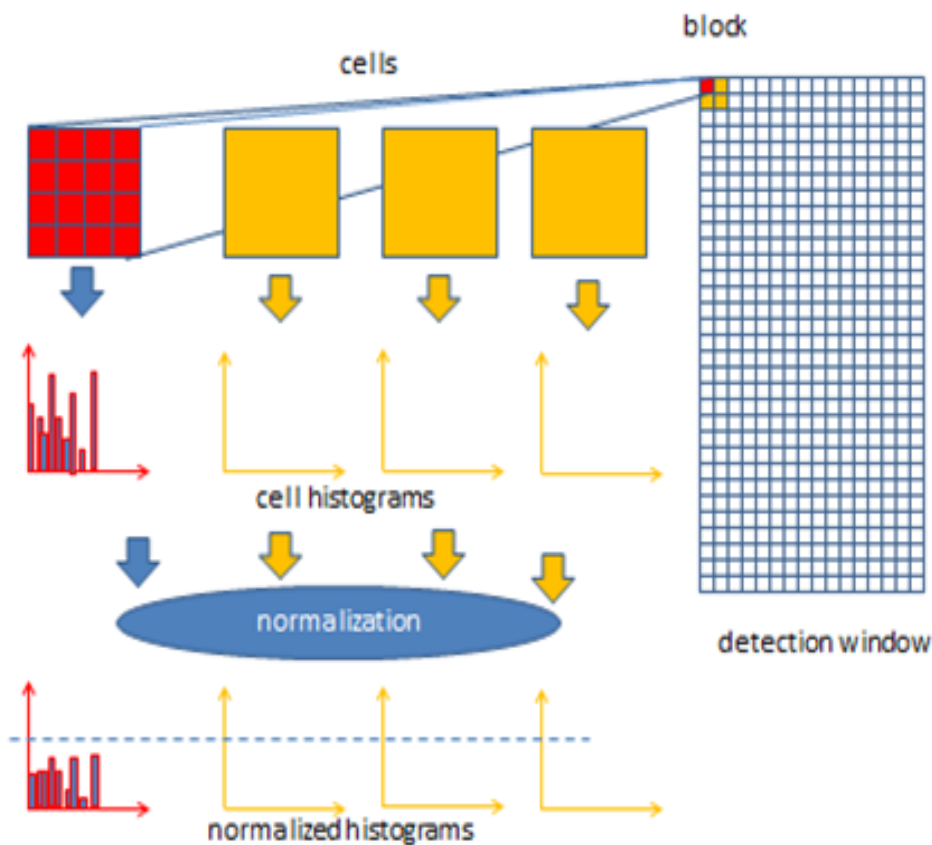
Histogram takes the angle or orientation on the x-axis and the total sum of gradient magnitude on the y-axis.



Histogram of Gradients

Total Magnitude for 20
 $128+89+63+65+41+65+78 = 529$

HOG (cont.)



Computation of the HOG descriptor requires the following basic configuration parameters:

- ❖ Masks to compute derivatives and gradients
- ❖ Geometry of splitting an image into cells and grouping cells into a block
- ❖ Block overlapping
- ❖ Normalization parameters

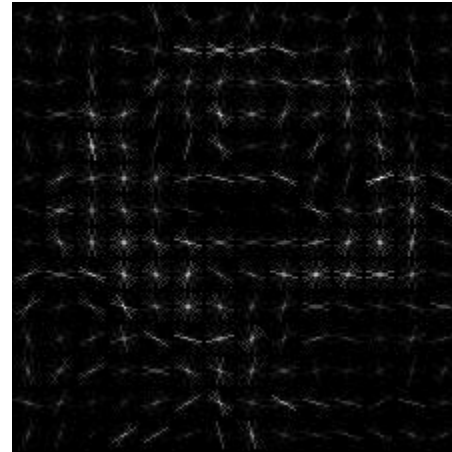
the recommended values for the HOG parameters are:

- ❖ 1D centered derivative mask $[-1, 0, 1]$
- ❖ Detection window size is 64×128
- ❖ Cell size is 8×8
- ❖ Block size is 16×16 (2×2 cells)

HOG (cont.)



Input image



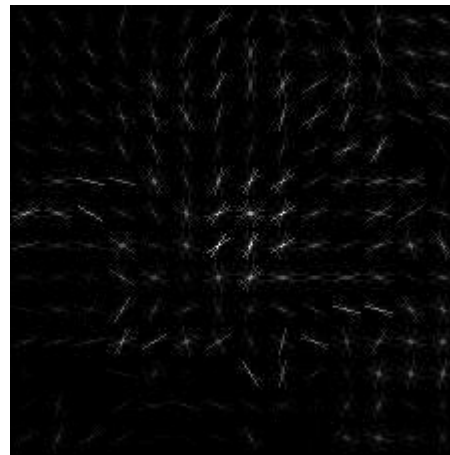
Histogram of oriented gradient

```
from skimage.feature import hog
from skimage import io
image = io.imread('rose.jpg')
fd, hog_image = hog(image, orientations=8,
pixels_per_cell=(16, 16),
cells_per_block=(1, 1), visualize=True)
```

HOG (cont.)



Input image



Histogram of oriented gradient

Next Week Lecture (Week12)

- Lecture12:Image Classification

Thank You