Haar Features

Set of Correlation Responses to Haar Filters

Input Image

$\otimes$

H_A

H_B

H_C

H_D

Haar Filters

$=$

$V_A[i,j]$

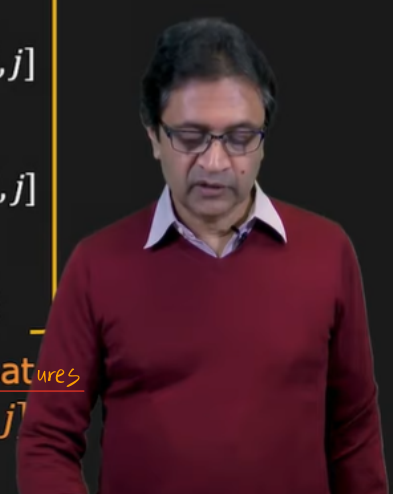
$V_B[i,j]$

$V_C[i,j]$

$V_D[i,j]$

Haar Features

$\mathbf{f}[i,j]$



Computing A Haar Feature

$\otimes$

H_A

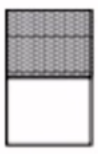
White = 1, Black = -1

Response to Filter H_A at location (i,j):

$$V_A[i,j] = \sum_m \sum_n I[m-i, n-j] H_A[m,n]$$

$$V_A[i,j] = \sum \text{(pixel intensities in white area)} - \sum \text{(pixels intensities in black area)}$$

1. What are Haar features?



Delta = White_region - Black_region

변화량

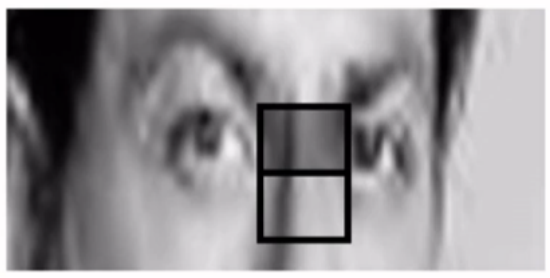
2	3	1	0	1	5	3	2	0	0
1	4	2	3	0	1	4	5	5	1
2	3	0	4	1	5	0	0	2	5
1	4	0	5	1	2	2	3	3	4
4	5	0	2	1	1	3	4	3	0
2	3	1	0	1	5	3	2	0	0
1	4	2	3	0	1	4	5	5	1
2	3	0	4	1	5	0	0	2	5
1	4	0	5	1	2	2	3	3	4
4	5	0	2	1	1	3	4	3	0

D_1 = 1 - 2 = - 1

D_2 = 4 - 3 = 1

2. How are they useful?

Goal: delta should be as high as possible.



Haar features only at certain locations are activated.

Activated: High Delta.

Dark pixels: lower values

Bright pixels: higher values

4. How 180,000+ features.

	1	2	3	4	5	6	7	8	9	10
1	2	3	1	0	1	5	3	2	0	0
2	1	4	2	3	0	1	4	5	5	1
3	2	3	0	4	1	5	0	0	2	5
4	1	4	0	5	1	2	2	3	3	4
5	4	5	0	2	1	1	3	4	3	0
6	2	3	1	0	1	5	3	2	0	0
7	1	4	2	3	0	1	4	5	5	1
8	2	3	0	4	1	5	0	0	2	5
9	1	4	0	5	1	2	2	3	3	4
10	4	5	0	2	1	1	3	4	3	0

Rows : 10 Columns = 9 Total = 10 * 9 = 90 (features)

한 개의 Haar filter를 통해 생성된 한 개의 Haar feature의 크기

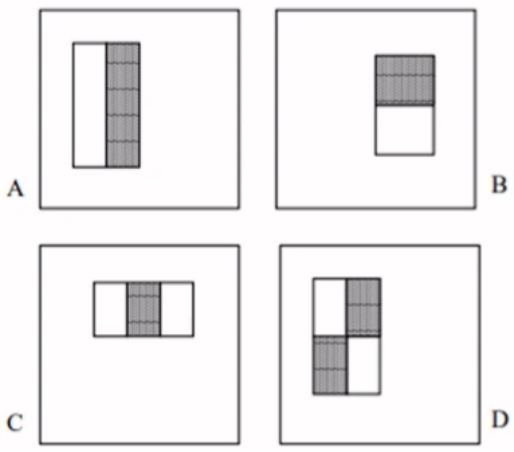
4. How 180,000+ features.

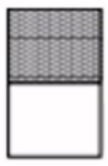
	1	2	3	4	5	6	7	8	9	10
1	2	3	1	0	1	5	3	2	0	0
2	1	4	2	3	0	1	4	5	5	1
3	2	3	0	4	1	5	0	0	2	5
4	1	4	0	5	1	2	2	3	3	4
5	4	5	0	2	1	1	3	4	3	0
6	2	3	1	0	1	5	3	2	0	0
7	1	4	2	3	0	1	4	5	5	1
8	2	3	0	4	1	5	0	0	2	5
9	1	4	0	5	1	2	2	3	3	4
10	4	5	0	2	1	1	3	4	3	0

Rows : 9 Columns = 9 Total = 9 * 9 = 81 (features)

한 개의 Haar filter를 통해 생성된 한 개의 Haar feature의 크기

4. How 180,000+ features.





Size.

Position.

Size.

Position.

All shapes , size , positions = 180,000+ features.

모든 Haar feature를 concate 해서 산출된 벡터의 크기

: 특정 윈도우에 대한 feature vector.

5. How would these features look in a dataframe.

Size: 2*1

2	3	1	0	1	5	3	2	0	0
1	4	2	3	0	1	4	5	5	1
2	3	0	4	1	5	0	0	2	5
1	4	0	5	1	2	2	3	3	4
4	5	0	2	1	1	3	4	3	0
2	3	1	0	1	5	3	2	0	0
1	4	2	3	0	1	4	5	5	1
2	3	0	4	1	5	0	0	2	5
1	4	0	5	1	2	2	3	3	4
4	5	0	2	1	1	3	4	3	0

M(21)11	M(21)21	...	M(21)1010	M(22)31	....				
-1	1								