

Computer Vision: Face Detection & Recognition

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Part I: Face Detection

1 What is Face Detection

2 Face Detection Applications

- Auto focus using face detection in Smart Phones
- People Search in Search Engines like MS Bing

3 Viola-Jones Algorithm

4 Haar-like features

- Calculate haar-like features
- Example on haar-like features

5 Integral Image

6 AdaBoost

7 Cascade Classifier

Outline

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What is Face Detection

- **Object detection** is one of the computer technologies that is connected to image processing and computer vision. It is concerned with detecting instances of an object such as human faces, buildings, trees, cars, etc. [3]
 - The primary aim of face detection algorithms is to determine whether there is any face in an image or not.

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Face Detection Applications

- Auto focus using face detection in Smart Phones
- People Search in Search Engines like MS Bing

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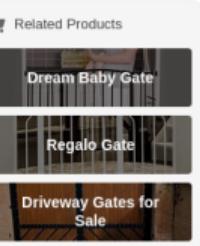
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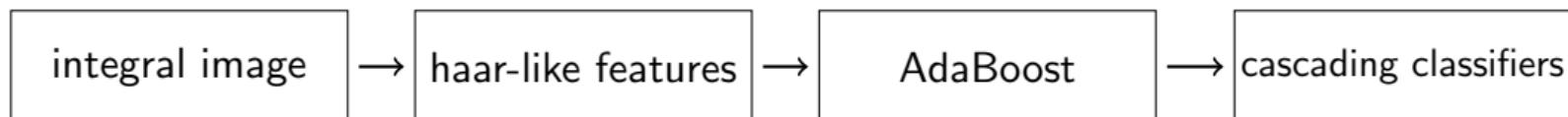
The Microsoft Bing search results page for the query "gates". The top navigation bar includes "SEARCH", "CHAT", "IMAGES" (selected), "Inspiration", "Create", "Collections", "VIDEOS", "MAPS", "NEWS", and "MORE". Below the search bar are filters for "Image size", "Color", "Type", "Layout", "Just faces", "Date", "License", and "Clear filters". A grid of images shows various types of gates: Home Security Gates, Metal Gates, Side Gate, BackYard Gates, Security Gates for Doorways, Driveway Gates, Gate Art, Garden Gates Wooden, Steel Security Gates, and Baby Gate. Below this, a large image of Bill Gates is followed by several smaller images of him. To the right of the main image is a "Related Products" sidebar with links to "Dream Baby Gate", "Regalo Gate", and "Driveway Gates for Sale". Below the images are news snippets about Bill Gates.

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Viola-Jones Algorithm

- Viola Jones algorithm is named after two computer vision researchers who proposed the method in 2001, Paul Viola and Michael Jones in their paper, “Rapid Object Detection using a Boosted Cascade of Simple Features” [4].
- The Viola Jones algorithm has four main steps, which we shall discuss in the sections to follow:
 - Creating an integral image
 - Selecting Haar-like features
 - Running AdaBoost training
 - Creating classifier cascades



- this algorithm works on grayscale image

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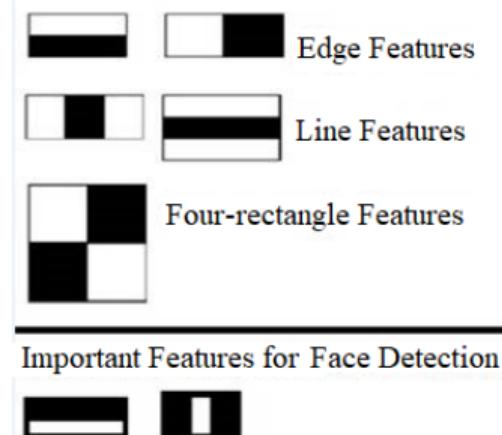
- Calculate haar-like features
- Example on haar-like features

5 Integral Image

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Haar-like features

- Haar-like features are digital image features used in object recognition.
- There are 3 types of Haar-like features that Viola and Jones identified in their research:



- we can divide a group of pixels into two categories, white (1) and black (-1)
- different sizes for the same feature

Calculate haar-like features

for every image apply sub-windows of 24×24 :

$$\delta = white_{region} - black_{region} \quad (1)$$

Example:



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

Figure: src: Haar Feature In Detail (youtube) [2]

Example on haar-like features

$$D_1 = 1 - 2 = -1$$

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

Example on haar-like features

$$D_1 = 1 - 2 = -1$$

$$D_2 = 4 - 3 = 1$$

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

Example on haar-like features

Extracting a 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)

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Integral Image

We Use Integral Image approach to Running time

1	1	1	1
1	1	1	1
1	1	1	1

Original Image

1	2	3	4
2	4	6	8
3	6	9	12

Integral Image

- Sum of all left and top pixels.

Figure: src: CVision Viola Jones (youtube) [1]

Integral Image

We Use Integral Image approach to Running time

1	1	1	1
1	1	1	1
1	1	1	1

Box sum = 4

Original Image

1	2	3	4
2	4	6	8
3	6	9	12

Sum from Int
Img = $12 + 2 - 4 - 6 = 4$

Integral Image

- Sum of all left and top pixels.

Figure: src: CVision Viola Jones (youtube) [1]

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AdaBoost

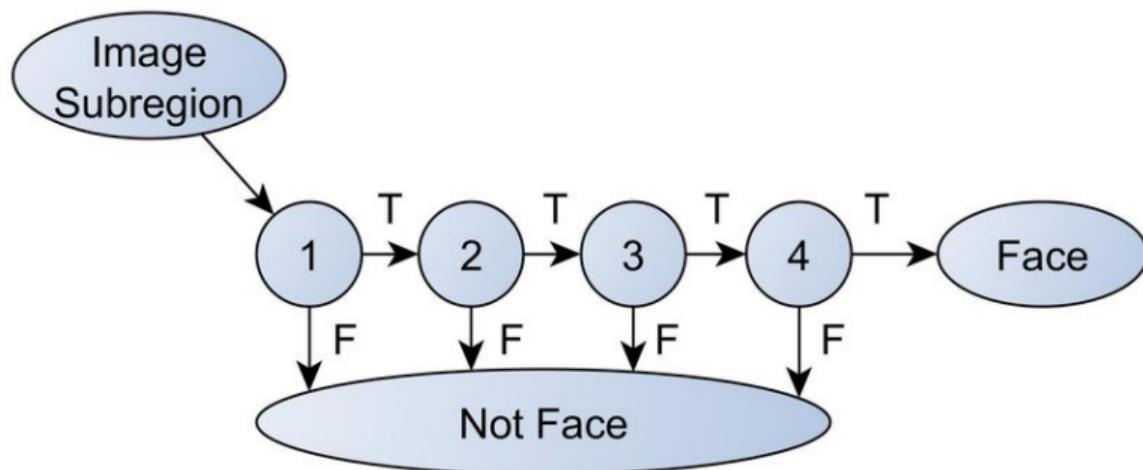
- Eliminate the irrelevant Features
- with this technique, their final set of useful features got reduced to approx 6000

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Cascade Classifier

- A set of weak classifiers are combined to form a strong classifier.
- The more weak classifier combined, the stronger the cascade classifier will be.



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