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Face detection using Viola-Jones algorithm

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Abstract

Face detection can be regarded as a specific case of object-class detection. In object-class detection, the task is to find the locations and sizes of all objects in an image that belong to a given class. Face-detection algorithms focus on the detection of frontal human faces. It is analogous to image detection in which the image of a person is matched bit by bit. Image matches with the image stores in database. Any facial feature changes in the database will invalidate the matching process. In this paper a reliable face-detection approach has been proposed. Each possible face candidate is normalized to reduce both the lighting effect, which is caused by uneven illumination; and the shirring effect, which is due to head movement. This is the primary structure for protest location which gave reasonable outcomes for continuous circumstances. Paul Viola and Michael Jones had proposed the calculation in year 2001. It was gone for focusing on the issue of Shot revelation yet can likewise be prepared for recognizing diverse question classes. It is executed in Open CV as Haar Detect Objects. It is favored for its vigorous nature and its quick revelation of Shots (full frontal upright countenances) in down to earth circumstances.

Keywords: Face detection, Viola-Jones, Haar, Human face

1.Introduction

Face recognition is the problem of identifying and verifying people in a photograph by their face. It is a task that is trivially performed by humans, even under varying light [1] and when faces are changed by age or obstructed with accessories and facial hair. Nevertheless, it is remained a challenging computer vision problem for decades until recently. Deep learning methods can leverage very large datasets of faces and learn rich and compact representations of faces, allowing modern models to first perform as-well and later to outperform the face recognition [2] capabilities of humans. There is often a need to automatically recognize the people in a photograph. There are many reasons why we might want to automatically recognize a person in a photograph. For example: We may want to restrict access to a resource to one person, called face authentication [3][4]. We may want to confirm that the person matches their ID, called face verification. We may want to assign a name to a face, called face identification. Generally, we refer to this as the problem of automatic “face recognition” and it may apply to both still photographs or faces in streams of video. Humans can perform this task very easily. We can find the faces in an image and comment as to who the people are if they are known. We can do this very well, such as when the people have aged, are wearing sunglasses, have different colored hair, are looking in different directions, and so on [5]. We can do this so well that we find faces where there aren't any, such as in clouds. Nevertheless, this remains a hard problem to perform automatically with software, even after 60 or more years of research. Until perhaps very recently. For example, recognition of face images acquired in an outdoor environment with changes in illumination and/or pose remains a largely unsolved problem. In other words, current systems are [8] still far away from the capability of the human perception system. Face recognition is often described as a process that first involves four steps; they are: face detection, face alignment, feature extraction, and finally face recognition[6][7].

1. **Face Detection**. Locate one or more faces in the image and mark with a bounding box.
2. **Face Alignment**. Normalize the face to be consistent with the database, such as geometry and photometrics.
3. **Feature Extraction**. Extract features from the face that can be used for the recognition task.
4. **Face Recognition**. Perform matching of the face against one or more known faces in a prepared database.

A system may have a separate module or program for each step, which was traditionally the case, or may combine some or all the steps into a single process. The below figure represents the flow of the recognition process for the face detection.

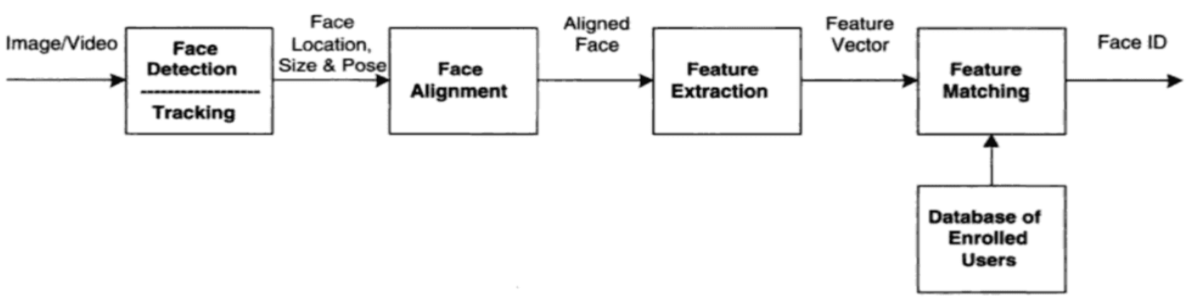

Figure1.Face recognition processing flow

- **Face detection**: The face to be tracked (query image) from the image /video for the purpose of automatic detection.
- **Face alignment**: The face location, size and pose to be computed
- **Feature extraction:** Apply the proposed model and obtain the feature vectors
- **Feature matching**: The obtained features have to be compared with the database image features for the matching purpose.
- **Data Base**: The identification of the face (query image) can be done once the feature vectors are matched with the database image.

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2.Motivations and Challenges

From Instagram filters to self-driving cars, Computer Vision technologies are now deeply integrated into the lifestyle of many people. One important Computer Vision application is the ability to have a computer detects objects in images. Among those objects, the human face receives the most attention since it has many useful applications in security and entertainments. Hence, this paper focuses on a popular face detection framework called the Viola-Jones Object Detection Framework. The aim here is to provide with the understanding of the framework so that we can confidently use an open-source implementation like the OpenCV. Viola-Jones Object Detection Framework can quickly and accurately detect objects in images and works particularly well with the human face (Viola & Jones, 2001). Despite its age, the framework is still a leading player in face detection alongside many of its CNNs counter parts. The Viola-Jones Object Detection Framework combines the concepts of Haar-like Features, Integral Images, the AdaBoost Algorithm, and the Cascade Classifier to create a system for object detection that is fast and accurate.

3. Implementation of Viola Jones detector

The primary venture of the Viola-Jones Shot discovery calculation is to transform the info appreciation into a fundamental appreciation. It is carried out by making every pel equivalent to the whole total of all pels to the left or more of the concerned pel. This takes into consideration the computation of the whole of all pels inside any given rectangle utilizing just four qualities. All these qualities are the pels in the indispensable appreciation that correspond with the corners of the rectangle in the info appreciation. The Viola-Jones Shot detector dissects a given sub-window utilizing characteristics comprising of two or more rectangles. There are 5 of such characteristics. Each one characteristic brings about a solitary worth which is computed by subtracting the total of the white rectangle from the aggregate of the dark rectangle. Viola-Jones have empirically observed that a finder with a base determination of 24*24 pels gives palatable effects. While considering all conceivable sizes and positions of the characteristics, what added up to give or take 160,000 separate characteristics can then be built. Consequently, the measure of conceivable characteristics boundlessly dwarfs the 576 pels held in the locator at base determination.

The 5 basic Haar-features are:

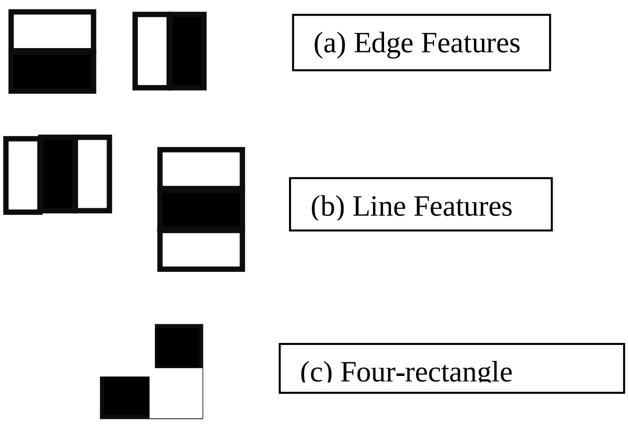

Figure.3.1: The 5 basic Haar-features

Rectangle_Feature_value f = Σ (pels values in white area) – Σ (pels values in shaded area)

If Rectangle_Feature_value > threshold, then feature =1 else feature = 0

The integral image at location (x, y), is the sum of the pel values above and to the left of (x, y).

Input image:

1	1	1
1	1	1
1	1	1

Integral Image:

1	2	3
2	4	6
3	6	9

Figure. 3.12

If A,B,C,D are the values of the integral images at the corners of the rectangle R. The sum of image values inside R is:

Area_R = A + D – B – C

If A,B,C,D are found, only 3 additions are needed to find Area R

4. Results and Discussion

This is the primary structure for protest location which gave reasonable outcomes for continuous circumstances. Paul Viola and Michael Jones had proposed the calculation in year 2001. It was gone for focusing on the issue of Shot revelation yet can likewise be prepared for recognizing diverse question classes. It is executed in Open CV as Haar Detect Objects. It is favored for its vigorous nature and its quick revelation of Shots (full frontal upright countenances) in down to earth circumstances. It contains six phases specifically.

STEPS:

A. Read Image:

In this phase a method that can extract the shape of the eyes, nose, mouth, and chin, is used and it helps to distinguish the Shot by distance and scale of those organs.

Fig 4.1. Image to be read

B. Detect Image:

The main concern of Shot detection is to identify all image regions which contain a Shot regardless of its direction, background & lighting conditions. Such task is tricky since Shots can have a vast assortment in terms of shape, color, size, or texture. Image detection phase does this.

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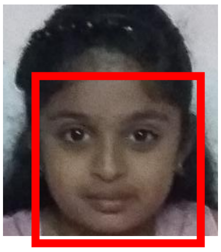

Fig.4.2: Detected Image

C. Identify Motion Feature Points:

Feature points of an image like eyes, chin, eyebrows, lips, nose, etc. are identified and marked during this phase.

Fig.4.3: Image Motion Feature point detected

D. Color Space Transformation and Lighting Compensation:

In this phase membrane-color detection is used as an intermediate step of Shot detection.

Fig.4.4: (a). Normal Image. (b) Color Space Transformation of an Image

E. High Frequency Noisy Removing:

Noise from the image is removed in this stage using noise removal algorithms

Fig.4.5: Noise Removal from the Image

F. Edge Detection and Size Reduction:

Image edges are detected and marked in this stage. End points of features, chooses the dimensionality reducing linear projection that maximize the scatter of all projected samples.

Fig.4.6: Edge Detection and Size Reduction

The fundamental rule of the Viola-Jones calculation is to sweep a sub-window fit for catching Shots over a given info appreciation. The fundamental appreciation transforming methodology might be to rescale the information appreciation to different sizes and after that run the altered size locator through these appreciations. This methodology ends up being tedious because of the figuring of the diverse size appreciations. In opposition to the standard methodology Viola-Jones rescaled the detector rather than the data appreciation and run the locator commonly through the appreciation each one time with an alternate size. From the get-go one may suspect both methodologies to be similarly tedious, however Viola-Jones have concocted a scale invariant detector that requires the same number of computations whatever the size. This locator is built utilizing a supposed-fundamental appreciation and some basic rectangular characteristics reminiscent of Haar wavelets. Viola-Jones Shot indicator has three recognized key commitments, which prompt high handling rate and discovery rates. These key commitments are the basic appreciation, a proficient taking in calculation focused around Adaboost, and a course structure.

5.0 Conclusion.

In this paper, we have presented a detailed study of Viola Jones algorithm and its major steps. We have successfully implemented Viola jones algorithm to detect faces in real-time. The input can be taken through any working camera given that it is connected to the system. Even after evolution of a number of technologies for facial detection, this algorithm is still widely used at present to detect faces by a number of big companies, particularly because of how fast and simple it is.

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