IMPLEMENTATION AND ANALYSIS OF FACE DETECTION METHODS

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Abstract: Human face detection is an important research area having wide application in Public security, Electronic commerce, Video conferencing, Smart cards, Law enforcement & surveillance, human-machine interface, advertisement industry, content-based image retrieval, gesture recognition, crowd surveillance and face recognition, entertainment services, etc. Face detection is one of the most complicated problems in computer vision area. A lot of various studies have been performed for Face detection. And they have many problems like having different lighting conditions, having glasses, facial hair or mustache on face, skin color, different orientation pose or occlusion of face. In this paper we implement and analyze Viola Jones method, Skin color based detection for detecting the faces and Background Subtraction method for finding faces in motion. Later the time taken to detect faces from images/videos from all these methods are tabulated and compared for a better detection method.

Keywords: Face detection, viola jones method, background subtraction method.

1. Introduction

Human face detection and tracking is an important investigation area having wide application in Public security, Electronic commerce, Videoconferencing, Smart cards, Law enforcement & surveillance, human-machine interface, advertisement industry, content-based image retrieval, gesture recognition, crowd surveillance and face recognition, entertainment services, etc. Numerous researches generally gave careful consideration to Face Recognition calculations considering Face Detection tasks (essential first stage for all face acknowledgment frameworks) to be almost solved.

Face detection is a method of recognizing and finding faces in input images. Since the face identification is frequently conveyed under real-time necessities, conventionally exclusive keen hardware has been used to pledge a adequate performance level. The primary CPU-based constant face discovery calculation was developed by Viola and Jones using: Integral image, Adaboost Algorithm and Cascade classifier.

Skin color is an imperative component of human appearances. The transmission of skin color groups in a little locale of the chromatic color space. Processing color is faster than preparing other facial features. In this way, skin color detection is accomplished on the input color image to lessen the computational complexity. In view of the precision of skin color detection influences the aftereffect of face discovery framework, picking a suitable color space for skin color detection is essential. Among various color space, RGB color space is delicate to the difference in intensity.

Visual analysis of human motion is at present a standout amongst the most dynamic exploration views in computer vision. The motion of human body location is mainly essential component of the human body motion investigation, the reason is to distinguish the moving part from the

foundation picture in feature successions, and the subsequent treatment, for example, the objective arrangement, the human body following and conduct comprehension, its viable recognition assumes a critical part in detection. The Background subtraction algorithms is to utilize the distinction technique for the present picture and foundation picture to recognize moving articles, with modest algorithm, it is sensitive in the outside environment and has poor anti-intervention capability. This gives the broad article information in case of background is known.

Computer vision is a field that incorporates techniques for acquiring, processing, assessing, and comprehension pictures and high-dimensional information from this present reality keeping in mind the end goal to deliver scientific or typical information. A subject in the advancement of this field has been to copy the capacities of human vision by electronically seeing and comprehension an image. Computer vision has additionally been portrayed as the endeavor of robotizing and incorporating an extensive variety of procedures and representations for vision perception.

Be that as it may, on application that oblige high-determination images comprising numeral of faces, today's real time detection algorithms might at present devour important CPU resources or maybe unsuccessful to the real-time constraints. Therefore, it is still serious to progress high performance face detection results with a practical hardware cost.

2. Methodology

For detecting Face/faces in real time / prerecorded image, Viola Jones method and Skin color based methods are used. Background Subtraction method is used to detect faces in the Video. All the three methods are implemented and analysed. Later the time taken to detect faces from images/videos from these methods are tabulated and compared for a better detection method.

After the comparison of all these methods with several images from real time / prerecorded image, a plot is generated that indicates the best Face Detection method which results in lesser detection time.

3. Face detection methods

In this paper, three methods are used for Face Detection and are compared:

- Viola-Jones Face Detection method
- Skin color based Face detection
- Background Subtraction Method

3.1 Viola-Jones Face Detection Method

Viola Jones Object Detection framework developed by Paul Viola and Michael Jones in 2001 be one of the first methods to provide object detection at very fast rates. It is the method for rapid and correct object detection through Adaboost machine learning. The major features of Viola Jones method are:

Haar –like feature rectangle

The Viola-Jones cascade classifier is a face detection algorithm based on Haar-like features. A few Haar-like feature rectangles used in this project are shown in Fig.1. The quality value of feature rectangle is the result of the white section pixel value sum subtracting the black section pixel value sum. The quality value of feature rectangle is used for the basis for face detection, because that there is a clear difference between facial in color, shape, and location distribution, and compared to the outside word nonface clutter the face itself has a very high regularity.

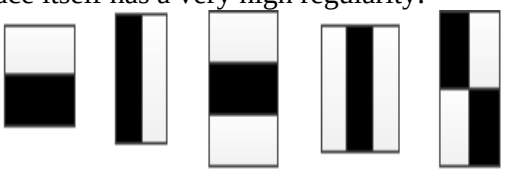

Figure 1: Haar-like feature Rectangle

Integral Image Representation

Detection of Objects requires computation of haar features and in order to compute them, integral image is required. Integral image is obtained using few operations per pixel. Later, Haar features of any type is computed in constant time. The calculation of feature rectangle's characteristic value is an important part of the face detection process. The pixel value sum's calculation within a rectangular region can be simplified as a fixed times of addition or subtraction operations. The calculation of the

point ii (x, y)'s integral value and the pixel value sum S within the rectangular region are performed as in Equation 1 and Equation 2, where i (x', y') is the point (x',y')'s pixel value of image, (xA, yA), (xB, yB), (xC, yC) and (xD,yD) are the rectangular region's top left, top right, bottom left and bottom right corner's coordinate respectively.

$$ii(x,y) = \sum_{x' \le x, y' \le y} i(x', y') \quad (1)$$

$$S = ii(x_D, y_D) - ii(x_C, y_C) - ii(x_B, y_B) + ii(x_A, y_A) \quad (2)$$

Adaboost Algorithm

The Adaboost algorithm, which created efficient classifiers from set extracting important features. This can be utilized as a part of mix with numerous knowledge algorithms to enhance the performance. The Adaboost algorithm is used to select the feature rectangle which covers facial characteristics, composes them into a weak classifier, then creates a strong classifier using a group of weak classifiers, and last concatenates the strong classifiers to a cascade classifier. The algorithm can produce a simple and efficient classifier by setting appropriate return value of classification function and through iterative learning, and the classifier can significantly increase the speed of face detection.

Cascade Classifier

The "cascade" classifier which focuses on Object like parts and discards the background. Cascade is a type of mechanism that knows its region of attention and discarded region are not likely to contain any object as shown in Figure 2. This is very fast in Real Time detection.

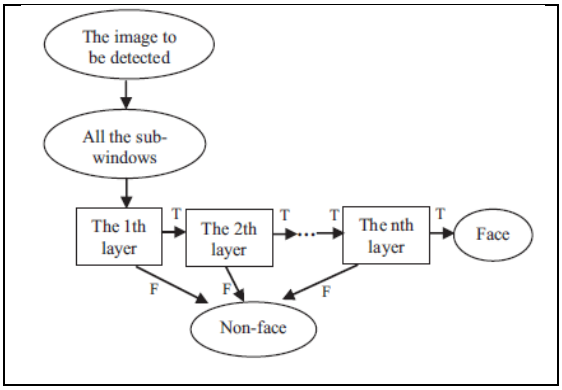

Figure 2: The structure of Cascade Classifier

The Face detection steps are shown in Figure 3:

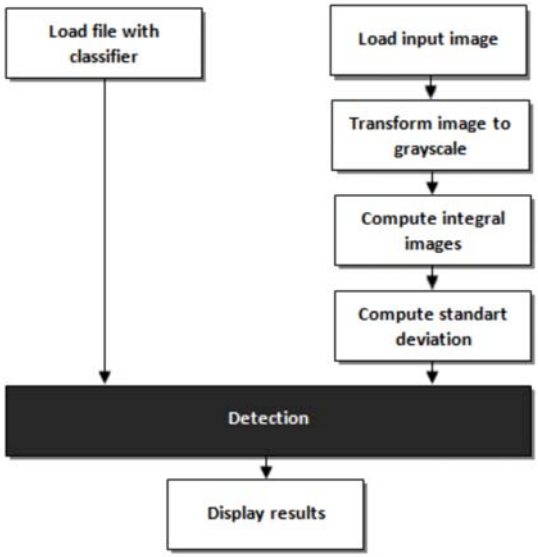

Figure 3: Face Detection steps

3.2 Skin color based Face Detection

Color is an imperative component of human faces. Utilizing skin-color as an element for following a face for few points of interest. Color handling is quicker than preparing additional facial elements. In few lighting conditions, color is introduction invariant. This property makes movement inference much less demanding on the grounds that just an interpretation model is required for movement estimation. Following human confronts utilizing color as a component has a few issues like the color representation of a face got by a camera is impacted by numerous variables (encompassing light, protest development, and so on.), distinctive cameras deliver fundamentally diverse color values notwithstanding for the same individual beneath the same lighting circumstances and skin color contrasts from individual to individual. Keeping in mind the end goal to utilize color as a component for face following, we have to tackle these issues. A drawback of the color indication is its affectability to light color changes and, particularly on account of RGB, affectability to brightening force. One approach to build resistance toward power changes in images is to change the RGB image into a HSV color space. The main difficulty is doesn't work with all sort

of skin hues, and is not extremely powerful under fluctuating lighting conditions.

RGB color model:

RGB is a color space started from CRT show applications, when it was helpful to represent color as a blend of three colored rays (red, green and blue). It is the generally utilized color space for handling and locating away of advanced image information. The RGB color model is an added substance color model in which red, green, and blue light are included in different approaches to recreate a wide cluster of colors. Input RGB gadgets are color TV and camcorders, image scanners, and computerized cameras. Output RGB gadgets are TV sets of different innovations (CRT, LCD, plasma, and so forth.), Computer and cell telephone shows, feature projectors, multicolor LED shows, and so forth. The primary reason for the RGB color model demonstrated in Figure 4 is for the detecting, demonstration and presentation of images in electronic frameworks.

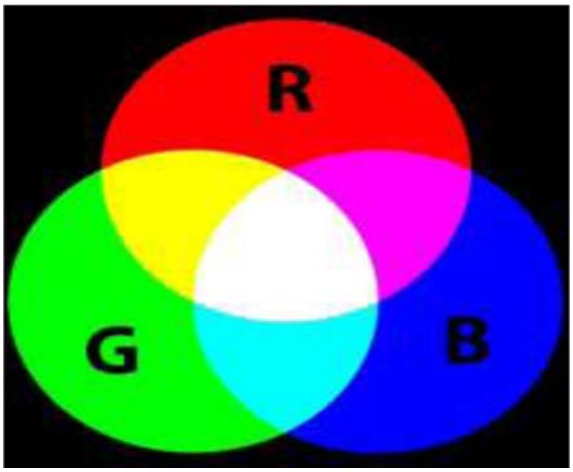

Figure 4: RGB color model

The RGB color 3D shape is denoted by a 3-dimensional 3D cube with red green and blue at the corners on every point demonstrated in Figure 5. Gray at the beginning. White at the inverse end of the solid shape. The gray scale takes after the line from gray to white. In a 24-bit color representation framework with 8 bits for each color channel, red is (255, 0, 0). On the color 3D square, it is (1, 0, 0). The RGB model rearranges the outline of computer representation frameworks yet is not perfect for all applications. The red, green and blue color parts are exceptionally associated. This makes it hard to execute some image handling calculations. Hence the locality of interest is changed over from RGB color space to HSV color space

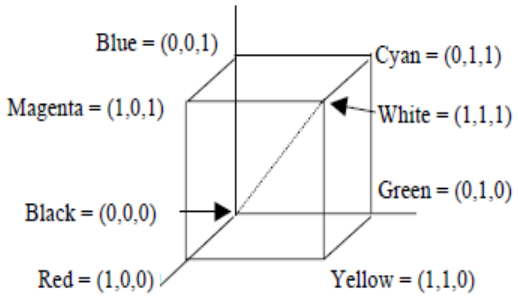

Figure 5: RGB Color Cube

HSV Color Model

In the HSV color model, where H, S and V positions for Hue Saturation and Value respectively. The detected region of interest is taken from the image and altered from RGB color space into HSV color range. For each of the color range, the pixels that fall in the domain of skin are converted to white and the pixels that are not in the domain are converted to black. Finally the face is detected from the image.

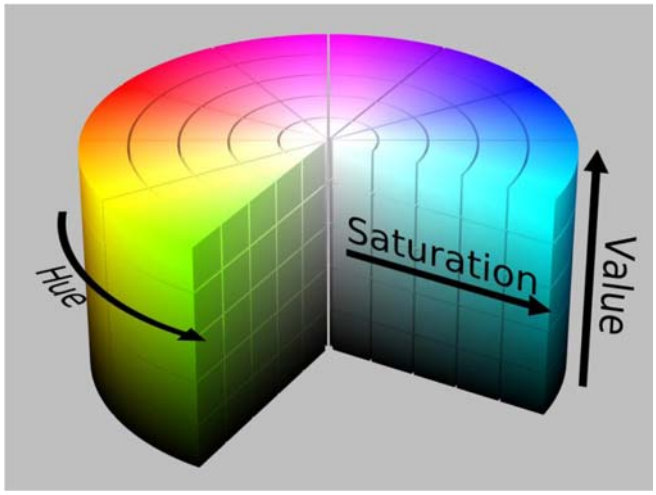

Figure 6: HSV color space

3.3 Background Subtraction Method

The background subtraction method is a simple algorithm used to take the difference of the present image and foundation image to identify faces in motion, but perceptive to the variations in the outer environment and has poor anti-

obstruction capability. This provides the most complete information if the background is known.

The methods used in moving object detection are

- Frame subtraction technique
- Background subtraction technique and
- Optical flow technique.

Optical flow technique is recognized when the camera moves yet the strategy are excessively difficult and not appropriate for continuous frameworks. Frame subtraction technique is more suitable to changes of the dynamic scene, its estimation is straightforward and simple to represent. It is more suitable for ongoing preparing, however can't separate a absolute blueprint of moving article. Background subtraction technique can give the most finish item data on account of the Background. In the genuine checking frameworks, cameras and Background are settled. The present image with the settled Background distinction is received to get competitor area of moving face.

The aim of the Background subtraction technique is to estimate the grayscale distinction among every purpose of the present image and Background image and afterward set an threshold to figures out the pixels which are on the moving focuses. The calculation is portrayed as:

$$D_k(x,y)=\begin{cases}1 & |F_k(x,y)-B_{k-1}(x,y)|>T \\ 0 & others\end{cases}$$

Where D_k (x, y) is the double image of differential results. B_{k-1}(x, y) is the Background image F_k(x, y) is the present edge .T is dim scale edge, its size decides the exactness of Face identification.

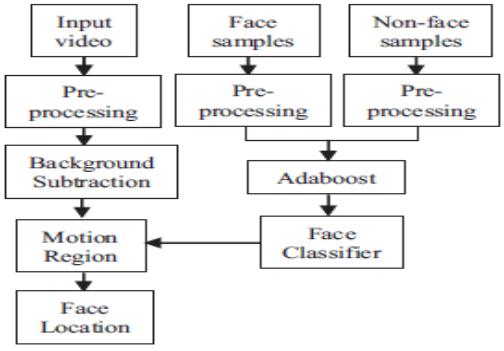

Figure 7: The flow of Face Detection System

The whole detection flow is demonstrated in Figure 7 . Initially preprocessing the input video is done. Than by utilizing the Background subtraction method, remove the region contain the human face, after the treatment, the larger part of non-face window are barred, the workload of the subsequent face discovery will be extraordinarily diminished. At last, utilizing multi-layer classifier which are made out of Haar features to get the accurate position of human faces in the candidate area.

4. Experimental Results

This section stats a detailed experimental comparison of the above. Face detection methods has been presented. Table 1 illustrates the comparison of the algorithms. This comparison illustrates that the Viola Jones method gives good results but the time consumption is more than the others. Skin color detection on HSV color space and Background subtraction method are more efficient. Figure 8 illustrate a relative graph based on the experimental results of the comparative performance of all the algorithms.

Sl No	Face Detection Methods	Number of Frames	Detection Time in ms
1	VIOLA JONES METHOD	30	7080
2	SKIN COLOR BASED DETECTION METHOD	30	240
3	BACKGROUND SUBTRACTION METHOD	30	540

Table 1: Comparison of the algorithms

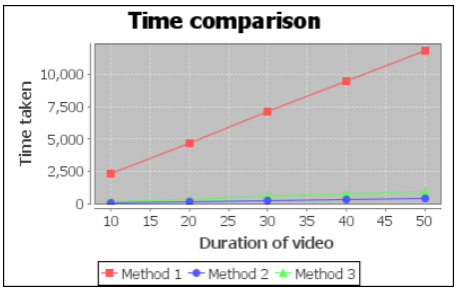

Figure 8: Comparative chart (Method 1 represents the results of Viola Jones method, 2 represent the results of Skin color based Face detection and 3 represent the results of Background Subtraction method)

5. Conclusion

In this paper a comparison has been made for detecting faces, using Viola Jones classifier method, skin color detection on HSV color spaces and Background subtraction method. We have found that Viola Jones classifier method gives good results for detecting frontal faces but for finding faces in motion, takes more time to detect and does not give accurate results. Skin color detection on HSV color space and Background subtraction method are more efficient in comparison to first method by detecting faces in motion giving accurate results. In future, the accuracy for finding faces in motion by Viola Jones method can be improved.

6. References

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