# A Survey of Human Face Detection System

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*Abstract*— Human face detection is recently an active research topic area in the computer vision. Image processing to detect human face has become a very important application area in present time for video surveillance, human computer interface (HCI), human safety, and image database management. A large number of researchers are working on face detection based on facial features to detect human face. In this paper we discuss face detection challenges, different types of face detection techniques and its applications.

***Key words:*** Image Processing, Face detection

## I. INTRODUCTION

Face detection is currently an interesting research topic because it is used in various applications. Monitoring is a major concern in various applications such as face recognition, human computer interaction, video surveillance system, biometrics, face database management, feature extraction and tracking, gesture recognition and facial expressions recognition, security system and so on. The most crucial process is to detect faces and owing to its numerous applications, a face detection system must be accurate. Researchers in the field of image and video processing have made it possible to detect faces in an image. Without accurately detecting human faces, the target tracking or any other subsequent processing will be wrong [1]. There are several face detection systems have been introduced such as Viola-Jones algorithm, Principle Component Analysis, AdaBoost algorithm, Skin Color, Wavelet and Artificial Neural Networks. The various challenges are associated with face detection that can be attributed due to the following factors:

### *A. Pose:*

The faces in the images are vary due to the relative camera-face poses (like frontal, upside down, 45 degree,) and some of facial features such as an eye, nose or the lip may be become partially occluded.

### *B. Presence or Absence Of Structural Components:*

In these Facial features such as mustaches, beards, and glasses may or may not be present and there is a great deal of variability among these components including shape, size, and color.

### *C. Facial Expression:*

The person's facial expressions are affecting the appearances of faces.

### *D. Occlusion:*

In an image with a group of people, some faces may partially occlude other faces. Faces may be partially or fully occluded by other objects.

### *E. Imaging conditions:*

When the image is formed, the factors such as changeable lighting condition and camera characteristics such as sensor response, lenses are affect the appearance of a face.

Detection rate and the number of false positives are important factors in evaluating face detection systems. Detection rate is the ratio between the number of faces correctly detected by the system and the actual number of faces in the image.

Paper organization is as follow: In Section II, we survey different techniques for face detection and survey different works related with software and hardware implementation of face detection for various applications. In Section III, various applications of face detection are presented with example. Finally, in Section IV, we conclude the paper.

## II. LITERATURE SURVEY

There are four techniques for face detection system as follows:

### *A. Knowledge-Based Methods:*

These rule-based methods, the rules are used to capture the relationships between facial features. This method is designed mainly for face localization. This method is following rule of face structure such as eyes, being bilateral symmetry, nose and mouth, being in middle of face, and so on to capture position of face [2].

### *B. Feature Invariant Approaches:*

These are used to find structural features that are not affected by variable face orientations, and changeable lighting conditions. These features are used to locate faces. These methods are designed mainly for face localization. This method utilizes invariant features of face image such as skin color, hair color, face edge, texture, and so on [2].

### *C. Template Matching Methods:*

In this several standard patterns of a face are stored to describe the as a whole face or the facial features separately. The correlations between an input image and these stored patterns are calculated for detection. These methods have been used for both face localization and detection [2].

### *D. Appearance-Based Methods:*

The models are learned from applying a set of training images which should capture the representative variability of facial appearance. Then these learned models are used for detection. This method is designed mainly for face detection [2].

The significant amount of research work has been carried out on face detection in the past few years.

Kawulok et al. in [3] proposed a training based method a multi-level ellipse detector along with a support vector machine verifier to precisely detect human faces and eyes.

 

This system can be used for face recognition but it is not suitable for small faces.

Abin et al. in [4] presented a feature based real-time multiple face detection and tracking algorithm that uses skin color, edge and shape information. But its false detection rate is extremely high (27.6%).

Chen W et al. [5] presented a half-face template-based face detection system. In this system template matching algorithm is used to compare the candidate's half-face template with an average full-face template. It can detect side face pose.

In [6] Viola and Jones proposed a robust real-time face detection framework, in which training based method is built using the AdaBoost classifier. This method combines weak classifiers in cascade form strong classifier to remove the background region of the image and allows promising face-like regions to be processed.

For increasing processing speed hardware implementation is necessary. Some researcher worked on FPGA (Field programmable Gate Array) implementation of face detection system.

The following table gives which algorithm was implemented on FPGA and its detection rate.

| Sr. No. | Author | Year | Algorithm | Detection rate |
|---|---|---|---|---|
| 1. | Chang et al. [7] | IEEE 2012 | Skin color detection, LBP, Lip feature extraction | 94% |
| 2. | Hu et al.[8] | IEEE 2010 | Skin color detection | 90% |
| 3. | Farrugia et al.[9] | IEEE 2009 | Neural Network | 87% |
| 4. | Nguyen et al. [10] | IEEE 2006 | Edge detection and Lip feature extraction | 86% |

Table 1: Comparison with other FPGA based system

The most of face detection system uses skin color model, skin color detection in color images is a very popular and useful technique for face detection. The skin color detector detects whether or not certain regions in a color image to represent a human skin. It must specify certain rules to differentiate between skin and non-skin pixels. To build these rules, a human skin model must be built. Several skin color-modeling methods have been introduced. The selection of the color space that will be used in modeling skin color is very important; it is well known that different people have different skin color appearance, but these differences lie mostly in the color intensity not in the color itself. That is why many skin detection methods drop the luminance component of the color space. There are lots of color spaces that have been used in early work of skin detection, such as RGB, normalized RGB, YCbCr, and HSV [12]. The color spaces selected for use are mostly application oriented. For example RGB originated from CRT display which required additive color scheme to display any color in a black background of CRT. CMYK originated in printing, where ink is used to subtract color from white paper to create colored image or black. Artists prefer HSV scheme to digitally represent their work because it is considered to be natural to 'think' or 'perceive' color in terms of hue and saturation. Orthogonal color spaces like YCbCr is used for digital storage and video and image compression schemes like MPEG and JPEG.

*1) RGB Color Space:*

An RGB image is stored as an m-by-n-by-3 data array that defines Red, Green, and Blue color channels for each individual pixel. The color of each pixel is determined by the combination of the three color intensities stored in each pixel's location. The RGB color space is one of the most used color model for processing digital images, it is not widely used in skin color detection algorithms because it consist chrominance and luminance components are mixed [12].

*2) HSV Color Space:*

Hue-Saturation based color spaces specify color based on three intuitive properties: Hue, Saturation and Value. Hue defines the dominant color (such as red, green, purple and yellow) of an area, Saturation measures the colorfulness of an area in proportion to its brightness and Value measures the color luminance. The HSV Color space is unsuitable in our application because of problem of hue discontinuities, and dependence of both Saturation and Value on illumination conditions.

*3) YCbCr Color Space:*

YCbCr color space for skin detection algorithm because it has a separate luminance component which can be eliminated to make skin color detection independent of illumination conditions. Two important goals are achieved by dropping the luminance component; first the model becomes independent of the differences in skin appearance that may arise from the difference in skin luster or lighting conditions; second the color space dimensions are reduced so our algorithm needs to classify each pixel by checking value of only two color components Cb and Cr, thereby reducing the computational load.

## III. APPLICATIONS

This section presents various applications in which face detection is a first step for various applications. Without accurate detect face we cannot do further processing. The following face detection with recognition applications are considered in the open literature and as commercial applications.

1) It can be deploy in ATM to prevent the frauds, in this system first prepare the database of all ATM customers with the banks & deployment of camera and face detection system at all ATMs. So, whenever user will enter in the ATM his/her photograph will be taken and compare with database to permit the access after it is matched with stored photo from the database.
2) To prevent duplicate voting, in this system database of all voters are prepared, then at the time of voting the high resolution camera with face recognition equipped of voting site will accept a subject face 100% and if match is found it generates the recognition for voting.
3) In passport and visa verification can also be done using face detection with recognition system as explained above.

4) Driving license verification can also be exercised with this system as explained earlier.
5) To identify terrorists at public places such as airports, railway stations and malls the face detection with recognition will be secured as compared with other biometric.
6) In defense area and all other important areas the face detection can be deployed for better security.
7) This system can also be used effectively to replace biometric attendance and this system can be deployed also in various government and private offices for identification, verification and attendance.
8) It can be deployed in police station to identify and verify the criminals.
9) It can be deployed for security purpose in banks for identification and access control verification and of authentic users [11].

## IV. CONCLUSIONS

In this paper the various methods of face detection system with different algorithms are reviewed. Various applications of face detection system are discussed. In face detection system skin color detection method is fast, less computation require. We can combine skin colour with another facial feature extraction to increase its detection rate.

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