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Study & Analysis of Different Face Detection Techniques

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Abstract-Authentication & Identification has become major issue in today's digital world. Face detection plays a significant role in authentication & identification. In this paper several existing face detection approaches are analyzed and discussed. Each approached is discussed briefly & compared with the other in terms of key evaluation parameters. As face detection is the elimentry yet an important step towards automatic face recognition, main goal of this paper is to come up with an approach that is a good candidate for face detection.

Keywords: Face Detection, Skin Color Modeling, Haar like Feature, Principle Component Analysis.

INTRODUCTION

Human face detection is gaining intrest as an improtant research area with many applications. The applications are video conferencing, human-computer interaction, content-based image retrieval, and automatic authorization etc. Face detection problem can be stated as, determining whether there are human faces in the image, and if there are, returning the location of each human face in the image, regardless of its position and lighting condition.

In recent years, face recognition has concerned much attention. It has numerous applications in computer vision communication and regular access control system. Face detection is the elimentry yet an important step towards automatic face recognition. However, face detection is not clear-cut because it has lots of variations of image look, such as pose variation (front, non-front), occlusion, image orientation, illuminating situation and facial appearance.

Face detection is the middle of all facial analysis, e.g., face localization, facial feature detection, face recognition, face verification and facial expression recognition. Moreover, it is a fundamental technique for other applications such as content-based image retrieval, video conferencing, and intelligent human computer interaction (*HCI*).

The objective of face detection is to find out whether or not there are any faces in the image and, if present, return the location and the extent of each face [1]. While face detection is a trivial task for human vision, it is a challenge for computer vision due to the variations in scale, location, orientation, pose, facial expression, light condition, and various appearance features (e.g., presence of glasses, facial hair, makeup, etc.).

To evaluate the performance of face detectors, various metrics are used, e.g., learning time, execution time, the number of samples required in training, and the ratio between the detection rate and the false alarm.

The rest of this paper is organized as follows: In Section 2 we briefly present the evolution in the area of face detection. Sections 3 provide a more detailed survey and discussion of the different subareas.

SEVERAL FACE DETECTION TECHNIQUES

Yang *et al.* [2] gives face detection approaches into four major categories: *Knowledge-based*, *Feature invariant*, *Template matching* and *Appearance-based* approaches. *Knowledge-based approaches* [3] [4] [5] depend on a set of rules, based on human knowledge, to detect faces. For example, a face often includes two eyes, a nose and a mouth within certain distances and positions relative to each other. *Feature invariant approaches* [6] [7] [8] locate faces by extracting structural features of the face. Generally, a statistical classifier is trained and, then, used to differentiate between facial and non-facial regions. *Template matching approaches* [9] [10] use predefined or parameterized face templates to locate and detect faces, by computing the correlation values between the template and the input image. *Appearance-based approaches* [11] [12] [13] depend on a set of delegate training face images to find out face models. Generally, appearance-based methods have shown superior performance compared to others [1]. Up till now, Viola-Jones face detector [13] has the most impact in face detection research during the past decade. It is broadly used in genuine applications such as digital cameras, and digital photo managing software.

A. Feature Base Face Detection

Anima Majumder, L. Behera and Venkatesh K Subramanian et. al. presented different approach for fully automatic detection of facial features. The new techniques may use the basic concepts of facial geometry. They proposed to locate the mouth position, nose position and eyes position. The estimation of detection region for features like eye, nose and mouth enhanced the detection accuracy significantly. Hear we can use the H-plane of the HSV color space to propose for detecting eye pupil from the eye detected region.

The proposed approach, at first, they detect the face using Viola and Jones' Boosting algorithm and a set of Haarlike cascade features. The eye look for area is minimized by assuming the eyes expected position to be at the upper part of the face. Haar-like features cascade is used for the eye detection. It locates the rectangular regions containing eyes. Given the eyes ROI, an algorithm is developed to locate the eye pupil by taking Hue information of the eye image.

The hue image is threshold and contour is detected in the threshold image. Centroid of the contour is detected as the eye pupil. Next, the nose is detected using haar-like features. Having known the eyes center, and the position of the nose, an approach is proposed based on the facial geometry for mouth location estimation. An algorithm is developed to locate the lips corners points, which are considered as good features for tracking lips movement. Finally, nostrils are detected from the nose ROI by taking threshold of the gray nose image and obtaining the contours in the threshold image.

The proposed a robust algorithm for automatic and accurate detection of different facial features. An improvement over detection of eyes, mouth and nose are done by estimating the probable region for each features.

Geometrical interpretations of location of facial features, used in the algorithms are described with pictorial descriptions. It is observed that, with the use of facial geometry, the accuracy of features (eyes, nose and mouth) detection is greatly improved over that of using only the algorithm in whole face image.

The proposed lip detection algorithm is found to be accurately detecting the lips corners for both neutral face images and smiling face images. The eye pupil detection method using H-plane of the HSV color planes image is found to be robustly detecting the pupil in spite of obstacles like wearing spectacles, bad illumination of eye area, variation is sizes of eyes. Algorithm developed using corner detection method, for detecting both inner and outer eye corners are found to be giving accurate results even in faces wearing spectacles. The proposed method for nostrils detection is also found to be accurately detecting in all kind of frontal images tested.

Future work can be done by extending the proposed approach in posed/tilted face images. The work can also be extended for expression recognition and automatic tracking of features in videos [14].

B. Geometric Based Face Detection

Padma Polash Paul and Marina Gavrilova et. al. presented a PCA based modeling of geometric structure of the face for automatic face detection. The method improves the face detection rate and limits the search space. Skin Color Modeling (SCM) is one of the best face detection techniques for image and video. However, feature selection is very important for even better template matching performance in terms of detection rate and time.

This paper presents an efficient feature extraction and selection method based on geometric structure of the facial image boundary and interior. To model the geometric structure of face, Principle Component Analysis (PCA) and canny edge detection are used. Fusion of PCA based geometric modeling and SCM method provides higher face detection accuracy and improves time complexity. Both models provide filtering of image in term of pixel values to get the face location that are very fast and efficient for large image databases. Proposed system uses skin color model to reduce the search space. Orientation invariant threshold based on geometric model and improves system further. For reliable template matching, feature extraction and selection based on novel combination of geometric filter with SCM filter is introduced.

Proposed system is composed of two major components: first, skin regions are segmented using skin color model. In the second part, segmented regions are filtered using geometric model of face.

They can focus on four color spaces which are normally used in the image processing field:

RGB: Colors are precise in terms of the three main colors: red (R), green (G), and blue (B).

HSV: Colors can be represnted individually in the terms of hue (H), saturation (S), and intensity value (V). They are the three attributes that are apparent about color. The conversion between HSV and RGB is nonlinear.

The major goal in this segmentation process is to take away the background of the image from skin regions using formerly discussed skin color model. First, input image is changed into chromatic color space. A grayscale image of skin possibility is constructed using Gaussian model. Skin pixels have some set of stable values for each r, g and b component. A normalized image is consists of has three principles and they are normalized-red, normalized-green and normalized-blue. These normalized components are extracted by Segmentation process and later two images are constructed. Each of these images is changed into black and white image by applying dissimilar threshold for normalized input image.

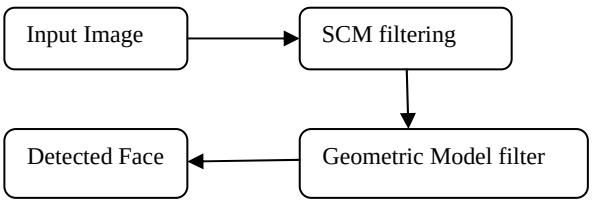

Fig. 1 Proposed Face Detection Block Diagram

Their geometric modeling has three key steps. In the first step, detected skin regions are projecting using PCA. In the second step, projected skin regions are reconstructed using smaller number of Principal Components (PCs). Finally edges are detected from reconstructed skin regions. Since detected skin regions are in different size, each region is resized in to same resolution. A predefine mask is applied on each skink regions after resizing. Threshold value is rotation invariant because we are taking the cumulative sum of the projected geometric structure.

Another advantage of the proposed method it is very fast in computation because of the filtering. If the filter values of

skin segments are within the range of a face or non face system can take decision so time complexity to identify the face become O(1). Fusion of PCA based geometric modeling and SCM method provides higher face detection ccuracy and improves time complexity. Convincing experimental results confirm that the proposed method improves the face detection rate and limits the search space, thus making it very fast and efficient for large image databases [15].

C.High-Level Language based Face Detection

P Daesik Jang, Gregor Miller, Sid Fels, and Steve Oldridge et. al. give a new methods for a user oriented language model for face detection. Hear many open sources or commercial libraries to solve the trouble of face detection. There are still hard to use because they need explicit knowledge on details of algorithmic techniques.

They projected a high-level language model for face detection with which users may develop systems easily. Importantconditions are mainly considered to classify the big trouble of face detection. The conditions recognized here are then represented as expressions in terms of a language model so that developers may use them to express various problems. Once the conditions have developed by users, the proposed associated interpreter interprets the conditions to find and classify the best algorithms to solve the represented problem with corresponding conditions.

The purpose of this technique is to come up with a high-level language model for face detection with which users will expand systems easily and even without specific knowledge of face detection theories and algorithms. By doing this, the problem of selecting algorithms and deciding complicated parameters for algorithms are isolated from development of face-detection applications.

Developers just need to define the problem and express it with the language model suggested and an interpreter will select algorithms appropriate for the associated sub-space of the problem. They first consider the important conditions to classify the huge problem of face detection. The conditions identified here are then expressed in terms of a language model so that developers have been used them to express various requirements of a given problem. Once the conditions are expressed by developers, the interpreter plays an important role to interpret the conditions to find and organize the optimal algorithms to solve the represented problem.

The model is a part of the Open Vision Language (Open-VL), a vision language that allows programmers to describe their vision problem in terms of what it is they want to do, instead of how they want it done. A proof-of-concept is implemented and some example problems are tested and analyzed. They present two different detection problems to validate and demonstrate the ease of use of our proof-of-concept language model proposed in this paper. Three different face detection algorithms have been implemented for the selection of proper algorithms in this paper: AdaBoost based algorithm, Neural Network based algorithm, and Color based algorithm.

The first case is to detect an upright, frontal and large face for face identification. Face detection is often used as a preprocessing for identifying persons by providing the exact future improvement, the technique need more face detection algorithms will be analyzed and added for more practical and better usability of the language model. Some intelligent approaches for selecting algorithms are necessary to be considered for more optimal selection process [16].

D. Haar Like Feature Based Face Detection

T Ning Jiang, Wenxin Yu, Shaopeng Tang, Satoshi Goto et. al.[17] proposed to improve the performance on Haar feature based cascade detector. First, we define a new feature for cascade detector. That feature was called Separate Haar Feature. Second, they defined a new decision algorithm in cascade detection to develop the detection rate. There are following three key conditions. The first is “Separate Haar Feature”, which adds a don’t-care area between the rectangles of Haar Feature. The second is the algorithm for selecting the best width for this don’tcare area.

Finally, proposed a new decision algorithm which makes the decision by not only a stage result in cascade detection process to develop the detection rate.In this cascade algorithm, when an image was rejected by any stage, it is not calculated in the left stages. This cascade algorithm can discard the background images rapidly, but once a wrong detection occurs in one stage, this wrong detection will occurs in the detection.

Then we proposed to use the results of the front stages to extend the current stage threshold. This cascade algorithm is good for discarding the background images rapidly, but it also discards the face images when a wrong detection occurs in any stage. They want to use more information to do the decision. They proposed to save the value distance between stage value and threshold of the front stages which is detected and accepted in and using this message together with the threshold and value in the current stage to do the decision.

They have two proposals to improve the detector. In the first proposal, improve the feature extraction part to extract powerful feature value. And second, improve the cascade decision algorithm by adding more messages from front stages results to do the stage decision. Area of face to recognize. In this case, the majority cameras are installed in front of a door and the person to be recognized is required to stand at a precise position so the face of the person should be acquired correctly. As a result, the face in the image taken is well positioned and the size is big enough not only for detection but for recognition. The second case simulates face detection used for a surveillance system. Detecting faces and analyzing the activity is one of the important functions for intelligent surveillance. In this problem, faces are relatively far from the camera and the pose and angle of the face can’t be guaranteed to be at a certain range. In that sense, the face detection should deal with small faces with arbitrary pose and in-place rotation.

Important conditions for the face detection problem that can be identified easily by users are investigated and the

architecture for the language model based on these conditions was developed. The problem of selecting algorithms and deciding complicated parameters for algorithms are isolated from development with the proposed language model. Table 1 shows Theoritical comparison of several existing methods in terms of key parameters with Feature base face detection. Table 2 shows pros & cons of several existing methods.

TABLE 1.
THEORITICAL COMPARISON OF SEVERAL EXISTING METHODS IN TERMS OF KEY PARAMETERS WITH FEATURE BASE FACE DETECTION

Approach /Parameter	Haar like Feature base Face Detection	Geometric Base Face Detection
Precision	High	Low
Execution Time	Low	High
Learning Time	High	High
Ratio between detection rate & false alarm	High	Low

TABLE 2.
PROS & CONS OF SEVERAL EXISTING METHODS

Technique	Merits	Demerits
Feature base Face Detection	• More accurate • Low execution time	• High learning time
Geometric Base Face Detection	• Effective approach • Easy to implementation	• Low accuracy • More false alarm
Haar Like Feature Base Face Detection	• Improved feature extraction part • Less false alarm	• High execution time • Complex to implement

CONCLUSION

Authentication & Identification has become major issue in today's digital world. Face detection plays a significant role in authentication & identification. There are several existing approaches available to do so. In this paper several methods are explained, analysed & compared. From theoritical analysis & comparison and focusing on the key parameters, haar like feature extraction face detection approach is found as a very good candidate for face detection.

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REFERENCES

[1] B C. Zhang and Z. Zhang, A survey of recent advances in face detection. Technical report, Microsoft Research, 2010.

[2] M.-H. Yang, D. Kriegman, and N. Ahuja, "Detecting faces in images: A survey," *IEEE Trans. On PAMI*, vol.24, pp. 34–58, January 2002.

[3] T. Kanade, "Picture processing system by computer complex and recognition of human faces," in *doctoral dissertation*, *Kyoto University*, November 1973.

[4] C. Kotropoulos and I. Pitas, "Rule-based face detection in frontal views," in *Proc. of IEEE Int. Conf. on Acoustics, Speech and Signal Processing (ICASSP 97)*, vol. IV, pp. 2537–2540, 1997.

[5] G. Yang and T.S. Huang, "Human face detection in a complex background," *Pattern Recognition*, vol. 27, no. 1, pp. 53–63, 1994.

[6] R. Kjeldsen and J.R. Kender, "Finding skin in color images," in *2nd International Conference on Automatic Face and Gesture Recognition (FG 96)*, pp. 312–317,1996.

[7] T.K. Leung, M.C. Burl, and P. Perona, "Probabilistic affine invariants for recognition," in *Proc. IEEE Comput. Soc. Conf. Comput. Vision and Pattern Recogn*, pp.678– 684, 1998.

[8] K.C. Yow and R. Cipolla, "A probabilistic framework for perceptual grouping of features for human face detection," in *Int. Conf. Automatic Face and Gesture Recognition*, pp. 16–21, 1996.

[9] I. Craw, D. Tock, and A. Bennett, "Finding face features," in *ECCV*, pp. 92–96, 1992.

[10] A. Lanitis, C. Taylor, and T.F. Cootes, "An automatic face identification system using flexible appearance models," *Image and Vision Computing*, vol. 13, pp. 393–401, 1995.

[11] H.A. Rowley, S. Baluja, and T. Kanade, "Neural network-based face detection," *IEEE Transactions On Pattern Analysis and Machine intelligence*, vol. 20, pp. 23–38, 1998.

[12] E. Osuna, R. Freund, and F. Girosi, "Training support vector machines: an application to face detection," in *CVPR*, pp. 130–136, 1997.

[13] P. Viola and M. Jones, "Rapid object detection was using a boosted cascade of simple features," in *Proc. Of CVPR*, pp. 511–518, 2001.

[14] *Anima Majumder, L. Behera and Venkatesh K Subramanian, " Automatic and Robust Detection of Facial Features in Frontal Face Images", 2011 UKSim 13th International Conference on Modelling and Simulation, pp. 331-336*

[15] *Padma Polash Paul and Marina Gavrilova, "PCA Based Geometric Modeling for Automatic Face Detection", 2011 International Conference on Computational Science and Its Applications, pp. 33-38.*

[16] *Daesik Jang, Gregor Miller, Sid Fels, and Steve Oldridge, "User Oriented Language Model for Face Detection", ISSN- 978-1-61284-035-2, IEEE 2010, pp. 21- 26.*

[17] Ning Jiang, Wenxin Yu, Shaopeng Tang, Satoshi Goto, "Cascade Detector for Rapid Face Detection", 2011 IEEE 7th International Colloquium on Signal Processing and its Applications, pp. 155-158.