Face Detection With "Adaboost" Technique Implementation and Result Comparison

Ishvari S. Patel	Sutex Bank College of Computer Applications & Science. Amroli. Surat-394107, Gujarat, India
Dr. Kamaljit I. Lakhtaria.	Department Of Computer Science, Gujarat University

ABSTRACT

Face detection is an important step in face feature and gesture recognization system. This paper presents face detection system based on adaboost and cascade classifier approach. Here we discuss on Jones and Paula Viola developed method of face detection which is divided into three different methods - "Integral image", "Cascade", "AdaBoost". This method is implemented and tested on our database. Result accuracy is 99.67 which are compared with other technique.

1. Introduction

Face detection become essential research area in computer filed in resent year. Some of applications related to it are remote access, robotics, biological vision, photography etc… face detection is primary step to identify human face in image regardless of face size, location. Earlier face detection was done based on skin color, texture and motion. Face detection done by Jones and Paula Viola is based on statistic method. In this paper we implement face detection algorithm and compared result with other existing approach.

2. Related work

Some of the research work related to face and face feature extraction is given in the following section.

Stiefelhagen et.al. [1], using a skin-color model, the eyes, lip-corners and nostrils the face is located and tracked inside the facial region. For pixels the input image is searched with skin colors and the largest connection region of skin-colored pixels in camera-image is considered as the region of the face. Certain constraint is satisfied by doing tracking eyes by looking for two dark regions in tracking eyes. Search lips initially by predicting the approximate positions of the lip corner, using the positions of the eyes and the face-model. By searching for two dark regions you can find the nostrils by which certain geometric constraints are satisfied. Oliver , Nuria et.al. [2], Tracking shape, classification of mouth and the human face was performed by hidden markov modes and 2D blob features in this paper. Result accuracies were very good. Mohamed, Aamer SS et.al.[3], The skin color which is the main feature of faces for detection is the content of this system and by using the neural networks the skin face is examined thereafter its learnt from the feature of faces that it is classified whether face is comprised in the original image or not. Using neural network this problem are divided into three stages which are, pre-processing, segmentation and classification. In Pre-processing, by cropping or cutting the image of skin face and non skin face manually the data is collected and the dataset of face and non-face is obtained. In segmentation, Different human faces are collected and thereafter it analyzes the histogram values of chrominance (color detail of the picture) component to signify the probability of the pixel which belongs to the skin region. On large dataset of images face and non face is classified on neural network which are the basics of face detection methods. In order to classify features and training data propagation neural network is backed by multi layer perception. On a dataset frontal color face images this system has been tested and it was found that the result accuracy was fabulous. Siew Wen Chin et.al. [4], lips detection and tracking system based on watershed segmentation and skin/non-skin

detection done to recognize the face region and the lips region is then detected from the face region in this paper. The input image into region is segmented by the watershed algorithm in this paper. In this method we found a good performance as far as the model results are concerned. Kadlec et.al. [5], Edge detection and color filtering for noise reduction were used in this paper lip detection technique. Blue chrominance and red chrominance were seperated by color scheme YCbCr. As compared to other face regions the mouth is considered to comprise high red and low blue components. And as compared to other face regions to low blue components. This method is extremely fast as far as low resolution image is concerned. Vladimir Vezhnevets et. al. [6], Mounth, eyebrow line, nostrils and bounding ellipse are detected in this paper face. Face tracking using color-based image segmentation and intialization of the face ellipse are few techniques used here. Jun He et.al [7], this method is based on the difference between skin and lip on chrominance and R/G. Look for the skin area on the basis of threshold value, thereafter find the lip area on the basis of individual chrominance property of skin and lip adaptively. The method is fast, fit and also very effective for detecting and tracking lip in actual time lip-reading application. Vinay Kumar et.al. [8], In this paper a skin color model is used to detect facial regions in the image. Then by using lip color model lip region is extracted from the face region. To differentiate among the regions of interest they use threshold value. It is matched with the series of templates after extracting lip region from the image and on the basis of best correlated template it recognizes emotion. Dewi Agushinta R. et. al. [9], In this research, a system is developed that differentiates face features like face boundary, mouth, nose, eyes. On a frontal single image this process is conducted. After combining other features to construct face semantic distances between components are evaluated. By going through the process of face detection on the basis of skin color difference among featurs are measured, cropping to normalize face region, extraction of nose, mouth, eyes features. Distance between right eye - mouth, Left eye - Right eye, Left eye - Mouth, Left eye - nose, Right eye - Nose, Nose Mouth, Nose height, Nose mouth is measured. Jamal Ahmad Dargham et. al.[10], In this paper a lips detection module, a face verification module and a skin detection module are three major face detection system. To remove objects those are either smaller or larger that a particular size, size filtering is performed on image regions. After size filtering whatever skin regions are remained are considered as face candidates. Erosion, Dilation and filtering operations are performed. Thereafter, only on face candidates the lips detection is carried out and thus it reduces the search space. Then to determine the lips candidates, post processing steps as same as to those performed on skin detection are carried out trailed by size filtering. Up to 87 percentages were the correct detection

rate that this system achieved. S. Halder, D et. al. [11], The fuzzy model, designed in this paper, consider value of height and width of a facial component and generates the value of shape for different facial components. Six facial components have been considered to define a face in this paper. They are Right Eye, Right Eyebrow, Left Eye, Left Eyebrow, Nose and Lip. Each facial component has its corresponding width (W) and height (H). We get the output of the shape description of respective facial component once these values are feeded into fuzzy system.Eun-Jung Holden et. al. [12], In this paper there is a requirement of prior knowledge of each of the seven facial points for e.g. Nose center point, four lips point left and right eye corner point. Sample geometric relationships between the seven facial points are required as well. The feature detection process finds all possible matched locations for each facial point in the image if an unknown face image is given. By finding the combination of facial points that closely match the sample geometric relationships of the facial points on can bring the solution to this correspondence problem. Mark Barnard et. al.[13], The use of active contour models or snakes to detect outer lip contours are considered as the one of the most common lip tracking methods. Combination of snakes and a 2D template matching technique are used by this paper in lip tracking method. Schwerdt et. al. [14], In this paper, face contour detection is done by Color Histogram and by Color Histogram itself does eye blink detection left and right eye and also mouth detection. Color Histogram maintains a rectangle for both eyes and mouth. Calculation of size, center and orientation of the face is done by them.Ali Atharifard et. al.[15], In this paper, by color segmentation and facial feature the face detection is done and geometric relations between them is detected. In YCbCr color spaces the skin color images are analyzed in this paper. One can find a weaker response around eye region in eye detection model cr color component and on the other hand the cb component has a storage value. In comparison with the other facial regions lip color region contains a strong red component and weak blue and green component.

3. Face detection Algorithm

Jones and Paula Viola developed the method of face detection which is divided into three different methods they are "integral image", "Cascade", "AdaBoost". Find the brief below [16].

INTEGRAL IMAGE

By using an intermediate representation integral image represent by rectangular two dimensional image features could be computed in quick time. [17-19]

The following figure represents four "RECTANGLE FEATURE" which isn't in the fixed area size. Integral value is collected and then rectangle feature scans the images. The calculation of the integral value is derived from the difference white and gray area of integral. The rectangle features are A, B, C, and D. Following figure 1 represent rectangle features.
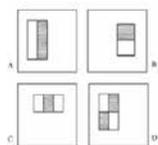
Figure 1: Rectangle features

The rectangle feature are placed the image random size and location, one feature is defined as rectangle feature is placed on the image one time with specific size and specific location.[1]

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

i(x,y) is the original image and ii(x,y) is Integral Image. For the grayscale images, values in pixels is the range from 0 -255. Color images are strongly recommended to convert into grayscale.

The value of the integral image at three is the sum of the area in pixels of A and C. The sum of pixels in area 'D' is : ii4 + ii1 – (ii2 + ii3)

ii1 = Sum of Pixels in Area 'A'

ii2 = Sum of Pixels in Area 'A' + Sum of Pixels in Area 'B'

ii3 = Sum of Pixels in Area 'A' + Sum of Pixels in Area 'C'

ii4 = Sum of Pixels in Area 'A' + Sum of Pixels in Area 'B' + Sum of Pixels in Area

'C' + Sum of Pixels in Area 'D'

As a result:

The sum of pixels in Area 'D' = ii4 + ii1 – (ii2 + ii3)

Thus, the calculation of rectangle feature is only related to the point of rectangle feature of integral image, instead of the coordination of the point. System only use constant time to calculate the integral image what matter the size of the rectangle feature. This method has been increased greatly to detection speed.

B.ADABOOST AND CASCADE

AdaBoost is a short form of Adaptive Boosting. In 1995 [20] Yoav Freund and Robert Schapire proposed AdaBoost which is a machine learning algorithms. It picks up couple of thousand features and assigns weight to each one on the basis of the set of training images. Assigning each weak classifier with best combining weights is the main aim of Adaboost. And the results have proved that it works in generalization performance [21,22]. Various weak classifiers are required to construct a strong classifier. Weak classifier just handles a slightly different though various weak classifiers could be used to increase the whole performance. Figure 2 represent adaboost method.
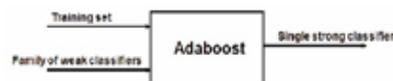
Figure 2: Basic idea of AdaBoost

The weak classifier selects and rejects single rectangle feature from the optimal threshold classification function. This process can be presented as follows, hj(x) is θ_j k classifier which is computed by feature fj, threshold and parity pj.   [2]

$$h_j(x) = \begin{cases} 1 & \text{if } p_j f_j(x) < p_j \theta_j \\ 0 & \text{otherwise} \end{cases}$$

The beginning point of each and every weak classifier could be changed so that the false negative rate is develops to zero. The importance of this algorithm is simple in individual and achieve height detection rate in the total performance.

Selection method and measuring the integral images in the face's image is shown in the following example of adaboost. The integral images measurement between eyes and upper cheeks is done by AdaBoost .Following figure 3 represent rectangle features in image.

Figure 3: Rectangle feature in image

The total performance of detection is a decision tree from one to one which is known as "Cascade" as shown in the below figure. Firstly most of the features are rejected by the classifier and positive results are transferred to next classifier and it goes on. A negative result could be rejected immediately to "Reject Sub-window. Only few sub-windows are used by the classifier at the last stage. The quantity of detection rate could be increased once a few round of classification is done. The former classifier only has low detection resolution, and filter out majority part of the non-face features for more information. Pictures of human face would be the final image. Following figure 4 represent cascade classifier.

Figure 4: Cascade classifier
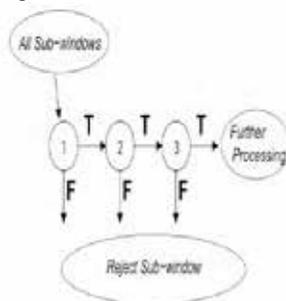
The factors that has to be improved (highly detection rate) are increases the number of classifier stages, number of features in each stage and the threshold value of each stage in addition.

Training data is divided into two different parts after the preparation. One among those two parts is positive training sets and other is negative training sets. Positive training set is a set of face images cropped with fixed sized. Whereas negative training set is a sequence of non-face images.

The cascade classifier resizes the image as per its own criteria and generates the result either positive or negative. It generally tries to resize the object of interest (face) to its own criteria. If the objects Generality fit to its boundary then scan could be easier but it is also convenient than resizing image itself. Here the scan procedure should be follow several times at different scale to find of object (face) of an unknown size due to this reason [23].

4. RESULT
In this section, we tested model to check the performance of it. Testing is done for face detection. We tested this model for our own database. We try to cover different aspect related to face detection.

All male images successfully detect face. We have one female image as non face object. Image fail to detect face because face is not shown fully. This model is tested for non face images also. These images successfully not produced face image.

Table 1 shows result comparison with other methods.

Table 1 Algorithm Result Comparison

REFERENCE	METHOD	ACCURACY (%) FACE
Jamal Ahmad Dargham et. Al[10] [In House Database]	MLP neural network	87
Jamal Ahmad Dargham et. Al[10] [WWW database]	MLP neural network	80
Ali and Sedigheh et.al [15]	Component based approach	97.66
Our database	Adaboost and Cascade classifier	99.67

In table 1, face detection result is figure out. Jamal Ahmad Dargham et. Al[25] method gives 87% and 80% result for in house and www database. Ali and Sedigheh et.al[26] method gives 97.66% result for face detection. Adaboost and Cascade classifier method with our database gives 99.67% result for face detection.

5. CONCLUSION
This model works effectively for our database. Face detection result for our database is 99.67 %. Our method result compared with different existing methods. Result accuracy of this model still needs improvements to increase the robustness of the proposed method.

6. References
[1] Stiefelhagen, Rainer, Uwe Meier, and Jie Yang."Real-time lip-tracking for lipreading" *Eurospeech*. 1997.

[2] Oliver, Nuria, Alex P. Pentland, and Francois Berard. "Lafter: Lips and face real time tracker." *Computer Vision and Pattern Recognition, 1997. Proceedings., 1997 IEEE Computer Society Conference on*. IEEE, 1997".

[3] Mohamed, Aamer SS, Ying Weng, Stan S. Ipson, and Jianmin Jiang. "Face detection based on skin color in image by neural networks." *Intelligent and Advanced Systems, 2007. ICIAS 2007. International Conference on*. IEEE, 2007.

[4] Siew Wen Chin , Kah Phooi Seng , Li-Minn Ang , King Hann Lim." New Lips Detection. And Tracking System". International MultiConference of Engineers and Computer Scientists 2009 Vol-I

[5] Kadlec, Jaroslav. "Lip detection in low resolution images." *Proceeding of the 10th Conference and Competition STUDENT*. 2004.

[6] Vezhnevets, Vladimir. "Face and facial feature tracking for natural Human- computer Interface." *Proceedings Graphicon-2002* (2002): 86-90..

[7] Jun He, and Zhang Hua. "A real time lip detection method in lipreading." *Control Conference, 2007. CCC 2007. Chinese*. IEEE, 2007.

[8] Vinay Kumar , Arpit Agarwal , Kanika Mittal . "Tutorial: Introduction to Emotion Recognition for Digital Images" inria-00561918, version 1 - 2 Feb 2011.

[9] Dewi Agushinta R, Adang Suhendra, Yuhilza Hanum. "Facial Feature Distance Extraction as a Face Recognition System Component".

[10] Jamal Ahmad Dargham, Ali Chekima. "Component-based Face Detection in Colour Images". *WSEAS International Conference. Proceedings. Mathematics and Computers in Science and Engineering*. Eds. N. E. Mastorakis, et al. No. 10. WSEAS, 2008.

[11] S. Halder, D. Bhattacherjee, M. Nasipuri, D. K. Basu and M. Kundu. "Fuzzy Classification of Facial Components for Face Construction". International Journal of Recent Trends in Engineering, Vol 2, No. 2, November 2009.

[12] Holden, Eun-Jung, and Robyn Owens. "Automatic facial point detection." *Proc. Asian Conf. Computer Vision*. Vol. 2. No. 731-736. 2002.

[13] Mark Barnard , Eun-Jung Holden, Robyn Owens. "Lip tracking using pattern matching snakes". The 5th Asian Conference on Computer Vision, 23–25 anuary 2002.

[14] Schwerdt, JL Crowley K., and J. B. Durand. "Robustification of detection and tracking of faces." *Computer Vision and Mobile Robotics Workshop*. 1998.

[15] Ali Atharifard and Sedigheh Ghofrani. "Component-Based Face Detection in Color Images". World Applied Sciences Journal 13(4): 847-857, 2011.

[16] *Viola–Jones* object *detection* framework - Wikipedia, the free encyclopedia.

http://en.wikipedia.org/wiki/Viola_Jones_object_detection_   framework. (Access 2014)

[17] Konstantin's g. derpanis, "Integral image-based representations" , *Department of Computer Science and Engineering York University Paper* 1.2 (2007): 1-6.

[18] Simone Frintrop, Maria Klodt, and Erich Rome. "A Real-time Visual Attention System Using Integral Images". *International conference on computer vision systems*. 2007.

[19] Haar-like *features* - Wikipedia, the free encyclopedia.http://en.wikipedia. org/wiki/Haar like_features (Access 2014)

[20] Yoav Freund and Robert E. Schapire. "A decision-theoretic generalization of on-line learning and an application to boosting" *Computational learning theory*. Springer Berlin Heidelberg, 1995.

[21] Robert E. Schapire, Yoav Freund, Peter Bartlett, and Wee Sun Lee. "Boosting the margin: A new explanation for the effectiveness of voting methods" *Annals of statistics* (1998): 1651-1686.

[22] AdaBoost - Wikipedia, the free encyclopedia, http://en.wikipedia.org/wiki /AdaBoost (Access 2014)

[23] Cascade classification – openCV documentation, http://docs.opencv.org/ modules/objdetect/doc/cascade_classification.html (Access 2014)

[24] Lakhtaria, Kamalji I. "Analyzing Zone Routing Protocol in MANET Applying Authentic Parameter." arXiv preprint arXiv:1012.2510 (2010).

[25] Lakhtaria, Kamaljit I. "Enhancing QOS and QOE in IMS enabled next generation networks." Networks and Communications, 2009. NETCOM'09. First International Conference on. IEEE, 2009.

[26] Lakhtaria, Kamaljit I., and Dhinaharan Nagamalai. "Analyzing Web 2.0 Integration with Next Generation Networks for Services Rendering." Recent Trends in Networks and Communications. Springer Berlin Heidelberg, 2010. 581-591.

[27] Kamaljit, Lakhtaria. "Analyzing Zone Routing Protocol in MANET Applying Authentic Parameter."

[28] Lakhtaria, Mr Kamaljit, et al. "Securing AODV for MANETs using Message Digest with Secret Key." Nettork Security & Its Applications (IJNSA) 1 (2009): 111-116.

[29] Hidoussi, Faouzi, et al. "Centralized IDS based on misuse detection for cluster-based wireless sensors networks." Wireless Personal Communications 85.1 (2015): 207-224.