Face Detection based on Skin Color in Image by Neural Networks

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Abstract- **Face detection is one of the challenging problems in the image processing. A novel face detection system is prsented in this paper. The approach relies on skin-based color features extracted from two dimentional Discreate Cosine Transfer (DCT) and neural networks, which can be used to detect faces by using skin color from DCT coefficient of Cb and Cr feature vectors. This system contains the skin color which is the main feature of faces for detection, and then the skin face candidate is examined by using the neural networks, which learn from the feature of faces to classify whether the original image includes a face or not. The processing is based on normalization and Discreate Cosin Transfer. Finally the classification based on neural networks approch. The expriment results on upright frontal color face images from the internt show an exellent detection rate.**

Keywords- face detection, skin color segmentation, compressed domain , neural networks.

I. INTRDUCTION

Face detection is an active area of research spanning disciplines such image processing,, pattern recognition and computer vision .face detection and recognition are preliminary steps to wide of applications such as personal identity, video surveillance etc. the detection efficiency influences the performance of these systems, there have been various approaches for face detection, which classified into four categories (i) knowledge based method (ii) feature based method (iii) template matching method (iv) appearance based method .a comprehensive survey of the face detection given in [1],[2].

In the compressed domain chrominance, shape and DCT information coefficient was combined by Wang and Chang [14] to achieve high-speed face detection without decoding of the compressed video image.

The proposed technique derived from [12], in their works a direct access content and extraction features in compressed domain instead of pixel domain. The algorithm works directly on the DCT coefficient parameters, DCT coefficient as a features based compression reduce spatial redundancy and captures the compact information a bout the patterns .color information is used as the main detection clues, a skin color model is created in the level of ycbcr color space .The reason for choosing Cb and Cr Color space that there is no information about luminance, classification using only pixel chrominance, skin segmentation may become more robust to lighting variations if pixel luminance is discarded and speed up the calculation in detecting the skin face regions.

The objectives of this research are to develop better normalization methohd and also aim to improve the segmentation that will assist and quick detecting faces from images. And also to implement a classifier face based on neural networks for face detection.

Most of the interest reader are referred to the comprehansive survey on face detection by Yang et al [1] ,and by Hjelmas and Low[13] .

The new algorithms introduced combines two methods to perform fast and accurate face detection system , which are a feature based methods and image based methods, the feature based method used a pre-processor of the image based method and guides the search of image based methods using neural networks that examine the face candidate regions instead of performing huge search in every part of the test image[5].Hwei proposed Extraction regions of skin can be either pixel–based [7] or region based [8],[1] .The diagram of our proposed techniques is presented in fig .1 skin segmentation is applied using the predefined color range threshold of Cb and Cr range .2D Discreet Cosine Transfer (DCT) for each sub-block image is computed and features vector are formed from the DCT coefficients ; where DCT can be as signature useful for recognitions tasks such as facial expression recognitions.[9].[10].

II. FACE DETECTION IN IMAGE

Many techniques for face detection in image were classified into four categories

- Knowledge based method

It dependence on using the rules about human facial feature .It is easy to come up with simple rules to describe the features of a face and their relationships. For example, a face often appears in an image with two eyes that are symmetric to each other, a nose, and a mouth. , and features relative distance and position represent relationships between feature. After detecting features, verification is done to reduce false detection. This approach is good for frontal image; the difficulty of it is how to translate human knowledge into known rules and to detect faces in different poses.

- Image Based method:

In this approach, there is a predefined standard face pattern is used to match with the segments in the image to determine whether they are faces or not. It uses training algorithms to classify regions into face or non-face classes. Image-based techniques depends on multi-resolution window scanning to detect faces, so these techniques have high detection rates but slower than the feature-based techniques. Eigen-faces and neural networks are examples of image-based techniques. This approach has advantage of being simple to implement, but it cannot effectively deal with variation in scale, pose and shape

- Features Based method:-

This approach depends on extraction of facial features that are not affected by variations in lighting conditions, pose, and other factors. These methods are classified according to the extracted features[1]. Feature-based techniques depend on feature derivation and analysis to gain the required knowledge about faces. Features may be skin color, face shape, or facial features like eyes, nose, etc.... Feature based methods are preferred for real time systems where the multi-resolution window scanning used by image based methods are not applicable. Human skin color is an effective feature used to detect faces, although different people have different skin color, several studies have shown that the basic difference based on their intensity rather than their chrominance. Texture s of human faces have a special texture that can be used to separate them from different objects. Facial Features method depends on detecting features of the face. Some users use the edges to detect the features of the face, and then grouping the edges. Some others use the blobs and the streaks instead of edges. For example, the face model consists of two dark blobs and three light blobs to represent eyes, cheekbones, and nose. The model uses streaks to represent the outlines of the faces like, eyebrows, and lips .Multiple Features methods use several combined facial features to locate or detect faces. First find the face by using features like skin color, size and shape and then verifying these candidates using detailed features such as eye brows, nose, and hair.

- Template Matching method

Template matching methods use the correlation between pattern in the input image and stored standard patterns of a whole face / face features to determine the presence of a face or face features. Predefined templates as well as deformable templates can be used.

III. FACE DETECTION ALGORITHMS

Information of skin color in a color image is a very popular and useful technique for face detection. The obvious advantage of this method is simplicity of skin detection rules that leads to construction of a very rapid classifier. We can use color information as a feature to identify a person's face in an image because human faces have a special color distribution that differs significantly, although not entirely, from those of the background objects. Previous studies have found that pixels belonging to skin region exhibit similar chrominance components within and across different human races. In the YCbCr color space, chrominance components are represented by Cb and Cr values. Thus, skin color model can be derived from these values. By using threshold techniques , skin color pixels are identified by the presence of a certain set of Cb and Cr values which corresponding to to the respective ranges of R_{Cb} and R_{Cr} values of skin color. Otherwise, the pixel is classified as non skin color.

The system being designed into three main categories, pre-processing , segmentation, classification using neural networks

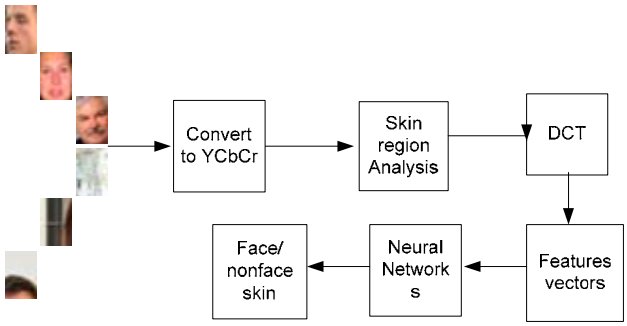


Fig.1 The proposed system of Face detection

A. PRE-PROCESSING

In fact , processing skin color is faster than other facial features , collecting a data set of skin face by cropping or cutting manually the image skin face and non-skin face to get a dataset of face and non-face. Different people have different skin color, while the difference lies mostly in the color intensity not in chrominance color itself. Literature survey show that YCbCr color space is one of the successful color spaces in segmenting skin color accurately .Selecting the suitable color space to model skin color and a void variation of lighting condition Cb and Cr Color space. Extract DCT coefficient features from Cb and Cr blocks

B. SEGMENTATION SKIN COLOR

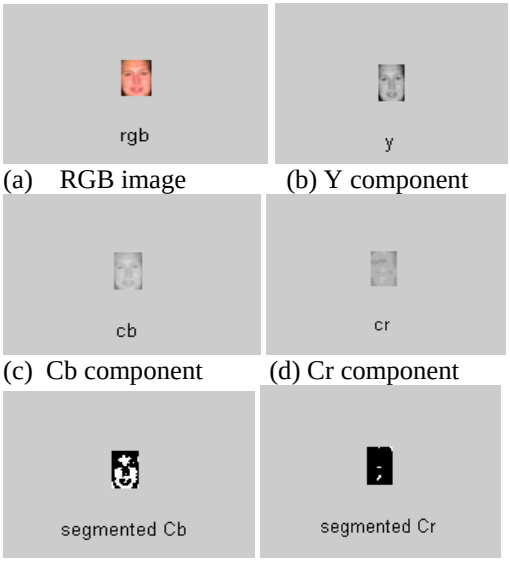
Skin color information is very important features for many researches, however the accuracy of skin color detection is important for face detection [6].

In this paper we convert the image from RGB to ycbcr .where are RGB is sensitive to the variation of intensity.

Many skin detection method ignore the luminance component of the color space, to achieve independent model of the differences in skin appearance that may arise from the difference of human race, and also reduce the space dimension. After collecting a different human faces and analyzing the histogram distribution sample skin color values of chrominance component to represent the likelihood of the pixel belonging to the skin region.

it was found that the chrominance component of the skin color fails in a certain range .X is skin color [1], if its projection on the Cb and Cr plane is inside predetermined rectangle $C_b \in R_{cb}$ and $C_r \in R_{cr}$ i.e., $C_{r1} \le C_r \le C_{r2}$ and $C_{b1} \le C_b \le C_{b2}$ .where R_{cb} =[C_{b1} , C_{b2}] and

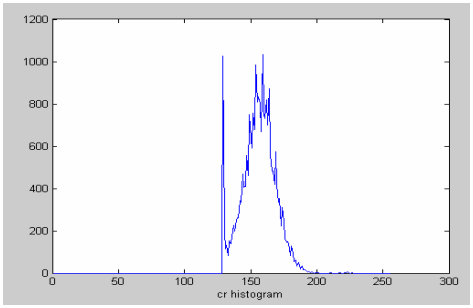
R_{cr} =[C_{r1} , C_{r2}] ,which are found experimentally used to eliminate quickly non-skin face color. And also to improve the segmentation of skin color regions . Fig.2 shows the distribution histogram skin regions sample and the threshold of for Cb and Cr color space.



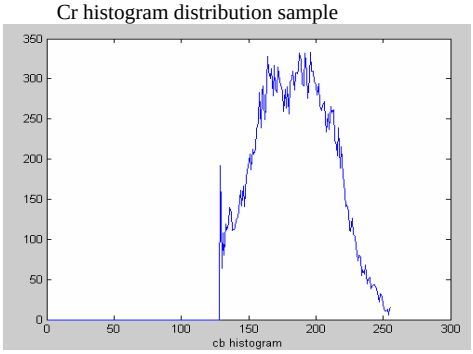
(a) RGB image (b) Y component

(c) Cb component (d) Cr component

(e) region segmented on Cb (f) region segmented on Cr



Cr histogram distribution sample



Cb histogram distribution sample

Fig.2 skin face region segmentation

C. FEATURE ETRACTION

Discrete cosine transform is used widely in many application and mainly used in the compressed data domain. and forms the basis well known JPEG image compression format. Jiang el.al [12] introduced a simple low cost and fast algorithms that extract dominant color feature directly fro DCT rather than in the pixel domain.

The extracted DCT Coefficient can be used as type of a signature of which might be useful for recognition task, such as facial expression recognition [11].

The proposed technique derived from [12], The system calculates the 2D-DCT for each cropped skin block coming out of the previous stage. This results in a matrix of 1 × 48 coefficients of both Cb and Cr color space components within the processed image block.,. Which are these values is taken to construct the feature vector. Empirically, the upper left corner of the 2D-DCT matrix contains the most important values, because they correspond to low-frequency, however the upper most coefficient is called DC and it correspond to average light intensity of the block. The others are called AC, and those coefficient provide useful information about the texture detail in the blocks. For each block we use the DC's and the first three zig zag order AC's as a set of 1 × 4 vector coefficients as shown in fig.3.

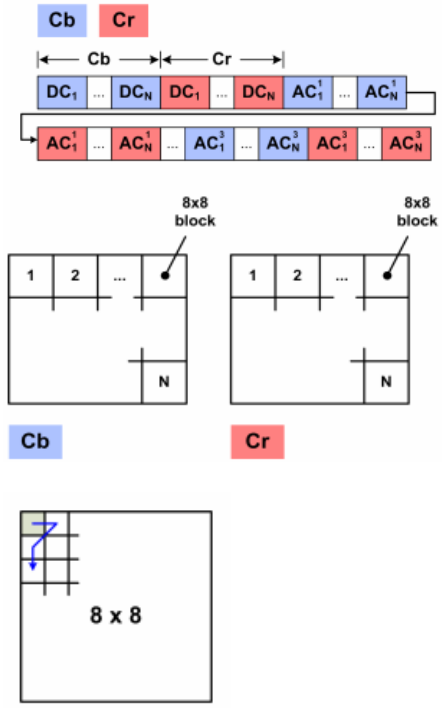


Fig.3. feature extraction from DCT coefficient

D. CLASSIFICATION

Neural networks are often used in face detection , Rowley, Baluja, Kanade [3] proposed a face detection methods based on neural networks, that could discriminate between face and non face on large dataset images.

In our system , we use (MLP) multi layer perception back propagation neural networks in order to training data set and classify features that are extracted using DCT (Discreet Cosine Transfer coefficient) .after divided into blocks of size 8x8 pixels). Training using a vector obtained from 18X27 training data set of 8x 8 pixel block for true oval face may usually guarantees that only pixels the face are used as input to neural networks, however, to produce an output of 0.9 for the skin face and 0.1 for the non-skin face after repeatedly presented input samples and desired targets, compared the output with the desired and measuring the error and adjusting

the weights until correct output for every input[4].The main advantage of choosing Backprobagation neural networks the simplicity and capability in supervised pattern matching .

IV. NEURAL NETWORKS

Neural networks have been applied in many pattern recognition problems like object recognition .there is many image based face detection using neural networks the most successful system was introduced by Rowley et al [3] as using skin color segmentation to test an image and classify each DCT based feature vector for the presence of either a face or non face .

The neural networks used in this paper backprobagation neural networks and was chosen because of simplicity and its capability in supervised pattern matching.

The structure of the neural network with three layers , the input layer is a vector of 1xn DCT coefficient vectors of neuron from each image either face or non face image , the hidden layers has n neurons , and the output layer is a single neuron which is 0.9 if the face is presented and 0.1 otherwise. The neural networks is trained using DCT coefficient feature vectors after skin face color candidate obtained from the segmentation stage, which are the DC and the first three zig zag order AC's features samples from each blocks 8x8 pixels of an manually cropped image 18x27 pixel of face and non-faces to classify each feature vector as output value 0.9 for a face and 0.1 for non-face

V. EXPRIMENTS AND RESULTS

We show in the section a set of experimental results to presents the performance of the proposed system , the experimented was implemented using Matlab Version 7.2 on the Intel Pentium(4) 2.80Ghz 1.00GB of RAM and Windows XP operating system .

This section presents results of experiment applied on the unknown input test image containing a face or non-face.

Starting with sliding overlapping window 18x27, by overlap scanning the window , where different overlap parameter used 1,2 up to the half pixels , in our experiment 9 pixel is the half of the window it might be maximum overlap, then each part of the unknown test image is scanned using slid window and extracted the DCT features and feed it to the trained neural networks of the dataset of images . However the neural networks tested with the trained neural networks and classify it to see if the part containing a face or non face.

The experiment results shows that our face detection system is reliable that neural networks able to detect and classify pattern features accurately under different overlap sliding scan window over the unknown input test image. The converge response of training dataset shows accurate and excellent face and non classification as in fig.4a , In fig.4b the result is reasonable, since the test set error and the validation set error have similar characteristics , and The next step is to perform some analysis of the network response. By putting the entire data set through the network (training, validation and test) to perform a linear regression between the network outputs and the corresponding targets as shown in fig.4c, according to the excellent response of the Backprobgation neural networks with the target desired ,the classification performance provides a comprehensive excellent picture of the classification performance of the classifier.

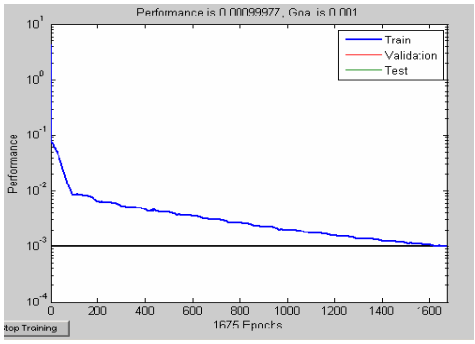


Fig.4a Training performance

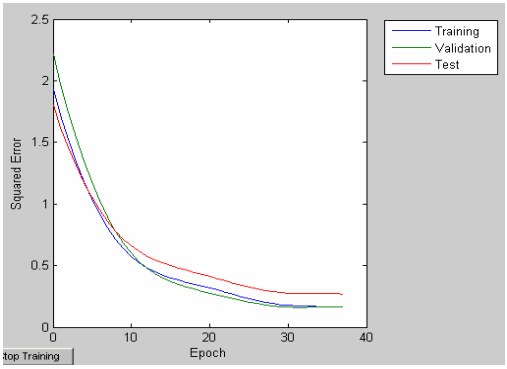


Fig.4b NN's trained with the training, cross-validation and testing

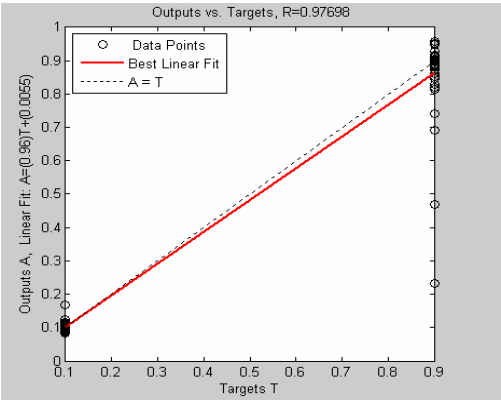


Fig.4c Linear regression

VI. CONCLUSIONS AND FUTURE WORK

This paper proposes a new algorithm for face detection in the compressed domaian , exctracted DCT coffecient vector features after segmentation a face skin candidate using skin color information on both Cb Cr color space, along with backprobgation neural networks classifier. we have divided the problem into three stages pre-proocessing ,segmentation , and classification using backprobagation neural networks. The system has been tested on a dataset of upright frontal color face images from the internet and achived exellent detection rate..These methods as a future work, will improve the detection of faces in compressed images to be use for face image retrieval based on skin color and also we may split the features DC's and AC's and feed it as two inputs to the neural networks. However the system proposed can be used as first step to face recognition system [5].

REFERENCES

[1] Y. Ming-Hsuan, D. J. Kriegman, and N. Ahuja, "Detecting faces in images: a survey," *Pattern Analysis and Machine Intelligence, IEEE Transactions on*, vol. 24, pp. 34-58, 2002.

[2] H. Rein-Lien, M. Abdel-Mottaleb, and A. K. Jain, "Face detection in color images," *Pattern Analysis and Machine Intelligence, IEEE Transactions on*, vol. 24, pp. 696-706, 2002.

[3] H. A. Rowley, S. Baluja, and T. Kanade, "Neural network-based face detection," in *Pattern Analysis and Machine Intelligence, IEEE Transactions on*, vol. 20, 1998, pp. 23-38.

[4] F.Smach,M.Atri,J.Miteran and M.Abid " Design of a Neural Networks Classifier for Face Detection" in Journal of computer Science 2(3):pp257-260,2006

[5] Lamiaa Mostafa,Sharif Abdelazeem " Face Detection Based on Skin Color Using Neural Networks" in GVIP 05 Conference, pp19-21 ,Dec 2006, CICC, Cairo, Egypt.

[6] Hwei-Jen Lin, Shu-Yi Wang, Shwu-Huey, and Yang –Ta-Kao " Face Detection Based on Skin Color Segmentation and Neural Network" *IEEE Transactions on*, Volume: 2, pp1144- 1149, ISBN: 0-7803-9422-4

[7] V. Vezhnevets, V. Sazonov, and A. Andreeva, "A survey on pixel-based skin color detection techniques", in *Proc. Graphicon-2003*

[8] H. Kruppa, M. A. Bauer, and B. Schiele, "Skin patch detection in realworld images", in *Proc. of the DAGM-Symposium*, 2002, pp. 109-116.

[9] L. Ma, Y. Xiao, K. Khorasani, and R. K. Ward, "A new facial expression recognition technique using 2D DCT and k-means algorithm", in *Proc. International Conference on Image Processing*, Oct. 2004, pp. 1269- 1272.

[10] L. Ma and K. Khorasani, "Facial expression recognition using constructive feedforward neural networks", *IEEE Transactions on Systems, Man and Cybernetics*, Part B, Vol. 34, No. 3, June 2004, pp.1588 – 1595

[11] L. Ma, Y. Xiao, K. Khorasani, and R. K. Ward, "A new facial expression recognition technique using 2D DCT and k-means algorithm", in *Proc.International Conference on Image Processing*, Oct. 2004, pp. 1269-1272.

[12] Jiamin Jiang,Ying Weng,and P.LI " Dominant colour extraction in DCT Domain" in Image and Vision computing 24 , 2006 published by Elsevier B.V,pp.1269-1277.

[13] E. Hjelmås, and B. K. Low, "Face detection: a survey", *Computer Vision and Image Understanding*, Vol. 83, No. 3, Sept. 2001, pp. 236-274.

[14] H. Wang and S. –F. Chang, "A highly efficient system for automatic face region detection in mpeg video," In *IEEE Trans*. CSVT, 7(4), 1997.