Face Recognition using Segmentation Method and Measurement based Approach under Varying Poses and Illumination

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Abstract- Face recognition being the most important biometric trait it still faces many challenges, like pose variation and illumination variation etc. Usually facial image consists of background that is mostly of no use for recognition purpose. We make use of skin-segmentation method in order to detect only face of the subject in the image .This method exhibit illumination problem. To overcome, we propose a new measurement based approach that can enable us to identify a person uniquely. The idea is to make the approach highly analytical which has little or no effect of variable factors like illumination, pose etc. The objective of this paper is to presented idea of skin segmentation and MIP for 2D images. This in turn shall improve the efficiency by a greater amount for face detection in any pose and illumination.

Keywords- Face, Poses, Face Length.

I. INTRODUCTION

The most evolved of all systems on earth is the human body. Among all the human body parts such as eyes, fingers etc., the face plays a major role for any social intercourse in conveying identity and emotion. We can recognize thousands of faces learned throughout our lifetime and identify familiar faces at a glance even after years of separation. Therefore, computational models of faces have been an active area of research since late 1980s. However, developing a computational model of face recognition is quite difficult, because faces are complex, multidimensional, and subject to change over time.

A Face Recognition System is a computer application for automatically identifying or verifying a person from a digital image or a video frame from a video source. One of the ways to do this is by comparing selected facial features from the image and a facial database. Face is an object consisting of various features, which look alike but are unique. Thus, these features are the basic foundation for determining individual's identity. And for this it is necessary to detect the face from the overall image which holds these required features. But there are certain obstacles.

Now consider an image of a person clicked in open environment, that system views not only the face of the subject but other details also; e.g. respective background images and other details. These details play no important role to attain our purpose of recognition. In another example consider a complete image of a person with minimal background details. In this though little background information is given which is not an issue, but still processing performed on complete image is unnecessary and time consuming. In this problem the useless information is details about body parts other than the subject's face. Because of such reasons most of the Face Recognition systems either ignore the unnecessary details or they simply remove the details on the image that are of no use for further process. Ignoring this problem may provide the solution but reduces the efficiency and increases the cost of the computation. Removing the unwanted piece of information speeds up the execution since it has to perform processing on the face only and this reduces the lines of code which spontaneously reduces the cost of computation. This treatment of superfluous information in the image is called as Preprocessing. Thus our approach is based on removing these details which are useless for further process of recognition and also facilitates the execution in descent manner.

There are number of approaches for detection of the face on subject: Face Detect Method [1, 5], Face Image Normalization [2], Face Detection Method [3], Late Fusion of Color spaces method [4] etc. Most of the method are only applicable to detect the face only if they are frontal else they can give mixed outputs. To overcome this limitation of pose and orientation imposed on the image we apply the method of Skin-Segmentation [6]. Working on this simply justifies our claim of solving the face detection problem on any pose. Moreover illumination, pose and expressions are also the one of the factors that affects the performance of face recognition system. Therefore, in the past few years, many approaches to cope up with these variations have been proposed.

All the approaches towards illumination problem can be broadly categorized as: transformation of images with variable illumination to a canonical representation [14, 15] extracting illumination invariant features [16, 17] modeling of illumination variation [18, 19].
As this, skin segmentation method persist the problem of illumination and high processing of images which motivates us to develop new measurement based approach.
In the following Subsection related previous work along with overview of proposed approach is described. The first subsection proposed approach describes our method for faces invariant to pose. The second subsection proposed approach describe method to annihilate illumination based problems by using a completely measurement based approach. As this measurement based approach is at initial phase and having large ways to go for research.

II. PROPOSED APPROACH

In this seminar, two approaches are proposed; the first approach is skin segmentation for face detection which illuminates pose variation problem. But the illumination variation problem is still present. So to avoid this problem the next approach is proposed as Measurement Based approach which solves illumination variation problem.

A. *Skin Segmentation Method.*

There are various techniques used in different approaches: Global Approach (PCA [6], LDA [7]), Template Matching Approach [8], Local Feature Based Approach (EBGM [9]), Geometric Based Approach [10]. In most of the above techniques that are used globally are sensitive to the head rotation. In most of them faces are considered as flat surfaces and the difference in orientation of the compared faces are ignored. Actually, a face is a 3D convex object with ability to rotation and shape changing [10, 11]. And PCA is the approach that is only applicable to frontal faces. In this we are focuses on detecting of the face on the image. Once the face is detected we remove the background and other unnecessary details, thus the remaining processes are performed on the acquired face.
Our method is applicable to the faces in any pose. Thus our method gives satisfactory results for faces invariant to pose. In order to detect the face Skin-Segmentation [12] technique is used. Our approach consists of following steps:

(1) Apply Skin-Segmentation on the image.
(2) Detect the face using bounding box.
(3) Extract the face from the image.

A.1. Face Finding Using Skin -Segmentation

In the technique of Skin–Segmentation, a range is specified of the chrominance component of an image [13]. Based on this range specified, the system is able to differentiate between skin color and the background. Based on this, the system can obtain the face on the image.

Consider the following example, in which skin segmentation is applied on the given query image. Figure1 shows that the complete image is segmented such that only the pixel containing the value near to the range specified for skin color is present else are set to 255 i.e. set to white color. But if observed other than background even eyes, lips and some part of the face are also segmented. This restricts us to use some important features like eyes and lips corner and in some cases nose-tip which can be used for feature extraction in the process of Face Recognition.

A.2. Face Finding With Bounding Box

In Fig 2(i) with the background details some required fiducially points are also lost. In order to avert this problem a bounding box is applied on the segmented image. This can be done by identifying the x, y co-ordinates on that image and height and width for the box. This would give minimum dimension of the box which could accommodate only the face which is required, Fig 2(ii) shows segmented image with the bounding box. In next step bounding box is applied on actual image ie Fig 2(i) which gives crop image Fig 2(iv).

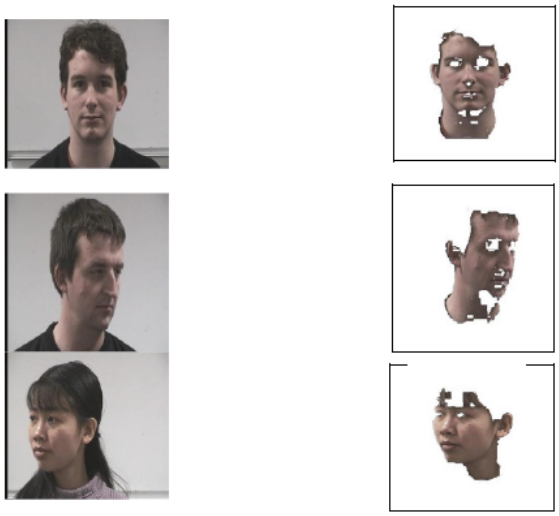

Fig.1. (i) Actual Query image (ii) Segmented Image (Irrespective to the pose).

Fig. 2(i)

Fig. 2(ii)

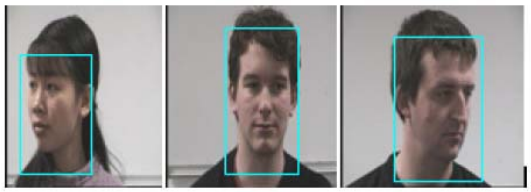

Fig. 2(iii)

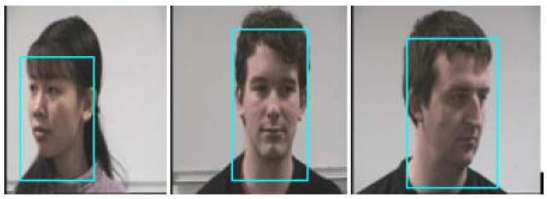

Fig. 2(iv)

Fig.2. (i) Actual Query image (ii) Segmented image with bound box (iii) Bound Box implied on Actual Image and (iv) Cropped Image.

Skin-Segmentation approach improves the overall performances for face detection under varying poses. But this approach suffers from illumination problem during skin segmentation process .Many of the time due to shadowing or lighting effects, unable Skin-Segmentation method to recognize that particular part of face. And requires high image processing which in turn increases time and cost.

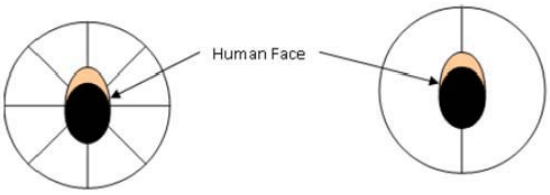

Fig.3. Left, photos from different angles.

Fig.4. Right, photos from different angles.

To overcome illumination problem, Measurement based approach is under research which improve overall performances.

B. *Measurement Based Method.*

Overall in our research we have tried to annihilate illumination based problems by using a completely measurement based approach. In this approach we initially would take a number of photographs of a face from various angles and using these several measurements can be obtained. These measurements would be stored in the database from where they can be retrieved during recognition. In this, eight photos were taken out of which front side four photos are enough for recognition. These facial photographs are to be taken from the two sides as shown in Figure 3 and Figure 4, one from the front and another from the back.

We use the simple distance formula for calculating proportional distances of the various prominent features on human faces which include the distance of the nose and ears, the length of the extrapolated face and its extrapolated width. The formula used is as explained below:-

Consider a case when one corner of the nose has a co-ordinate (n1, n2), and the other end has co-ordinate (n3, n2) (we consider only 2D photos). Say the chosen center point is the midpoint thus the co-ordinate for the center of the nose is,

$$C_1 = ((n_1 + n_3/2), n_2) \quad (1)$$

Now we find the approximate distance of the center of the nose to the right or left end of the face. Say the co-ordinates at the right corner are (x1, y1) the coordinate of the left corner is (x2, y2) the center in this case is

$$C_2 = ((x_1 + x_2/2), y_1 + y_2/2) \quad (1)$$

Consider the case as we take the center of the extrapolated forehead the same way as we took for the real corners in the equation (1) and (2) above we find another center for the bottom of the face , consider that the co-ordinates are found to be (t1, t2) and (b1, b2) respectively. Applying simple distance formula to get D1.

$$D1 = ((t_1 - b_1)^2 + (t_2 - b_2)^2)^{1/2} \quad (3)$$

Now consider a horizontal distance.

$$D2 = ((t_1 - b_1)^2 + (t_2 - b_2)^2)^{1/2} \quad (4)$$

Next step to find the ratio the same this ratio is called the face shape ratio FSR (R1).

$$R1 = D1/D2 \quad (5)$$

That means the ratio of the vertical face length to the horizontal face length is called (FSR) or the face shape ratio.

The idea is to go about finding a number of FRS's in order to improve the efficiency of our approach. Say we find a series of FRS's named FSR1, FSR2, and FSR3…FSRn. We then find the average of these and present it as

$$FSR_{avg} = \frac{FSR_1 + FSR_2 + \ldots\ldots + FSRn}{n} \quad (5)$$

This value of FSR is stored in the database along with the image. So next time as we have the extracted frame from the video we shall compare it to the standard values and the one that matches the closest is the received image tally from the database. In such a case statistical creation of virtual data which has the highest probability of being closest to the actual value can be calculated and based on this virtual data the person can be recognized this statistical creation of the data is similar to the concept of extrapolation described above.

In this case the efficiency and probability of recognizing the person decreases but it still allows us to refine our search.

Consider a case in which there is data of 1000000 people in the database. In such a case even if we don't get the exact person we can still refine our search to a few that are present in the database, say about 5 or 10 and then the other recognition methods can be used like applying filters and considering the illumination effect the skin tone matching etc. to further filter the search.

The idea is to make the approach highly analytical which has little or no effect of variable factors like illumination, pose etc, we consider various facial photographs say one with facial hair the others without them and so on however what we consider is the average value of the square roots thus the efficiency is highly improved. With the presented idea the idea of Most Informative Photograph (MIP) is turned obsolete here every facial photograph shall be a potential facial photograph, a photograph capable of presenting some information again we consider a number of facial photographs and find the average of the values for comparison with the database. This in turn shall improve the efficiency by a greater amount.

Yet this proposed approach is under implementation so as to validate its performance against other approaches of face recognition under pose and illumination problems.

III. CONCLUSION

This paper, proposed a novel approach for face detection based on skin segmentation. The final output of the approach exhibited good accuracy. The proposed method has desired performance even though illumination variations were present. To avoid these illumination variations we proposed a new measurement based approach from only four facial photographs has been proposed. These photographs have been taken from different angles. Since it is a measurement based approach there is no effect of illumination in recognition task. Operation of such systems in an uncontrolled environment is highlighted, where the recognition performance can be affected by numerous variations during the image acquisition.

Although the research of this approach is under progress, some preliminary results and theory knowledge encourage us.

REFERENCES

[1] Stein, S. and Fink, G.A., "Automatic Face & Gesture Recognition" Workshops (FG 2011)", Santa Barbara, CA, USA, pp. 519 – 524, March 2011 IEEE International.

[2] Nicolas Gourier, Daniela Hall and James L. Crowley, "Facial Features Detection Robust to Pose,Illumination and Identity", France, 2004.

[3] Jui-Chen Wu, Yung-Sheng Chen, and I-Cheng Chang, "An Automatic Approach to Facial Feature Extraction for 3-D Face Modeling": IAENG - International Association of Engineers,2006.

[4] Yuri Vanzine, "Facial Feature Extraction" C490/B657 Computer Vision.

[5] Peter Adrian, Uwe Meier and Andre Pura Haarcascade_frontalface_ http://www.mathworks.de/matlabcentral/fileexchange/19912

[6] Sarkar, Sayantan and Kayal, Subhradeep (2011) "Face Detection and Recognition using Skin Segmentation and Elastic Bunch Graph Matching". BTech thesis.

[7] Y. Adini, Y. Moses, S. Ullman; "Face recognition: the problem of ompensating for changes illumination direction",IEEE Transactions on Pattern Analysis and
Machine, vol.19, pp.721-732, 1997.

[8] W.Y. Zhao, R. Chellappa; "Illumination-insensitive face recognition using symmetric shape-from-shading", IEEE Conference on Computer Vision and Pattern Recognition, vol.1, pp. 1286, 2000.

[9] P.N Belhumeur, J.P Hespanha, D.J Kriegman; "Eigenfaces vs. Fisherfaces: recognition using class specific linear projection", IEEE Transactions on pattern analysis and machine, vol.19, pp.711-720, 1997.

[10] B. M. Stewart, T. Sejnowski; "Viewpoint invariant face recognition using independent Component analysis and attractor networks", In M. Mozer, M. Jordan, & T. Petsche, (Eds.),Advances in Neural Information Processing

[11] Systems 9. Cambridge, MA: MIT Press: pp. 817-823, 1997.

[12] P.N Belhumeur, D.J Kriegman; "What is the set of images of an object under all possible illumination conditions", Int. J. Computer Vision, vol. 28, no.3, pp.245–260, 1998.
O. Arandjelovic, R. Cipolla; "A Methodology for rapid illumination-Invariant face recognition using image processing filters", Int. J. Computer Vision and Image Understanding, pp. 159-171, 2009.

[13] T. Zhang, Y. Y. Tang, Z. Shang, X. Liu; "Face Recognition Under Varying Illumination using Gradientfaces", IEEE Transactions, vol.18, no.11, pp.2599 – 2606, 2009.

[14] P.N Belhumeur, D.J Kriegman; "What is the set of images of an object under all possible illumination conditions", Int. J. Computer Vision, vol. 28, no.3, pp.245–260, 1998.

[15] O. Arandjelovic, R. Cipolla; "A Methodology for rapid illumination-Invariant face recognition using image processing filters", Int. J. Computer Vision and Image Understanding, pp. 159-171, 2009.

[16] M. Lades, J. C. Vorbruggen, J. Buhmann, J.Lange, C. Malsburg, R. P. Wurtz, W. Konen, "Distortation invariant object recognition in the dynamic link architecture", IEEE
Trans. ,vol.42, pp.301-311,1993.
[17] L. Nanni, D. Maio, "Weighted sub-Gabor for face recognition", Int. J. Pattern Recognition Letters, vol.28, no.4, pp. 487-492, 2007.
[18] P. Hallinan; G. Gordon, A. Yuille, D. Mumford, "Two- and Three-Dimensional Patterns of the Face", A.K.Peters, 1999.
[19] A. Shashua; "Geometry and Photometry in 3D Visual Recognition", PhD thesis, MIT, 1992.