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Face Identification and Recognition Using Facial Skin Marks - A survey

Sudha Magdum[1], Prashant P. Patavardhan[2]

[1]*P. G. Student, Department of Electronics and Communications Engineering, GIT, Khanapur, India*
[2]*HOD, Department of Electronics and Communications Engineering, GIT, Khanapur, India*

***Abstract*—Skin biometrics is one of the most reliable physical characteristic than textual passwords. Skin biometrics can be effectively used for person identification in an intuitive way. The natural facial marks and lines on the skin image can be used to identify the correct person. Face verification using facial marks technique has many applications in variety of fields such as criminal identification, person verification, forensics etc. In this paper, different techniques for face verification using facial marks are discussed. Amongst all available techniques the performance parameters are compared to check the performance parameters. Since the area is currently one of the most on the go and the bulk of research is very large, this survey covers some of the significant methods**

Index Terms—active appearance model, active shape model, canny algorithm, Fast radial symmetry transform, laplacian of gaussian operator, Speed up robust feature detector

I. Introduction

Now-a-days biometrics is playing a very important role in face recognition. The face recognition algorithms use just the primary face features to identify the person's identity. Hence in many situations these algorithms have poor performance to authenticate the person. Accidental situations like earthquake, any natural calamity or an accident can sometimes partly or completely damage these primary features. Hence there is a need to find an alternative, so we go with biometrics.

There are various biometric techniques like iris biometrics, skin biometrics and finger print biometrics etc. All these are much more accurate than those face recognition algorithms. Now-a-days there is a boom of soft biometrics which have many applications in variety of fields. The facial marks are mostly used to identify the identity in criminal applications, fraud detection, forensics, authentication applications etc.

During the natural calamities or the accidents faced by individuals may dame the primary facial features like eyes, nose, mouth etc. hence there face cannot be recognized with the primary features hence we go with the skin marks detection and verification techniques. The skin marks may be temporary or permanent both types can be used to detect the face. The facial marks are identified, located and then matched in order to detect the exact face from the database. There are various algorithms available at each step throughout the process. ASM or AAM contour can be used to locate the primary features and then they can be masked. Viola-jones algorithm can also be used to locate the primary features. This can be easy done using computer vision tool box. Neural networks can also be used where we can train the model using training images and later we can predict the behaviour by applying the test image.

Facial marks can be matched using various techniques few of them are

- The weighted Euclidean distance can be observed to check the similarity metric
- Histogram intersection technique can also be adopted
- Weighted biphartite graph matching technique could also be used.

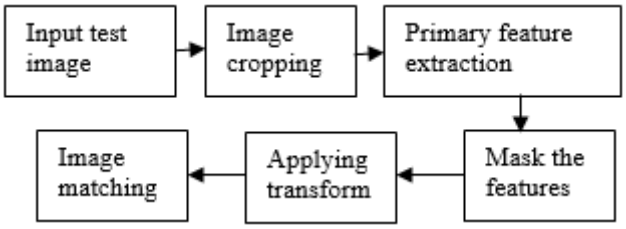

Fig. 1. Simplified system flow diagram

The Fig. 1 shows the simplified system flow diagram. The technique of face identification and verification using facial marks uses a set of database where all available images are previously stored. The test face image is taken as an input to the complete system. The image can be an RGB image. This image is resized or cropped to a particular to a particular size such that only the face is visible. The primary face features can be extracted by using viola-jones algorithm. It uses the computer vision toolbox to extract the primary features such as eyes, nose, mouth etc.

These features were detected using bounding box and computer vision tool box and are masked so that only skin region with marks could be visible.

Later the face image with masked features is processed with gradient based transform known as fast radial symmetry transform to detect the darker regions with radial symmetry and highlight the facial marks and threshold them so that they are easily visible. The output of this FRST transform highlights radially symmetrical regions and suppresses regions which are asymmetrical. These facial marks are used as biometric signatures for authenticating a person.

The feature landmark locations were converted from pixel location to barycentric co-ordinate system. These co-ordinates are rotation scale and translation in variant. These co-ordinates are computed using the reference triangle that forms the basis of the transformation. The vertices of the triangle are obtained

from the centre of the two eyes and the tip of the nose. These points can be automatically localized using STASM.

II. Related Work

A. Knowledge based Approach

Chaoying Tang [7] proposed a technique for skin image analysis using knowledge based approach. Many criminal cases need to identify the criminal without the facial image as CCTV captures the images in various directions and from different angles hence many times clear face is not visible. In such situations it is necessary to process the available data that is the visible skin portion to identify the exact identity of the person. In such application we can go with this technique in which the criminals can be identified just with the exposed skin image. In this paper [7], they have proposed a technique to remove the jpeg blocking artifacts using knowledge based approach and recovers the skin features. The various algorithms like One-pass algorithm, Markov chain model based algorithm, knowledge based approach and the performance of these algorithms is compared. It is found in the results after the comparison of all algorithms that knowledge based approach performs best as compared to the two others. Automatic skinmark detection rate for the KB based approach is 90.1% while for FOE it is 82.5%, SADCT 80.2 %, ADPROC 54.2%, NLF 62.1% etc.

B. Fast Radial Symmetry Transform

Nisha Srinivas [5], proposed a technique to identify the identical twins with their facial marks. In this paper [5], the test image is applied to a five level Gaussian pyramid. Each level of the pyramid is processed separately. The skin mark which is detected in most of the level could be the efficient and easily definable skin mark and can play a significant role in distinguishing between identical twins. Here, they have extracted the primary facial features using ASM contour and later these features were masked in order to extract only the skin portion of the image. Fast radial symmetry transform was used to highlight the skin marks which were later considered as the features for matching the image. The transform detects bright or dark regions with high radial symmetry at different scales. The locations and landmarks of the skin marks are identified can is converted from pixel location to barycentric co-ordinate system. The triangulation for the barycentric coordinates was determined by considering the top of nose and the centre of the two eyes as the vertices of the triangle. Bipartite graph matching technique was used to match the facial marks between two twins. The results were analyzed by performing various experiments to determine whether manual face marks detection performs better or automatic face mark detector performs better. It was found that the EER percentage for manually detected face mark is more than automatically detected face marks. It is 32.58% for manual detection and 26.86% for automatic detection.

C. Pore-Principal Component Analysis

Dong Li [6] proposed a technique to verify the face using pore scale features. In this technique they have used high resolution images in order to identify the facial pores easily. The technique called as Pore-Principal Component Analysis (PCA) Scale Invariant Feature Transform (PPCASIFT) which is adapted from PCA-SIFT is modified for the extraction of a set of distinctive pore-scale face features. The advantages of both techniques PCA as well as SIFT are considered. Here they have also used robust fitting task for the face verification. Hence the face can be easily detected and identified even if the pose or orientation of the face position varies. The behaviour of the methods i.e PSIFT and PPCASIFT were evaluated with the images under pose variations, expression variations. To compare the performances of the different methods, Receiver-operating characteristic (ROC) curve by varying a threshold to produce different false-rejection rates (FRR) and false-acceptance rates (FAR). It is observed in the results that PPCA-SIFT have the least EER rate than PCA, Gabor + PCA, LBP, LBP+PCA, PSIFT. The EER for PPCA-SIFT is 4.64% if all images from database are considered.

D. Laplacian of Gaussian Operator

Anil K. Jain [1] proposed a technique to use the micro features such as freckles, moles, scars, pimples, acne etc to recognize the face with high efficiency. The primary features such as eyebrows, eyes, mouth and nose were detected using active appearance model (AAM) were masked. The local regularities were detected using LoG operator. The differentiating marks were combined with commercial face matcher so that face matching accuracy could be enhanced. The method proposed [1] differs in many aspects than previously implemented techniques. It detects the marks which are only locally salient and focuses on detecting the meaningful marks. Experimental results based on FERET and Mugshot databases show that the use of facial marks improves the rank-1 identification accuracy from 92.96% to 93.90% and from 91.88% to 93.14%, respectively. This technique does not distinguish between the individual marks categories. Instead, they focus on to automatically detecting as many of these marks as possible.

E. Relatively Permanent Pigmented or Vascular Skin Marks

Arfika Nurhudatiana [8] proposed Relatively Permanent Pigmented or Vascular Skin Marks (RPPVSM) technique for criminal identification. In many cases the criminal complete face images cannot be observed in such situation the observed skin portion of the criminal is captured and the vein patterns are determined. The manual RPPVSM identification is protracted and long, an automatic RPPVSM identification system was conferred during this paper. It includes of skin segmentation, RPPVSM detection, and RPPVSM matching algorithms. This system achieved rank-1 and rank-10 identification accuracies of 76.79% and 88.97%, respectively, higher than the identification accuracies given by existing skin mark detection methods previously proposed for face recognition systems. To handle identification with limited numbers of RPPVSM, a fusion scheme with inferred vein patterns is also proposed. The fusion was tested and the evaluation was carried on 2,360 images of chests, forearms, and thighs collected mostly from Asian subjects, who tend to have fewer RPPVSM than Caucasian subjects. These results

clarifies that the fusion technique improves vein identification in all body parts with improvement rates varying between 2% and 5% depending on the number of RPPVSM detected. This was the primary work carried on automatic identification in colour skin pictures supported non-facial skin marks and fusion with inferred vein patterns in rhetorical settings.

F. The Knowledge Base using Mahalanobis

Biman Chandra Dey [2] proposed a technique to detect acne scar- pixels in color images. The three RGB planes represent the data. The knowledge base was build using the background pixels and the interested lesions from the images present in the database. The clusters built from knowledge base are found to be distinct in the RGB space. The classification as well as segmentation is performed using mahalanobis distance method which is a minimum distance technique. The Bayes method has also been implemented. The results are assured by the manual classification and scar observation. The minimum distance classifier gives better results as compared to bayes classifier. The sensitivity and specificity averages are 90.36 and 93.82 respectively.

G. Canny Algorithm

Ziaul Haque Choudhury [3] proposed a technique to locate the face marks hidden under the cosmetics with the help of global and local texture analysis. The primary face features were detected using active appearance model (AAM) and PCA. The primary face features such as eyes, nose, and mouth are removed from the face image. The generalized face mask is created which is used to detect the face and locate the primary features. Lastly, the canny algorithm is used to identify the local irregularities and the edges in the image and the Speed up Robust Feature algorithm is used to detect the facial features. All the detected facial marks are connected to increase the face recognition accuracy. The technique some-what differs other techniques (1) detects all the facial marks that are important and covered under cosmetics. (2) This technique concentrates on important facial marks instead of extracting texture patterns that are implicitly based on facial marks.

III. Discussion

The proposals discussed in section-3, describes the various available techniques for the facial mark detection and person verification. The performance parameters of those techniques were also discussed. Let us compare the size of database used and the performance parameters measured in the Table-I.

TABLE I
UNITS FOR MAGNETIC PROPERTIES

Group	Size of the Database	Results
Chaoying Tang	500 skin sub-images	Skin mark detection rate: KB approach 90.1%
Arfika Nurhudatiana	500 images	Accuracy Rank1:76.79% Rank50:96.92%
Brendan Klare,	174 images	Verification performance FAR: 1% TAR: 37%
Unsang Park	554 images	equal error rates (EERs) FaceVACS : 3.853% fusion of facial marks and FaceVACS: 3.839%
Ziaul Haque Choudhury	1000 images	Mark detection accuracy: 83%
Fabiola Becerra-Riera	530 images	Precision: 73.13%
Ziaul Haque Choudhury, K.M. Mehata	1000 images	Accuracy: 90%

IV. Conclusion

The facial mark features of each individual are unique. An approach towards appropriate individual recognition using facial marks can be achieved. There other approaches for individual recognition using primary features such as eyes, nose, mouth etc. in such applications the primary features must be clearly visible. In this paper, an attempt has been made to present the various available techniques for individual identification using the facial skin marks. The survey of the techniques provides a platform for the development of the novel techniques in this area as future work.

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