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Learning Role of Facial Marks in Automatic Face Recognition for Forensic Science Applications

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***Abstract*— In forensic science applications, when an image is partially damaged or occluded, some ancillary information like facial marks and gender can be used to enhance the face recognition accuracy. This information coupled with traditional face matcher provides more descriptive evidence and at the same time may speed up the recognition process. This paper proposes a method to utilize facial marks for improving face image matching.**

***Index Terms*—soft biometric, facial marks, global features, face vacs**

I. INTRODUCTION

Face matching is a very important tool for the forensic science applications. The results of face matching are extensively used in courts as evidence. A traditional face matcher provides numerical scores that shows the similarity of the subject. A face contains two types of texture features, local and global. Local features are described ad specific marks on the face like mole, scars, pockmark, acne and freckles[1] while global features includes eyes, nose, mouth, ears etc. if the face images are damaged and a conventional face matcher does not provide enough accuracy, facial marks can be used to improve the recognition rate. It has been shown that most of the facial marks are temporally invariant so they can be useful for face matching [2].

Current identification process in law organizations is based on manual verification. This process is called ACE-V i.e. analyze, compare, evaluate and verify [3]. However this procedure is time consuming and subjected to manual mistakes. With the availability of higher resolution sensors, an increase in face image database size, and improvements in image processing, the facial marks can be used to provide good accuracy as well as speed to the recognition process [4]. Since these marks are not distinctive, a conventional face matcher should be used along with facial marks matcher.

Traditional face- identification systems generally uses either local or global texture features to encode the images. Local methods first detect the individual parts of the face (i.e., eyes, nose, mouth, chin, and ears), before encoding the textural content of each of these parts (e.g., EBGM and LFA) [5], [6]. Global methods consider the complete face as a single unit during the encoding process (e.g., PCA, LDA, Laplacian faces, etc.) [7], [8], [9]. These methods do not specially use the facial marks i.e. scars and moles etc. it has been shown that automatic facial marks detection coupled with a conventional matcher increases the recognition chances [10].

Previous work on facial features has accepted that facial marks mostly remain unchanged as suggested by Munro [11] and Ekman [12]. However there are only few studies that have reported the utilization of these marks in recognition process. Lee et al reported on "Scars, marks and tattoos" while Lin et.al. used SIFT operator to obtain facial marks and then combined it with a global face matcher[13]. Kumar et al.[14] reported the use of male, chubby, flash etc while Pamudurthy et al.[15] showed the use of fine- scale skin marks pattern. However these methods are more suited for multimedia applications rather than forensic science.

The utilization and importance of facial marks features can be combined into four categories: 1) to help the traditional face matcher in improving recognition accuracy; 2) Provide fast response to the recognition process; 3) allow the recognition when the images are partially damaged; and 4) provide more expressive verification about the similarity or dissimilarity between face images, which can be used in the courts.

II. FACIAL MARKS CHARACTERISTICS

To learn the use of facial features in face recognition process, a study has been done with a data base from FERET [16] that includes 625 images including 230 subjects. All the subjects are seen from front pose or nearly front pose and images of the same person appeared either in training set or test set. Table I shows the data base summary.

Table I

Persons	For training	For test
Females	100	145
Males	100	280
Total	200	425

The following eight facial features are selected for the experiment.

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1) Freckle: small spots from concentrated melanin;
2) Mole: growth on the skin (brown or black);
3) Scar: marks left from cuts or wounds;
4) Pockmark: crater-shaped scar;
5) Whitening: skin region that appears white;
6) Dark skin: skin region that appears dark;
7) Abrasion: wound (includes clots);
8) Wrinkle: fold, ridge, or crease in the skin;

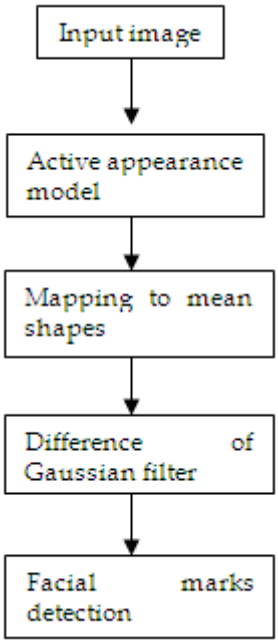
The characteristics of marks color is shown in table 2.

Table II

Mark	Color	% of appearance
Freckle	Point dark	73%
Mole	Point dark	1%
Scar	Linear dark	1.3%
Pockmark	Point dark	0.4%
Whitening	Irregular light	7.2%
Dark skin	Irregular dark	2.1%
Abrasion	Irregular light	0.004%
Wrinkle	Linear dark	3.4%

III. DETECTION OF MARKS

A conventional blob detector like difference of Gaussian (DOG) [17] may be used for marks detection. However, due to the presence of global features like eyes, mouth, ears etc these detectors may provide a number of false responses. Hence it is necessary to first localize the global features and then extracting the facial marks. The process of marks detection is shown in flow chart below.



IV. MATCHING OF FACIAL MARKS

Table 3 shows the matching results using facial marks. The rank-one matching accuracy of the state-of-the-art commercial face matcher, FaceVACS [18] is enhanced as a result of using facial marks. The matching accuracy of FaceVACS also improves by combining it with the mark-based matcher. The equal error rates (EERs) are observed as 3.968% and 3.829% from FaceVACS and the combination of facial marks and FaceVACS, respectively.

Table III

Matcher	Without gender information	With gender information
Face VACS	86.2%	87.4%
Face VACS with facial marks	87.1%	87.8%

V. CONCLUSION

A facial mark based face recognition system has been proposed which may improve the recognition rate and help in speeding up the recognition process. Facial marks based system provides more meaningful information about images rather than a simple numerical score provided by the traditional matcher. Facial marks can be used to assist other proofs presented in the courts and strengthen the case when other proofs are not available or not sufficient.

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