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## Matching Composite Sketches to Facial Photographs Using CBR Approaches

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**Abstract:** Facial Sketches are most widely used in law enforcement agencies for identification and apprehension of suspects, which may involve in several criminal activities. If the photographs of the suspect is stored in the mug shot data base, then the identity of the suspect is possible, but in most of the cases that it is a possibility that the photographs of the suspect is not available then two methods are used first is forensic sketch and the second is composite sketch software. The forensic sketch which is drawn by the expert artist according to verbal description provided by an eyewitness Unlike sketches, hand drawn by artist, composite sketches are drawn using one of the several facial composite software system (FACES and Mac-a-Mug etc). We propose a component based representation (CBR) approach that is used to measure the similarity between composite sketches and facial photographs. First the preprocessing technique is applied on both sketches as well as on face photo and after that components are extracted using 13 point marking and after that the multi scale local binary pattern (MLBP) is applied on each of the extracted region of face photo and sketch and finally the similarity which is obtained from individual facial photograph and sketch components are fused together so, that the total components similarity is obtained. Experimental results for matching 50 composites against 50 facial photographs show that the proposed method achieves (50% to 60%) performance as compared to a leading commercial face recognition system. We believe that our prototype system will be of great value in law enforcement agencies for catching a flitting suspect in a timely fashion.

**Keywords:** Component based face recognition, composite sketches, forensic sketches, MLBP, PCA.

### I. INTRODUCTION

FACE recognition is a very important application of criminal's identity which is involved in various types of criminal activity. If a facial photographs of suspects are available, then the identity of the criminal is possible, but in most of the cases there is a possibility that the images of the suspect is not available in a mug shot, then in that case a Forensic method will be applied, in forensic method the sketches were drawn by expert artist with the help of verbal description which is to be provided by the eyewitness. Due to budgetary reasons, many law enforcement agencies use facial composite software, which allows the user to create composite sketches (computer generated facial composite) instead of using hand drawn forensic sketches. The composite sketches are better than forensic because facial composite software kits, which allow even a non artist to draw a sketch after only several hours of training. Some of the widely used facial composite software kits include Identikit, Photo-Fit, FACES, Mac-a-Mug, and EvoFIT. The 80% of the officers in the law enforcement agencies used composite sketches. Despite of this high percentage of law enforcement agencies using a computer generated composites, the automated face recognition for computer generated composites has not been studied. In this paper, we propose a study of a face recognition system to match composite sketches to facial photographs or mug shot. To do this task, we propose a new face recognition algorithm for matching composite sketches to facial photographs. The objective of this approach is to (1) the objective is to measure the similarity between sketches and photographs. (2) To effectively match composite sketches against a large scale gallery database. (3) So that it can successfully recognize a face based on sketches.

The remainder of this paper is structured as follows. Section II introduces the related work (literature survey) on face recognition. In section III the proposed component based representation (CBR) for composite sketch recognition is present. In section IV, experiments are performed to verify the effectiveness of CBR approaches for matching purposes. Finally, Section V includes our contributions and the lists the directions of future work.

## II. RELATED WORK ON FACE RECOGNITION

This section describes the various existing schemes which are compared in this paper [2][6][7]

### A. Face recognition using various classifiers: Artificial neural network, linear discriminant analysis, principal component analysis

Classifiers are used to increase the generalization accuracy for face recognition. (LDA), principal component analysis (PCA) etc. Since the classifier are very important in face recognition because it will take a definitive decision about the class and require training sample, all this is having only 'P' dimensions So, with the help of PCA compression is possible. [2]

### B. Locating facial feature with an extended active shape model

In their paper they have proposed an extension active shape model by considering a more facial landmark. The extended active shape model is consisting of following extensions. 1) More landmark are consider then of actually needed. 2) Choosing a two dimensional landmark instead of one landmark template 3) Noise to be added in training set. By considering the entire above factor which help the ASM (active shape model) to locate the facial feature so, it helps to identify the face photo of the suspect. [3]

### C. Lightning aware preprocessing for face recognition across varying illumination

If there is a variation in the facial image like variation in expression and also the overexposure, underexposure, brightness, shadow all these factors are create a crucial problem for the identification of face. In theses paper they have proposed a preprocessing technique there are various preprocessing technique available like HE (histogram equalization) and SSR (single scale retinex) and GIC (gamma intensity correction) and also LN (local normalization) etc. But all this method or approach is having some negative or positive effect also so it indicates that the above approaches is not an optimal. So, to eliminate this effect the preprocessing should be adaptive and optimal hence LAP (lightning aware preprocessing) was proposed to perform the preprocessing adaptive for face recognition. So LAP performs a lightning normalization for the facial image with different lightning conditions.[4]

### D. Hand drawn face sketch recognition by human and PCA-based algorithm for forensic application

In this paper they have proposed a comparison performance of human and PCA (principal component analysis) in recognizing a facial sketch. There are five sketch artist since the sketch is drawn manually according to the description and each expert artist draw 50 sketches per subject so, for one subject there is about 250 sketches and also the fusion of sketches which is drawn by the different artist so, the recognition accuracy is improved. The main working of PCA is as follows : 1) n dimensional is a original data 2) calculate 'n' Eigen vectors and Eigen values 3) choose only the first 'p' eigenvectors, based on their Eigen values 4) so, final data set is having only 'p' dimensions. So, with the help of PCA data compression is possible. [5]

### E. Matching forensic sketches to mug shot photos

In this paper they have proposed matching a forensic sketch to mug shot data base. They have used a LFDA (local feature based discriminant analysis) for individually representation of both sketch and photo for this they have used a SIFT (Scale invariant feature transformation) and MLBP (multi scale local binary pattern) both are used as a feature descriptors with the help of LFDA matching is performed so that it was recognize the heterogeneous face based on sketches.[6]

## F. EUCLBP matching algorithm for forensic application

In this paper they have consider a three different types of sketches that are used for performance evolution: 1) Viewed sketch. 2) Semi forensic sketch 3) Forensic In this paper they have proposed a EUCLBP algorithm (extended uniform circular local binary pattern). The EUCLBP algorithm is applied to extract the facial information in a local facial region along with the minute details since both the sketch and facial image are divided into multi resolution pyramid, which help to build the discriminating the facial pattern that pattern is used to form a unique signature of both facial image and sketches. After that the memetic algorithm is applied to match this two EUCLBP descriptor. The LBP (local binary pattern) is used as a dense descriptor which helps to compute the texture feature for every pixel of an input image. The CLBP (circular local binary pattern) is corresponding to the gray level intensity of center pixel of circle. Since the optimized weight for the feature extracted image and matching that feature extracted image with the dataset so, that the top matches are obtain. [7]

## III. PROPOSED SCHEME

Most of the law enforcement agencies are essentially used facial composite sketches which are drawn by the composite software system. A composite sketch is constructed by individually selecting a each facial components following a verbal description provided with an eyewitness. [1]

Inspired by the principle of facial composite systems and existing work on photo to photo matching, we proposed a component based representation (CBR) for matching composite sketches to facial photograph. As illustrated in Fig1

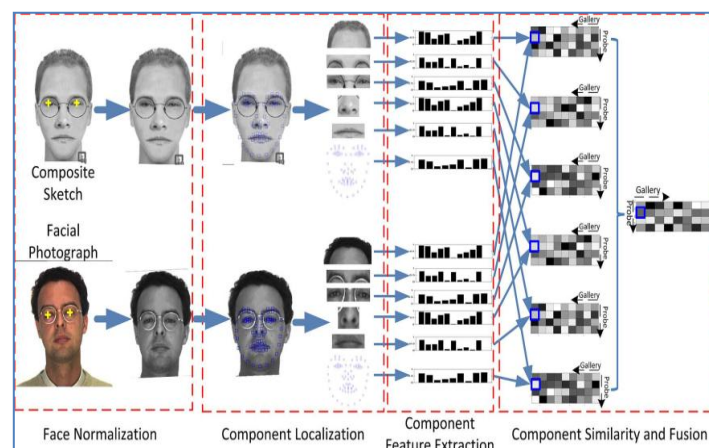


Fig. 1: Overview of the component-based representation approach for matching composite sketches to face photos.

The component based representation (CBR) is having a four process. 1) Face normalization 2) Facial feature are extracted by considering a  $10 \times 10$  window with 50% overlapping. 3) local feature is extracted with the help of LBP (local binary pattern) and LBP(multiscale local binary pattern) [6] 5) The last process consists of the matching process in which the histogram similarity is matched. The details of all these steps are explained as follows. [1]

## 1. Face Normalization

The face normalization are includes the preprocessing technique in which first the color conversion is performed on both sketches as well as on facial photographs so that both are converted into a gray level image.

After that the Rotation is applied to converting gray level image and finally the Scaling is performed on Rotated image. Here, the dimension of the sketch is large as compared to facial photograph so, we have to fixed an image with the dimension of  $200 \times 150$  so, that the dimension of the sketch and facial photographs should not be varied. [1]

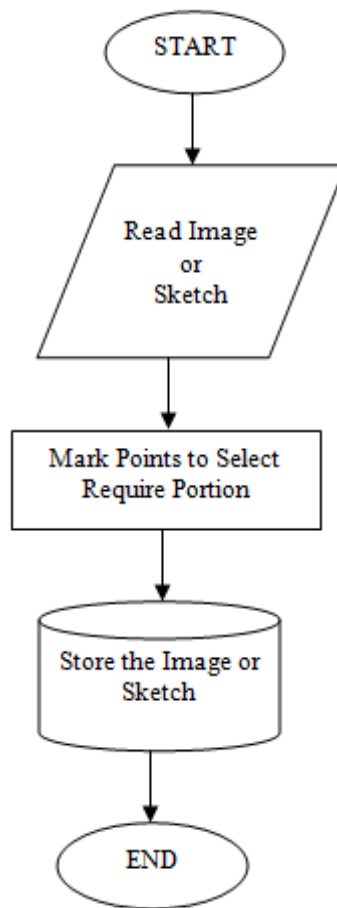


Fig2: The flowchart for cutting an image and sketch

**2. Facial Component Localization**

The mug shot photographs are usually captured with the cooperation of the subject, and the composite sketches are typically synthesized in frontal pose. The pose and scale variations between facial photographs and composite sketches can be effectively eliminated with the above mentioned face normalization step. Therefore, in the proposed method, a more efficient approach is utilized for locating the facial components from normalized frontal photographs and composite sketches.

Here, we are considering a window or component of 10\*10 with 50% overlapping and having an orientation of 8 pixels. Every time a 10\*10 window is considered with respect to the horizontal as well as vertical axes.[1]

**3. Components Feature Extraction**

The feature which are extracted by considering a 10\*10 window with 50% overlapping, in each of the extracted component local binary pattern(LBP) is applied, which allow to robustly match corresponding facial components under the intensity discrepancy between composite sketches and facial photographs.

The LBP code of pixel is calculated by thresholding neighboring pixel intensity with the intensity of the center pixel. The LBP code of pixel (x ,y) in image I can be calculated as

$$LBP_{p,R}(x,y) = \sum_{p=0}^{p-1} 2^p \text{sign} ( I(xp,yp) - I(x,y) )$$

Where

(xp,yp) is a P sampled neighbor pixel of pixel (x,y), the distance from (xp,yp) to (x,y) is not larger than R pixel and Sign(.) function is defined as  $Sign(d) = \{ 1 \text{ if } d > 0 \text{ and } 0 \text{ otherwise} \}$  but at some scale LBP is insufficient to capture all the features

of different facial components. Thus, multiscale LBP (MLBP) a concatenation of LBP histograms at different radii  $R \in \{1, 3, 5, 7\}$  is used to capture the features at various scales in different facial components.[1]

#### 4. Components Similarity and Fusion

After the decomposition of overlapped block, a facial component is divided into n patches. Let  $A_i, B_i$  be the photo patch and corresponding composite patch respectively, with MLBP (multi scale local binary pattern), the feature extracted for  $A_i, B_i$  is calculated based on the normalized histogram intersection. Now  $S_i$  is calculated with the help of the following formula.

$$S_i = \frac{\sum_{j=1}^D \text{Min} ( H_{ai}^j, H_{bi}^j )}{\text{Min} ( \sum_{j=1}^D H_{ai}^j, H_{bi}^j )}$$

Where  $H_{ai}$  and  $H_{bi}$  are the MLBP (multi scale local binary pattern) histogram that are extracted from  $A_i, B_i$  respectively.

The similarity is matched by comparing a descriptor histogram for  $R=1, 3, 5$  and  $7$  for sketch image with corresponding the descriptor histogram for  $R=1, 3, 5$  and  $7$  for facial photo is compared with the help of this method we get 32196 histogram so, we have to find the mean of 32196 and that mean value is stored. Here, we have considered two types of similarity, the first one is perfect match which is obtained with the help of maximum value of histogram descriptors and second is nearest match which is obtained with the help of nearest value of histogram descriptors.

The CBR process is helping to match a composite sketch with facial photograph. Here, The sketch is considered as a query sketch and this sketch is compared with all the facial photographs that is stored in a database in our case here we have considered 20 composite AR database for female with corresponding a 20 facial photograph and the same is considered for 20 composite AR database for male with corresponding a 20 facial photograph .

The MBLP is applied on each of  $10*10$  window with 50% overlapping and finally a histogram descriptors is obtained with the help of this we get 32196 histogram, but it is impossible to store 32196 histogram so we have to find “Mean” and on the basis of this we are calculating a similarity for the best match and nearest match, the best match is obtained with the help of maximum value of mean and nearest match is obtained with the help of nearest value of the mean.

### IV. EXPERIMENTAL RESULTS

#### A. Composite Skecth Database

In our experiment we choose to use the AR database because it has been used in the previous study also. The composite sketches are constructed with the help of FACES and IdentiKit. Here we have 20 facial photographs and 20 composite sketches for female and same for male also which is obtained from AR database.

#### B. Experimental Analysis

SR.No	Data Set	Male Images	Male % Accuracy	Female Images	Female % Accuracy
1	AR Composite and Photographs	70	56.9%	53	43.1%

Table1: shows the Gender distribution of Composite Sketches and Mug shot

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
1	similarity index	similarity index	similarity index	similarity index	similarity index	similarity index	similarity index	similarity index	similarity index	similarity index	similarity index	similarity index	similarity index	similarity index	similarity index	similarity index	similarity index	similarity index	similarity index	similarity index
2	0.516652	1	0.454305	2	0.524127	3	0.492781	4	0.454514	5	0.467343	1	0.420256	7	0.420271	3	0.470746	9	0.443491	15
3	0.488248	3	0.433338	8	0.454525	1	0.496621	19	0.42577	10	0.464805	6	0.414554	3	0.453957	19	0.455337	1	0.441102	10
4	0.460623	19	0.415522	1	0.449945	15	0.431412	14	0.419788	4	0.450901	3	0.404889	18	0.444212	7	0.429562	19	0.423268	13
5	0.457455	4	0.413815	10	0.440149	7	0.428897	3	0.416341	2	0.437739	4	0.395856	20	0.440889	1	0.428718	3	0.421178	7
6	0.447245	6	0.410744	3	0.435791	19	0.426788	1	0.411809	3	0.431146	14	0.379627	17	0.438448	15	0.413341	4	0.413117	14
7	0.444077	12	0.403404	5	0.42991	18	0.424292	17	0.411289	15	0.429239	8	0.378803	15	0.434622	14	0.408883	12	0.414704	19
8	0.440968	15	0.401085	6	0.425806	17	0.420117	15	0.410007	1	0.427476	15	0.375594	4	0.429451	17	0.408458	6	0.413033	16
9	0.435142	14	0.395094	19	0.423396	16	0.414479	20	0.407044	7	0.422443	19	0.365375	5	0.42281	18	0.406004	8	0.408884	3
10	0.433973	9	0.390751	15	0.416344	20	0.409523	7	0.403715	14	0.41892	9	0.365345	10	0.417016	8	0.384884	14	0.39579	4
11	0.429543	17	0.389327	4	0.416666	14	0.40898	6	0.402541	8	0.418908	2	0.365107	14	0.41427	4	0.388735	15	0.391039	1
12	0.422153	18	0.384635	16	0.413035	4	0.409541	18	0.396371	6	0.416479	16	0.368881	16	0.406505	20	0.383294	17	0.382695	17
13	0.421837	7	0.379106	14	0.41148	6	0.399347	12	0.393109	16	0.412536	10	0.368826	19	0.403483	16	0.382425	7	0.383482	18
14	0.405712	11	0.37817	13	0.407792	12	0.391284	10	0.390807	19	0.410288	12	0.363893	6	0.400382	10	0.379195	10	0.382059	8
15	0.405166	8	0.375378	9	0.398574	13	0.390802	16	0.390061	17	0.409958	5	0.363897	8	0.398139	6	0.374197	2	0.382093	6
16	0.399696	13	0.372425	7	0.396498	9	0.3908	2	0.381734	13	0.399856	11	0.356945	1	0.397968	12	0.372242	18	0.376665	11
17	0.399505	20	0.369064	18	0.3914	11	0.387537	5	0.379002	18	0.392848	13	0.350852	11	0.395361	9	0.368472	5	0.375673	20
18	0.394331	16	0.365849	12	0.389381	8	0.385734	9	0.373349	11	0.391037	17	0.347123	9	0.390717	13	0.362258	11	0.366286	5
19	0.388043	2	0.365507	17	0.374313	10	0.383404	13	0.372861	9	0.387299	18	0.335071	13	0.381683	11	0.361802	16	0.363758	9
20	0.380592	5	0.361029	11	0.354322	2	0.374852	8	0.366236	20	0.378789	7	0.330429	2	0.376952	5	0.356805	13	0.362598	2
21	0.370375	10	0.352979	20	0.348652	5	0.374004	11	0.349652	12	0.374206	20	0.323849	12	0.370396	2	0.346986	20	0.353018	12

Table 2: Show a Similarity values of different sketch along with facial photographs

SR.No	Data Set	Male Images	Male % Accuracy	Female Images	Female % Accuracy
1	AR Composite and Photographs	10	70%	10	80%

Table 3: Shows the experimental analysis on the basis of our Contribution.

As in table1, it shows the Gender distribution of composite sketches and mug shot, There they have consider a AR Composite and Photographs dataset having 70 male images and getting 56.9% accuracy where as they have take 53 female images and getting 43.1% accuracy.

In this experiment they have manipulate the data. As in table2, it shows the similarity values of different sketch along with facial photographs.

As in table 3, it shows the experimental analysis on the basis of our “Contribution”, here the same data set i.e AR composite and photographs are consider along with 10 male sketch with corresponding 20 facial photographs and getting 70% accuracy where as 10 female sketch is consider with corresponding 20 facial photographs and getting 80% accuracy. In this experiment no manipulation in the dataset is done.

C. Average Calculation of Face Recognition Accuracy

Here, we have Consider  $\implies$  10 Female Composite Sketches (From AR dataset)

Also we consider  $\implies$  20 Female Facial Photographs (From AR dataset)

- 1) The Similarity Calculation is shown in table 2. Form this, table we can concluded that sketch no. 5, 6, 8 is not perfectly matched.(it gives a nearest matched) .
- 2) Matched image=( no. of query sketch)-(Unmatched sketch with an image)

$$= 10 - 3$$

$$= 7$$

3) In Terms of Percentage= 70%

4) Accuracy Increase =(70-43.1)%

$$= 26.9\%$$

$$\approx 27\%$$

5) Accuracy increased= 27%

## V. RESULTS

Here we try to match the facial photographs with the help of composite sketches so, with the help of CBR approaches we are getting a perfect matching.

## VI. CONCLUSION

In this paper the component based representation is an effective approach for matching a composite sketch to the facial photographs and it also measure the similarity between the composite sketches and the mug shot photographs. Hence the CBR approach will successfully recognize the face based on the sketches.

## VII. CONTRIBUTION

Instead of using ASM (active shape model) for the extraction of feature we are using 10\*10 windows with 50% overlapping for the extraction of the components and also the illumination preprocessing is used and the rotation is performed with the help of line coordinates.

## VIII. FUTURE WORK

Good intensity is used to remove the light illumination and more precise feature can be extracted from the face as well as sketches. The Automated technique can be used to extract the facial components, the face and sketch can be made intensity homogenous and also more similarity calculation factors can be added such as a) Atrophy, b) Haudroff Daictance etc.

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