Implementation of Extended Uniform Circular Local Binary Pattern Algorithm for Matching Sketches with Digital Face Images

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Abstract— **This paper presents an efficient algorithm for matching sketches with digital face images. The proposed system Enhanced Uniform Circular Local Binary Pattern (EUCLBP) is used to extract the minute information present in local facial region. To determine the exceptionality of criminal, development in biometric technology have provide law enforcement agency various tools but, several crimes take place where no information of criminal is present, but instead an eyewitness description of the crime is presented. In these situation, a forensic artist is commonly made to work with the eyewitness in order to draw a sketch that describe the facial look of the criminal according to the spoken description.**

I. INTRODUCTION

Face recognition under pose, illumination and expression is meticulously studied by researchers and many techniques have been proposed to cater to these variations [1]. However, a very important law enforcement application that has received relatively less attention is matching sketches with digital images. An automated sketch to digital image recognition system can assist law enforcement officials and make the recognition process efficient and relatively fast. Sketches and digital images can be perceived as two different modalities. Therefore, existing state-of-the-art face recognition algorithms require additional mechanism to handle nonlinear variations posed due to variations in sketches and digital images.To address this important problem, researchers have proposed algorithms to match sketches with digital images. Robert and Niels [4] proposed photometric standardization of sketches to compare it with the digital photos. They further geometrically normalized sketches and photos to match them through Eigen analysis. Wang and Tang [3] proposed Eigen transformation based approach that transforms a digital image to sketch and then performs matching. In another approach, they presented an algorithm that separates shape and texture information and then applied Bayesian classifier for recognition [7]. In their recent approach, they have used Markov random fields to automatically synthesize sketches from digital images and vice-versa [8].

This transformation reduces sketches and digital images to a single modality so that matching can be done efficiently. Local facial primitives include eyes, nose, lips, hair, and eyebrows and face outline whereas global features include geometric distances between fiducial points. Zhang *et.al.* [7], [8] compared the performance of humans and PCA-based algorithms with sketch-photo pairs with variations in gender, age, ethnicity and inter-artist variations. They also provide discussion about the quality of sketches in terms of artist's skills, experience, exposure time and distinctiveness of features. Complimentary information obtained from multi-sketch fusion of sketches drawn by several artists leads to better recognition rates for humans as well as PCA based algorithm. Recently, Klare and Jain [5] proposed a Scale Invariant Feature Transform (SIFT) based local feature approach where sketches and digital images are matched directly using the gradient magnitude and orientation within a local region. Klare and Jain [6] further extended their approach using Local Feature Discriminant Analysis (LFDA) to match forensic sketches. In this paper, a computationally fast and efficient sketch to digital image matching algorithm is proposed. It has been observed by several sketch artists that "*Generating a sketch is an unknown psychological phenomenon but what a sketch artist observes while drawing a sketch are the facial texture which he/she tries to embed in the sketch through a blend of soft and prominent edges*". The proposed algorithm is designed based on this observation and hence follows two principles:

1) Information vested in local regions can have high discriminating power.
2) Facial patterns in sketches can be described by texture operators efficiently.

We thus propose an algorithm to match sketches with digital images that can handle the non-linear variations present in these modalities. Fig. 1 shows the steps involved in the proposed algorithm that starts with computing Laplacian pyramid to preserve soft edges and significant high frequency information present in the image.

The algorithm extracts texture features computed using the proposed Extended Uniform Circular Local Binary Patterns (EUCLBP) at each level of the Laplacian pyramid. Matching is performed using genetic optimization based weighted Chi square distance measure.

II. PROPOSED WORK

To extract discriminating information from local regions of both sketches and face images using the automatic algorithm. An Enhanced Uniform Circular Local Binary Pattern (EUCLBP) is used to extract the structural information along with minute details present in local facial regions. The memetic optimization algorithm is proposed to assign optimal weight to every local facial region to boost the identification performance, a Discrete Wavelet Transform (DWT) fusion based preprocessing technique is used to improve the quality of images and improve the identification performance. Enhanced Uniform Circular Local Binary Pattern Matching Algorithm extracts perceptive information present in local facial regions at dissimilar levels of granularity. Both sketches and digital face images are decaying into multi resolution pyramid to preserve high frequency information which forms the perceptive facial patterns. The Extended uniform circular local binary pattern matching descriptors use these patterns to form a unique signature of the face image. More, for matching, a mimetic optimization base method is planned to find the optimum weights corresponding to each facial region.

III. IMPLEMENTATION

Preprocessing

A Multiscale retinex (MSR) i.e a retinex which combines several Single scale retinex (SSR) outputs to produce a single output image which has both dynamic range compression and color constancy and good tonal rendition.a single scale retinex(SSR) is can either achieve color rendition or dynamic range compression bt not both. MSR overcome this limitations both color constancy and dynamic rande successfully accomplished. the multiscaleretinex (MSR) algorithm with four iterations. MSR is applied on both red and luma channels.MSR can be written as,

$$R_{MSR}(x, y) = \sum_{n=1}^{N} Wn. (x, y) \qquad (1)$$

Where

$$(x, y) = logI(x, y) - \log(Fn(x, y) * I(x, y)) \qquad (2)$$

Here $Rn(x, y)$,denotes a retinex output associated with the n the scale for an input image $I(x, y)$.Note that gain Wn is determined so that it can satisfy the condition of The symbol "*" in Eq. (2) denotes the convolution operation and N is the number of scales weight associated with the nth scale.$Fn(x, y)$ Denotes a surround function.


Fig1: Input digital and sketch images from database

Fig2: multi scale retinex output

Noise removal in the previous step may lead to blurring of edges with symmetric low pass filter of size 7x7 with standard deviation of 0.5 efficiently restores the genuine facial edges. Applying this iener filter. Wiener filtering is an effective linear image restoration approach. The task is to find the estimate of the "best" image f is done usually in frequency domain:

$$F(u, v) = \frac{|H(u, v)|^2}{H(u, v)|H(u, v)|^2 + N(u, v)^2|F(u, v)|^2} G(u, v)$$

Where $H(u,v)$ is the degradation function, $G(u,v)$ is the Fourier transform of the degraded image, $N(u,v)$ is the power spectrum of noise, 2 $F(u,v)$ is the power spectrum of the undegraded image. The Wiener filter performs deconvolution in the sense of minimizing a least squares error i.e.:$e2 = E\{(f - \hat{f})2\}$, where E is the mean value, f is the undegraded image which is usually not known.
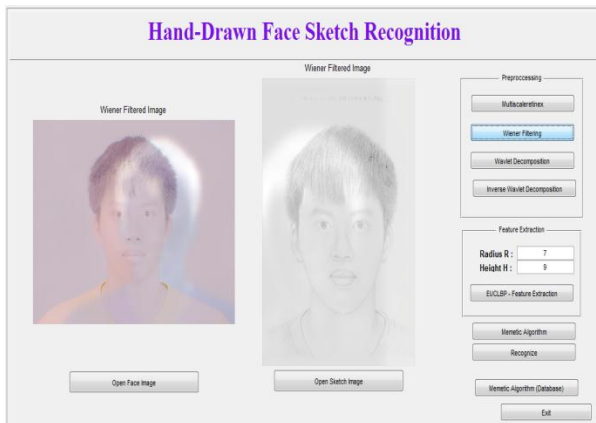
**Fig3.wienere filter output**

After computing the globally enhanced red and luma channels, DWT fusion algorithm is applied. to compute a feature rich and enhanced face image Single level DWT (with db 9/7 mother wavelet) is applied to obtain the detailed and approximation bands of these images.let, LL, LH ,HL and HH be the four subband where LL represents the approximation. Sub band, and LH, HL, and HH represent the detailed subbands.

To preserve features of both the channels, find the average of and for the coefficients from the approximation band. The approximation band of the enhanced image. All three detailed subbands are divided into windows of size 3× 3 and the sum of absolute pixels in each window is calculated. For the ith window in HL subband of the two images, the window with maximum absolute value is selected to be used for enhanced subband HL. Similarly, enhanced subbands HLand HH are also obtained

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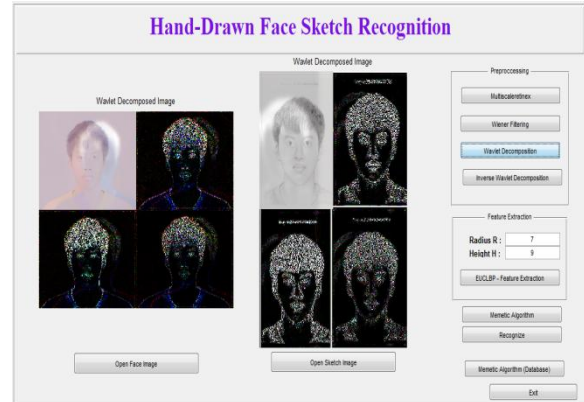
Fig4. Descrete Wavelet transform output

Finally, inverse DWT is applied on the four subbands to generate a high quality face image.
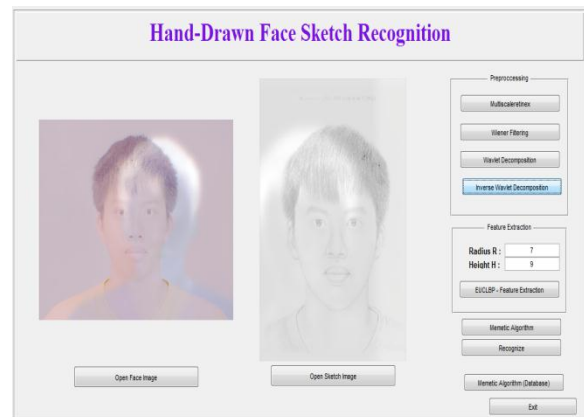
Fig5.Inverse Descrete wavelet transform

Feature Extraction by using EUCLBP LBP represent the description of pixel region image in the binary form. Basic LBP operator uses eight pixels of neighborhood, accepting thecentral pixel as a threshold. Pixels with the values, higher than the central one (or equal to it), accept the value those which are lower than the central one, accept the value of. Thus, we get the eight –bit binary code, which describes the pixel vicinity. An extension of this approach is to have the pixel neighbors well separated on a circle around a central pixel.

The circle can have different diameters and varying number of neighbors to account for texture at very different scales. Similar to basic LBP, Circular LBP (CLBP). CLBP is extended to Uniform Circular Local Binary Patterns to achieve robustness to the rotation variations and dimensionality reduction.

A binary pattern is called uniform binary pattern if it has at most two bitwise transitions from 0 to 1 or vice versa. Uniform LBP determine only important local textures, such as ends of lines, edges, angles, spots. Encoding difference of signs between the neighbouring pixels is not sufficient for describing facial texture. Other important features could also be derived from the information that lies in the difference of the gray level values. A method to encode the exact difference of gray level intensities and reported a marked improvement in the performance of texture descriptors. This forms the motivation to further extend Uniform CLBP to encode exact gray level difference along with the original encoding. The proposed descriptor is called Extended Uniform Circular Local Binary Pattern. The combination of the exact gray level difference and adds a complimentary layer of discrimination on top of the original descriptor which provides the assimilated information. Layer 1is Uniform CLBP that encodes difference of signs while the other three layers encode the exact gray level differences. We experimentally observed that Layer 1 and Layer 2 of EUCLBP are the most discriminating. Therefore, the final descriptor is the concatenation of Layer 1 and Layer 2 histograms.

Memetic Algorithm for Matching Sketches Images

Memetic algorithm (MA) can be successfully used to optimize such large search spaces. It is a form of hybrid global-local heuristic search methodology. The global search is analogous to traditional evolutionary approaches such as population-based method in a Genetic Algorithm (GA), while the local search involves refining the solutions within the population. From an optimization perception, MAs have been established to be more efficient and effective than traditional evolutionary approaches such as GA. In this research, memetic algorithm is used for weight optimization.

The steps involved in the memetic optimization process are described below:

1. *Memetic Encoding:* A chromosome of length is encoded where each unit in the chromosome is a real valued integer representing the equivalent weight.
2. *Initial Population:* A population of 100 chromosomes is generated starting with a starting point chromosome.
3. *Fitness Function:* Fitness is evaluated by performing recognition using the weights encoded by each chromosome. 10 best performing chromosomes from a population are selected as survivors to perform crossover and mutation.
4. *Hill Climbing Local Search:* The survivors obtain in Step 3 are used to find superior chromosomes in their local neighborhood and parents are selected.
5. *Crossover and Mutation:* New population is generated from parents obtained after local search in Step 4. A set of uniform crossover operations is performed followed by mutation. To avoid local optima, adaptive mutation and random offspring generation techniques are used.
6: Repeat Steps 3–5 till convergence criteria is satisfied.

IV. EXPERIMENTAL RESULT

In this paper, we have done our experimental setup based on the image processing tool to make the analysis for the feature extraction and to find the matching image in the data sets.
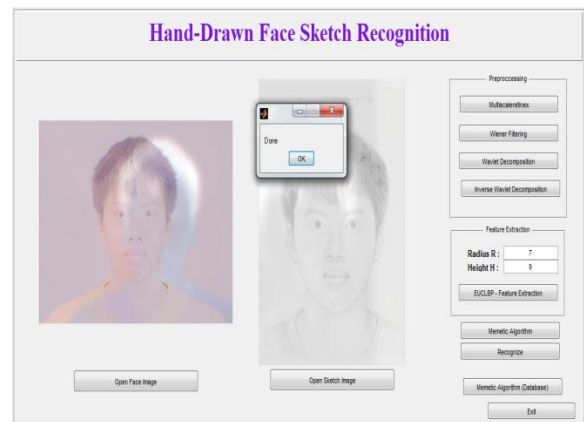
Fig6 Matching sketch with digital image

Recognition Rate by using EUCLBP and Memetic optimization are given in below table.

Table 1.
Recognition Rate

Prob Data set	Recognition Rate in%
10 Images	82%
20 Images	86%
30 Images	74.33%
40 Images	83.5%
50 Images	87%

V. CONCLUSION

Forensic face sketch matching technique is tried to improve the enhancement in current state of the art face sketch matching systems. Since, there are some limitation on forensic sketch and digital image Recognition. To overcome the Recognition problem, the preprocessing and feature extraction technique(EUCLBP) is used for face sketch recognition.

VI. FUTURE SCOPE

In future work, to calculate the optimized weight for the feature extracted image and then match it with the data set which obtain the top matches. Semi-forensic sketches are introduced to bridge the gap between viewed and forensic sketches. Training on semi-forensic sketches can better model the variations for matching forensic sketches as compared to algorithms trained on viewed sketches.

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