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Research Article

MATCHING FACIAL SKETCHES USING ANN

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ABSTRACT

Face identification has always been a very demanding field for the researches and its applications may be very helpful for personal verification and identification. Facial sketches also play an important role in crime investigations. Hence there is a need for the methods or algorithms that matches facial sketches to digital photos. There are different types of algorithms that can be deployed for forensic sketch based face recognition as well as composite sketch recognition. In this paper we compare different algorithms like Weber Local Descriptor (WLD), Multi-scale LBP operator (MLBP), Tchebichef moments which are used for facial sketch recognition by using Artificial Neural Network (ANN). Our comparison output shows that composite sketches are matched with higher accuracy rate than forensic sketches.

INTRODUCTION

Face Recognition is the ability to identify people by their facial features. Recently face recognition has received a great deal of importance from the scientific and industrial communities over the past decades owing to its wide range of applications in information security. Facial sketches play an important role in assisting law enforcement. Facial Sketches used by law enforcement can be of two types called forensic and composite sketch. Sketch artist draw the sketch by the description provided by the witness called as forensic sketch and composite sketches are drawn by using software tools. Once the sketch is ready it is send to law enforcement officers and for social medias with the hope to find the suspect.

Types of Sketches

In general sketches are classified into three types.

- ***Viewed Sketches:*** these sketches are drawn by seeing the photographs and not based on description. Therefore viewed sketches are not used under law enforcement.
- ***Forensic sketches***: Form 19th century forensic sketches are being used in investigations. These sketches are drawn by forensic artists by interviewing the eye-witness. Forensic sketches real world scenarios which suffer from three challenges are namely, memory gap, communication gap and modality gap [01].
- ***Composite sketches***: Composite sketches are popular and sketches are generated using software tools by selecting different facial parts. In fact, 80% of law enforcement agencies reported using some form of software to generate facial sketches of suspects [01]. Based on comparison we can conclude that composite sketches require less experience and time consuming. The difference between forensic sketch and composite sketch is as shown in the Figure 1.

Figure 1 Difference between Composite Sketches and Forensic Sketches

This paper analyses the performance of different algorithms applied for forensic and composite sketch matching using artificial neural network classifier.

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Organization: The paper is organized into following sections. The section II presents the research work on existing work. The proposed techniques are explained in section-III. The experimental results obtained are illustrated in section IV. Section V contains Conclusion.

LITERATURE SURVEY

Survey is a critical part of the research work. It is important because, it illustrates how the proposed research is linked to prior works in statistics. It demonstrates the awareness to complete the research work. It increases the statistical knowledge of the study area. It also helps in generating new ideas.

Suad Haji *et.al* [02] the aim of this work is to present a windows based real time application for face recognition. This novel proposed technique is used in various fields of commercial applications. Both Eigen and Local Binary Patterns algorithms are used to eliminate the impact of light exposure which will change the accuracy of the method.

A Vinay *et.al* [03] proposed an efficient and robust technique for real-time face recognition. Here pre-processing is applied to remove noise. The proposed scheme is tested on different benchmark datasets namely, FACES94, FACES95, FACES96 and Grimace which pose challenges in illumination, pose, expression, head scale and rotation. Finally proposed system achieved 91% accuracy.

Decheng Liu *et.al* [04] A new composite sketch based face recognition technique by extracting two image feature descriptors from components, fusing and combining facial parts with different weights. Experiments on the E-PRIP database show that the proposed technique achieves better result when compared with existing methods.

Ramya Srinivasan *et.al* [05] presents a robust unsupervised system for face identification. Here saliency maps of second order statistics are used as image descriptors. Using saliency maps thus constructed as the face descriptors brings in an additional advantage of emphasizing the most discriminative regions of a face and thereby improves recognition performance.

Ergun Gumus *et.al* [06] this work presents an evaluation of using different techniques for face identification. As feature extracting methods are benefit from wavelet decomposition and Eigen faces method which is based on Principal Component Analysis (PCA). Here distance classifier and Support Vector Machines (SVMs) are applied for classification after generating feature vectors,. Here ORL database of face which includes 400 images of 40 people. Finally the Wavelet–SVM classification approach for 240 image training set achieves the superior accuracy i.e. 98.1%.

Mithila Sompura *et.al* [07] presents a fast efficient technique is implemented with the better identification rate of face in several conditions. The global features and local features are extracted by using PCA (Principle Component Analysis) and LBP (Local Binary Pattern) respectively. So the fusion of Global and Local features are fed to the MLP (Multilayer Perceptron). The BPMLP (Back propagation Multilayer Perceptron) is applied for the classification. The proposed method gives 93% accuracy.

Qingxiang Feng *et.al* [08] proposed a novel SSP classifier and its FSSP are proposed for face identification. The SSP techniques first adopt the SSP score, which can be expressed in terms of the superposition of the addition of the regression parameters of each class in iterations. Experimental outcomes are the proposed SSP and FSSP classifiers achieve better RR than the well-known SRC, RRC, RCR, TPTSSR, LRC, CRC, SVM, and NN classifiers.

METHODOLOGY

This part is concerns with the description of various methodologies are used for sketch based face identification purpose.

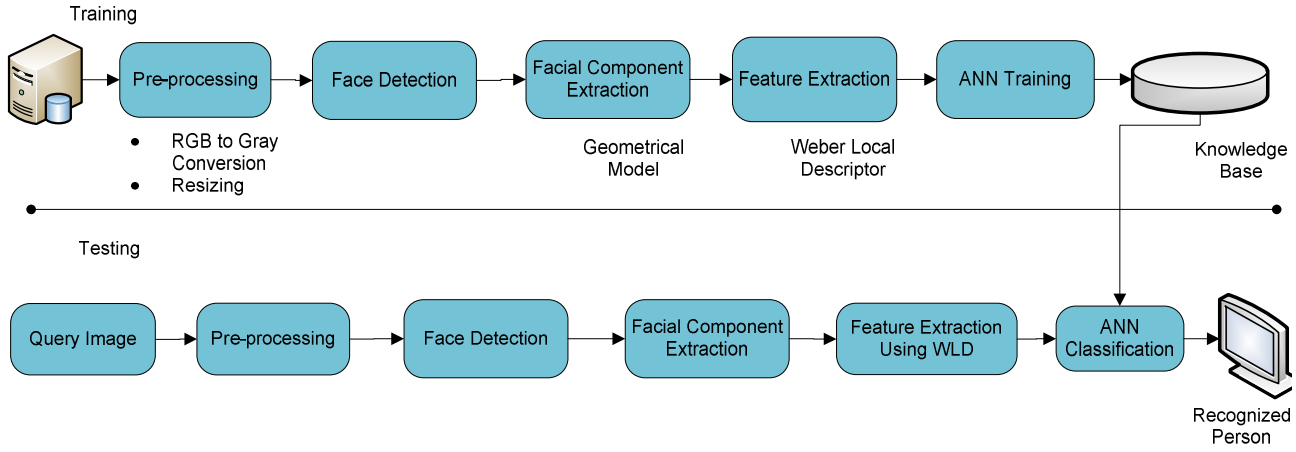

Figure 2 Functional flow the Proposed System.

Forensic sketch based Face Recognition using Geometrical Face Model

Figure 2 depicts the functional flow of our proposed system. The proposed sketch based face identification consists of two phases namely training phase and testing phase. It includes different modules such as pre-processing, face-detection, facial component extraction, feature extraction and *ANN* classifier. In training phase, as a first step, images are prepared for further processing task by performing pre-processing steps like image

resize and *RGB* to gray conversion. Next, using AdaBoost algorithm face region is identified.

Algorithm: *AdaBoost Algorithm for face detection*

Input: *Images* $(x_1,x_2),...,(x_m,x_n)$ *where* $y_1 = 0,1$ *for negative and positive faces, initializing the weights* $w_{1,i} = \frac{1}{2m}, \frac{1}{2t}$ *for* y_1*=0,1, where m and* $\int$ *are the positive and negative numbers.*

Output: *Face Detection*

Step 1: *First step is weight Normalization*

$$w_{1,i} \leftarrow \frac{w_{1,i}}{\sum_{j=1}^{n} w_{1,j}} \quad (1)$$

Step 2: *Select the best weak classifier wrt the weighted error.*

$$\varepsilon_t = min_{f,p,\theta} \sum_i w_i |h(x_i, f, p, \theta) - y_i| \quad (2)$$

Step 3: *Defines* $h_t(x) = h(x, f_t, p_t, \theta_t)$ *where* f_t, p_t*,and* θ_t *are the minimization of* ε_t

Step 4: *Update the weight*

$$w_{t+1,i} = w_{t,i}\beta^{1-e_i} \quad (3)$$

Where e_i*=0 if example* x_i*=is classified correctly and* e_i*=1 otherwise, and* $\beta_t = \frac{\varepsilon_t}{1-\varepsilon_t}$

Step 5: *The final classifier is can be mathematically computed as:*

$$c(x) = \begin{cases} 1 \; if \; \sum_{t=1}^{T} \alpha_t h_t(x) \geq \frac{1}{2} \sum_{t=1}^{T} \alpha_t \\ 0 \; otherwise \end{cases} \quad (4)$$

Where $\alpha_t = log \frac{1}{\beta_t}$

Using geometrical structure of face, main components like eyes, nose and mouth are marked. From each facial component a texture feature called *WLD* is extracted and feature vector of each image are stored in the database.

In testing phase, a query image will match to a particular class of the database which has similar features of the query image. Similar steps in the training phase are carried to the query or input image and using *ANN* classifier the image is classified [09].

Composite Sketch based Face Recognition using ANN Classification

Figure 3 shows the functional flow of the proposed methodology. The computer generated composite sketches are given as the input images for further processing. The proposed face identification scheme consists of two phases training and testing. In the first phase i.e. training process database images are trained, each image face region is located, pre-processed and texture features like MLBP and Tchebichef moment invariant features are extracted. The resultent feature vectors are stored in the database for matching with test images. Next step is testing step, build up with different modules namely pre-processing Module where input images are resized and conversion from *RGB* to gray scale image is performed [10].

In Face identification scheme the location of face region is located and cropped. For the recognition of the face, different facial parts of the face are located referring the geometrical structure of the face. The MLBP and Tchebichef moment invariant features techniques are used to extract the facial components like eyes, nose and mouth features. The Figure 4 shows MLBP flow chart.

Finally, extracted feature of a particular person needs to be identified, for this a ANN classifier is trained. Here the classifier is firs trained with composite sketches features taken from the database in the training phase to create a knowledgebase. Every time a test feature is extracted they are compared with the knowledgebase using ANN classifier to get the classified output [11].

EXPERIMENTAL RESULTS

We have implemented and evaluated our proposed Face Recognition technique using Matlab2012a. To test our implemented work, we carry out several tests on different databases. The entire work is divided in to two parts namely, Forensic and composite sketch based face recognition. Following explanation shows the outcomes of both Forensic and composite based face identification system.

Result of Forensic Sketch based Face Recognition System

This proposed work used CHUNK student dataset which includes a total 188 sketches. The few sketch images are used to from the database to get the hopeful result. The Figure 5(a) shows the input image whose forensic sketch generated by a forensic artist is as depicted in Figure 5(b) column.

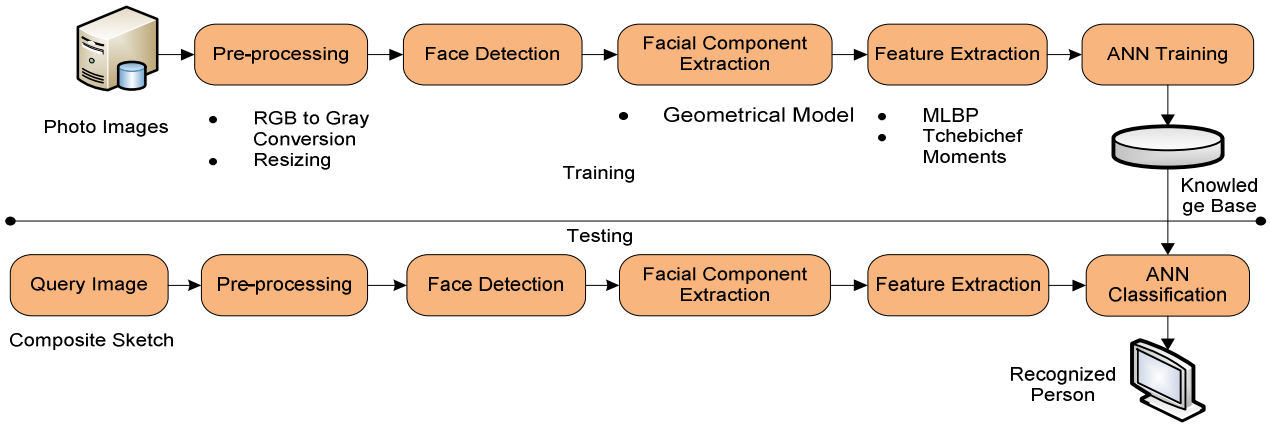

Figure 3 Functional Flow of the Proposed System.

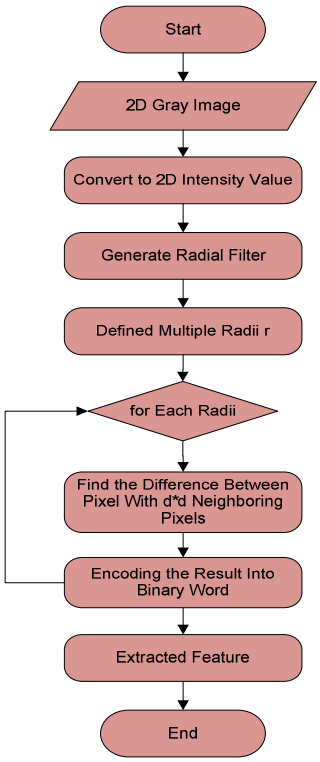

Figure 4 MLBP Flow Chart

The face detected using AdaBoost as shown in Figure 5(c) column. The resultant classification after training ANN classifier matched sketch image with the database is represented in Figure 5(d) column. Table 1 represents the accuracy based on different approaches to comparing with our proposed method and figure 6 represents the comparison graph of the existing and the proposed system.

Table 1 Comparison Table of Accuracy Rate

Approach and Features	Recognition Rate
PCA (Eigen face Features)	86%
PCA (DCT Normalization features)	86 %
LBP [17]	81%
Proposed (Geometric measurements with WLD)	93%

Composite Sketch based Face Recognition System

Experiments are conducted on 36 composite images of e-PRIP Software-Generated Composite (PRIP-VSGC) database generated using FACES [12] and using Identi-Kit [13]. Figure 7 shows a result for all the intermediate results obtained taking composite sketch as the input from the dataset taking 36 composite sketches. The confusion matrix is a prediction analysis which is helpful to calculate true positive, true negative, false positive and false negative rates as in Table 2. It helps to analyze the performance of the methodology.

(a) **(b)** **(c)** **(d)**

Figure 5 Test Images and result of classification (a) Original photos (b) forensic sketch (c) Face detection (d) Classification result.

By using confusion matrix, we can calculate accuracy, parameters by using Equation (5). In this research work proposed system performance is calculated by considering accuracy parameter.

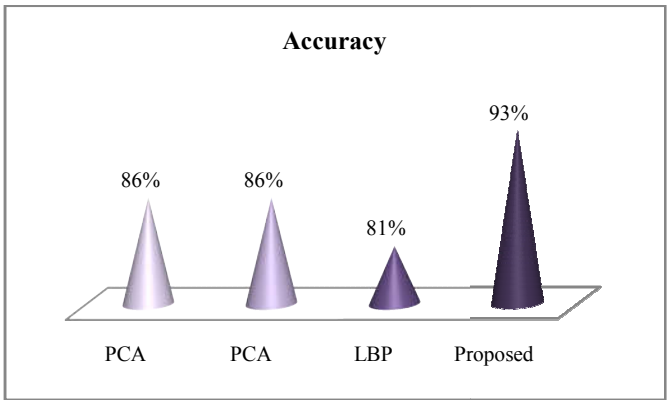

Figure 6 Accuracy comparison Graph for the Proposed and the Existing System

The amount of precision of a quantity is called as accuracy which is given by the formula,

$$ACC = \frac{T_P + T_N}{P + N} = \frac{T_P + T_N}{T_P + T_N + F_P + F_N} \quad (5)$$

Table 2 Confusion Matrix

N = 38	Predicted No	Predicted Yes	
NO	TN = 3	FP = 1	4
Yes	FN = 1	TP =33	34
	4	34	

The proposed model evaluated totally 120 sketch images out of 109 are true positive (*TP*), 5 are true negative (*TN*), 3 are false positive (*FP*), and false negative *(FN*) score is 3.

The figure 7 and figure 8 (a) is the Original image, (b) is the Face detected, (c) is the cropped face area; (d) Left eye region; (e) Right eye region, (f) Nose region, (g) Mouth region; (h) Facial Component recognition outcome.

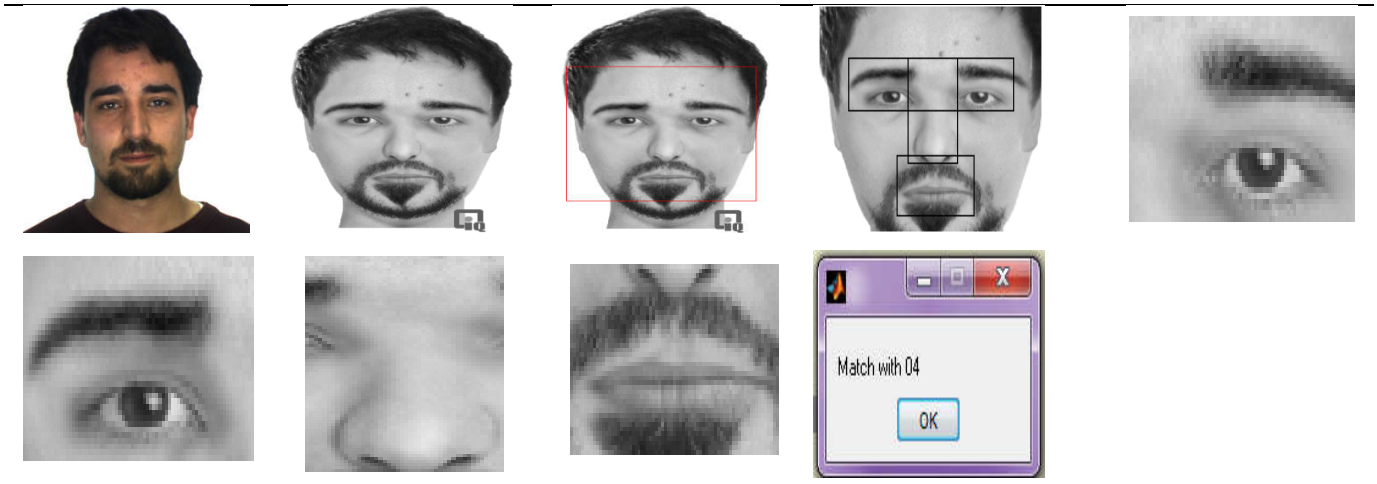

Figure 7 (a) Original image: (b) Face detection; (c) Cropped face ; (d) Left eye region; (e) Right eye region; (f) Nose region;(g) Mouth region; (h) Facial Component Identification.

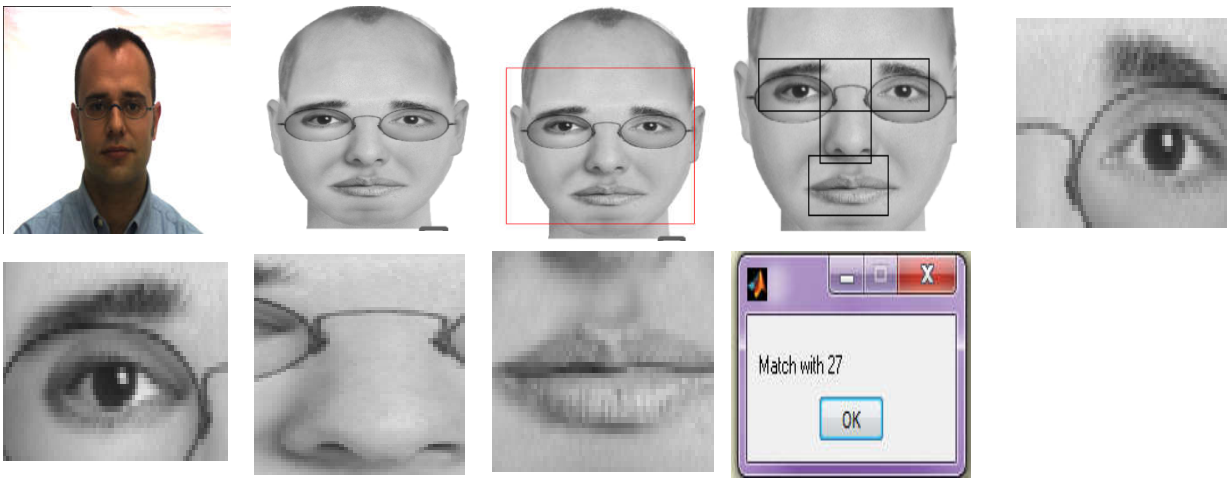

Figure 8 (a)Original image: (b) Face detection; (c) Cropped face ; (d) Left eye region; (e) Right eye region; (f) Nose region;(g) Mouth region; (h) Facial Component Identification.

Table 3 Accuracy Comparison of Existing and Proposed Model

S.NO	Author Name	Algorithm	Accuracy
01	Paritosh Mittal *et.al*[14]	Deep Belief Network (DBN)	58%
02	Daniel Heinsohn *et.al*[15]	Adaptive Sparse Representations	88.8%
03	Mohammed Saaidi *et.al* [16]	DCT+LBP+ANN	93.3%
04	Proposed Method	ANN	95%

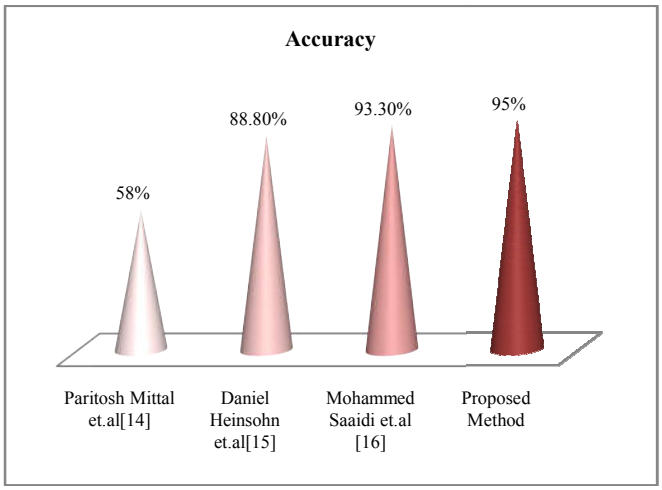

Figure 9 Accuracy comparison Graph for the Proposed and the Existing System

Above Table 3 represents the Accuracy Comparison of Existing and Proposed Model Figure 9 shows the performance of the proposed system with 96%. Finally the expected comparion output is represented in Table 4 and Figure 10 respectively.

Table 4 Accuracy comparison of ANN and SVM Method

S.NO	Sketch Type	Classifier	Accuracy
01	Forensic sketch	ANN	93%
02	Composite Sketch	ANN	95%

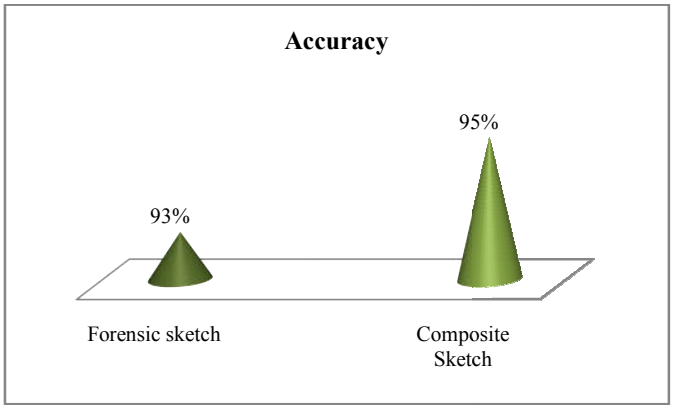

Figure 10 Accuracy comparison graph of ANN Method

CONCLUSION

In this research work presented a comparison of forensic and composite sketch based face recognition. Here we have presented a comparison between different face recognition algorithms like AdaBoost algorithm, a Weber Local Descriptor (WLD), Multi-scale LBP operator (MLBP), Tchebichef moment, ANN classifier. The overall performance for face recognition by using these algorithms we concluded that the multiple feature extraction method reduces the complexity and computational time. In order to increase classification performance ANN classifier is used. The results have produced an efficient accuracy rate.

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