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A ROBUST FACE DETECTION METHOD USING NEURAL FUZZY SYSTEM AND LOCAL SIFT FEATURES

Harjinder Kaur[1], Rahul Malhotra[2], Kulbhushan Rassewat[3]

[1]M.Tech Student, Department of E.C.E GTBKIET CHHAPIANWALI, MALOUT, PUNJAB, INDIA
[2] Director & Principal, CHHAPIANWALI, MALOUT, PUNJAB, INDIA
[3] Assistant Professor, Department of E.C.E GTBKIET CHHAPIANWALI, MALOUT, PUNJAB, INDIA

Abstract - *Security has become highly necessary these days. Identity authentication is an inseparable part of security systems. It is employed at many places. For this various techniques are utilized. Many of them include usage of passwords, tokens, cards etc. But traditional methods of identification or authentication, based on possession of any card or token or remembrance of password have many drawbacks. Biometric system establishes a direct link between the service and the actual user. There is absolutely no chance of forgetting or losing a biometric trait. Fingerprint, palm print, hand geometry, Iris, Retina, Face, Ear, Voice, Signature, Gait, Keystroke, Odor, DNA, ECG, EEG, Dental X-ray etc. are the various biometric traits that can be measured and used for identification of individuals.*

It this research work, we had represented a novel method for detection of face for biometric system is proposed. The system is based upon fuzzy logic and local SIFT features. The fuzzy system is used to detect the location of face and local SIFT features are used for detection the face. The system is compared with other existing techniques and it is found that proposed techniques is far better than existing systems. The detection rate is enhanced and there is improvement in true false detection and also computational time is reduced in proposed system.

Key Words: Face Detection, Face Recognition, Biometrics, Face Identification, IRS, Infrared.

1. INTRODUCTION

Biometrics means "life measurement". It is a Greek word which is made by combining two words bio and metrics. Bio means life and metrics means measurement. So it involves measurement of a live trait. It uses any human trait to verify identity of any person.

In biometrics following two types of characteristics of a human can be measured:

1. Physiological: It involves deriving biometric data by measuring body parts. For example: face, fingerprint, palmprint, ear, hand geometry, dental X-ray, iris, retina, DNA etc.

2. Behavioural: It involves deriving biometric data when body performs an action. For example: voice, keystroke, signature, odor etc.

1.2 Types of biometric systems:

1.2.1 Automated identification systems: These systems are operated by the professionals. They are mainly used by police or investigation teams. The use of these systems is to discover a person under consideration or to identify a criminal based on the traits left by the criminals. No access is provided to the enrolled users. Hence, operators of the system donot have a lot of reasons to cheat.

1.2.2 Biometric Authentication System: These are used for controlling access. They are used by normal users. They are used to verify a person or to check identity of an individual. Security of such systems is more complex task.

1.3 Working of Biometric Authentication System:

Practically working of every biometric authentication system is same. In the beginning, the process of enrollment is done. In enrollment registration of every new user is done into a database. A particular characteristic is selected and features of selected characteristic are extracted. For this features are usually passed through an algorithm that turns the selected features into a template. This template is stored in the database. The stored template consists of a very small amount of information as compared to the actual features. This template store features in the form of numbers. It is understable only by the biometric system that produced it. To identify any person, the system extracts the appropriate feature, translate this feature into a template by applying the same algorithm that the original template was computed with, and then compare the new template with the database to determine if there is a match, and hence, either an verification or identification is done as shown in figure 1.1

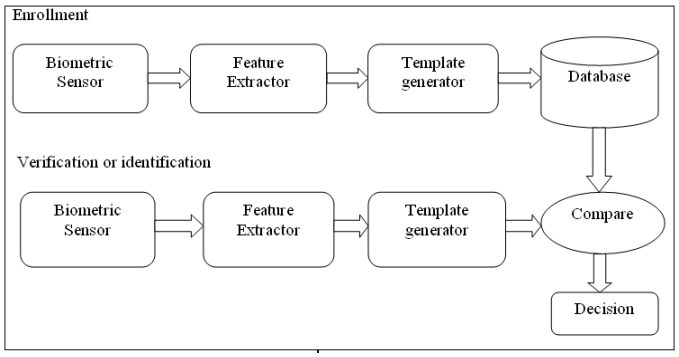

Figure 1.1 Biometric authentication process.

1.4 Need of Face Recognition

Face is the unique character of each individual with the help of which we can distinguish one individual from another. It is the mostly used method by each individual to identify other individual at first glance. Essentially face recognition is a way to seek other image of face with matching features of one image. Initially was begun to recognize the criminals and authorized person for security purposes. Now a day it is commonly used in schools, colleges and industries for attendance purposes

2. LITERATURE REVIEW

Marian Stewart Bartlett et al (2002) This paper offers an algorithm Independent Component Analysis for face recognition. In this paper two approaches are used for recognition first is that in which random variables are images treated as input and output will produce in pixels form. Second approach is that in which random variables are pixels treated as input and output comes in the form of images. This algorithm is tested on FERET and gets good performance

Chong Yaw et al (2006) The geometrical and numerical errors of Zernike moments area unit explored and methods field unit planned to slash them. The geometrical error is diminished by using mapping the entire pixels of targeted image within the unit disk. The numerical error is eradicated victimization the deliberate distinctive Zernike moments anyplace the Zernike polynomials subject unit built-in mathematically over the corresponding intervals of the photo pixels.

Rakesh et al (2012) [17] This paper measures the similarity between images to label a Self-Organizing Map (SOM). It covered issues like the non specific structure for face acknowledgment, calculates that may influence the execution of the recognizer, and a few best in class face acknowledgment calculations. This paper ensures that the proposed technique will be helpful for face recognition against light variation, facial expressions and poses.

Surabhi Varshney et al (2014) [26] this paper shows the review of different techniques used for face recognition in different ways and defines working of these algorithms. Explanation of Independent Component Analysis (ICA), the Neural Networks, Linear/Nonlinear Projection Methods, Elastic Bunch Graph Matching (EBGM), Linear Discriminate Analysis (LDA) and Principle Component Analysis (PCA) is provided in this paper.

3. PROBLEM FORMULATION & OBJECTIVES

3.1 Problem Formulation

Face recognition is very important topic of biometrics for security and authentication purposes. Everyone has a unique face for recognition. Different algorithms are already in use for face recognition like Principal Component Analysis (PCA), Independent Component Analysis (ICA), Linear Discriminant Analysis (LDA), Neural Network (NN), Support Vector Machine (SVM) etc. All these method provide face recognition but they have some disadvantages. They fail to provide recognition of faces in the conditions such as variance in pose, scale or illumination of face. So, Research is always ongoing for improvement new, fast and efficient techniques.

3.2 Objectives

Objectives are as follows: -

- To study and analyze existing techniques for face recognition.
- To develop a novel approach using SIFT to achieve high face recognition rate.

4. RESEARCH METHODOLOGY

4.1 Proposed Algorithm

Proposed algorithm is based on combination of SIFT, Feed Forward Neural Network and Fuzzy Inference System. This algorithm will be helpful for human face recognition for different angle images of face. In this algorithm we have to perform following steps for recognition:

1. Prepare the database
2. Add images to the database 1 by 1.
3. Calculate SIFT of each image for local features.
4. Remove unstable keypoints from local SIFT features i.e. low contrast points and poorly localized points along the edges.
5. Train the Neural Network for given set of test images.
6. Select the test image.
7. Calculate SIFT of test image.
8. Run the Fuzzy Inference System
9. Epochs and gradient values from ANN are input to fuzzy inference system and used to make the decision for test image.

10. Pass the test image values to FIS.
11. Compare the test image values with database values to find out the matching image.

4.2 Parameters

Following parameters are used for evaluation of the results :-

1. **Keypoints :-** SIFT calculates the value of potential keypoints. For this maxima and minima of a set of Difference of Gaussian (DoG) filters applied at different scales all over the image. Given a Guassian blurred image
   $L(x, y, \sigma) = G(x, y, \sigma) * I(x, y)$
   where I(x,y) is the given image and * designates convolution operator
   $G(x, y, \sigma) = \frac{1}{2\pi\sigma} e^{\frac{x^2+y^2}{\sigma^2}}$
   Where σ is the standard deviation of the distribution.

Epochs- Fewer epochs mean network learns in small repetitions. Less time means network achieved goal easily and shortly. Lower value of epochs is associated with higher network accuracy**.**

5. WORK DONE

5.1 Face Recognition

In biometrics we have many ways to recognize a person but face recognition is one of the best from them because in this recognition there are no needs to involve person to whom we are recognizing. In face recognition we use images to match a person or take direct data from camera and camera can record the face from some distance, also even if person did not have attention. Face recognition is an important topic in security system for recognition. It was started in 1960 by Woody Bledsoe, Helen Chan Wolf, and Charles Bisson with a semi-automated system. In this system administrator was required to match the distance and ratio of points including ear, eyes, nose and mouth from photograph to compare with reference data. This is a computer based security system which provides an identity to a face if that face is stored in database.

5.2 Database Used

Face Pix database is used to test the system which is created at Center for Cognitive Ubiquitous Computing (CUbiC), is used to test the system. This dataset is provided by Arizona State University of US and freely available for researches all over the World. This dataset is in jpg format. This dataset contains 6660 images in which 74 images of different 90 persons are collected. Faces in images are set at different angles.

Following two options are provided to use images of the database:-

1. Add images to database one by one.
2. Select entire database at once.

5.3 Graphical User Interfface (GUI)

GUI of the system consists of seven buttons. Figure 1 shows various buttons of the GUI.

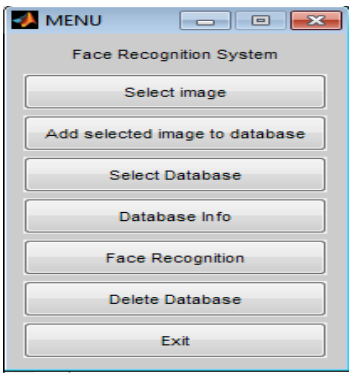

Figure 1 Graphical User Interface

Functioning of each button is as follows:-

5.3.1 Select image :

Select image button is used to select image for two purposes:-

To add an image to database : It is used to add an image to create a database of the images. Any number of images can be added using this option. Each image added using this is assigned a unique id. SIFT features are extracted of each added image. These features are then fed in to neural network for training.

To select an image for face recognition : It is used to select an image that is to be recognized. One image is selected for recognizing. This image is then compared with the image/images stored in the database. SIFT features are extracted of the selected image. These extracted features are then fed into the neural network for comparing these features with the features of database images. Figure 2 shows the example of an image that appears after its selection.

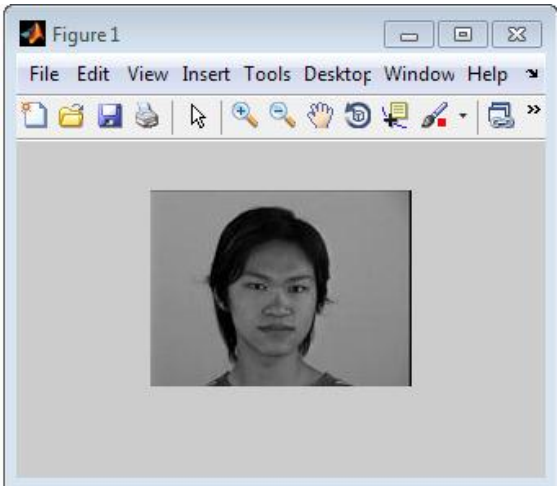

Figure 2 Selected image

If no image is selected for adding it to database or for recognition, then it displays an error message of "No image has been selected" as shown in figure 3

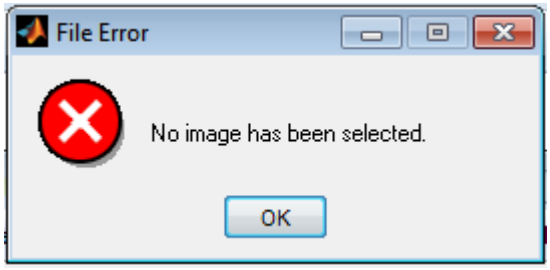

Figure 3 Error if no image is selected

5.3.2 Add selected image to database :

It is used to add selected image to the database. This option is used to create our own database of the image. On clicking on this button image selected using select image button will be added to the database.

5.3.3 Select database:

This button is used to select entire database at once. Using it all the images stores in the folders will be selected in the database. This option can be used when a large number of images are to be selected from database as in it there is no need to add images one by one in the database. SIFT features of all the images of the entire database are extracted and fed into the neural network for training.

5.3.4 Database Info:

On clicking on this button information related to database created using select image button is displayed. It displays the number of images added in the database. Figure 4 displays the information regarding database that has 5 images in it.

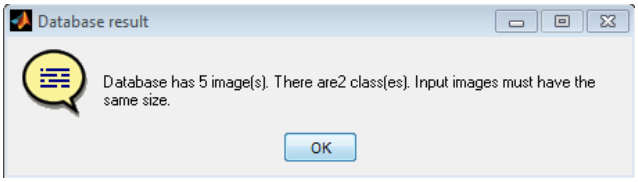

Figure 4 Database information

If database does not contain any image i.e. if database is empty then it displays a message that "database is empty" as shown in figure 5

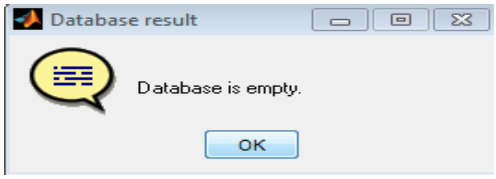

Figure 5 Database information if it is empty

5.3.5 Face recognition:

It is used to recognize test image with the database. On clicking this button SIFT features of test image are compared with the SIFT features of all the images of the database. If a match is found then test image and its sample image is displayed. Thus it helps to recognize an image with other images and displays the results of the recognition. Figure 6 shows the result of face recognition if an image exists in the database. First image is the test image and second image is the image that matches with the test image. after recognition of faces

5.3.6 Delete Database:

This button is used to delete the created database. Database created using select image button can be deleted by clicking on this button. When a new database is to be created, previous database can be deleted using this button. It removes all the images from the selected database. Before deleting database a confirmation message is displayed, as shown in the figure 7, that shows asks whether database is surely to be deleted or not.

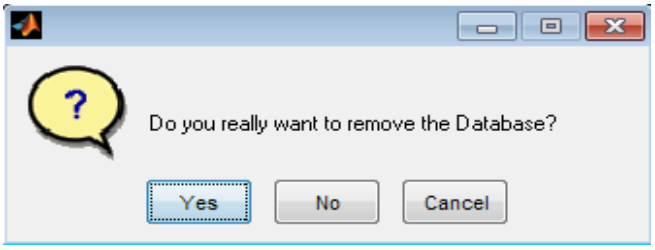

Figure 7 Confirmation message for removing database

After successfully removing all the images from the database a message is displayed that confirms that all the images from the database are successfully removed so that, if needed, a

new database can be created. Figure 8 shows the message displayed after a database is deleted.

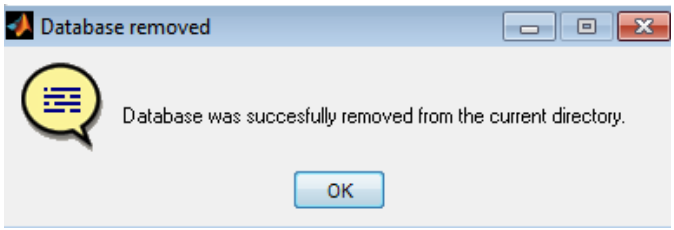

Figure 8 Database removal message

5.3.7 Exit:

This button is used to close GUI.

6. RESULTS

Proposed technique show good results, when we apply it on a large dataset of images. This technique allows recognition against pose variations and at any angle between -90 degree to +90 degree and provide better recognition rate. It is tested on Facepix database. This dataset contains 6660 images in which 74 images of different 90 persons are collected. Faces in images are set at different angles. Figure 6.1 to figure 6.6 shows various faces at different pose of angles on which the proposed technique is tested.

Figure 6.1 Image 1 for recognition

Figure 6.2 Image 2 for recognition

Figure 6.3 Image 3 for recognition

Figure 6.4 Image 4 for recognition

Figure 6.5 Image 5 for recognition

Figure 6.6 Image 6 for recognition

Table 6.1 shows results of recognition of various images in terms of various local keypoints. If value of these parameters is same for test image and image in the database, then image is recognized from the database else it is declared out of the database.

Table 6.1 Results after extracting features of faces

Image	Local keypoints
Figure 6.1	86
Figure 6.2	104
Figure 6.3	104
Figure 6.4	100
Figure 6.5	113
Figure 6.6	84

Comparative analysis

Comparative analysis of various existing algorithms is shown in the table 6.2. In this different types of existing techniques are compared like Principal Component Analysis (PCA), Independent Component Analysis (ICA), Linear Discriminant Analysis (LDA) and Support Vector Machine (SVM).

Table no. 6.2: Comparison of different algorithms

s. no.	Algorithm	Database	Recognition rate	Advantage	Disadvantage
1	PCA	AR-Faces	70	Reduce dimensionality	Class seperability remain same
2	LDA	AR-Faces	88	Reduce dimensionality Increase class seperability	N/A
3	ICA	FERET	89	Exploits higher order statistics	N/A
4	SVM	FERET	77-78	N/A	N/A
5	CFF	FRGC version 2	80.3		
6	PCNN	FRGC version 2 and Yale	85	Facilitates efficient hardware mapping	N/A

Table 6.3 shows the performance of proposed technique. From this we find that proposed algorithm is more efficient than existing techniques in case of face recognition. It also has the advantage to recognize a face in case of pose and angle.

Table 6.3 Performance of proposed technique

s.no.	Algorithm	Database	Recognition rate	Advantage
1.	**Z_S_N**	Face Pix Database	97	Pose variations and high performance rate

6. CONCLUSIONS

Face recognition is most important technique of biometrics which contains many local and global features for recognition in case of security. This technique is more helpful and in case of security and authentication as compare to password using or other biometrics techniques because in this technique no one have to remember any password or activity to remind the system. Also no one can copy your face as password or signature. The proposed work is based on face recognition system which will be helpful against poses and different angles of system. In this system, we used Scale Invariant Feature Transform (SIFT) for feature extraction. SIFT find local key points of images. We use neural network for pattern classification and recognition with two input, one output and 10 hidden layers. Network will produce output for testing image from dataset and show identity of face. Neural network is an automatic system which can classify the training data according to target data, this classification is done by the hidden layers. When we compare the results of proposed algorithm with existing algorithms we find that it performs better.

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BIOGRAPHIES

HARJINDER KAUR,
M.Tech (Student), Department of E.C.E GTBKIET Chhapianwali, Malout, Punjab, India

Dr. RAHUL MALHOTRA,
Director & Principal, GTBKIET Chhapianwali, Malout, Punjab, India

Er. KULBHUSHAN RASSEWAT,
Assistant Professor, Department of E.C.E GTBKIET Chhapianwali, Malout, Punjab, India