Face Recognition Using HOG and Different Classification Techniques

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***Abstract*— Face recognition based unimodal biometric system is developed in this work. The face features are extracted by Histograms of Oriented Gradients (HOG). For person identification of KVKRG face database several techniques were used. In this experiment total, 500 images were used. KVKRG Face database is developed under UGC-SAP Phase I (which is the researchers own major contribution) having 10 poses of each subject. Six and four samples were utilized for training and testing, respectively. Classifiers such as Ensemble Subspace Discriminate, SVM, Linear Discriminate, k-NN, were used for person classification. The Ensemble (Subspace Discriminate) and Linear Discriminant given highest recognition rate as compare to other classifiers. From the obtained results, it is found that the biometrics system generates results quikly and acuratly and improves the overall system performance.**

Keywords—face detection; face recognition; HOG; identification; unimodal biometric system;

I. INTRODUCTION

Face is a part of the human body which is mostly used for recognizing each other. The face recognition system is one of an important application in pattern recognition [1]. Also, for developing face recognition system, different concepts should be utilized such as: enhancement, segmentation, feature extraction, classification etc. The face has many features which are very easily for human to recognize, but in case of computer system, it's quite tough to achieve a higher accuracy in face recognition system as compare to the human brain [2]. Generally based on something that one has (key, chip card or magnetic card) or one knows (password, PIN), identity verification has achieved more reliable verification and identification famous as biometrics. Face recognition is widely used and accepted biometric system. To get higher level of security researchers develop this biometrics application. Uniqueness, universality, measurability, permanence and performance are factors require to be satisfied by biometric indicators. Face recognition's capability to recognize a person without the object's cooperation. As compare to other biometrics trait, face recognition has high performance and lack of uniqueness which make face recognition a powerful tool for biometric applications [3-6].

II. RELATED WORK

C. B. Yuvaraj, et al. [7] have reported face detection and recognition, their finding in the development of system, useful to maintain the attendance. For face detection, they used Haar features based on the Viola-Jones method. Haar cascades are more useful to detect the faces with fewer variations in the training image set. To generalize the system fine tuning has to do in terms of the number of cameras needed and the length of the video clip is important.

J. A. Chagas Nunes, et al. [8] used wavelet faces algorithm and the Linear Regression Classification for face recognition. They achieved higher performance by using the following steps. Step 1: The Wavelet decomposition considering 7 different Wavelet functions from 4 families, extending Chien and Wu's method, applying more Wavelet functions. Step 2: LRC method. This method shows higher performance than the original LRC method.

F. Paes Ferreira and T. B. A. de Carvalho [9] have studied face recognition using Wavelet decomposition as an extraction of facial features with well-known Eigen and Fisher faces. They evaluate seven different wavelet functions in five face databases. For classification they used the Support Vector Machine (SVM), Nearest Neighbours (1-NN), and Naive Bayes. Higher mean recognition rate i.e. 95% is achieved with feature extraction using Haar wavelets or Symlets 2.

S. Soltanpour and Q. M. J. Wu [10] have given the three-dimensional face recognition by high order local pattern descriptor with the conjunction of the sparse representation based classifier. The various steps are carried out on two famous 3D face databases, FRGC v2.0 and Bosphorus to get the higher acceptable performance under facial expression.

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S. B. Dabhade, et al. [11] developed a human authentication system using Hyper Spectral face. For the development of face recognition system they use Hong Kong PolyU Hyper Spectral Face Database. (KPCA) Kernel Principle Component Analysis algorithm gives important features of the Hyper spectral Face Dataset. For classification of extracted features, they used similarity measurement technique i.e. Mahalinobis Cosine (Mahcos). Finally, they got the Recognition rate is 69.20% on the basis of One Rank Level.

M. Wu and T. Lu [12] developed a face recognition algorithm based on LNMF and LBP. The coefficient matrix got through the test sample database, which has a projection to non-negative subspace. The experiment is done by applying neighbour distance classifier. The result shows that the recognition rate is improved.

R. Y. Dillak, et al. [13] have reported face recognition system in which they have developed a new technique. The following four steps have been carried out on Essex database for face recognition. Pre-process, feature extraction, train and test the data. The recognition rate is achieve by Elman Levenberg Neural Network. Database is consist of face images of 395 persons. They used total 7900 face images of male and female for recognition. They got 98.86% recognition. It is higher than previous methods.

III. METHODOLOGY

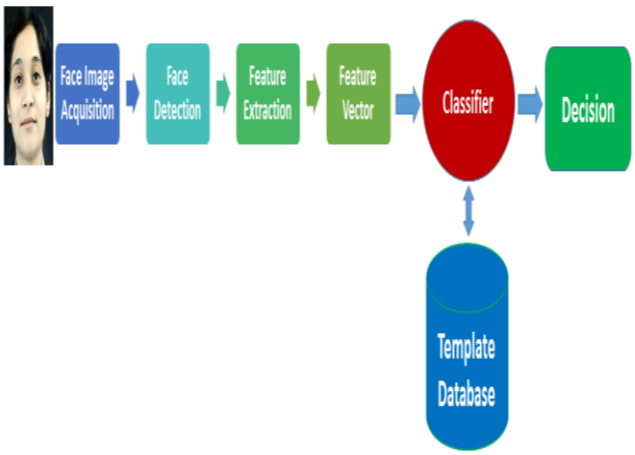

Figure No. 1. Face Recognition process

Face detection is the process to find whether an image contains a face, and if so, here is located in the image. Face detection is an important step in face recognition algorithm, with the aim to localize and extracting face region from simple or complex background [14]. Vila-John algorithm is applied for detecting the face in the images. A human face is a highly variable and dynamic object, thus it is difficult to detect a face. For the face with the different challenging condition which is maintained above.

Histogram of Oriented Gradient (HOG) algorithm is used for feature extraction. The algorithm steps of the HOG are the following [15-18]: -

These are the three steps detailed.

The first step is image/matrix is divided into cells and blocks.

Where, Cell = 8×8 pixels, Block = 2×2 cells along with 50% overlapping for the face recognition technique, these are presented according to the relevant circumstances.

Once the size of a face image is 64×64, then the number of Blocks is 49(7×7=49 Blocks).

The second step of this process (0-180^o) is the gradient orientation direction. Those directions will be separated into 9 bins. The following equations are to compute the gradient magnitude and orientation.

$$dx = I(x+1, y) - I(x-1, y) \quad (1)$$

$$dy = I(x, y+1) - I(x, y-1) \quad (2)$$

$$m(x, y) = \sqrt{dx^2 + dy^2} \quad (3)$$

The third step is to compute the histogram of each cell with respect to the direction of 9 bins.

The total no of all these features = NB × CB × P (4)

These are the three steps where NB is the total number of blocks in the face image. The CB is the cells number in each block. P is the bins Orientation is assigned by 9. From the third equation, the total numbers of HOG features are 49x4x9=1764.

Famous feature extraction algorithm HOG is used on KVKRG Face Database.

IV. DATABASE

Table 1 shows the KVKRG Face Database Properties Descriptions.

The Source: The database is developed at Multimodal Biometric Research Lab, Department of Computer Science and Information Technology, Dr. Babasaheb Ambedkar Marathwada University, Aurangabad, Maharashtra, India under the UGC SAP (II) DRS Phase-I.

Table No. 1 KVKRG Face Database Properties Descriptions

Properties	Descriptions
No. of individuals	50
Total no. of samples	500
Static or Videos	Both
Single or Multiple	Multiple
Gray or Color	Color
Resolution	640*480
Face Pose	looking left, Normal, looking right with 45°, looking up, looking Down
Facial expression	Small smile, big smile, Neutral, closed eye,
Illumination	Not Applicable
Accessories	Moustaches, glasses, beards,
3D data	Not Applicable
Ground truth	Not Applicable

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V. RESULTS AND DISCUSSION

For this experiment, we used KVKRG face database. This contained 50 subjects and 10 samples of each. Here we have taken 6 samples for training i.e. 300 and 4 samples for testing i.e. 200.

First, the SVM (Medium Gaussian SVM) classifiers were applied which are obtained the recognition rate of 83%. It means 83% persons are identified and 17% persons are not identified. The second time the SVM (Quadratic SVM), SVM (Cubic SVM), SVM (Coarse Gaussion SVM) is applied and it gives the same RR 90%. As compared to the previous recognition rate it is increased by 7% and also shows that the 90% persons are identified only 10% persons are not identified. A third time the SVM (Linear SVM) is applied and it got the RR 91%. It means it is increased by 1% and identified the persons by 91%. The fourth time the KNN (Weighted KNN) gives RR 92%. It is increased by 1%.Fifth time the Ensemble (Subspace Discriminate) give RR 98%. It is increased by 6%. Then, the Linear Discriminant gives RR 100%. It means all 100% persons are identified. The highest recognition rate is obtained by Linear Discriminant. The following Table No. 2 and Figure No. 2 show the comparison between different classifier accuracy and training time for KVKRG face database.

Result for Unimodal: KVKRG Face Database

Subject: 50 Repetitions: 10 Total: 500

Feature Extraction Technique: HOG

Validation: 40% Training: 6 Testing : 4

Table No. 2 Different classifier, accuracy and time in a sec for KVKRG Face database

Sr. No.	Name of Classifier	Accuracy in Percentage	Training Time in Sec
1	Linear Discriminant (Linear Discriminant)	100	2.5105
2	SVM (Linear SVM)	91	20.053
3	SVM (Quadratic SVM)	90	25.080
4	SVM (Cubic SVM)	90	24.107
5	SVM (Medium Gaussion SVM)	83	20.305
6	SVM (Coarse Gaussion SVM)	90	24.39
7	KNN (Fine KNN)	88	23.383
8	KNN (Weighted KNN)	92	1.1089
9	Ensemble (Subspace Discriminate)	98	30.135
10	Ensemble (Subspace KNN)	88	4.7173

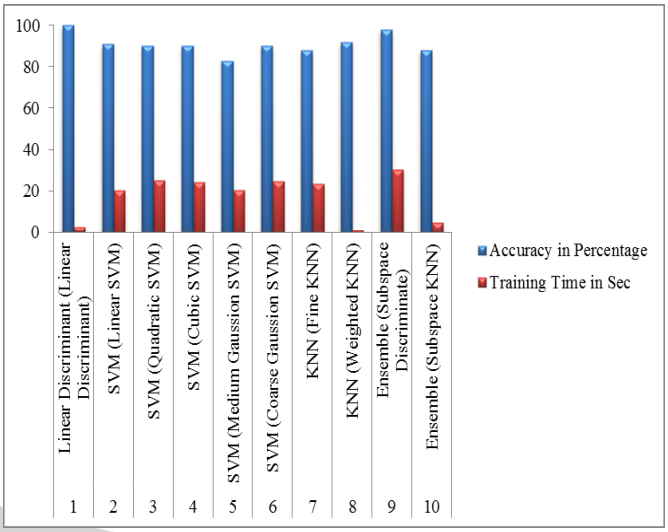

Fig. No. 2 Different classifiers, accuracies and times in the sec for KVKRG Face database

VI. CONCLUSION

The face recognition system based on Histogram of Oriented Gradient (HOG) was described in this research paper. KVKRG Face databases were used for this experiment. Vila-John algorithm is applied for detecting the face in the images. The Histogram of Oriented Gradient (HOG) is used to extract face features from the databases. Where, different classifications were adopted during the experiment such as SVM, KNN, LDA etc. Due to random selection of samples, recognition rate for some classifier are increased or decreased but those changes are not exceed ±1.6%. It is worth noting that face recognition rate exclusively depend on sampling of data base, classification and techniques of feature extraction. Finally, it is concluded that linear discriminant and Ensemble (Subspace Discriminate) are favorable classifiers to give better results for KVKRG face data base than other classifiers.

VII. ACKNOWLEDGMENT

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