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Extraction of Face Texture Features Based on Histograms of Oriented Gradients (HOG)

Pravin G. Sarpate[1*], Ramesh R. Manza[2]

[1*]Department of CS and IT., Dr. Babasaheb Ambedkar Marathwada University, Aurangabad, India
[2] Department of CS and IT., Dr. Babasaheb Ambedkar Marathwada University, Aurangabad, India

[*]*Corresponding Author: pravingsarpate@gmail.com, Tel.: +91-9762239818*

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***Abstract*—** This research paper is designed on a unimodal biometric system. This system is based on Face recognition. The proposed modal consists of two major processes, the enrollment and the recognition. The enrollment is used for acquiring the template features which are called as the training features. The recognition means the involvement of the method which identifies the feature vectors from the template features to which that specific class belongs. This process is called as the testing and accuracy is obtained from this process. The Histograms of Oriented Gradients (HOG) are used for extracting the face features. This technique is applied for identification of a person on KVKRG face database. In this experiment total 200 images were used. KVKR Face database is developed under UGC-SAP Phase I (which is the researchers own major contribution) having 10 poses of each subject. The highest recognition rate is obtained by Ensemble (Subspace Discriminate) that is 98.8% and Linear Discriminant that is 100%. The experimental result has shown that biometrics system record an improvement in the overall system performance. Its results are quick and accurate.

***Keywords*—**Biometrics, Face Recognition, Histogram of Oriented Gradients, Multimodal Biometrics, Verification

I. INTRODUCTION

Face recognition has a very wide range of applications. On account of this it has received significant attention. The application of face recognition has tremendously expanded recently, not only in the public sector but also in the use of personal devices. The public sectors like security, surveillance and access control for offices. Personal devices which are used as digital cameras, service robots, smart phones and laptops. Numerous studies on face recognition have been reported in recent years. The recognition performance which is a major component of the practical face recognition. The biometric systems is very much influenced by changes and variations in the lighting or illumination conditions, the viewing point direction or the poses taken facial expressions, the process of aging and the use of disguises [1, 2]. This is a challenging task because there are many of unresolved issues which have resulted from these particular conditions. There are three broad categories in which the existing face recognition algorithms are generally classified.

This categorization is based according to the type of features used:

1. Holistic methods: These Holistic methods represent the whole facial region. It represents a high-dimensional vector. The same is used as an input to a classifier.
2. Local methods: These methods extract local features from facial regions. The eyes, nose, mouth and cheeks are then extracted these features for recognition are used.
3. Hybrid methods: In the hybrid methods, both the holistic and local features are combined used to recognize a face. Hybrid is the combination of the local and holistic features used to recognize a face. Zhao et al. [1] have claimed that "…one can argue that these methods could potentially offer the better of the two types of methods."

The paper is organized as following: section II brief discuss about the related studies. Section III contents the methodology of the research. The results and discussion are mentioned in the section IV. The fifth section discusses the conclusion. At the end the acknowledgment and references.

II. RELATED WORK

In this section, The related research work is highly significant to present the literature survey. The traditional solution for different pose problems of the face image is to keep many different posed images. The same person's face has the database of different images. Consists of this variety matching each coming probe face image matched with its

corresponding pose stored in the database. This is the modern approach. It constructs frontal pose out of different pose. Some transformation techniques and artificial modeling are used to match and pair these face images. The modern updated solution is more efficient solution in real-life condition where normally limited face images in the database (gallery) per each person for matching is kept. In modern solution, generally there are three approaches for handling the pose transformation issues.

Firstly, the different poses are used in the 3D modeling of frontal poses [3]. This approach has become highly popular on account of its recognition rate, yet the major issue or problem with this popular approach is there. Firstly it is required more than one training image for modeling. It has an extensive computational cost. It limits its application in real life condition [4].

Secondly, 2D modeling of face image is processed through some geometric techniques. These geometric techniques are Elastic Bunch Graph Matching (EBGM) [5]. That matching and pairing graphs Active Appearance Model (AAM) the model that depends on either active appearance or active shape, Active Shape Model (ASM).There are many more such techniques [6], [7]. This technique has a very good recognition rate. The major problem of with this approach is that of detection of fiducially feature point detection [8], [9]. This approach uses the geometric features. To locate the landmarks exactly for feature extraction has become very difficult. Mostly the manual intervention is generally required to identify the place of the landmarks.

The third approach is known as holistic or intensity based techniques. This new approach is based on statistical technique and has been in use from the present decade alone. (PCA, Gabor Wavelet and etc.) [10], [11].The features are either extracted or transformed in this third holistic or all comprehensive approach. The holistic features are intensity features. In using this approach, it is essential to find the transformation more accurately. The conventional linear regression technique does not perform well when there is presence of multicollinearity and heteroscedasticity, ridge regression is used to overcome this shortcoming. Multicollinearity or many sided joint linearity arises. For this it is essential that two or more predictor variables in a multiple regression model are highly correlated. Heteroscedasticity or multi-dimensional variety arises due to variance of regression estimation error not being constant for all values of independent variable. This means that error term for each observation can and does vary as observed by Gross and others [12].

The literature survey is very important as a step of research on the papers on face recognition. Offer information on various techniques and algorithms used for face recognition [13]. In the last decade mainly algorithms are developed for face recognition [14]. Most of these algorithms like Neural Networks, work only for the single image of a system. But this single image system in classroom attendance system helps to recognize the multiple faces [15]. The AdaBoost Algorithm is the most efficient algorithm for multiple face recognition and other purposes [16].

III. METHODOLOGY

The Fig. 1 shows the details about proposed system.

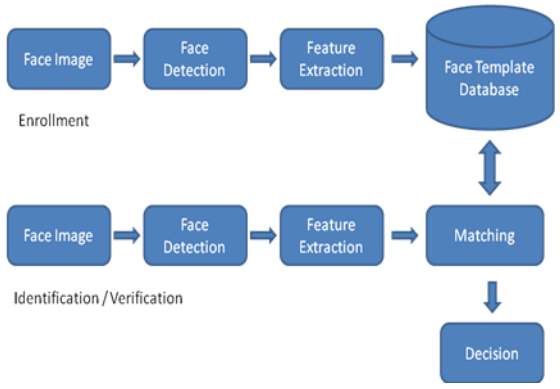

Figure.1. Proposed System

The algorithm steps of the Histogram of Oriented Gradient (HOG) are the following as outlined in their papers by Navneet Dalal and Bill Triggs as well as Wei Jia, Rong-Xiang Hu, Ying ke Lei, Yang Zho and Jie Gui [17][18], Alsubari Akram, and R. J. Ramteke [19]: -

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

The second step of this process (0-180^o) is the gradient orientation direction. Those directions will be separated to 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 the respect to the direction of a 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.

For the face recognition technique, these are presented according to the relevant circumstances. The experiment has

been done using well-known feature extraction algorithm HOG on KVKRG Face Database.

The Database: KVKRG FACE DATABASE

Table 1 shows the KVKRG Face Database Properties Descriptions

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

Table 1. KVKRG Face Database Properties Descriptions

Properties	Descriptions
# of subjects	20
# of images/videos	200
Static/Videos	Both
Single/Multiple faces	Multiple
Gray/Color	Color
Resolution	640*480
Face pose	Normal, looking left, looking right with 45°, looking up, looking down
Facial expression	Neutral, small smile, big smile, closed eye,
Illumination	N/A
Accessories	Glasses, beards, moustaches
3D data	N/A
Ground truth	N/A

IV. RESULTS AND DISCUSSION

For this experiment, we used KVKRG face database. This contained of 20 subjects and 10 samples of each. Here we have taken 6 samples for training i.e. 120 and 4 samples for testing i.e. 80. Table 2 shows the result of different classifier, accuracy in percentage and training time in sec.

First, the SVM (Coarse Gaussian SVM) classifiers were applied which are obtained the recognition rate 86.3%. Second time the KNN (Fine KNN) and SVM (Linear SVM) is applied and it got the RR 87.5% which is increase by 1.2%. Third time the SVM (Cubic SVM), SVM (Quadratic SVM), Ensemble (Subspace KNN) is applied and it got the same RR 88.8%. It is increase by 1.3%. Fourth time the KNN (Weighted KNN) and Ensemble (Bagged Trees) gives RR 92.5%. This is increase by 3.7%. Fifth time Ensemble (Subspace Discriminate) give RR 98.8%. Then, the Linear Discriminant gives RR 100%. The highest recognition rate is obtained by Ensemble (Subspace Discriminate) and Linear Discriminant. The following Fig. 2 shows the comparison between different classifier accuracy and training time for KVKRG face database, Fig. 3 shows scatter plot of Linear Discriminate and Fig. 4 shows parallel coordinates plot of Linear Discriminate.

Table 2. Different classifier, accuracy and time in sec

Sr.No.	Name of Classifier	Accuracy in Percentage	Training Time in Sec
1	Linear Discriminant (Linear Discriminant)	100	0.9426
2	SVM (Linear SVM)	87.5	8.0459
3	SVM (Quadratic SVM)	88.8	7.8106
4	SVM (Cubic SVM)	88.8	7.7074
5	SVM (Coarse Gaussion SVM)	86.3	7.5892
6	KNN (Fine KNN)	87.5	0.78771
7	KNN (Weighted KNN)	92.5	0.79269
8	Ensemble (Bagged Trees)	92.5	2.3474
9	Ensemble (Subspace Discriminate)	98.8	4.6433
10	Ensemble (Subspace KNN)	88.8	1.8319

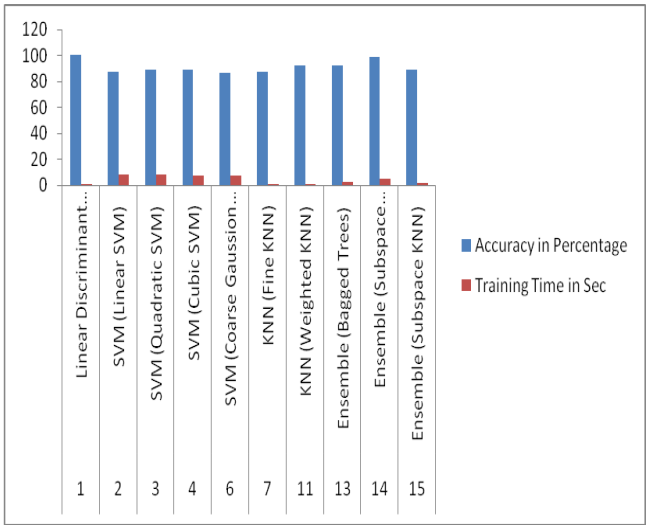

Figure.2. Comparison between different classifier accuracy and training time

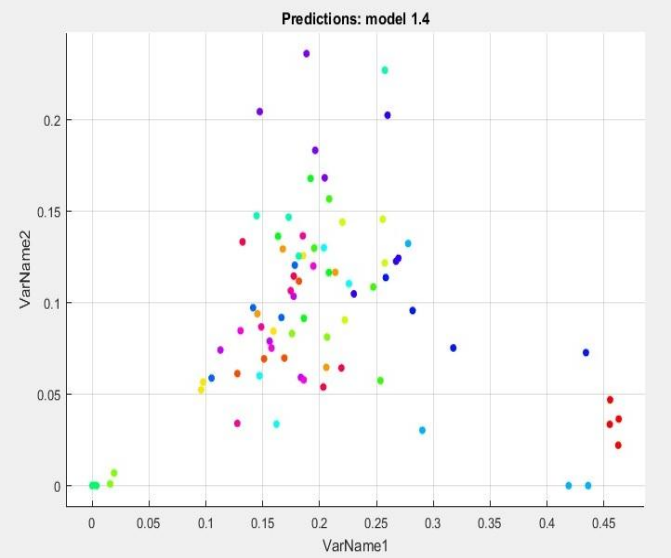

Figure.3. Scatter plot of Linear Discriminate

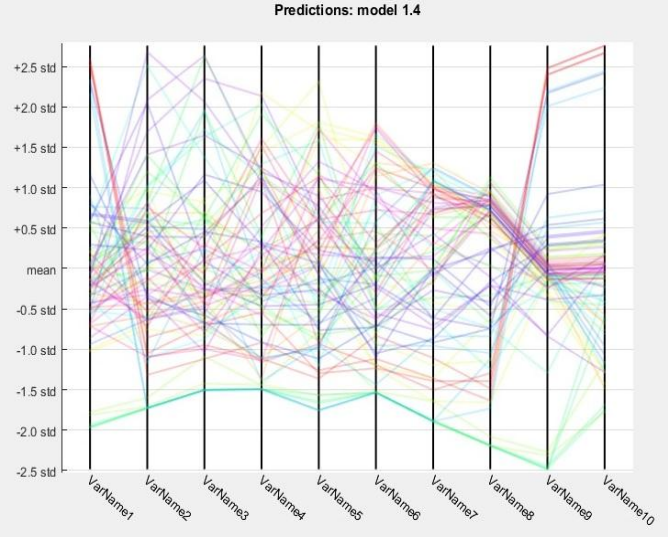

Figure.4. Parallel coordinates plot of Linear Discriminate

V. CONCLUSION

From the experimental results, we have found the recognition rate for some classifiers are increased or decreased due to the random selection of samples but those changes are not exceed ±1.6%. For obtaining the result, first we have extracted the texture features of KVKRG face database with the help of Histogram of Oriented Gradient (HOG) and the Linear Discriminate classifier is applied, so the highest recognition rate was 100%. When we applied Ensemble (Subspace Discriminate) classifiers on KVKRG face database, the recognition rate is 98.8%.

Therefore, it is concluded that, the face recognition rate is dependent on: the feature extraction techniques, the classification and the sampling size of database. In the present result, it is observed and concluded that, the Linear Discriminate (LD) and Ensemble Subspace Discriminate (ESD) are more suitable for KVKRG face database as compared to other classifiers.

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Authors Profile

Mr. P G Sarpate pursed Bachelor of Science from Dr. Babasaheb Ambedkar Marathwada University, Maharashtra, India in 2004 and Master of Computer Science from Dr. Babasaheb Ambedkar Marathwada University, Maharashtra, India in year 2006. He is currently pursuing Ph.D. in Department of Computer Science & Information Technology, Dr. Babasaheb Ambedkar Marathwada University, Maharashtra, India, since 2014. His main research work focuses on Image Processing, Signal Processing, Pattern Recognition, Biometrics.

Mr R R Manza pursed Bachelor of Science and Master of Science from Dr. Babasaheb Ambedkar Marathwada University, Maharashtra, India in year 1996 & 1998. He has passed SET/NET in 2002 from Pune university and UGC New Delhi. He is currently working as Associate Professor in Department of Computer Science & Information Technology, Dr. Babasaheb Ambedkar Marathwada University, Maharashtra, India. He is a life member of IEEE, IAEng, CSTA, IACSIT,ISCA,ISSS. He has published more than 118 research papers in reputed international journals and in Conference more than 134 research paper. His main research work focuses on Biomedical Image Processing using Matlab, Big Data Analytics, Data Mining, IoT and Computational Intelligence.

