IJISET - International Journal of Innovative Science, Engineering & Technology, Vol. 4 Issue 7, July 2017
ISSN (Online) 2348 – 7968 | Impact Factor (2016) – 5.264
www.ijiset.com

Comparison of Different Face Recognition Algorithms

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Abstract

This paper is about the different algorithms which are used for face recognition. There are so many algorithms which are available for face recognition. There are two approaches by which the face can be recognize i.e. face Geometry based and face appearance based [3]. The appearance based technique is also sub divided into two technique i.e. local feature and global feature based. In this paper we study, i) Correlation, ii) Template Matching, iii) Normalized Cross Correlation and iv) Kekre Transform and then compare these algorithm on the basis of their efficiency accuracy and execution time and checks which algorithm gives the better result. A face recognition technique that is robust to all situations is not available. Some techniques are better in case of illumination, some for pose problem and some for occlusion problem. This paper presents some algorithms for face recognition [5].

Keywords: *Face recognition, Normalized Cross Correlation, Kekre transform, CBIR*

1. Introduction

There are so many faces which the any normal human being see in his daily life, but out of which they remember few of them. The faces which they remember are based on some feature means they don't exactly know the correct face but they know the feature of the particular face of the person [3]. There are some special feature by which exact person is recognize, like his color of eyes, shape of the ear which remains same his all life [3]. There are some features which changes as the age increases like shape of nose, shape of the lips etc. Face Recognition is very complex process that find the exact match or minimum threshold value face to find out because the face image which are coming for recognition may contain noise or may be the light in the face or the color in the face image is not proper [3]. The face which are coming for recognition purpose contain many useful information but using all these information is very much time consuming and consume lots of cost, so we reduced the information using feature extraction techniques through which we have extracted our region of interest without losing useful information [3]. Feature extraction is an important and challenging step in the face recognition operation [6]. For this purpose we have used viola-jones algorithm which uses openCV commands to extract ROI. Most important geometric features includes eyes, nose, mouth and shape of head [6].

The Face Recognition can be used in many places like Air ports, Military bases, Government offices, also use for daily attendance purpose in the multinational companies [3]. Face Recognition has two phases first phase is the training of the faces in which the faces are saved in the database and second face is the identification phase in which they have to find who the user is by comparing it with all database images [3].

2. Overview of the System

The proposed face recognition system consists of two module which are the training of dataset and identification phases.
Fig. 1 shows flow diagram of Face Detection and Recognition System.

2.1 Training Module

The image is taken using a web camera and stored in a database. Next, the face image is detected and trained. During training, the face image is preprocessed. The features of the face image are extracted using several feature extraction techniques.

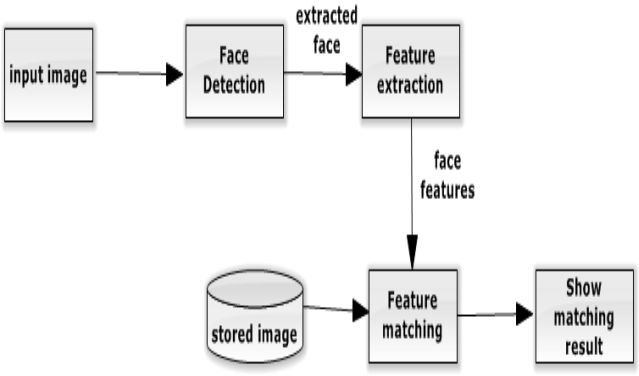

Figure 1: Flow Diagram of Face Detection and Recognition System

The features data is then stored together with the user identity in a database [3].

The purpose of the pre-processing module is to reduce or eliminate some of the variations in face. In preprocessing technique the color image is first converted into gray scale or in black & white image [3]. After that according to the algorithm the steps are apply into the image to store in the database and calculate the threshold value of those images, threshold value is also saved in the database.

2.2 Identification Module

A user's face is once again acquired and system uses this to identify who the user is. The input to the face identification module is the face image, which is derived from the database. Identification involves comparing the acquired biometric information against templates corresponding to all users in the database. The input image is compared to each image in database corresponding to all users which generate a values for each comparison. This value is then compared with threshold value and then results are generated [3].

3. Algorithms for Face Recognition

Though many face recognition techniques have been proposed and have demonstrated significant promise, the task of robust face recognition is still difficult. Face recognition methods have several problems [5].Orientation of face, Expression of face, pose variation, occlusion and illumination are some of them [5]. We have implemented multiple techniques on our training set, evaluated results for them and then compared their results. Further we have tried to remove shortcomings of one technique using the other.
We have implemented,

- Correlation
- Template Matching
- Normalized Cross Correlation
- Kekre Transform

3.1 Correlation

With Correlation, two images are super imposed on each other and results are recorded. We have correlated two features that are nose and eyes separately. Values are collected for three criteria that are – Same Person Same Image, Diff Person Diff Image and Same Person Diff Image. Our main area of concern was Same Person Diff Image.

3.1.1 Advantages of this algorithm:

- Helps in learning the basics of face recognition.

3.1.2 Disadvantages of this Algorithm:

- Unfortunately, the results of correlation were not reliable enough to give a threshold.
- Not invariant to changes in image amplitude such as those caused by changing lighting conditions across the image sequence because it is dependent on the size of the feature [1].

3.2 Template Matching

Template matching uses templates of input image and matches it with corresponding templates in the database. We have used templates of nose and eyes respectively to calculate results against diff images in the dataset.

Template Matching uses the technique of matching a template across the whole image by dividing it into columns and rows. The results of template matching were used to set a threshold value.

3.2.1 Advantages of this algorithm:

- Works effectively with small size images.
- Provide a better threshold value than correlation

3.2.2 Disadvantages of this Algorithm:

- Works well for just exactly same images
- Execution Time very High
- Can't cater pose and illumination variation at all.

3.3 Normalized Cross Correlation

The normalized correlation coefficient overcomes the difficulties of cross-correlation by normalizing the image and feature vectors to unit length, yielding a cosine-like correlation coefficient [1].

First we have taken a source image and an extracted face from the source image by using Region of Interest. Target image is chosen from the image database which consists of different images of same person taken at different times, from different viewpoints. Now select the sub region of both extracted face and target images [1]. Finally Normalized Cross Correlation is performed on these images.

The plot of NCC is shown in a figure 2.

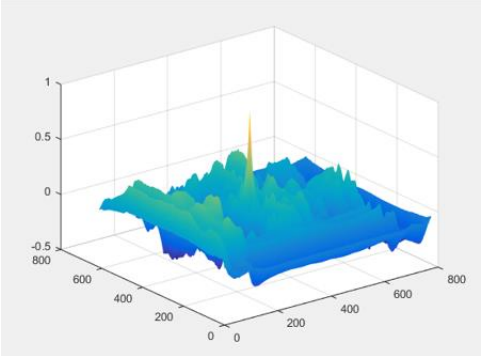

Figure 2: Plot of NCC

3.3.1 Advantages of this algorithm:

- Works for expression variation.
- Handled illumination variation to some extend
- Execution Time better than template matching

3.3.2 Disadvantages of this Algorithm:

- It can't handle pose variation at all.
- Can cater illumination variation to some extent.

Figure 3: Results of NCC

3.4 Kekre Transform

Kekre transform basically works on the concept of Content Based Image Retrieval (CBIR). This algorithm uses the concept of sectorization on images transformed using Full Kekre transform [4].

Kekre Transform matrix can be of any size NxN. All upper diagonal and diagonal values of Kekre's transform matrix are one, while the lower diagonal part except the values just below diagonal is zero [2], [4].

The Kekre transform matrix of dimension NXN is given below:

$$K(NXN) = \begin{bmatrix} 1 & 1 & 1 & \cdots & 1 & 1 \\ -N+1 & 1 & 1 & \cdots & 1 & 1 \\ 0 & -N+2 & 1 & \cdots & 1 & 1 \\ \vdots & \vdots & \vdots & \cdots & \vdots & \vdots \\ 0 & 0 & 0 & \cdots & 1 & 1 \\ 0 & 0 & 0 & \cdots & -N+(N-1) & 1 \end{bmatrix} \quad (1)$$

The typical CBIR system performs two major tasks.

-The first one is feature extraction (FE), where a set of features, called image signature or feature vector, is generated which describes the image stored in the library extensively. A feature vector is much smaller in size than the original image [2].

-The second task is similarity measurement (SM), where a distance between the query image and each image in the database using their signatures is computed so that the most relevant images can be retrieved [2].

Preprocessing is performed on the dataset for implementation of Kekre.

3.4.1 Advantages of this algorithm:

- Works for expression and pose variation as well.
- Handled illumination variation to some extent.
- Execution Time very low.

3.4.2 Disadvantages of this Algorithm:

- It can't handle illumination perfectly.
- Efficient but not accurate.

Figure 4: Result of Kekre Transform

Figure 5: Face Images of the Database

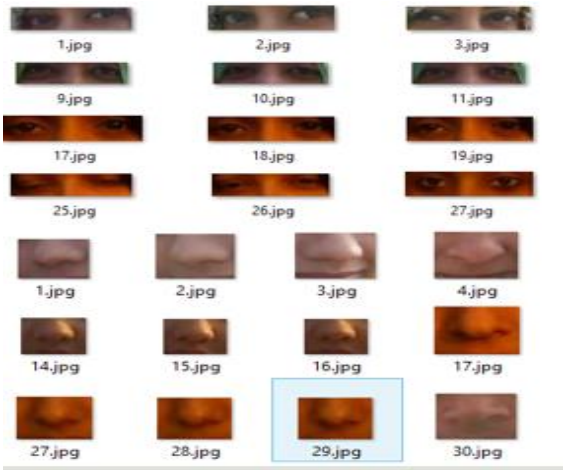

Figure 6: Extracted Features

4. Comparison between the Algorithms

We will compare these algorithms with respect to Efficiency and Average Execution Time.

Efficiency: The probability that algorithm will correctly identify an individual.

Execution Time: Execution time measures the time to perform the algorithm for one comparison between an input image and an image from database.

Name of Algorithms	*Average Execution Time / sec*	*Efficiency / in %*
Template Matching	2.05 min OR 125 sec	80 %
NCC	11.7101 sec	91.30%
Kekre Transform	33.3018 sec	83%

Table 1: Average Execution Time and Percentage Efficiency

Table. 1 shows average execution time of each algorithm calculated by measuring execution time of each comparison and then calculating average of execution time.

Also, it shows Efficiency for each algorithm, which states the probability that algorithm will correctly identify an individual.

Following plots show average execution time and efficiency graphs for above discussed algorithms.

Figure 7: Average Execution Times

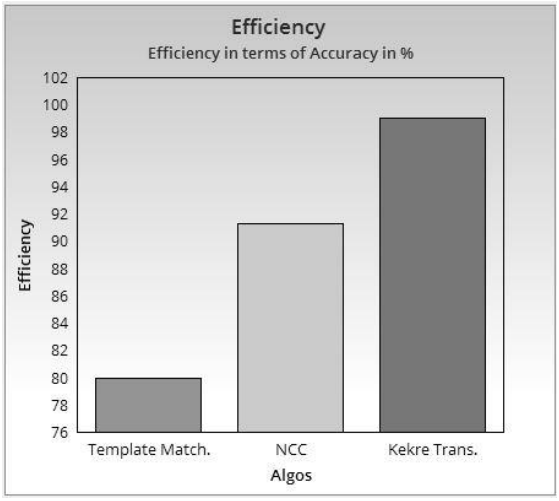

Figure 8: Efficiency of Algorithms

From the above results, it can be observed that Kekre has highest efficiency and lowest average execution time. Whereas template matching took too much time for execution but the results were still not efficient. NCC however shows a moderation between the two.

5. Combination of Two Algorithms

From the above mentioned results we have observed that Kekre is efficient but Normalized Cross Correlation has proved to be more accurate. So in order to improve the results we have combined these two algorithms to get efficiency of Kekre and accuracy of NCC.

We observed fail cases in the results of Kekre and then applied NCC to them. And observed that NCC has gained success where Kekre failed. Hence we can say that combination of these two can yield fruitful results.

Figure 9: Showing Combination of two Algorithms

Fig. 9 shows fail case of Kekre and when NCC is applied to the same image it was successful. So this is how we can say that combining two algorithms can increase accuracy as well as efficiency.

6. Conclusion

In this paper we have worked on four different face recognition algorithms and feature extraction techniques as well. Face recognition techniques have yielded better results when they are implemented with feature extraction.

Among all the four algorithms Kekre has worked most efficient for pose and illumination variation as well. Also Kekre Transform has least execution time. Whereas NCC and template matching can still further be improved. We also came to know that combining two or more techniques can improve the accuracy of system greatly.

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Shehryar Ali Khan received his BSc. Engineering in Electronics Engineering from Ghullam Ishaq Khan Institute (GIKI), Pakistan, in 2010. He has done his MS in Robotics & Intelligent Machine Engineering, from National University of Science & Technology (NUST). His major field of research is the study of dynamic collision avoidance in swarm scenarios. His research interests include motion planning, image processing, navigation and control of humanoids and mobile robots.

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Miss Raafia Shabbir has received her BE degree in Information Technology in April, 2016 from KICSIT (UET, Taxila), Pakistan. She has been a Gold medalist of his batch during graduation. Her life is full of appreciation and awards. Her contribution involved the research and development prospect of Algorithm using Digital Image Processing techniques. Currently, she is interested in research on new topics in areas of Robotics and Computer Vision. Her major interests involve problem solving and developing algorithms.

Salma Mehbub Malik [3]

Ms. Salma Mehbub Malik has received her BE degree in Information Technology in April, 2016 from KICSIT (UET, Taxila), Pakistan. She began her career in the field of Research and Development in September 2015. The main choice of her interest in research is Computer Vision and AI (Artificial Intelligence). She has done the algorithm development in MATLAB and Proteus. Her major interests involves the development of algorithm and build it into a refined Software Product.

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