Improved Face Recognition with Multilevel BTC using Kekre's LUV Color Space

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Abstract—**The theme of the work presented in the paper is Multilevel Block Truncation Coding based Face Recognition using the Kekre's LUV (K'LUV) color space. In [1], Multilevel Block Truncation Coding was applied on the RGB color space up to four levels for face recognition. The experimental results showed that Block Truncation Coding Level 4 (BTC-level 4) was better as compared to other BTC levels of RGB color space. Results displaying a similar pattern are realized when the K'LUV color is used. It is further observed that K'LUV color space gives improved results on all four levels.**

Keywords- Face recognition; BTC; RGB; K'LUV; Multilevel BTC; FAR; GAR.

I. INTRODUCTION

The term face recognition refers to identifying and verifying a face image. It is basically the process of classifying a face as 'known' or 'unknown', based on training set. While humans can easily identify faces, it is a challenging task for computer systems. The computer systems store the faces in such way that the important contents of the face image they store, can be used efficiently for recognizing the face.

There are many biometric systems such as finger prints, voice, iris, face and retina. Among these face recognition turns out to be the most effective system since it requires very less human interaction [21, 22]. Researchers from the field of biometrics, image processing, computer vision, pattern recognition system and neural network give a lot of importance to face recognition. It is the fastest growing biometric technology [18]. Some of the applications of face recognition include physical, security and computer access controls, law enforcement [12, 13], criminal list verification, surveillance at various places [15], forensic, authentication at airports[17], etc.

Many algorithms are used to make effective face recognition systems. Some of the algorithms include Principle Component Analysis (PCA) [2, 3, 4, 5], Linear Discriminant Analysis (LDA) [6, 7, 8], Independent Component Analysis (ICA) [9, 10, 11], Block Truncation Coding (BTC) [1, 15, 19, 22] etc.

The paper presents an approach to enhance the performance of BTC based face recognition using K'LUV color space.

Applying the technique described in [1], using K'LUV color, it is observed that K'LUV out performs RGB color space at each level of Multilevel BTC.

II. BLOCK TRUNCATION CODING

Block truncation coding (BTC) [1, 12, 13, 14] was developed in the early years of digital imaging more than 29 years. It was first developed in 1979 for greyscale image coding [14]. It is comparatively a simple image coding technique. BTC has played a vital role in the history of digital image coding in such a way that many advanced coding techniques have been developed, based on BTC.

III. MULTILEVEL BLOCK TRUNCATION CODING [1, 13, 20]

The feature vector in this algorithm is calculated by using Block Truncation Coding [12, 13 and 14]. In [1], BTC has been implemented up to four levels on RGB colour space for face recognition. The feature vector size at BTC-Level 1, BTC-Level 2, BTC-Level 3 and BTC-Level 4 was 6, 12, 24 and 48 respectively. In the same way BTC on K'LUV colour space is implemented up to four levels for face recognition.

IV. KEKRE'S LUV COLOR SPACE

It was obvious to extend BTC to multi-spectral images such as color images. Most color images are recorded in RGB space, which is perhaps the most well-known color space.

K'LUV color space [12] is a special case of Kekre transform. Where L gives luminance and U and V gives chromaticity values of color image. Positive value of U indicates prominence of red component in color image and negative value of V indicates prominence of green component.

Equation (1) gives the RGB to LUV conversion matrix which indicates the corresponding L, U and V components for an image from the R, G and B components.

$$\begin{bmatrix} L \\ U \\ V \end{bmatrix} = \begin{bmatrix} 1 & 1 & 1 \\ -2 & 1 & 1 \\ 0 & -1 & 1 \end{bmatrix} \begin{bmatrix} R \\ G \\ B \end{bmatrix} \tag{1}$$

The reverse conversion, that is from LUV color space to RGB color space is given in Equation (2).

$$\begin{bmatrix} R \\ G \\ B \end{bmatrix} = \begin{bmatrix} 1 & -2 & 0 \\ 1 & 1 & -1 \\ 1 & 1 & 1 \end{bmatrix} \begin{bmatrix} L/3 \\ U/6 \\ V/2 \end{bmatrix} \quad (2)$$

V. PROPOSED METHOD

For color space, for each BTC level; the feature vector for the query image and database set is by using Multilevel BTC.

In each level of BTC, the feature vector of the query image is compared with the feature vector of each image in the training set. The comparison (Similarity measurement) is done by Mean Square Error (MSE) given by equation 3.

$$\mathrm{MSE} = \frac{1}{\mathrm{MN}} \sum_{y=1}^{M} \sum_{x=1}^{N} [\mathrm{I}(x,y) - \mathrm{I}'(x,y)]^2 \quad (3)$$

Where,

I & I' are two feature vectors of size M*N which are being compared.

To assess the performance of the different BTC levels based face recognition techniques, False Acceptance Rate (FAR) and Genuine Acceptance Rate (GAR) are used.

VI. IMPLEMENTATION

A. Platform

The effectuation of the Multilevel BTC is done in MATLAB 2010. It was carried out on a computer using an Intel Core i5-2410M CPU (2.4 GHz).

B. Database

The experiments were performed on two face databases.

1) Face Database [16]

This database is created by Dr Libor consisting of 1000 images (each with 180 pixels by 200 pixels), corresponding to 100 persons in 10 poses each, including both males and females. All the images are captured against a dark or bright homogeneous background, little variation of illumination, different facial expressions and details. The subjects sit at fixed distance from the camera and are asked to speak, whilst a sequence of images is taken. The speech is used to introduce facial expression variation. The images were taken in a single session. The ten poses of Face database are shown in Figure 1.

2) Our Own Database [1, 20]

This database consists of 1600 face images of 160 people (92 males and 68 females).For each person 10 images are taken. The images in the database are captured under numerous illumination settings. The images are taken with a homogenous background with the subjects having different expressions. The images are of variable sizes, unlike the Face database. The ten poses of Our Own Database are shown in Figure 2.

Figure 1. Sample images from Face database

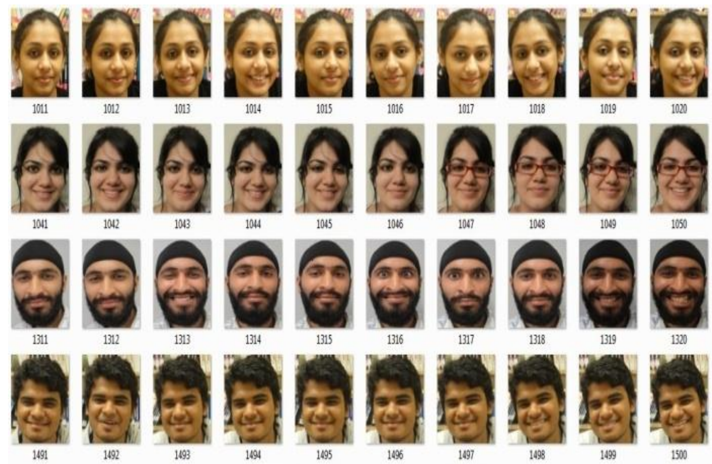

Figure 2. Sample images from Our Own Database

VII. RESULTS AND DISCUSSIONS

False Acceptance Rate (FAR) and Genuine Acceptance Rate (GAR) are standard performance evaluation parameters of face recognition system.

The False acceptance rate (FAR) is the measure of the likelihood that the biometric security system will incorrectly accept an access attempt by an unauthorized user. A system's FAR typically is stated as the ratio of the number of false acceptances divided by the number of identification attempts.

FAR = (False Claims Accepted/Total Claims) X 100 (4)

The Genuine Acceptance Rate (GAR) is evaluated by subtracting the FAR values from 100.

GAR=100-FAR (in percentage) (5)

In all 10000 queries (10 images for each of 1000 persons) are fired on face database and 16000 queries (10 images for each of 1600 persons) are fired on our own database. For each query, FAR and GAR values are calculated for respective BTC level based face recognition technique. At the end the average FAR and GAR of all queries in respective face databases are considered for performance ranking of BTC levels based face recognition techniques.

FAR and GAR are calculated for both RGB color space and K'LUV color space.

A. Face Database

To analyze the performance of proposed algorithm, 10000 queries are tested on the database. The feature vectors of each image for all four BTC levels in RGB color space and K'LUV color space were calculated and then compared with the database. The FAR and GAR values are calculated by employing equations 4 and 5.

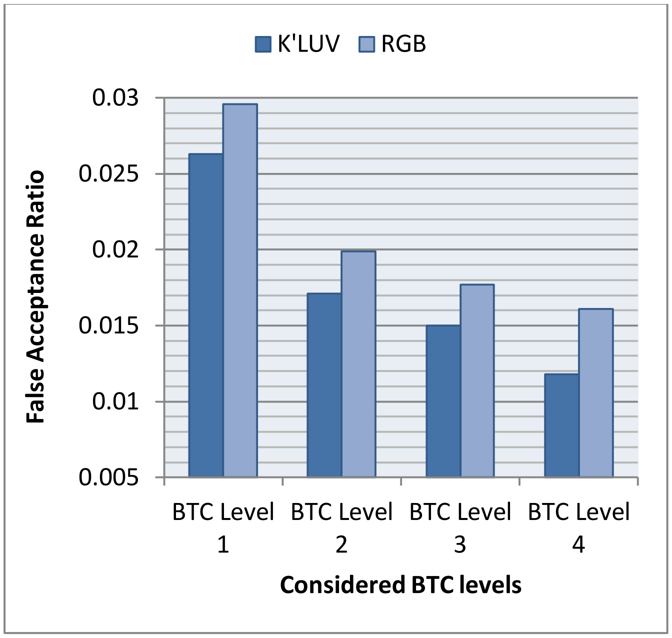

Figure 3. FAR values at different BTC levels of K'LUV and RGB color spaces for Face Database

Figure 3 gives the FAR values of the different BTC levels based face recognition techniques tested on face database for both RGB and K'LUV color spaces. Here it can be seen that the FAR values go on decreasing for each succeeding level of BTC of respective color spaces. This shows that the accuracy of face recognition increases with increasing level of BTC and hence BTC-level 4 gives the best result with the least FAR value in both the color spaces. Also the FAR values of K'LUV are lesser than the RGB as shown in the figure. Thus, it can be concluded that the implementation of BTC levels based face recognition techniques is better when applied in K'LUV color space.

Figure 4 gives the GAR values of the different BTC levels based face recognition techniques tested on face database for both RGB and K'LUV color spaces. Here it is observed that with each successive level of BTC the GAR values go on increasing in respective color spaces and hence a BTC-level 4 gives the best result with the highest value in both the color spaces. Also the GAR values of K'LUV are greater than the RGB as shown in the figure. Thus, it can be concluded that the implementation of BTC levels based face recognition techniques is better when applied in K'LUV color space. For optimal performance the FAR values must be less and accordingly the GAR values must be high for each successive levels of BTC. Thus, the performance of K'LUV color space for BTC levels based face recognition techniques is superior to the performance of RGB color space for Face database.

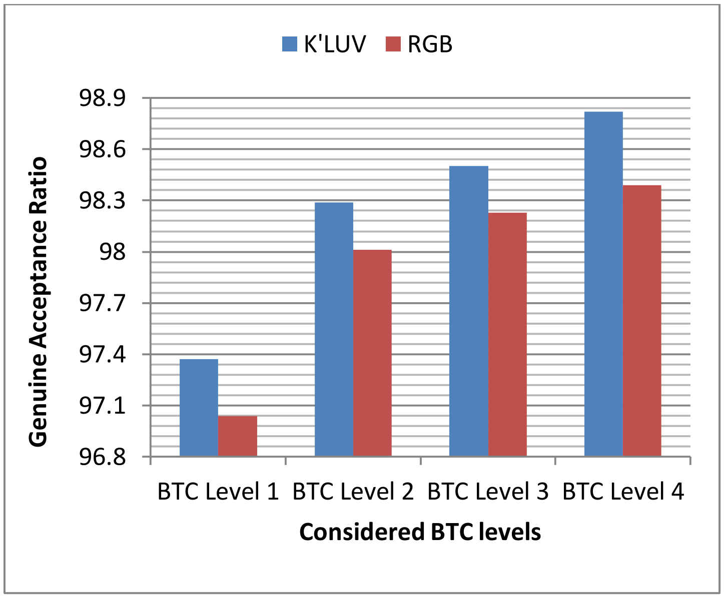

Figure 4. GAR values at different BTC levels of K'LUV and RGB color spaces for Face Database

B. Our Own Database

In all 16000 queries were tested on the database for analyzing the performance of the proposed BTC level based face recognition algorithm for both RGB color space and K'LUV color space. The experimental results of proposed face recognition techniques have shown that BTC level 4 gives the best performance in respective color spaces. The efficiency of the Multi-level BTC based face recognition increases with the increasing levels of BTC.

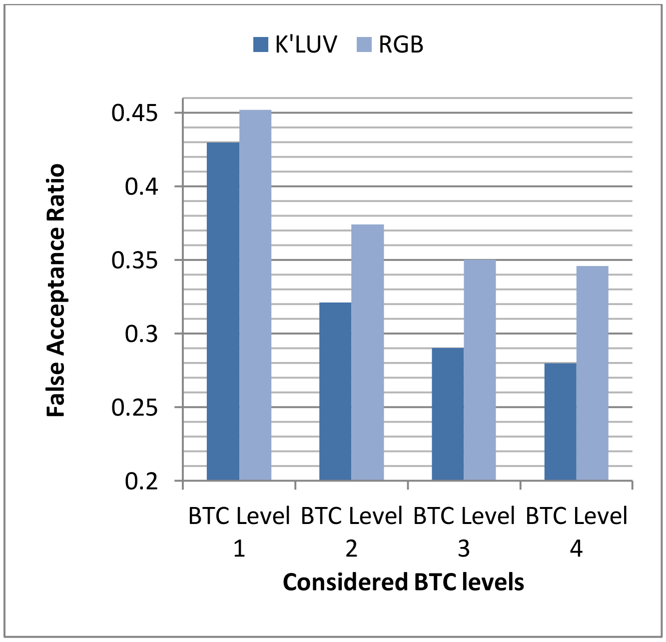

Figure 5. FAR values at different BTC levels of K'LUV and RGB color spaces for Our Own Database

Figure 5 gives the FAR values of the different BTC levels based face recognition techniques tested on Our Own Database for both RGB and K'LUV color spaces. The FAR values go on decreasing for each succeeding level of BTC of respective color spaces. Thus, when BTC based face recognition techniques is applied on Our Own Database, it gives a result similar to the Face Database; The BTC level 4 gives the best result for respective color spaces and K'LUV color space is better than RGB color space for implementing this proposed algorithm.

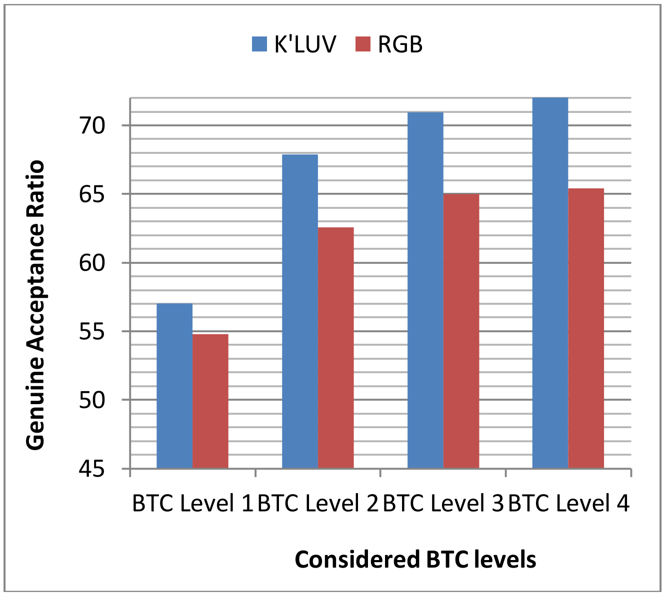

Figure 6. GAR values at different BTC levels of K'LUV and RGB color spaces for Our Own Database

Figure 6 gives the GAR values of the different BTC levels based face recognition techniques tested on Our Own Database for both RGB and K'LUV color spaces. It can be seen from the above figure that BTC-Level 4 has the highest GAR values and hence it is better than other BTC-Levels. Also the GAR values of K'LUV color space are greater than RGB color space at all the levels. Thus it can be concluded that the implementation of BTC levels based face recognition techniques is better when applied in K'LUV color space.

As seen from the performance of both the databases it can be concluded that the implementation of BTC based face recognition techniques on K'LUV color space is superior to RGB color space.

VIII. Conclusion

As the Multilevel BTC yields a greatly reduced feature space, this reduces the processing time required by the system. Thus, this system can be implemented is real time applications which generally require fast recognition time and have low computation power. The proposed face recognition system using Multilevel BTC has been tested using two face databases. For experimental analysis in all 10000 queries are fired on Face Database and 16000 queries on Our Own Database. The average FAR and GAR values of these queries clearly indicate that better performance is obtained when Multilevel Block Truncation Coding is employed using Kekre's LUV color space than RGB color space for face recognition.

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