ISSN (Print) : 2319-5940
ISSN (Online) : 2278-1021

IJARCCE

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 2, Issue 12, December 2013

Human Ear Identification using Vector Quantization Algorithms

Dr H. B. Kekre[1], Unnati Thapar[2], Neil Parmar[3]

Senior Professor, Department of Computer Engineering, MPSTME, NMIMS University, Mumbai, India [1]

Student, Department of Information Technology, MPSTME, NMIMS University, Mumbai, India [2]

Student, Department of Information Technology, MPSTME, NMIMS University, Mumbai, India [3]

Abstract:Biometrics refers to the identification of humans by their characteristics or traits. An important aspect of the characteristic is that it should be unique for every individual to enable identification by a biometric system. In this research paper, human ear has been used as a suitable characteristic for identification purposes. A raw image is taken an input and an edge detection operator has been used for enhancement to obtain the region of interest. Several Vector Quantization algorithms such as Linde-Buzo-Gray (LBG), Kekre's Error Vector Rotation (KEVR), Kekre's Median Codebook Generation (KMCG) and Kekre's Fast Codebook Generation (KFCG) have been applied to extract the unique features. The same process has been applied to another database containing images of the same ears for testing purposes. For each algorithm, accuracy has been calculated based on the number of correct identifications. The performance, accuracy and complexity of the algorithms are compared.

Keywords: Image Processing, Biometrics, Vector Quantization, Image Pre-Processing, Edge Detection, Linde-Buzo-Gray (LBG), Kekre's Error Vector rotation (KEVR), Kekre's Median Codebook Generation (KMCG), Kekre's Fast Codebook Generation (KFCG), Complexity.

I. INTRODUCTION

A. Biometrics

Biometrics refers to identification of humans by their characteristics and behavior. There are different human traits that can be used by a biometric system such as face, fingerprint, iris, voice, speech, hand geometry and retina. The selection of a particular biometric trait for use in a specific application involves the following factors.

Universality means that trait should be possessed by every person using a system.

Uniqueness means how well the trait distinguishes an individual from another.

Permanence means how the trait changes with time.

Measurability (collectability) means how easy it is to acquire the trait.

Performance indicates the accuracy, speed, and robustness of technology used.

Acceptability means the degree of public's approval to the technology.

Circumvention means how easily a trait might be imitated using a substitute.

Biometric verification is the methodology by which a person can be identified uniquely by evaluating one or more distinguishing biological traits. Whatever be the biometric methodology, the identification verification process remains the same. A record of a person's unique characteristic is captured and kept in a database. When identification verification is required, a new record is captured and then it is matched with the previous record in the database. If the data in the new record matches the data that is maintained in the database then the person's identity is confirmed.

A benefit of using biometrics is that people are relieved from the burden of remembering passwords or changing passwords frequently. Also it safeguards against intruders and password cracking software's on the internet. Thus it provides an efficient and reliable security solution to the password-based security systems.

In this paper, Section II gives an introduction to ear as a biometric trait and enlists the advantages of the same. Section III contains the method for processing a raw image to obtain the region of interest. Section IV gives a general explanation on Vector Quantization. Section V is an explanation on the proposed method, Section VI is a snapshot of the database used for the purpose and Section VII is a discussion on the various results obtained including observations, conclusion and comparisons.

II. EAR BIOMETRICS

Ear biometric system is a recognition system where the input image is condensed to a set of features which are used for comparison with the feature sets of other image to determine the identity.

Advantages of Ear Biometrics:

ISSN (Print) : 2319-5940
ISSN (Online) : 2278-1021

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 2, Issue 12, December 2013

- Ear does not vary with age and thus is a stable biometric.
- It has unique shape and geometry.
- It has all the factors that are required to be a biometric trait.
- The features of the ears are fixed and unchangeable as it is unaffected by emotions and expressions of a person.
- The distribution of colour is uniform in the ear and thus not much information is lost while working with the grey scale image or binary image.
- As ears are small in size it becomes faster to work with greater efficiency even with the low resolution images.
- Also ear images can neither be changed by makeup, nor glasses.

The operation of the ear identification system is as follows:

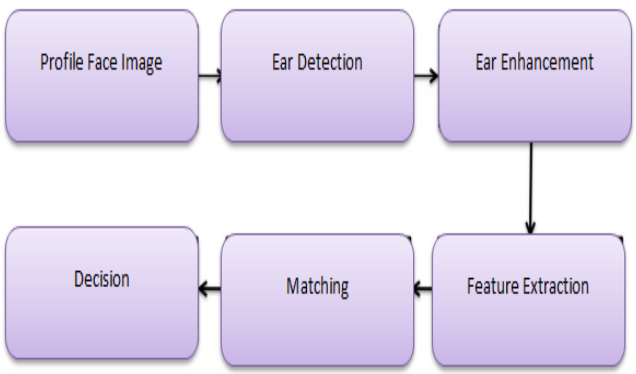

Fig.1.Ear Biometrics system operation.

A. Ear detection (segmentation):
Initially the position of the ear is localized in the image. The first and foremost stage involves localizing the position of the ear in an image. Here, a rectangular boundary is typically used to indicate the spatial extent of the ear in the given image [2,3]. Ear detection is a critical component since the errors in this stage can undermine the utility of the biometric system.

B. Ear normalization and enhancement:
The detected ear is subjected to an enhancement routine to improve the fidelity of the image. Also in order to facilitate feature extraction and matching the image of the ear may be subjected to certain corrections.

C. Feature extraction:
During the matching stage the segmented ear cannot be directly used. Extraction of features is to reduce the segmented ear into a mathematical model.

D. Matching:
In order to establish the identity of the input ear, the extracted features are now compared with those stored in the database. A match score of the two ear images is generated and similar score indicates the similarity of the two images.

E. Decision:
In this stage, the generated match scores are used and a final decision is made. The output of this verification mode is either a 'yes' or a 'no'.

III. Image Pre-Processing

The region of interest which in this case is the ear part is automatically cropped from the rest of the side face using the following pre-processing technique [2, 3].

A. Edge Detection

The Edge operator takes a grayscale or a binary image as its input and returns a binary image of the same size with 1's where the function finds edges and 0's elsewhere. Some of the methods used to detect edges are Sobel method, Prewitt method, Roberts method, Laplacian of Gaussian method, Zero-cross method and Canny method.

A raw image is taken as input. Pre-processing techniques are applied on the raw image to extract only the ear portion and eliminate all background details. The first step in the applied pre-processing technique is to detect edges. The edge boundary gives the region of interest. In this paper, the Robert edge detection operator is used for the purpose. The Robert edge operator is less time consuming than the Canny operator and highlights required edge boundaries. Unwanted noise is removed from the image. After the image is cleaned, the image is cropped at the boundaries. The cropped image is the required processed image. The above has been shown below in Fig.2

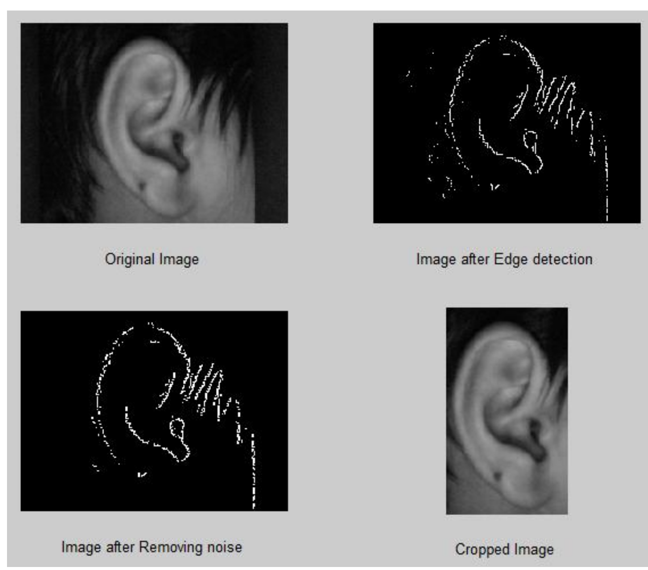

Fig.2.Preprocessed Image

ISSN (Print) : 2319-5940
ISSN (Online) : 2278-1021

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 2, Issue 12, December 2013

IV. VECTOR QUANTIZATION

Vector Quantization (VQ) [4, 7] is an efficient technique for data compression and has been successfully used in various applications such as index compression .VQ has been very popular in a variety of research fields such as speech recognition and face detection .VQ is also used in real timeapplications such as real time video-based event detection and anomaly intrusion detection systems, image segmentation, speech data compression, content based image retrieval CBIR and face recognition. Vector Quantization (VQ) [10] techniques employ the process of clustering. Various VQ algorithms differ from one another on the basis of the approach employed for cluster formations. VQ is a technique in which a codebook is generated for each image. A codebook is a representation of the entire image containing a definite pixel pattern which is computed according to a specific VQ algorithm. The image is divided into fixed sized blocks that form the training vector. Vector Quantization VQ can be defined as a mapping function that maps k-dimensional vector space to a finite set CB = {C1, C2, C3, ..…., CN}. The set CB is called codebook consisting of N number of code vectors and each code vector Ci = {ci1, ci2, ci3… cik} is of dimension k. The key to VQ is the good codebook. Codebook can be generated in spatial/transform domain by clustering algorithms.

The various Vector Quantization (VQ) Algorithms are as follows:

Linde-Buzo-Gray (LBG) [1, 10],

Kekre's Proportionate Error (KPE) [1, 5],

Kekre's Fast Codebook Generation (KFCG) [1, 5, 6],

Kekre's Error Vector Rotation (KEVR) [10] and

Kekre's Median Codebook Generation (KMCG) [1, 9]

V. PROPOSED TECHNIQUE

Five to seven images of each ear are taken and split into two databases: one containing a single image for feature extraction and the other containing the remaining images for testing purposes. The size of the image is 50 x180. The image is first divided into blocks of size 2x2. On each image Vector Quantization Algorithms have been applied to extract the unique features. These features are then compared with those from the testing database using minimum Euclidean distance as a measure. If the distance between two identical images is minimum, a match is found. The process is repeated for varying number of clusters. The accuracy is calculated as the total number of images correctly identified to the total number of images in the database. This value is expressed as a percentage. The accuracy and complexity of LBG, KEVR, KMCG and KFCG have been compared.

VI. SAMPLE DATABASE

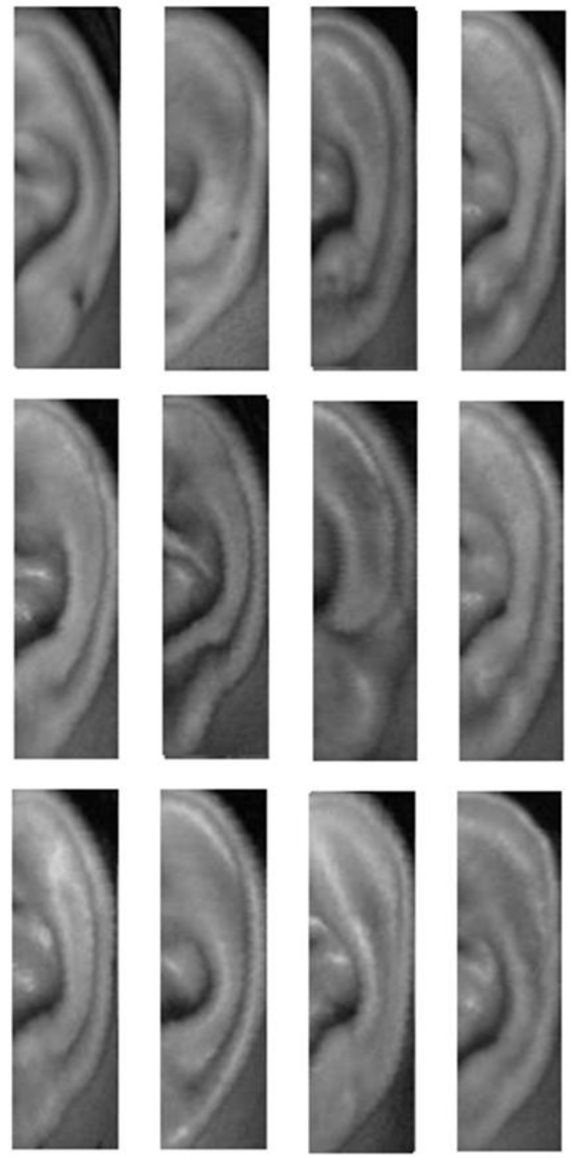

Fig. 3. Processed Sample Database

VII. RESULTS AND DISCUSSIONS

A. Linde-Buzo-Gray (LBG) Algorithm:

Fig.4 compares the accuracy for LBG algorithm varying the number of clusters. Codevector size 4 has been used. The algorithm has been implemented on a database consisting of 493 images. The testing database consists of 125 images.
It has been observed that as the codevector size increases, accuracy decreases. With codevector size 4, the accuracy is found to be better as compared to larger codevector sizes. With a codevector of size 2, computational time will double with a very slight improvement in accuracy.

ISSN (Print) : 2319-5940
ISSN (Online) : 2278-1021

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 2, Issue 12, December 2013

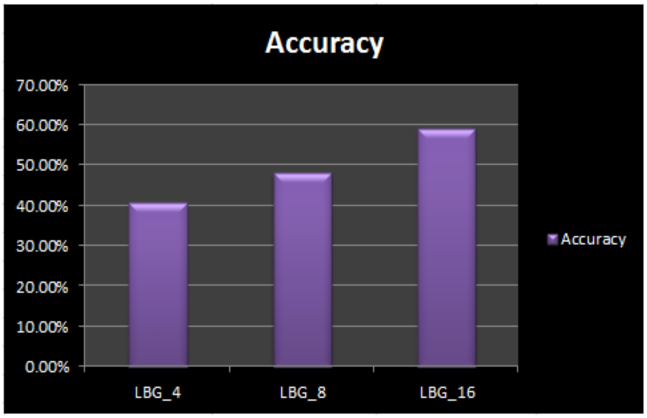

Fig.4. Graph showing the accuracy obtained for different clusters in LBG algorithm using codevector size 4.

1) Therefore, to reduce computational time to half, codevector size 4 is used with little compromise on accuracy. The resolution is better for smaller codevectors as compared to larger ones thereby increasing accuracy.

2) Accuracy of the algorithm has been calculated by determining the number of images correctly classified to the total number of images in database. This value is expressed as a percentage.

- Accuracy for LBG algorithm for 4 clusters is 40.8%
- Accuracy for LBG algorithm for 8 clusters is 48.0%
- Accuracy for LBG algorithm for 16 clusters is 59.2%

3) As the number of clusters increases from 4 to 8 and further to 16, the accuracy also increases.
4) In case of LBG algorithm [1, 6], constant error 1 is added to and subtracted from the centroid which forms clusters elongated at 135^0 to the horizontal axis leading to inefficient clustering. Clustering efficiency can be improved by KEVR, KMCG and KFCG.

B. Kekre's Error Vector Rotation (KEVR) Algorithm:

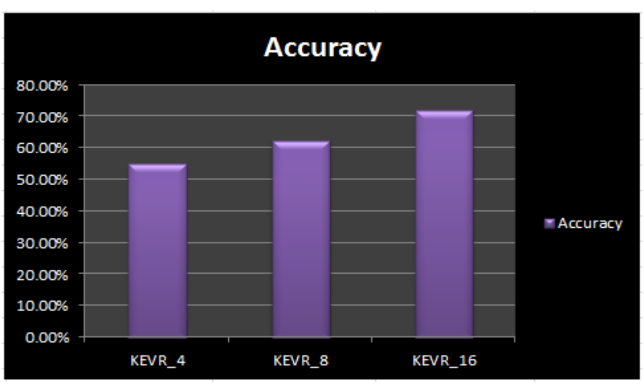

Fig.5. Graph showing the accuracy obtained for different clusters in KEVR algorithm using codevector size 4.

Fig.5 compares the accuracy for KEVR algorithm varying the number of clusters. Codevector size 4 has been used. The algorithm has been implemented on the same database.
1) It has been observed that as the codevector size increases, accuracy decreases. The same reason applies here.
2) The Accuracy is expressed as a percentage.

- Accuracy for KEVR algorithm for 4 clusters is 55.20%
- Accuracy for KEVR algorithm for 8 clusters is 62.40%
- Accuracy for KEVR algorithm for 16 clusters is 72%

3) As the number of clusters increases from 4 to 8 and further to 16, the accuracy also increases.
4) The overall accuracy of KEVR algorithm is found to be 10-15% higher than that of LBG algorithm. In case of LBG algorithm, constant error 1 is added to and subtracted from the centroid which forms clusters elongated at 135^0 to the horizontal axis leading to inefficient clustering. KEVR [10] increases clustering efficiency by introducing a new orientation every time to split the clusters.
5) The accuracy of KMCG and KFCG is found to be an improvement over that of KEVR. KMCG and KFCG lead to more efficient clustering.

C. Kekre's Median Codebook Generation (KMCG) Algorithm:

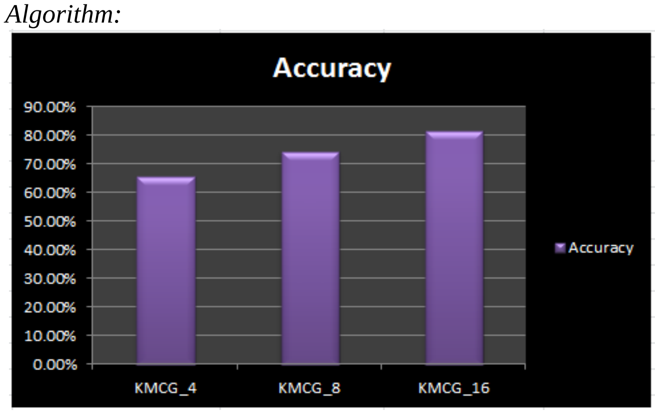

Fig.6. Graph showing the accuracy obtained for different clusters in KMCG algorithm using codevector size 4.

Fig.6 compares the accuracy for KMCG algorithm varying the number of clusters. Codevector size 4 has been used. The algorithm is implemented using the same database.
1) It has been observed that as the codevector size increases, accuracy decreases.
2) The Accuracy value is expressed as a percentage.

- Accuracy for KMCG algorithm for 4 clusters is 65.60%
- Accuracy for KMCG algorithm for 8 clusters is 74.40%
- Accuracy for KMCG algorithm for 16 clusters is 81.60%

3) As the number of clusters increases from 4 to 8 and further to 16, the accuracy also increases.
4) The overall accuracy of KMCG algorithm is found to be higher than that of KEVR and LBG algorithms. In KMCG [1, 9], the training vectors above the codevector are put into one cluster and those below the training

ISSN (Print) : 2319-5940
ISSN (Online) : 2278-1021

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 2, Issue 12, December 2013

vector are put into the other. Clusters of equal size are formed. More efficient clustering than LBG.

D. Kekre's Fast Codebook Generation (KFCG) Algorithm:

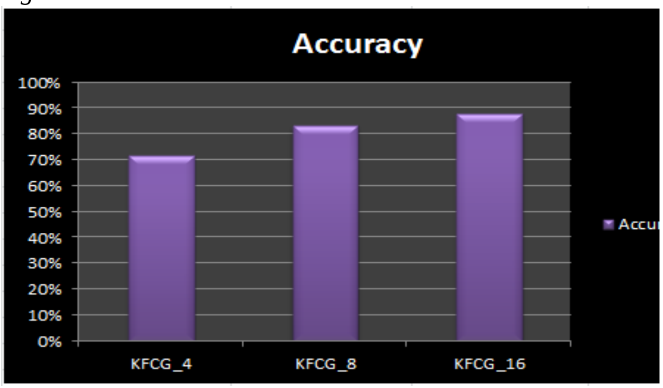

Fig.7. Graph showing the accuracy obtained for different clusters in KFCG algorithm using codevector size 4.

Fig.7 compares the accuracy for KFCG algorithm varying the number of clusters. Codevector size 4 has been used and the algorithm has been implemented using the same database.

1) It has been observed that as the codevector size increases, accuracy decreases.

2) The Accuracy value is expressed as a percentage.

- Accuracy for KFCG algorithm for 4 clusters is 72.0%
- Accuracy for KFCG algorithm for 8 clusters is 83.2%
- Accuracy for KFCG algorithm for 16 clusters is 88.0%

3) As the number of clusters increases from 4 to 8 and further to 16, the accuracy also increases.

4) The overall accuracy of KFCG algorithm is found to be higher than that of LBG and KEVR algorithms. In KMCG [1, 9], median of the sorted matrix is computed and all training vectors above the median are grouped into the first cluster and training vectors below the median in the second cluster. In KFCG [1, 8], the centroid of the training set is computed. The first element of training vector is compared with first element of centroid and based on the comparison two clusters are formed in the first iteration.

E. Comparing all the Algorithms:

TABLE I

Accuracy obtained for different clusters in different algorithms.

Algortihm	No. of Cluster		
	4	8	16
LBG	40.80%	48%	59.20%
KEVR	55.20%	62.40%	72%
KMCG	65.60%	74.40%	81.60%
KFCG	72%	83.20%	88%

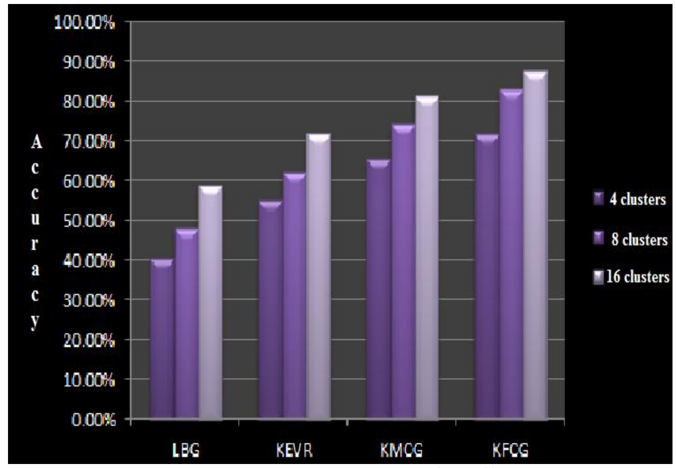

Fig.8. Graph comparing the accuracy obtained for different clusters in different algorithms.

The Graph in Fig. 8 is a compilation of the accuracy of the implemented VQ Algorithms with varying number of clusters. Codevector size 4 has been used.

For each algorithm, as the number of clusters increases from 4 to 8 and further to 16, the accuracy also increases.

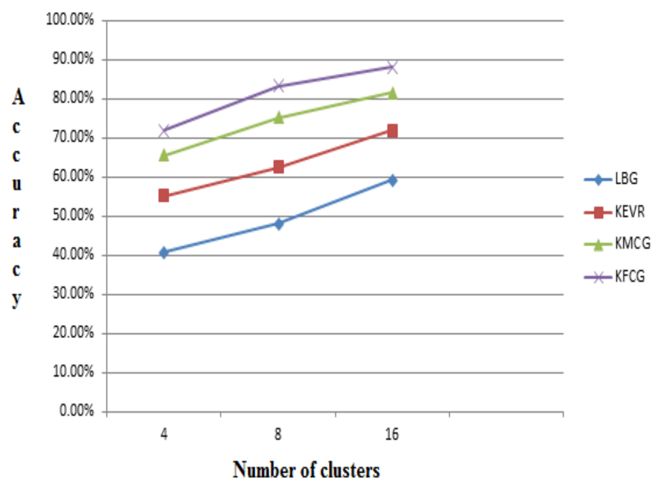

Fig.9. Graph

As seen in Fig. 9, the accuracy changes by approximately the same amount each time the number of clusters is doubled.

The overall accuracy for KFCG is the highest. The accuracy for KFCG with 16 clusters is 88%. This means that out of every 100 images in the database 88 are correctly identified. KFCG results in more efficient clustering than the above algorithms.

F. Complexity Analysis

Let n be the number of training vectors. In LBG, two vectors say v1 and v2 are generated by adding constant error to the code vector. Euclidean distance of each training vector is computed with both v1 and v2. Thus, for each training vector

ISSN (Print) : 2319-5940
ISSN (Online) : 2278-1021

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 2, Issue 12, December 2013

it involves the calculation of two Euclidean distances e1 and e2. A comparison is made between e1 and e2 and the training vector is grouped in the cluster to which it is nearer. Following this, for n training vectors, there will be 2n Euclidean distances and n comparisons. Similarly, KEVR also involves computation of Euclidean distance which makes them much more complex than KMCG and KFCG.

In KMCG, no Euclidean distance is computed. It involves sorting technique and the complexity can be further reduced by using a more efficient sorting algorithm. Sorting involves only comparisons whose number depends on the sorting algorithm. The complexity further reduces in KFCG as it neither involves computation of Euclidean distance nor any sorting technique. The first element of the training vector is compared with the first element of the code vector in the first iteration. If there are n training vectors, there will be n comparisons in the first iteration. Let the number of training vectors be k and n-k in cluster 1 and 2 respectively. Then, in the second iteration there will be k comparisons between the second element of the training vector and the second element of the code vector for cluster 1 and n-k comparisons for cluster 2. Therefore, the total number of comparisons will be n. For each iteration there are only n comparisons.

REFERENCES

[1] Dr. H.B. Kekre,TanujaSarode,PrachiNatu, and ShachiNatu, "Performance Comparison of Face Recognition Using DCT Against Face Recognition Using Vector Quantization Algorithms LBG, KPE, KMCG, KFCG ," International Journal Of Image Processing (IJIP), Volume (4): Issue (4).

[2] Haider Sh. Hashim, Anton SatriaPrabuwono, and SitiNorul Huda Sheikh Abdullah "A Study on Pre-processing Algorithms for Metal Parts Inspection", Volume (7) No.1, 2011.

[3] SonaliPatil, and Dr. V. R. Udupi, "Preprocessing To Be Considered For MR and CT Images Containing Tumors", Volume (1): Issue (4), July-Aug 2012.

[4] H. B. Kekre, and Tanuja K. Sarode, "Speech Data Compression using Vector Quantization."

[5] Dr. H. B. Kekre, ArchanaAthawale ,Dr. Tanuja K. Sarode, and KalpanaSagvekar, "Mixing Codebooks of LBG, KPE and KFCG Algorithms to Increase Capacity of Information Hiding", Volume (5) No.3, August 2010.

[6] H.B.Kekre1, Saylee Gharge2, and Tanuja K. Sarode, "Performance Evaluation of KFCG and LBG Algorithms in Tumor Demarcation of Mammograms", Volume (10): Issue (1), December 2010.

[7] H. B. Kekre, Tanuja K. Sarode, Vinayak Ashok Bharadi, Abhishek A. Agrawal, Rohan J. Arora, and Mahesh C. Nair, "Performance Comparison of DCT and VQ Based Techniques for Iris Recognition", Volume (8) No. 3, September 2010.

[8] Dr. H. B. Kekre, Dr. Sudeep D. Thepade, Dr. TanujaSarode, and Varun K. Banura, "Performance Comparison of Image Retrieval using KFCG with Assorted Pixel Window Sizes in RGB and LUV Color Spaces", Volume (3): Issue (1), Jan - March 2012.

[9] Dr. SudeepThepade, Dimple Parekh, Jinali Shah, Bhumin Shah, and ParasVora, "Classification of Fingerprint using KMCG Algorithm", Volume (1): Issue (6), JULY 2012.

[10] Dr.H.B.Kekre1, Dr.Tanuja K. Sarode2, Sudeep D. Thepade3, and ShrikantSanas, "Assorted Color Spaces to improve the Image Retrieval using VQ Codebooks Generated using LBG and KEVR."

BIOGRAPHIES

Dr. H. B. Kekre has received B.E (Hons.) in Telecomm. Engineering.from Jabalpur University in 1958, M.Tech (Industrial Electronics) from IIT Bombay in 1960, M.S.Engg. (Electrical Engg.) from University of Ottawa, Canada in 1965 and Ph.D. (System Identification) from IIT Bombay in 1970. He has worked as Faculty of Electrical Engg. and then HOD Computer Science and Engg. at IIT Bombay. After serving IIT for 35 years he retired in 1995. After retirement from IIT, for 13 years he was working as a professor and head in the Department of Computer Engg. and Vice Principal at ThadomalShahani Engineering. College, Mumbai. Now he is Senior Professor at MPSTME, SVKM's NMIMS University. He has guided 17 Ph.Ds, more than 100 M.E./M.Tech and several B.E./B.Tech projects, while in IIT and TSEC. His areas of interest are Digital Signal processing, Image Processing and Computer Networking. He has more than 450 papers in National / International Journals and Conferences to his credit. He was Senior Member of IEEE. Presently He is Fellow of IETE, Life Member of ISTE and Senior Member of International Association of Computer Science and Information Technology (IACSIT). Recently fifteen students working under his guidance have received best paper awards. Currently eight research scholars working under his guidance have been awarded Ph. D. by NMIMS (Deemed to be University). At present eight research scholars are pursuing Ph.D. program under his guidance.

Neil Parmar has recently graduated from B.Tech degree in Information Technology from Mukesh Patel School of Technology and Engineering, SVKM's NMIMS Deemed to be University. Her areas of interest include database management systems, data warehousing, computer networks and image processing. He has completed and presented various projects and seminars in the above mentioned domains.

Unnati Thapar has currently pursued her B.Tech degree in Information Technology from Mukesh Patel School of Technology and Engineering, SVKM's NMIMS Deemed to be University. Her areas of interest include operations research, computer networks and image processing. She has completed and presented various projects and seminars in the above mentioned domains.