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Fingerprint Classification using KEVR Algorithm

Sudeep D. Thepade
Professor
Computer Engg. Dept.,
Pimpri Chinchwad College of Engigineering, Pune

Dimple Parekh
Assistant professor,
MPSTME, SVKM's NMIMS
Deemed to be University, Mumbai

Vinita Murthi, Siddharth Mantri, Bhavin Shah
Student, B.Tech (COMP),
MPSTME, SVKM's NMIMS
Deemed to be University

ABSTRACT
Fingerprints offer an infallible means of personal identification. They are the most common and extensive form of biometric identification used at present. The use of fingerprint identification systems has become prevalent. The enormously growing size of fingerprint samples for identification systems has really become an issue these days. Fingerprint classification for the grouping of fingerprints which may further play as the pre processing of identification system has gained research momentum. The task of assigning the fingerprint to one of the considered classes is difficult. In this paper a novel technique based on Vector Quantization for fingerprint classification using Kekre's Error Vector Rotation (KEVR) is proposed. Also the comparison of the proposed method is done with the earlier presented fingerprint classification using KFCG. Here fingerprint classification is done on fingerprint images using KEVR codebook of size 8. The result obtained shows that this technique provides accuracy of 84% using KEVR codebook of size 8. Though this proposed method using KEVR takes little longer computations compared to existing method based on KFCG, it yields efficient results.

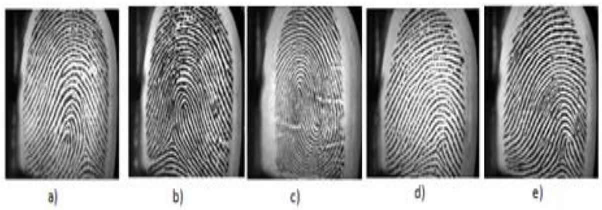
Keywords
Vector Quantization, KEVR, Fingerprint Classes, KFCG.

1. INTRODUCTION
Fingerprint classification is a process of assigning a fingerprint to the predefined group (class) [19]. This includes extraction of the extraction of the features of fingerprint images [18], which then are compared with the existing features of images of a database, and the most similar featured images are retrieved [15]. The paper proposes the use of Kekre's Error Vector Rotation (KEVR) technique based on Vector Quantization for classification of fingerprint images.

Vector Quantization is a lossy data compression method by which we compute a codebook consisting of a collection of vectors, obtained by following different algorithms to obtain the codebook as well as measure its performance [4, 10, 11]. The three main processes of vector quantization are, codebook generation, encoding and decoding. The key point of a VQ technique is to create a good codebook where the difference between the original image and the codeword is minimum [16]. The KEVR technique is based on Vector Quantization in which clusters are formed by following a specific algorithm which is dependent on the error vector with the cluster rotation.

The organization of the paper is as follows. Section II describes the various classes of fingerprints used in image retrieval methods, Section III describes how KEVR works, Section IV describes our work on fingerprint image retrieval using the KEVR algorithm, Section V consist of results and discussions.

2. FINGERPRINT CLASSES
A fingerprint is an individual's characteristic and it remains unchanged during his or her lifetime [17]. The general shape of the ridges and furrows, further extended by their counts form the basis for fingerprint classification. The ridge patterns of the fingerprints can be systematically classified as loops, whorls and arches [14]. Each of these classes can be sub-divided further based on the differences in their patterns as shown in Figure 1.



a)Left Loop b)Right Loop c)Whorl d)Plain Arch e)Tented Arch
Figure 1: Fingerprint Classes

It consists of one or more ridges entering from one side of the print, curving and exiting from the same side [19]. The loop pattern consists of a delta and a core. The delta is the point of convergence of the ridges [1, 2, 3], as shown in Figure 1(a) and the core forms the centre of the loop, as shown in Figure 1(b). About 60-65% of the human population falls under the **Loop** category. The left loop and right loop are known as The Ulnar Loop and The Radial Loop respectively.

Whorls contribute to around 30-35% of the population. They include two type lines and two deltas, as shown in Figure 1(c). The plain whorl must have at least one ridge that completes one circuit and an imaginary line that joins one delta to the other that touches this circuit. A central pocket whorl is similar, but the imaginary line does not the ridge circuit. A double loop consists of two loops that together form a whorl.

The **Arches** class of fingerprints constitutes to just 5% of the population. Their main characteristic is that they enter from one side and leave from the other side of the print. They do not have deltas or cores. Plain Arches have a smooth wave-like pattern, as shown in Figure 1(d), whereas Tented Arches show a prominent spike pattern, shown in Figure 1(e).

3. KEVR
Kekre's Error Vector Rotation algorithm is used for content based image retrieval and image compression [6, 7, 8, 9]. It creates a VQ codebook by taking using an error vector. This error vector sequences are created by taking the binary

representation of numbers from 0 to k-1 where k is the number of iterations. The 0s in the binary representations are replaced by 1 and the 1s are replaced by -1.

$$\begin{bmatrix} e1 \\ e2 \\ e3 \\ e4 \\ . \\ . \\ ek \end{bmatrix} = \begin{bmatrix} 1 & 1 & 1 & \ldots\ldots\ldots & 1 & 1 & 1 \\ 1 & 1 & 1 & \ldots\ldots\ldots & 1 & 1 & -1 \\ 1 & 1 & 1 & \ldots\ldots\ldots & 1 & -1 & 1 \\ 1 & 1 & 1 & \ldots\ldots\ldots & 1 & -1 & -1 \\ \ldots & & & & & & \\ \ldots & & & & & & \\ \ldots & & & & & & \end{bmatrix}$$

The algorithm is explained as follows. The process begins with one cluster having all the training vectors of the image. These training vectors are formed by taking non overlapping blocks and converting each block into a training vector. The mean of this cluster is then computed. In the first iteration of the algorithm, the error vector e1 is added and subtracted to the mean of the cluster creating two vectors v1 and v2. The clusters are created by comparing the mean square distance of each of the training vector with the vectors v1 and v2. Vector Xi is put in cluster 1 if it's mean square error with v1 is less than that with v2 otherwise it is put in cluster 2 [4, 5].

In the second iteration, the clusters 1 and 2 are considered and split into 4 clusters in the following way. The mean of cluster 1 is calculated which is then added and subtracted with error vector e2 as before two create two vectors v11 and v12. Vector Xi belonging to cluster 1 is put in cluster 1a if its mean square error with v11 is less than that of v12, otherwise it is put in cluster 1b. The similar process is followed to split cluster 2 into 2a and 2b [12, 13].

This procedure is followed until the desired codebook size is reached. This algorithm takes some time to compute as it uses mean square distances to compare vectors. However, in spite of quite a long run time, the results provided are highly accurate.

4. PROPOSED FINGERPRINT CLASSIFICATION USING KEVR

The KEVR Algorithm was applied on every input image of size 256x256 in the database. The codebook of size 8 was created and window size used was 8x8. Feature vectors were created and stored. The algorithm was applied on the test images as well. Mean square error between the test images and each of the feature vectors was calculated to decide which class the test image belonged to.

The percentage of classification accuracy is used to compare the performance of the variation of proposed fingerprint classification method.

Percentage Accuracy of Classification

$$= \frac{\text{No. of images successfully classified}}{\text{No. of classification attempt}} \times 100$$

5. RESULTS AND DISCUSSION

The KEVR Algorithm was applied on input images of size 256x256. The five fingerprint classes are considered alias Left Loop, Right Loop, Arch, Tented Arch and Whorl. Codebook of size 8 was used to classify fingerprint images. Based on the results it was observed that the KEVR-8 algorithm gives an overall accuracy of 84%. It was also observed that KEVR gives the best results for Left Loop, Right Loop and Whorl whereas it gives the poor results for Arch and Tented Arch as shown in Figure 2.

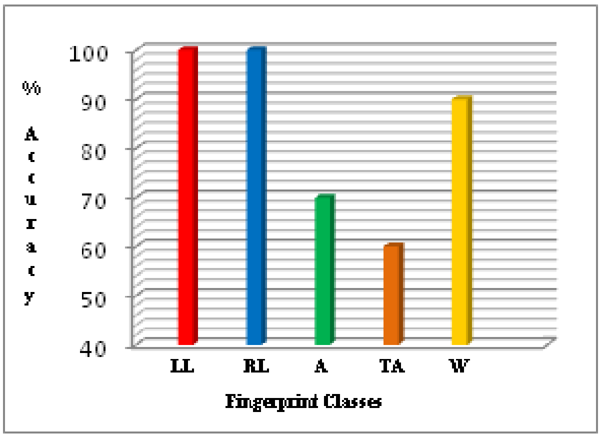


Figure 2: Percentage accuracy of proposed fingerprint classification using KEVR with codebook size 8 and window size 8x8

The figure 3 gives performance comparison of the proposed KEVR based fingerprint classification technique with the existing KFCG based classification technique [1]. Here for each of the considered fingerprint classes except the tented arch (TA), the proposed KEVR based fingerprint classification has given better percentage accuracy over the existing KFCG based classification. In overall accuracy the KEVR based method (84%) surpasses the KFCG based method (74%) by a large margin.

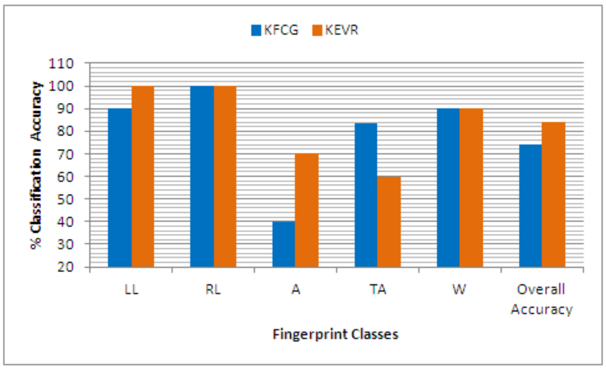


Figure 3: Performance Comparison of proposed fingerprint classification using KEVR with the existing fingerprint classification using KFCG

(For both vector quantization codebook generation methods the codebook size is 8 and window size taken is 8x8)

6. CONCLUSION

Any fingerprint identification system requires classification for efficient and faster results. Vector Quantization proves to be an efficient technique for classification and one of the vector quantization codebook generation techniques is Kekre's Error Vector Rotation (KEVR). It provides an accuracy of 84% on a codebook of size 8 and window of size 8x8 for fingerprint classification, which is 13.5% higher than the existing KFCG based classification (accuracy 74%). However, the KEVR it takes little longer time to compute the feature vector as compared to KFCG. Future work comprises of testing the accuracy of propose classification method with various codebook sizes.

7. REFERENCES

[1] H. B. Kekre, Dr. Sudeep D. Thepade, Dimple A Parekh, “Fingerprint Classification using KFCG Algorithm”, Internation Journal of Computer Sciences and Informaiton Security (IJCSIS), Vol 9, 2011.

[2] Dimple Parekh, Rekha Vig, “Review of Fingerprint Classification methods based on Algorithmic Flow”, Journal of Biometrics, Volume 2, Issue 1, 2011.

[3] R. Cappelli, "Fast and Accurate Fingerprint Indexing Based on Ridge Orientation and Frequency", IEEE Transactions on Systems, Man, and Cybernetics, Part B: Cybernetics, , Volume: 41, Issue: 6, pp. 1511 - 1521, Dec. 2011

[4] R. M. Gray, “Vector Quantization”, IEEE ASSP. Mag., pp.: 4-29, Apr. 1984.

[5] Dr. H.B.Kekre, Tanuja Sarode, “New Clustering Algorithm for Vector Quantization International Journal of Computer Science and Information Security.”, 2010

[6] H. B. Kekre, Sudeep D. Thepade, Tanuja K. Sarode and Vashali Suryawanshi. “Image Retrieval using Texture Features extracted from GLCM, LBG and KPE”. In: International Journal of Computer Theory and Engineering, Vol. 2, No. 5, October, 2010.

[7] H. B. Kekre, Tanuja K. Sarode, Sudeep D. Thepade, Shrikant Sanas, “Assorted Colour Spaces to improve the Image Retrieval using VQ Codebooks Generated using LBG and KEVR”, In Springer Int. Conference on Technology Systems and Management (ICTSM*)*, 2011

[8] H. B. Kekre, Tanuja K. Sarode, Sudeep D. Thepade, “Image Retrieval using Color-Texture Features from DCT on VQ Codevectors obtained by Kekre‘s Fast Codebook Generation” , In ICGST-International Journal on Graphics, Vision and Image Processing (GVIP), Volume 9, Issue 5, pp.: 1-8, 2009.

[9] H.B.Kekre, Tanuja K. Sarode, Sudeep D. Thepade, Shrikant Sanas, “Image Retrieval using Texture Features Extracted using LBG, KPE, KFCG, KMCG, KEVR with Assorted Colour Spaces”, In: International Journal of Advances in Engineering & Technology (IJAET), Vol. 2, Issue 1, pp. 520-531, Jan 2012

[10] H. B. Kekre, Tanuja K. Sarode, “New Clustering Algorithm for Vector Quantization using Rotation of Error Vector”, In.: International Journal of Computer Science and Information Security(IJCSIS), Vol. 7, No 3, 2011.

[11] Y. Linde, A. Buzo, and R. M. Gray, “An algorithm for vector quantizer design”, In.: IEEE Trans. Commun., vol. COM-28, no. 1, pp.: 84-95, 1980.

[12] H.B.Kekre, Tanuja Sarode, Sudeep D. Thepade, Supriya Kamoji, “Performance Comparison of Various Pixel Window Sizes for Colorization of Greyscale images using LBG, KPE, KFCG and KEVR in Kekre’s LUV Color Space”‖, In: International Journal of Advances in Engineering & Technology (IJAET), Volume 1, Issue 2, December 2011

[13] H. B. Kekre, Tanuja K. Sarode, “New Fast Improved Codebook Generation Algorithm for Color Images using Vector Quantization”, In: International Journal of Engineering and Technology, vol.1, No.1, pp.:67-77, September 2008

[14] Sir Edward R. Henry, "Classification and Uses of Finger Prints". London: George Rutledge & Sons, Ltd., 1900 http://www.clpex.com/Information/Pioneers/henry-classification.pdf.

[15] M.Chong, T.Ngee, L.Jun, R.Gay, “Geometric framework for fingerprint image classification”, In: Pattern Recognition, volume 30, No. 9, pp.1475-1488, 1997.

[16] Ruyi Zheng, Chao Zhang, Shihua He, Pengwei Hao, "A Novel Composite Framework for Large-Scale Fingerprint Database Indexing and Fast Retrieval", Hand-Based Biometrics (ICHB), International Conference on, pp. 1 – 6, 2011

[17] A. Gyaourova, A. Ross, "Index Codes for Multibiometric Pattern Retrieval", IEEE Transactions on Information Forensics and Security, On page(s): 518 - 529 Volume: 7, Issue: 2, April 2012

[18] S. Biswas, N.K.Ratha, G. Aggarwal, J. Connell, "Exploring Ridge Curvature for Fingerprint Indexing", 2nd IEEE International Conference on Biometrics: Theory, Applications and Systems, (BTAS 2008), pp 1 - 6 , 2008

[19] B. Bhanu, Xuejun Tan, "Fingerprint indexing based on novel features of minutiae triplets", IEEE Transactions on Pattern Analysis and Machine Intelligence, Volume.25, Issue.5, pp.616, 2003