Classification of Fingerprint using KMCG Algorithm

Dr. Sudeep Thepade, Dimple Parekh, Jinali Shah, Bhumin Shah, Paras Vora

Abstract— Fingerprints are the most widely used form of biometric identification. Fingerprint Classification is done to associate a given fingerprint to one of the existing classes. Classifying fingerprint images is a very difficult pattern recognition problem. In this paper, for classifying fingerprint a fresh technique based on vector quantization using KMCG algorithm is implemented. Vector Quantization is a lossy data compression technique, used in various applications. Fingerprint Classification is implemented, using KMCG with codebook of size 8 and window size 8x8. The proposed approach provides an overall accuracy of 80% by taking smaller computations as compared to conventional fingerprint classification techniques.

Keywords— Image Processing, Pattern Recognition, Vector Quantization, Kekre's Median Codebook Generation (KMCG), Fingerprint Classes.

1. INTRODUCTION

Fingerprints have been used as a means of identifying individuals and verify their identity for a very long time. The performance of fingerprint identification systems has greatly improved, but it is still influenced by many factors [1, 2]. One of the major problems in designing a fingerprint classification system is to determine what features are to be extracted and how can they classify the fingerprint into their respective classes. It not only separates the fingerprint into corresponding classes but also increases the accuracy and efficiency of fingerprint identification system. Vector Quantization [14] is a novel technique by which we compute a codebook consisting of a collection of vectors to obtain the codebook and measure its performance by following different algorithms [6]. The KMCG algorithm is based on this technique. VQ includes formation of clusters by following a specific algorithm which is explained in this paper. This paper is structured as follows: Section II describes the various fingerprints types used in image retrieval methods, Section III describes working of KMCG , Section IV describes our work on fingerprint image classification using KMCG algorithm and Section V consist of results and discussions.

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2. FINGERPRINT TYPES

According to the Henry system of classification, fingerprint comprises of three basic patterns [1,2,3]: loop, whorl and arch, which make up60–65%, 30–35% and 5% of all fingerprints respectively[13]. There are more complex classification systems to break down patterns even further, into plain arches or tented arches, and loops that may be radial or lunar, depending on the side of the hand toward which the tail points. Galton-Henry classification system records for more than 120 fingerprint classes. The five most common classes are:

2.1 Arch

Ridges enter from one side, rise to an emergence of a small bump, and then go down to the opposite side. Loops or delta points are absent. Fig 1(a) shows the pattern of arch.

2.2 Tented Arch

Similar to the arch, but here at least one ridge has high curvature, thus one core and one delta points are found. Fig 1 (b) shows the pattern of tented arch.

2.3 Left Loop

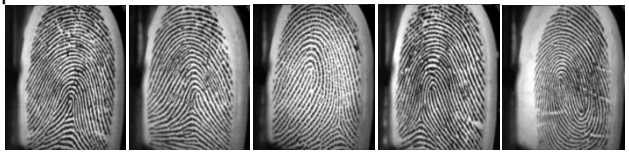
One or more ridges enter from one side, curve back, and go out the same side they entered. One pair of core and delta points is present. Fig 1 (c) shows the pattern of left loop.

2.4 Right Loop

It is same as the left loop, but in opposite direction. One pair of core and delta points is present. Fig 1 (d) shows the pattern of right loop.

2.5 Whorl

It contains at least one ridge that makes a complete 360 degree path around the center of the fingerprint. Two core and two delta points can be found. Fig 1 (e) shows the pattern of whorl.



a) b) c) d) e)

Fig. 1: Fingerprint Types a) Arch b) Tented Arch c) Left Loop d) Right Loop e) Whorl

3. KMCG

Kekre's Median Codebook Generation algorithm [1, 2, 3, 6, 7] is proposed for image data compression and content based image retrieval. This algorithm reduces the time for code book generation [8, 9, 10, 11,12]. It makes use of sorting and median technique for generating codebook. In this algorithm image is divided into blocks and blocks are converted to the vectors of size k. Fig.2 below gives a diagrammatic representation of KMCG Algorithm. It shows matrix T of size M x k consisting of M number of image training vectors of dimension k [6].

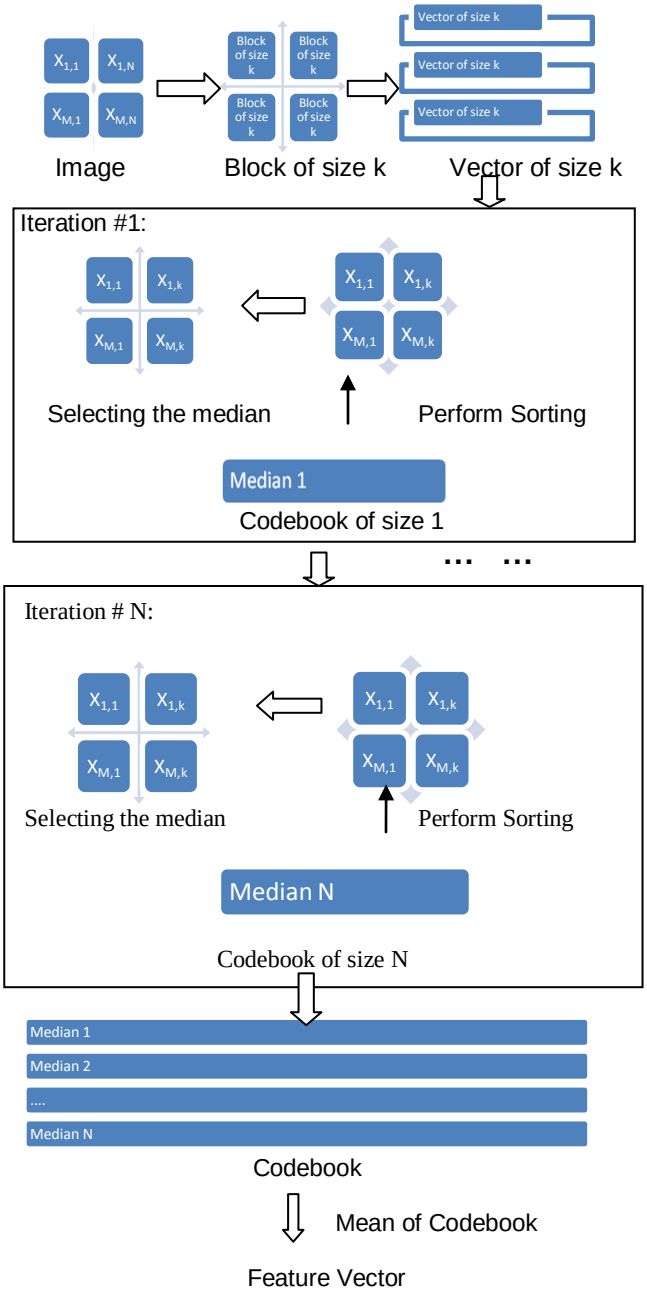


Fig. 2: Diagrammatic Representation of KMCG algorithm

Each row of the matrix is the image training vector of dimension k. The training vectors are sorted with respect to the first column of the matrix T and the entire matrix is considered as one single cluster. The median of the matrix T is chosen (code vector) and is put into the codebook, and the size of the codebook is set to one [10]. In this algorithm, once the codebook is generated, the feature vector for each of the fingerprint classes is computed. The feature vector is calculated by taking the mean of all images in each cluster. e.g.: In Cluster 1 the feature vector is the mean of all images in cluster 1. In this way the feature vector is calculated for all fingerprint classes and stored separately. This feature vector now becomes the identity of each of the fingerprint classes, and the images are tested by checking the Mean Squared Error (MSE) with the feature vectors of each of the classes.

4. "CLASSIFICATION OF FINGERPRINT USING KMCG" – PROPOSED TECHNIQUE

4.1 Codebook Generation using KMCG Algorithm

Input: Original Image for the given T=[X_1, X_2… X_M] be the training sequence consisting of M code vectors. Let the code book size be 'N' [7, 8, 9, 10, 11, 15].

Steps:

1. Sort the matrix T with respect to the first member of all the vectors, i.e. first column.
2. Compute the initial code vector by taking the median of the sorted matrix T. Current _ code_book_size=1.
3. Matrix T is divided into two equal parts.
i) Consider the training vector Xi of the cluster
ii) If (Xi< median), Xi is added in cluster 1
iii) Else, Xi is added in cluster 2
4. Compute the code vectors by taking the median of these clusters.
5.Current_code_book_size=Current_code_book_size*2
6. Repeat step 3 until the Current_code_book_size is less than or equal to N.
7. After the code vectors are found, find the mean of each last iterated cluster, i.e. code_book_size<=N.

5. RESULTS AND DISCUSSION

KMCG has been tested on a database of fingerprint images each of size 256x256 and window size 8x8. The images selected correspond to different classes like arch, tented arch, left loop, right loop and whorl. Codebook of size 8 was used for fingerprint classification using KMCG. It was observed that overall accuracy for KMCG-8 was 80% .It also shows that KMCG works best for Left Loop and gives poor results for Arch as shown in Table 1. Table 2 [1, 4, 5]gives comparison between KFCG, KEVR and KMCG algorithm for window size 8x8 and codebook size 8. It is seen that KMCG gives excellent results for left loop.

Table 1
Results of KMCG-8

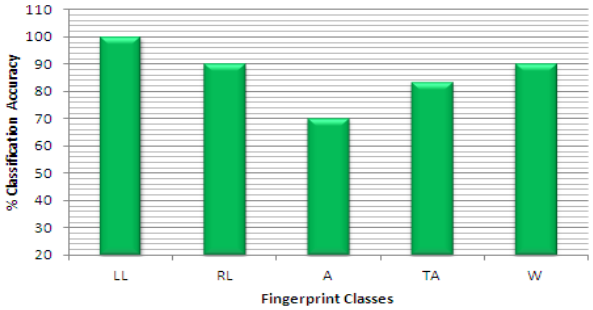
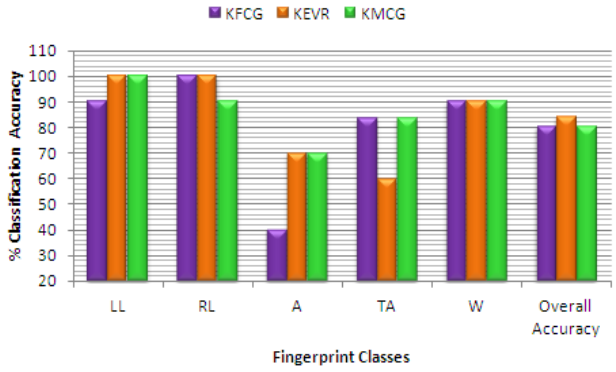


Table 2

Comparison between KFCG, KEVR and KMCG codebook size 8 and window size 8x8



6. CONCLUSION

Classification is an important task for the success of any Automated fingerprint Identification System. A novel technique based on Vector Quantization using Kekre's Median Codebook Generation (KMCG) provides accuracy of 80% for codebook size 8 and window size 8x8. It is computationally fast since it does not require any distance calculation. Future work consists of testing the proposed approach on a large database and making it more efficient by improving its accuracy further.

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