LBG ALGORITHM FOR FINGERPRINT CLASSIFICATION

Sudeep Thepade[1], Dimple Parekh[2], Unnati Thapar[3], Vandana Tiwari[3]
[1]Prof., Department of Computer Engineering, PCCOE, Pune, India
[2] Asst. Prof., Deptt. of Information Tech., MPSTME, NMIMS Univ., Mumbai, India
[3] B.Tech (I.T), 4th year , MPSTME, NMIMS Univ., Mumbai, India

ABSTRACT
Fingerprints are unique to each individual and can be used as a means to differentiate one individual from another. Therefore, it serves as an identity of an individual. Fingerprint Classification is done to relate a given fingerprint to one of the existing classes. Fingerprints are classified into pre-defined classes such as left loop, right loop, arch, tented arch and whorl. Classifying fingerprint images is a very complex pattern recognition problem, due to the minute interclass variability. The objective is to reduce response time, computation complexity and search space while classifying an image. In this research paper a novel technique based on vector quantization for fingerprint classification using Linde Buzo Gray (LBG) also called as Generalized Lloyd Algorithm (GLA) is proposed. Vector Quantization is a lossy technique for data compression and is used in various applications. For vector quantization to be efficient a good codebook is required. Classification is done on fingerprint images using LBG codebooks of sizes 4. The proposed technique takes lesser computations as compared to usual fingerprint classification techniques. It is observed that the method provides an accuracy of 80%.

KEYWORDS: *Vector Quantization, Linde-Buzo-Gray (LBG), Generalized Lloyd Algorithm (GLA), Fingerprint Classes.*

I. INTRODUCTION

Biometrics refers to the identification of humans by their characteristics or traits. In information technology, biometrics refers to technologies that measure and analyze human body characteristics, such as DNA, fingerprints, eye retinas and irises, voice patterns, facial patterns and hand measurements, for authentication purposes. While designing fingerprint identification system the major challenge is to determine what features are to be extracted and how these features can be used to categorize fingerprints into their respective classes. Poor quality and noisy fingerprint images result quite often in false or missing singular points which decreases the overall efficiency of the identification system. Fingerprint classification not only reduces comparisons of fingerprints, but also improves the overall efficiency of fingerprint identification system [14, 15].

The paper proposes a scheme to classify fingerprint images into their respective classes without pre-processing images or locating singular points. A technique called Vector Quantization (VQ) is used for classification. Several VQ techniques differ from one another on the method used to form the clusters [12, 13, 16]. LBG is the simplest Vector Quantization technique which involves the computation of Euclidean distance to form clusters.

The paper is organized as follows. Section II gives a brief description of various fingerprint types, section III explains LBG algorithm, section IV consists of results and discussions and section V concludes the paper.

II. FINGERPRINT TYPES

Fingerprints can be classified into the following types: loop which further can be sub-divided into right loop and left loop, arch which includes tented arch and plain arch and whorl [1, 3]. Majority fingerprint images fall into the loop category about 60-65% while arch and whorl comprise of 30-35% and 5% respectively. Figure 1 shows different fingerprint categories.

a) b) c)

Figure 1: Fingerprint Types. a) Loop b) Arch c) Whorl

2.1. Loop

Loops occur in about 60-70 % of fingerprint patterns encountered. One or more of the ridges enters on either side of the impression, re-curves, touches or crosses the line running from the delta to the core and terminates on or in the direction of the side where the ridge or ridges entered.
Loops can more specifically be classified as right loop and left loop by observing the left hand. If the ridges flow in the direction of the thumb, it can be classified as right loop and if it flows in the direction of the little finger then it can be categorized as left loop.

2.2. Arches

The arch pattern is made up of ridges lying one above the other. The ridges enter on one side and flow or appear to flow out from the other side. The tented arch consists of at least one protruding ridge which tends to bisect other ridges at right angles. Plain Arch has a wave like structure as compared to tented arch which has a sharp rise at the center.

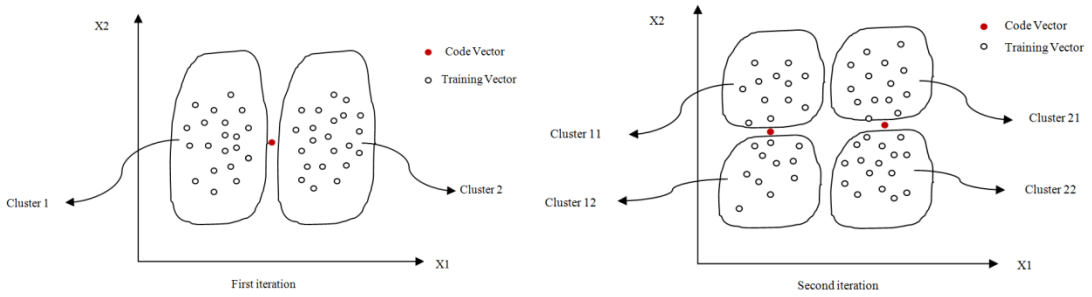
2.3. Whorl

The whorl pattern consists of one or more free recurving ridges which could be spiral, oval or circular and two delta points. The line of the fingerprint disc will bisect at least one of the ridges if it is placed on the delta points.

III. LINDE BUZO GRAY (LBG)

There are several Vector Quantization algorithms which differ from one another on the process used for cluster formations. The simplest VQ algorithm used to generate codebook is the Linde-Buzo-Gray (LBG) algorithm which is also called as Generalized Lloyd Algorithm (GLA). The image is divided into blocks of size 8X8 which form the training vector. Then centroid C1 is calculated for the training vector. Constant Error is added and subtracted to the code vector C1 to generate two vectors V1 and V2. Euclidean distance is computed for all the training vectors with vectors V1 and V2. If the Euclidean distance of the training vector with vector V1 is smaller as compared to the Euclidean distance with vector V2, then the training vector is put into V1 cluster otherwise into V2 cluster. Thus, we have two clusters at the end of the first iteration as shown in Figure 2.a. The same procedure is repeated with each cluster. V1 is split into two clusters V11 and V12. Similarly, V2 is split into two

clusters V21 and V22 [4, 5, 6, 7, 8, 9]. Thus four clusters are obtained at the end of the second iteration as shown in Figure 2.b.



a) b)

Figure 2: LBG Algorithm for 2 dimensional case.
a) First Iteration b) Second Iteration

IV. "CLASSIFYING FINGERPRINT USING LBG" – PROPOSED TECHNIQUE

LBG is applied on input image from each class in the database. Codebook of size 4 was used for classification. Features are extracted, collected and stored. Test image features are extracted, collected in the same way and stored. Euclidean distance is used to calculate the difference between features of stored images and test images. Minimum distance is calculated and the class to which the feature vector belongs is assigned accordingly. The percentage of classification accuracy is used to compare the performance of the proposed fingerprint classification method [2].

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

The LBG algorithm can be illustrated by the following diagrammatic representation as shown in Figure 3.

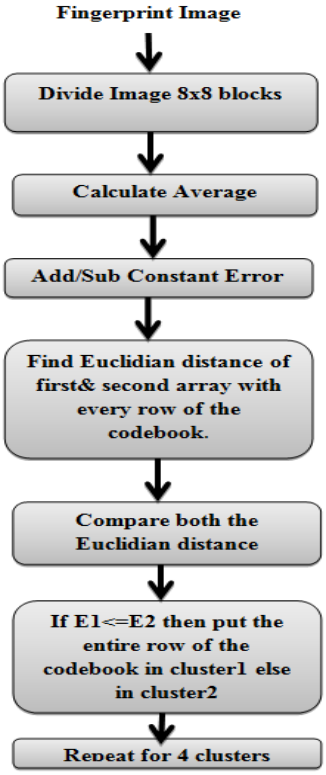


Figure 3: Block Diagram for LBG Algorithm

V. RESULTS AND DISCUSSION

The database on which LBG has been tested consists of 50 images each of size 256x256. The images used can be classified as left loop, right loop, arch, tented arch and whorl. Codebook of size four has been used for classification. The overall accuracy for LBG is 80% and from the graph shown in Figure 4 it can be further observed that LBG gives the best results for left loop class and poor results for arch class. In Figure 5 LBG results are compared with already existing KFCG results [1, 2, 10, 11]. For both vector quantization codebook generation methods the codebook size is 4 and window size taken is 8x8. It is observed that for each of the considered fingerprint classes except the left loop (LL) and tented arch (TA), the proposed LBG based fingerprint classification has given superior percentage accuracy over the existing KFCG based classification. Overall accuracy of the LBG based method (80%) outshines the KFCG based method (70%) by a large margin.

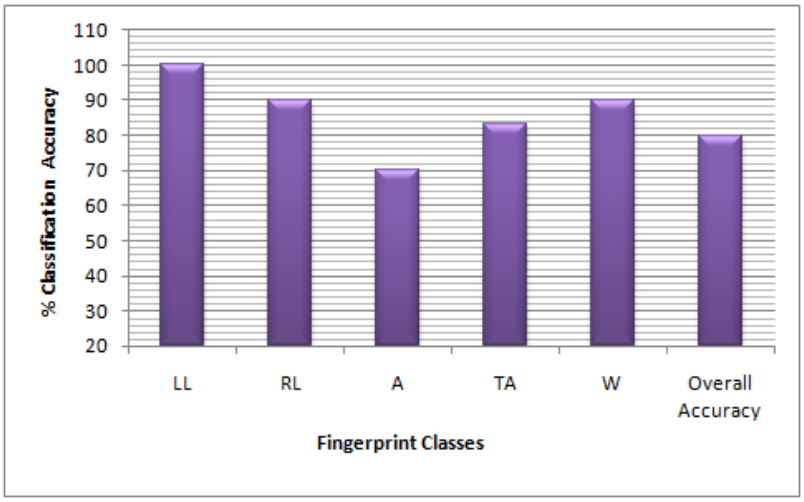


Figure 4: Results of LBG - 4

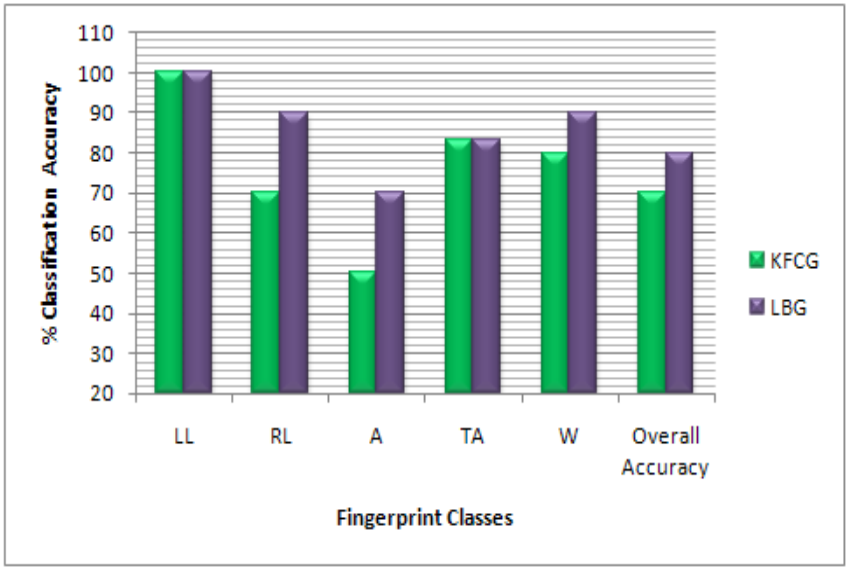


Figure 5: Performance Comparison of proposed fingerprint classification using LBG with the existing fingerprint classification using KFCG.

VI. CONCLUSIONS

Classification is a significant task for the successful realization of any fingerprint identification system. Linde Buzo Gray (LBG) also called as Generalized Lloyd Algorithm (GLA) is one of the vector quantization codebook generation technique. It provides an overall accuracy of 80% for codebook of size 4 and window size 8x8 which is 10% higher than the existing KFCG based

classification (accuracy 70%). Vector Quantization proves to be an efficient technique for classification of fingerprint images as it provides fast and efficient results. Future work consists of testing the proposed approach on a larger database.

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AUTHORS BIOGRAPHIES

Sudeep D. Thepade has Received B.E.(Computer) degree from North Maharashtra University with Distinction in 2003. M.E. in Computer Engineering from University of Mumbai in 2008 with Distinction, Ph.D. from SVKM's NMIMS in 2011, Mumbai. He has about 09 years of experience in teaching and industry. He was Lecturer in Dept. of Information Technology at Thadomal Shahani Engineering College, Bandra(w), Mumbai for nearly 04 years. Currently working as Associate Professor and HoD Computer Engineering at Mukesh Patel School of Technology Management and Engineering, SVKM's NMIMS, Vile

Parle(w), Mumbai, INDIA. He is member of International Advisory Committee for many International Conferences, acting as reviewer for many referred international journals/transactions including IEEE and IET. His areas of interest are Image Processing and Biometric Identification. He has guided five M.Tech. projects and several B.Tech projects. He more than 125 papers in National/International Conferences/Journals to his credit with a Best Paper Award at International Conference SSPCCIN-2008, Second Best Paper Award at ThinkQuest-2009, Second Best Research Project Award at Manshodhan 2010, Best Paper Award for paper published in June 2011 issue of International Journal IJCSIS (USA), Editor's Choice Awards for papers published in International Journal IJCA (USA) in 2010 and 2011.

Dimple A Parekh currently working as Asst. Professor in IT Department has completed M.Tech(I.T) from Mukesh Patel School of Technology and Engineering, SVKM's NMIMS Deemed to be University in 2011, B.Tech(I.T) from Thakur College of Engineering and Technology in 2005. She has worked in the area of Fingerprint Classification. Her areas of interest are Image processing, Computer Vision and Data Mining. She has 9 papers in International Conferences/Journals to her credit with Best Paper Award at IJCSIS, May 2011 and Best Research Project at Manshodhan 2011.

Unnati Thapar is currently pursuing 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.

Vandana Tiwari is currently pursuing her B.Tech degree in Information Technology Mukesh Patel School of Technology and Engineering, SVKM's NMIMS Deemed to be University. Her areas of interest include computer networks and image processing. She has worked on projects and seminars in the above mentioned domain.