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Garber Filter Based Hybridized Algorithm For Feature Extraction From A Fuzzy Fingerprint Image

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Abstract- Proper extraction of fingerprint functions is important for matching the fingerprint algorithms. Different pieces of fingerprint information, such as rigid orientation and frequency should be taken into consideration for good results. The quality of a fingerprint image is often required to improve the function extraction process. In this article we introduce a Hybridized Garber Filter Algorithm (HGFA) for Fuzzy Fingerprint Image Feature Extraction for effective fingerprint recognition.This paper describes a fingerprint detection system consisting of image preprocessing, filtration, extraction and recognition matching.Preprocessing of images includes normalization based on median value and variation. In order to prepare the fingerprint image further processing, Gabor filters are extracted. The Poincaré index with a partitioning technique is used for the identification of a particular point. The extraction of the ridge line is shown and also the minute extraction with CN algorithm

I. INTRODUCTION

For over 100 years fingerprints have been the golden standard in the forensic society for private identification. Over time, from its early use of finger print in former Babylon to its current use as a key technology for biometric safety devices and to be proof in law courts worldwide, fingerprint identity has developed [1]. Fingerprints are the finger-tip patterns that contain pores connects to sweat glands, created by extended papillary ridges. It is found in many years of studies and research that, unless their symmetry has continuously been affected by some deeply seated injury, papillary ridges [2,3], the hand fingers or the soles or toes, of the feet, stay true to the mould they are formed in nature throughout their lives. These ridges created during fetal life are not only immutable in life, but also seem to have the unique characteristics of lasting out every other recognizable characteristic of the body [4,5]. Fingerprints and finger marks all come together to provide police and courts with the most strong means to identify themselves [6]. The knowledge that the designs and details of the skin of a ridge are unique, immutable, universal, easily classified and leave signs on any matter handled with bare hands is the basis of how it has been a powerful tool [7]. The significance of fingerprints was understood and the detection techniques and operational and strategic applications of fingerprints were investigated.Fingerprints form certain patterns which seem to be of overall form and design similarity [8,9].

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II. FUNDAMENTALS OF FINGERPRINT

The use of fingerprints is based on a number of key values in forensic science. The first is that there is a very small probability to find two people with the same fingerprints. Actually, no two fingerprints were ever found to be identical [10]. Galton calculated that 1 million in 64 million were likely to find identical prints. A second principle is that the fingerprints of an individual do not alter over time. The pattern of a person's ridges at birth, palm and sole remains unchanged until death. until death [11].A detective may therefore be sure that the fingerprints of a criminal stay unchanged until death. Finally, the patterns of ridges on the fingers of the people are similar enough to classify. The fundamental fingerprint patterns include loops, whorls and arches found in fingerprints [12,13]. Approximately 60-65% of populations show loop patterns, 30-35% have whorls, and only around 5% have arches. Either the arches are plain or tentative and the whorls are classified as central pocket, side pocket, twins and accidentals [14,15].
Detailed examination of the skin on the friction ridges also shows that in most cases the rigid path is not always through the entire surface of the finger. Some ridges, called ending ridges, flow abruptly and end as others flow into two ridges, known as ridges or branches. In addition, certain ridges are wide and known as dots [16,17]. These ridge occurrences are usually referred to in terms of features or details and can be compared and identified using a fingerprint image. An arch has ridges from one side of its structure which create a wave from the other side in the center. In a whorl, friction ridges generally flow around or outward. The flow of a printed material is to be noted for orientational reasons and the areas that will eventually contribute to the identification process must be recognized for examination. While patterns can not only be used for individualization, they can be used for the exclusive decisions of examiners.

III. LITERATURE SURVEY

In[18] the author proposed a secure, Fuzzy Vault-Based System (FVS) of fingerprint verifications, where the sensitive biometric template was not stored, it was a transformed version. In order to attain the most reliance-sensitive reference point and to build a set of rotating and changing characteristics, we suggest an adaptive alignment method which serves as a lock set for the fluid vault. We are examining the flow parameters and the amount of models required to achieve a credible reference point, in order to achieve a high degree of accessing complexity for attackers with an acceptable legal unlock rate.

Fuzzy logic is a powerful problem solving technique and wide spreading recognition for a variety of applications. For applications in image understanding, FL is also considered for edge detection, feature extraction, classifying and clustering. It provides an simple and easy way to conclude unambiguously, inaccurately and vaguely [19]. Likewise, some of the FIS designs have the ability to provide a universal estimate, such as those used in artificial neural networks (ANN). The ANFIS is a systems referred as the Neuro-Fuzzy Systems (NFs). NFs merge the advantages of ANN and Fuzzy schemes.

The Author proposed QFingerMap, the global fingerprint feature, that provides fuzzy image information. A fuzzy rule combining information from various QFingerMaps is used to record an individual in a database. Error and the penetration rate of the Fuzzy Retrieval Scheme (FRS) [20] are comparable to other literature-based schemes, which can also be deployed on a global basis. However, it is possible to implement this scheme in platforms with much reduced computer resources and even reduced processing times.

IV. PROPOSED SYSTEM

In this paper, Garber filter based hybridized algorithm for feature extraction from a fuzzy fingerprint image has been proposed. The orientation location and minutia type can describe the fingerprints. The frequently used minutia are ridge bifurcation, ridge endings delta, and core. To identify and localize minutiae on a fingerprint pattern, the large amounts of data acquisition about an image is required. Regularly algorithms utilize the image preprocessing, for instance, lighting improving, histogram alignment or contrast to enhance image quality. In this paper, the image preprocessing is utilized aprimary image analysis, enhancing the image quality utilizing the only filtration. The experimental results show that the best results in image analysis are determined using filtration depends on frequency and image direction. The proposed algorithm is, therefore, the basis of the Gabor filter, which significantlyenhances fingerprint image quality. The proposed algorithm structure explained in Fig. 1.

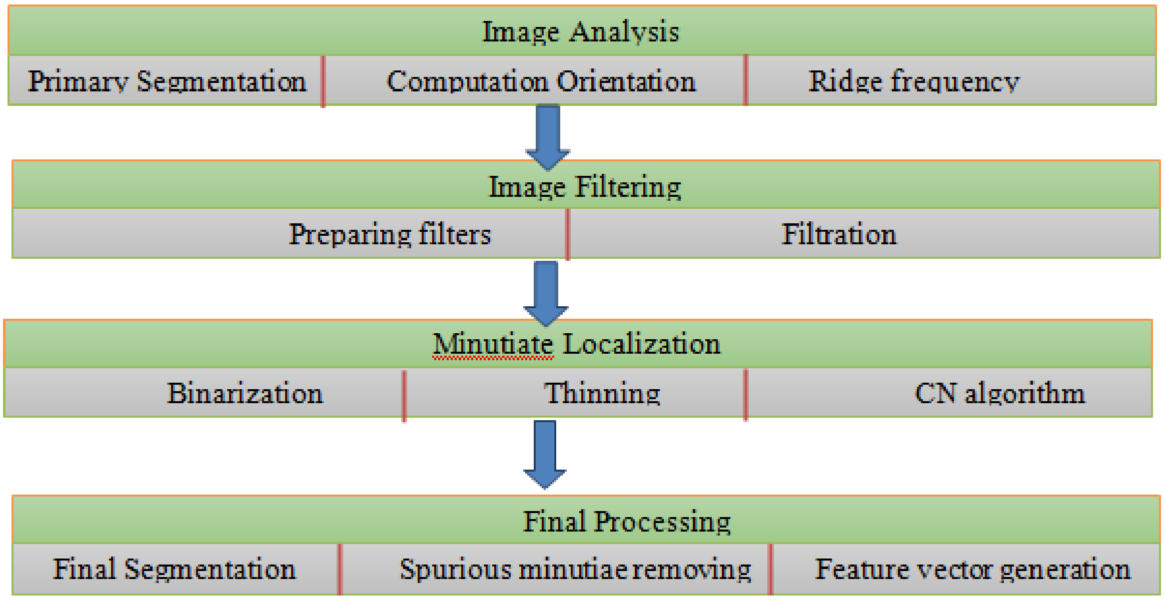

Fig 1: Proposed algorithm structure

V. PRIMARY IMAGE ANALYSIS

The fingerprint image is promptly analyzed after an optical scanner to data acquisition. This level is intended to make data required for appropriate filtration. Initial segmentation is carried out to identify the fingerprint region on the image output. Subsequently, the orientation of frequency and every pixel of ridges is evaluated.

VI. PRIMARY SEGMENTATION

Primary segmentation divides the area of a real fingerprint from the background. The existing methods generate the distortion in statistical data in further processing. A primary segmentation approach is easy and is depends on statistical elementary functions of variation and mean value. By evaluating the intensity mean of variation and pixels in intensity for every block, the data required for image separation is determined. Since the fingerprint is an important part of the image, let consider the set of parameters outlining a range of mean intensity variance and mean intensity to decide the existence or otherwise every block relates to the background or fingerprint.

VII. COMPUTATION ORIENTATION

The following step in the proposed algorithm is to evaluate the matrix of orientation for an input image. Sobel operator, a gradient filter has been used for the matrix of orientation. The Sobel operator contains two matrixes and input image provides a gradient in directions y and x correspondingly.

Let consider the input image be matrix B. The matrixes H_y and H_x consist of a gradient in the direction of horizontal and vertical, correspondingly.

$$H_y = \begin{bmatrix} +1 & 0 & -1 \\ +2 & 0 & -1 \\ +1 & 0 & -1 \end{bmatrix} * B \quad H_x = \begin{bmatrix} +1 & +2 & +1 \\ 0 & 0 & 0 \\ -1 & -2 & -1 \end{bmatrix} * B$$

As shown in the equation (1) where * denotes the convolutional mean two-dimensional operator.
The gradient magnitude computation has been calculated using these matrixes.

$$H = \sqrt{{H_y}^2 + {H_x}^2}$$

The direction of the gradient can be calculated by using the following equation (3)

$$\theta = \text{atan}(\frac{H_x}{H_y}) \quad (3)$$

Moreover, accurate results may be evaluated by considering the pixel locality:

$$U_y(j,k) = \sum_{v=j-\frac{P}{2}}^{j+\frac{P}{2}} \sum_{u=k-\frac{P}{2}}^{k+\frac{P}{2}} 2H_y(v,u)\, H_x(v,u)$$

$$U_x(j,k) = \sum_{v=j-\frac{P}{2}}^{j+\frac{P}{2}} \sum_{u=k-\frac{P}{2}}^{k+\frac{P}{2}} [{H_y}^2(v,u)\, {H_x}^2(v,u)]$$

$$\theta(j,k) = \frac{1}{2}\tan^{-1}\left[\frac{U_y(j,k)}{U_x(j,k)}\right] \quad (6)$$

As shown in the equation (6) where P is the size of the window, H_y and H_x are the gradient matrixes in horizontal and vertical correspondingly. Gaussian filtering has been used to reduce the error in the fingerprint image.

VIII. DELTA AND CORE DETECTION

Delta and Core recognition is very essential because these points are the reference points for minutiae recognition. Comparison of fingerprints in very large databases takes a crucial amount of period. To decrease the computation period, classification of fingerprints at the registration level is required. When deltas and cores are discovering, a fingerprint can be simply classified. There are many algorithms for classification of fingerprint for instance: line search based method or crossing number. Figure 2 shows the fingerprint directions map. Figure 3 shows the Directional map of Quantized directions.

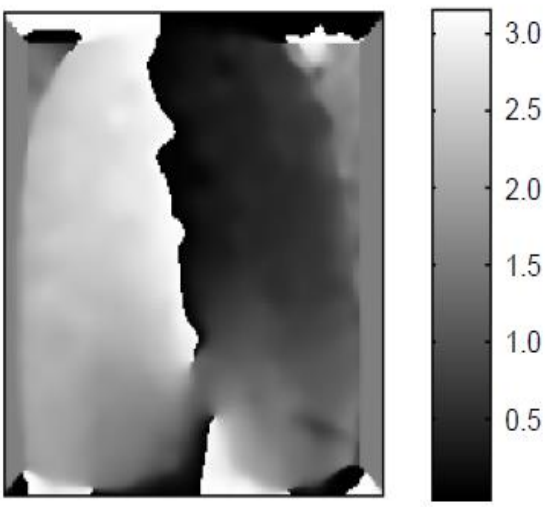

Figure 2. The fingerprint directions map

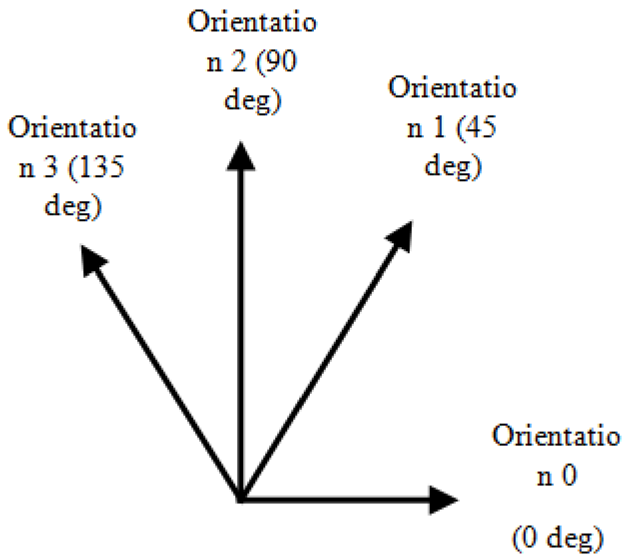

Fig 3: Directional map of Quantized directions

IX. FILTERING THE IMAGE

The Gabor filter has been used for the single image filtering to keep precisely choose ridge direction and frequency band. The fingerprint image contains numerous ridge directions and ridge frequencies, Gabor filters enhance image quality and fill discontinuities in a ridge flow. This supports the reduction of the list of false minutiae identified in the following step of the proposed algorithm. The Gabor filter depends onridge direction and spatial frequency. The fingerprint ridge image always has values well describing and Gabor filtering provides better results. The harmonic function defined as Gabor filter and multiplied by the Gaussian function. The value of points identified near the center of a ridge are amplified and the value of points localized further from the center is reduced.
Mathematical model of the Gabor filter is explained by the following equation (7),

$$H(y,x;\ \theta,g) = \exp[-\frac{1}{2}(\frac{y_\theta^2}{\rho_y^2} + \frac{x_\theta^2}{\rho_x^2})]\cos(2\pi g y_0)$$

$$y_0 = ycos(\theta) + xsin\,(\theta)$$

$$x_0 = -y\sin(\theta) + x\cos(\theta)$$

As shown in the equation (8) and (9) where θ denotes the orientation of the Gabor filter, g is the frequency of the sine wave,ρ_y *and* ρ_x indicates the Gabor filter standard deviation in vertical and horizontal correspondingly.
The original image is convoluted with the Gabor filter. The evaluation of the pixel convolution (j,k) demands the estimation of ridge frequency and orientation pixels in pixel locality. The Gabor filter binds function expressed by the following equation (10) is,

$$D(j,k) = \sum_{v=-\frac{P_y}{2}}^{\frac{P_y}{2}} \sum_{u=-\frac{P_x}{2}}^{\frac{P_x}{2}} H(v,u;Q(j,k),G(j,k)\ M\ (j-v,k-u)(10)$$

As shown in the equation (10) where D is the output image, Q is the orientation of the image, M is the input image, G denotes the ridge frequency, P_y and P_x are the length and width of the mask filter correspondingly.

X. MINUTIAE EXTRACTION

The Minutiae algorithm has applied, the image should be filtered into two stages: thinning and binarization. Binarization is a conversion of an image from grayscale to a binary image. Binarization support further image analysis, it permits to separate between the background and the epidermal ridges. In the proposed algorithm the set the binarization threshold to 0. To localize terminals and epidermal ridge bifurcations, thinning is included in image filtering. Thinning is a morphological conversion, and thinned images and transformed. For every point of a processed image, local point values are in relation with points of the structural element.
By estimate the CN number

$$CN = 0.51 \sum_{j=1}^{8,1} |W_j - W_{j-1}| \quad (11)$$

XI. OPTIMIZATION OF THE PARAMETER

This part showing the testing the algorithm with different parameter. This paper represents the graphical notation of the verified results.

A. Low Pass filtering directional map

For the proper filtration of the image, it is crucial to discover the direction of each pixel. The outcome of the directional map must have smoothly transforming values for locality pixel. To determine the effect, Gaussian filtering has used with standard deviation. The filter size N is the independent variable.

B. Parameter l of Gabor filter

Parameter l has an enormous influence on the filtration of the image. The following equation (12) and (13) ρ evaluated as

$$\rho_y = l_y G(j,k) \quad (12)$$

$$\rho_x = l_x G(j,k) \quad (13)$$

The proposed algorithm$l_y = l_x = l$. The image filtration results for l parameter for selected values. Figure 4 shows the filtered image (a, c, e, g) and the image orientation (b, d, f, h)]for different Gaussian filter sizes M

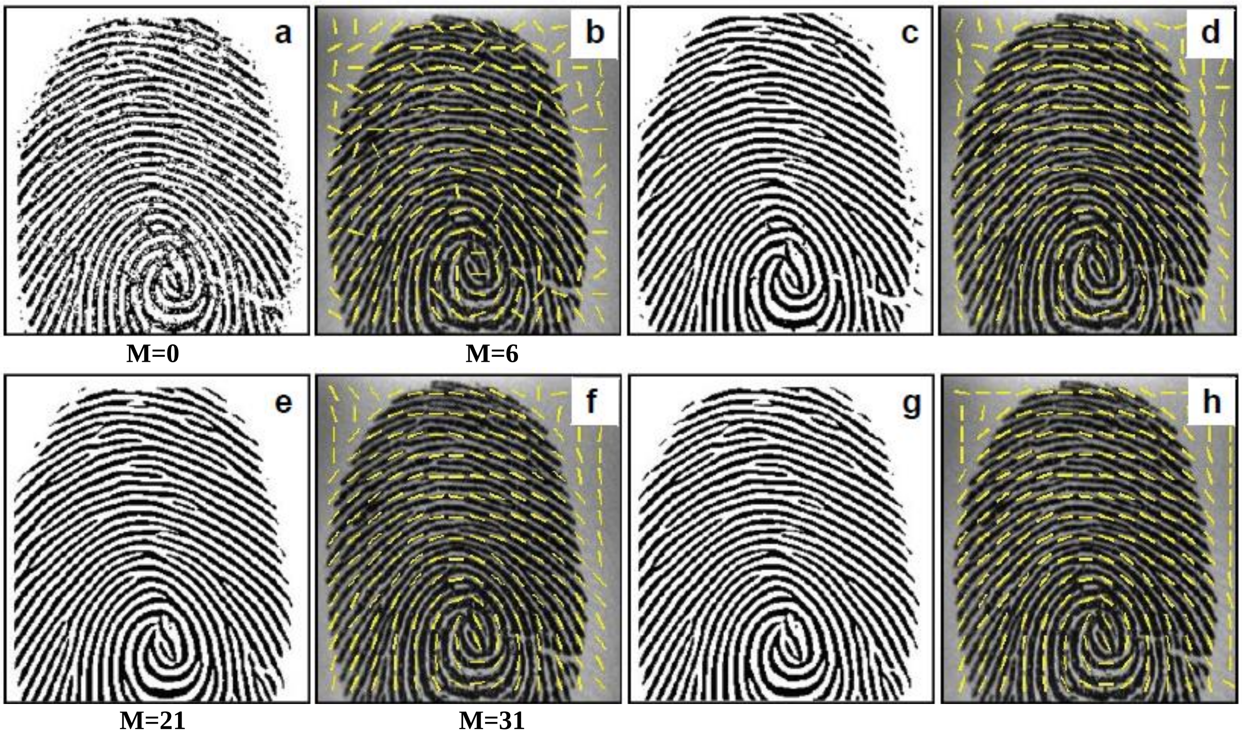

Fig.4 The filtered image (a, c, e, g) and the image orientation (b, d, f, h)]for different Gaussian filter sizes M

Size of the Gabor filter and its impact on quality filtering

The Gabor filter mask size has a huge impact on the filtration of the image. The size of the filter is estimated by ρ where $P_y = P_x = m\rho$. Figure 5 shows the Results of filtration for various n parameter values.

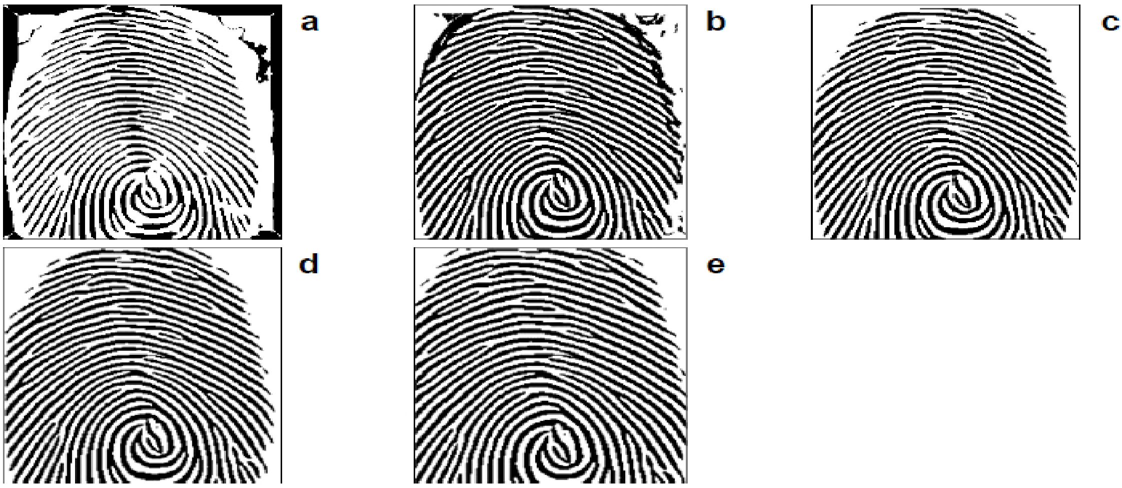

Fig.5 Results of filtration for various n parameter values: n = 1 (a), n = 2 (b), n = 2.5 (c), n = 3 (d) and n = 6 (e).

XII. RESULTS AND DISCUSSION

Fingerprint technology has permeated any possible safety system in use today, from providing business security to businesses all over the world to making smartphones & laptops safer against unauthorized access.. As the oldest biometric recognition system, it was well integrated across industries in company-level security applications. The wide acceptance and operational facility combined with economic efficiency give it a considerable impact on the other underdeveloped biometric technologies.The proposed Hybridized Garber Filter Algorithm (HGFA) for Fuzzy Fingerprint Image Feature Extraction achieves higher accuracy compared to other existing methods such as FVS, ANFIS,HGFA. Fig.6 shows the accuracy of Hybridized Garber Filter Algorithm (HGFA).

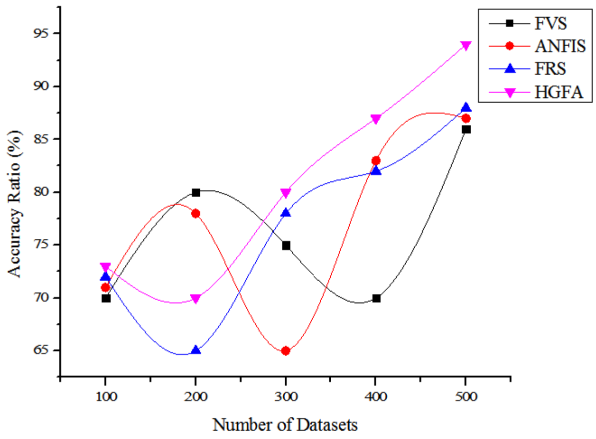

Fig 6. Accuracy of HGFA

A thorough, effective and efficient algorithm to enhance the general efficiency of a fingerprints recognition scheme because preserving real details while removing fake details in post-processing is very essential [21]. The proposed Hybridized Garber Filter Algorithm (HGFA) for Fuzzy Fingerprint Image Feature Extraction achieves higher performance compared to other existing methods such as FVS, ANFIS,HGFA. Fig.7 shows the performance of Hybridized Garber Filter Algorithm (HGFA).

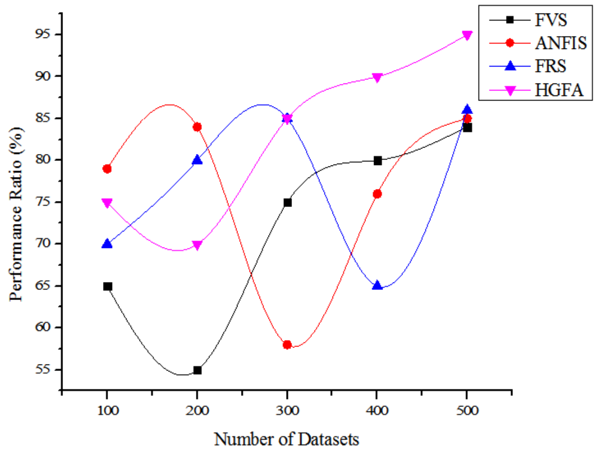

Fig 7. Performance ratio of HGFA

Predicting biometric efficiency in real time applications is an significant issue. This paper offers a binomial model for predicting the fingerprint verification and the performance of identification. The match and non match results are calculated using the matching metric amount of matching triangles between the query and gallery fingerprints. The proposed Hybridized Garber Filter Algorithm (HGFA) for Fuzzy Fingerprint Image Feature Extraction achieves higher prediction ratio when compared to other existing methods such as FVS, ANFIS,HGFA. Fig.8 shows the prediction ratio of Hybridized Garber Filter Algorithm (HGFA).

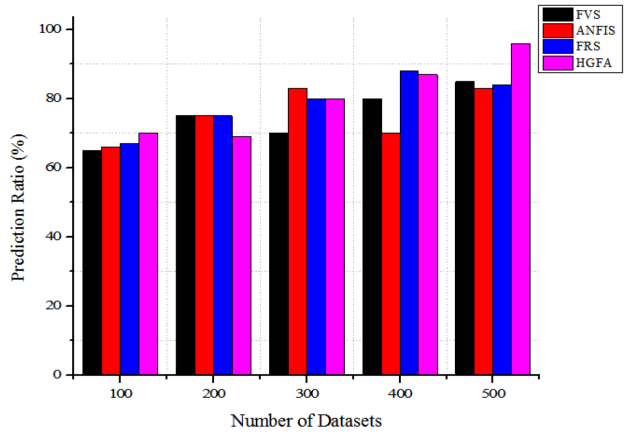

Fig.8 Prediction Ratio of HGFA

The proposed Hybridized Garber Filter Algorithm (HGFA) for Fuzzy Fingerprint Image Feature Extraction have low error rate when compared to other existing methods such as FVS, ANFIS,HGFA. Fig.9 shows the error rate of Hybridized Garber Filter Algorithm (HGFA).

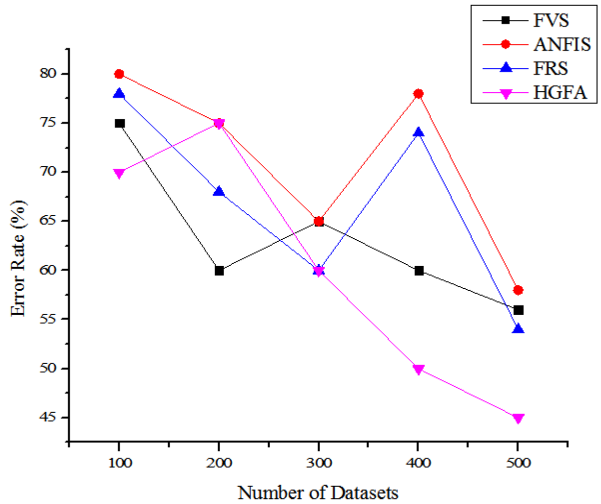

Fig 9. Error rate of HGFA

XIII. CONCLUSION

A new fingerprint extraction algorithm has been presented in this paper, and image preprocessing is not required.. The user of the software can display each stage of image processing. The final algorithm outcome is an optional vector (with focal points) that can be used in any fingerprint technique selected. Our fingerprint tests give good results for the different fingerprint images. This algorithm compares the results of fingerprint processing to the algorithm results presented in section 4. By increasing the precision of the directional and frequency maps, filtered image quality can be improved.

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