FINGERPRINT IMAGE ENHANCEMENT USING FILTERING TECHNIQUES

G. NAGENDRA [1] V.SRIDHAR[2] M.PRAMEELAMMA[3] M.ZUBAIR[4]

[1]Associate professor ,ECE , HOD&Associate professor,Dr.k.v subbareddy institute of technology, Kurnool
[2]Assistant Professor, ECE, VIDYA JYOTHI INSTITUTE OF TECHNOLOGY,AZIZNAGAR,hyderabad,India.
[3]Assistant Professor,CSE,MALLAREDDY COLLEGE OF ENGINEERING,hyderabad,INDIA.
[4]Assistant professor ,ECE , HOD&Associate professor,Dr.k.v subbareddy institute of technology, Kurnool
[1]nag20209@gmail.com, [3]pramee525@gmail.com,[2]varadalasri@gmail.com,[4] sendzubair@gmail.com

ABSTRACT: A fingerprint in its narrow sense is an impression left by the friction ridges of a human finger. In a wider use of the term, fingerprints are the traces of an impression from the friction ridges of any part of a human or other primate hand. A print from the foot can also leave an impression of friction ridges. A friction ridge is a raised portion of the epidermis on the digits (fingers and toes), the palm of the hand or the sole of the foot, consisting of one or more connected ridge units of friction ridge skin These are sometimes known as "epidermal ridges" which are caused by the underlying interface between the dermal papillae of the dermis and the interpapillary (rete) pegs of the epidermis. These epidermal ridges serve to amplify vibrationstriggered, for example, when fingertips brush across an uneven surface, better transmitting the signals to sensory nerves involved in fine texture perception. These ridges also assist in gripping rough surfaces, as well as smooth wet surfaces. This paper presents removal of noise from a fingerprint image . It was implemented using two methods. First is using histogram equalization, Wiener filtering , binarization and thinning . Second is using anisotropic filter. Second method was successful in removing noise .matlab environment was used simulation of proposed alogorithm.

Keywords: fingerprint image,anisotropic filter,noise,friction,wienerfiltering,IAFIS,RIDGE

I. INTRODUCTION TO FINGERPRINT ENHANCEMENT:

Fingerprints are today the biometric features most widely used for personal identification. Fingerprint recognition is one of the basic tasks of the Integrated Automated Fingerprint Identification Service (IAFIS) of the most famous police agencies. A fingerprint pattern is characterized by a set of ridgelines that often flow in parallel, but intersect and terminate at some points. Minutiae characteristics are local discontinuities in the fingerprint pattern and represent the two most prominent local ridge characteristics: terminations and bifurcations. A ridge termination is defined as the point where a ridge ends abruptly, while ridge bifurcation is defined as the point where a ridge forks or diverges into branch ridges this is shown in fig 1. The uniqueness of a fingerprint is determined by their local ridge characteristics and their relationships. Most automatic systems for fingerprint comparison are based on minutiae matching.

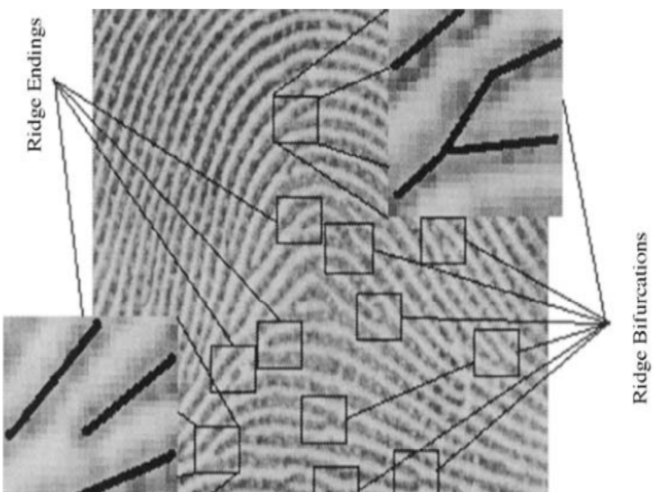

Fig 1 . Examples of minutiae (ridge ending and bifurcation) in a fingerprint image.

1.1 Noise in fingerprint images:

However the fingerprint images contain noise caused by factors such as dirt grease, moisture and poor quality of input devices and storage devices .So in a noisy fingerprint image ridges are not well defined and hence cannot be correctly detected . Noise might result in creation of false ridges and ignoring the genuine ridge lines ,fig 2. Shows a noisy finger print image images are prone to a variety of types of noise. Noise is the result of errors in the image acquisition process that result in pixel values that do not reflect the true intensities of the real scene. There are several ways that noise can be introduced into an image, depending on how the image is created. For example: If the image is scanned from a photograph made on film, the film grain is a source of noise. Noise can also be the result of damage to the film, or be introduced by the scanner itself If the image is acquired directly in a digital format, the mechanism for gathering the data (such as a CCD detector) can introduce noise. Electronic transmission of image data can introduce noise.

Fig 2 . noisy fingerprint image

Due to the presence of noise the false ridges may highly decrease the matching performance of the system .Using this fingerprint technology there are advantages in day to day activities like fingerprint recognition devices for desktop and laptop access are now available from many different vendors . With these devices users no longer need to type passwords instead only a touch provides instant access . This is also used in checking fingerprint for new applicants to social service benefits to ensure recipients do not fraudulently obtain benefits under fake name .

This work proposes two methods for removing noise in a fingerprint image. The first one is carried out using histogram equalization, Wiener filtering binarization and thinning. The second method uses a unique anisotropic filter for direct gray-scale enhancement .

1.2 HISTOGRAM EQUALIZATION OF FINGER PRINT IMAGE AND HISTOGRAM:

Experimental results show that the contrast of ridges is expanded , histograms for the original image and the histogram equalized image are also shown : We can also observe that along with ridges contrast , the background noise is also enhanced.

It shows that the desired ridges as well as the noise are enhanced . Actually the noise is the unwanted in a fingerprint image which creates problem in detecting the true ridges . So noise removal is not successful.

Intensity adjustment is an image enhancement technique maps an Image’s intensity values to a new range. To illustrate, this figure 4 shows low-contrast image with its histogram. Notice in the histogram of the image how all the values gather in the center of the range. For the increased contrast in the o/p image, and that the histogram now fills the entire range . From fig 7,13,14,1617,18 we can observe that histogram equalized image has become dark which is not the goal of this work .If the image is dark the histogram will be biased towards the dark end of the gray scale . The low dynamic range is evident from the fact that the width of histogram is narrow with respect to entire gray scale. If graph is distributed evenly then improvements in average intensity and contrast are evident as in fig 4, 6,10 ,11,12

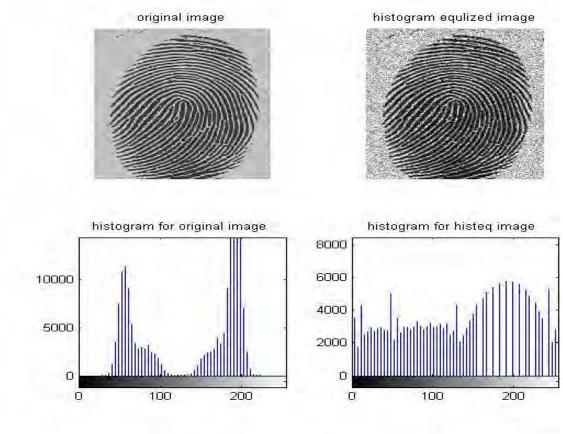

Fig 4:

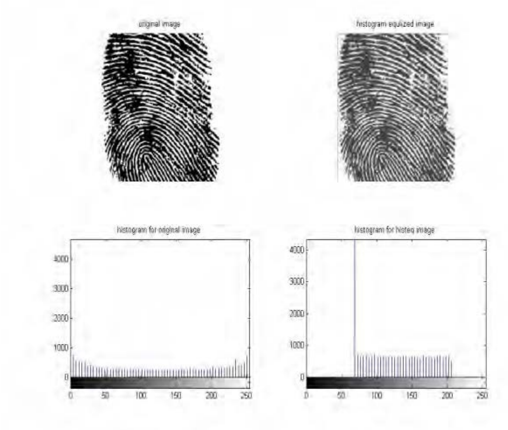

Fig 5:

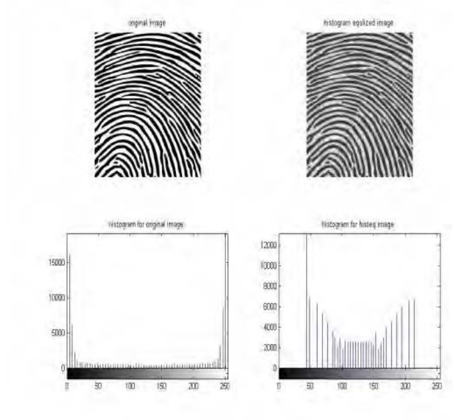

Fig 6:

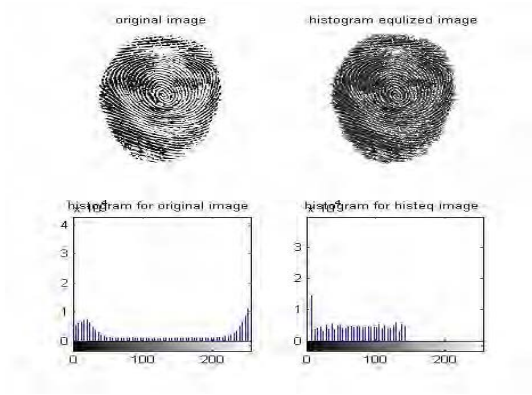

Fig 7:

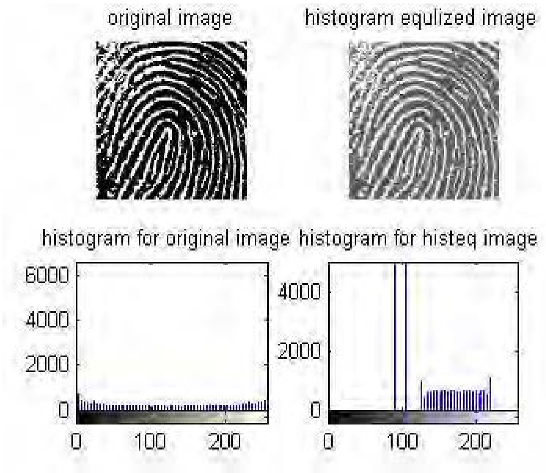

Fig 8:

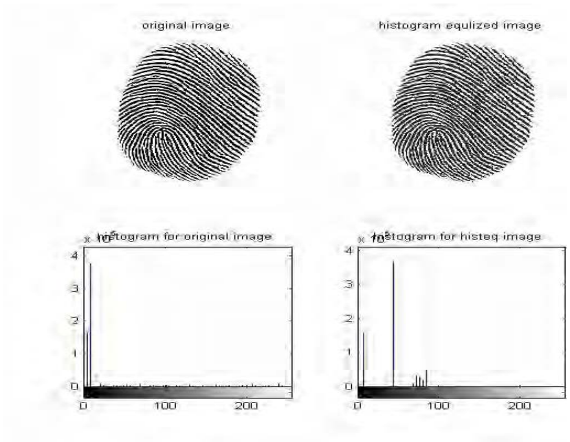

Fig 9:

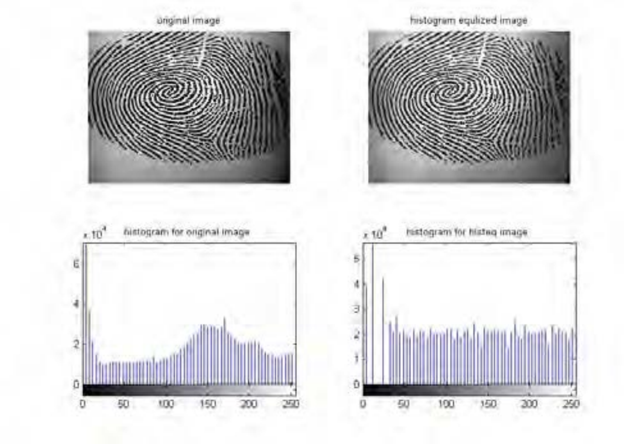

Fig 10:

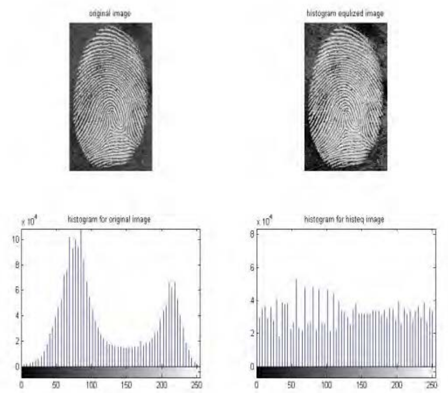

Fig 11 :

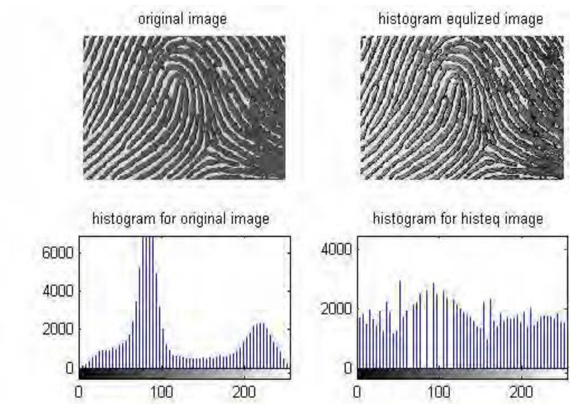

Fig 12:

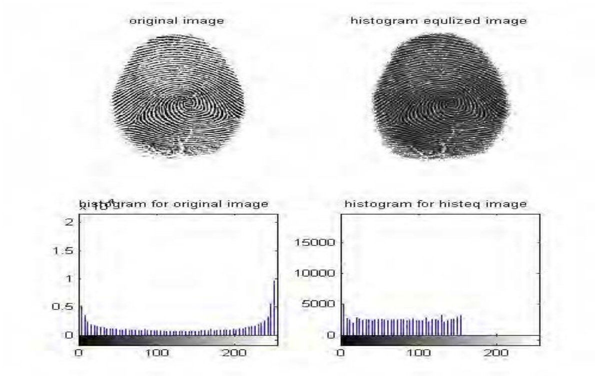

Fig 13:

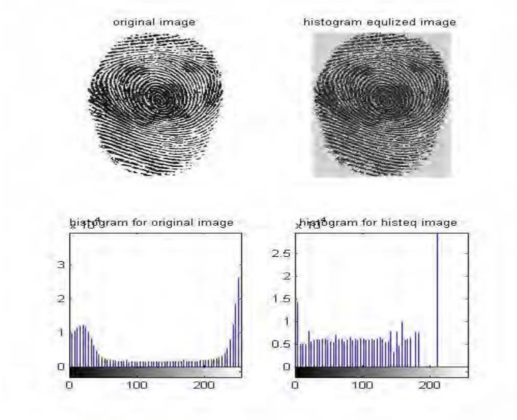

Fig 14 :

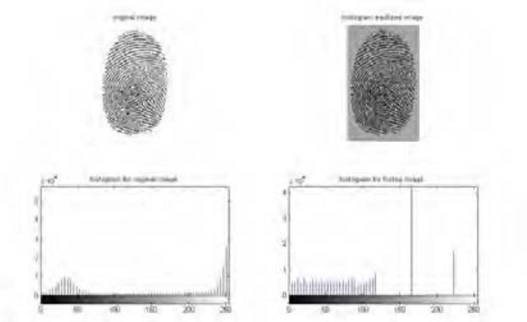

Fig 15 :

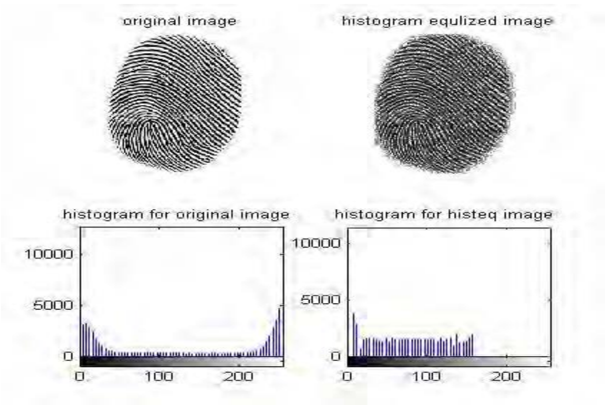

Fig 16 :

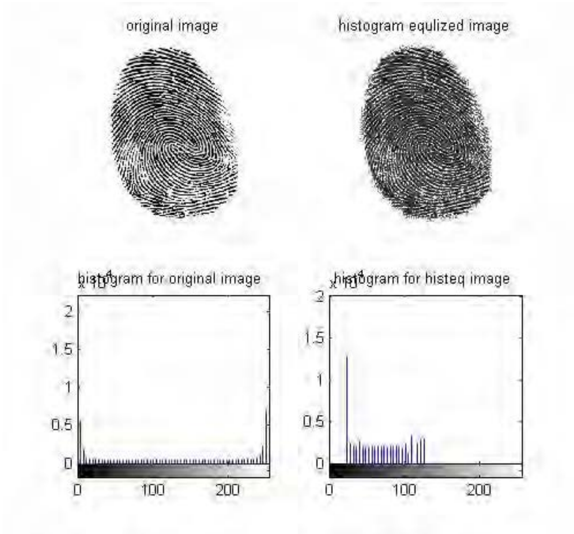

Fig 17 :

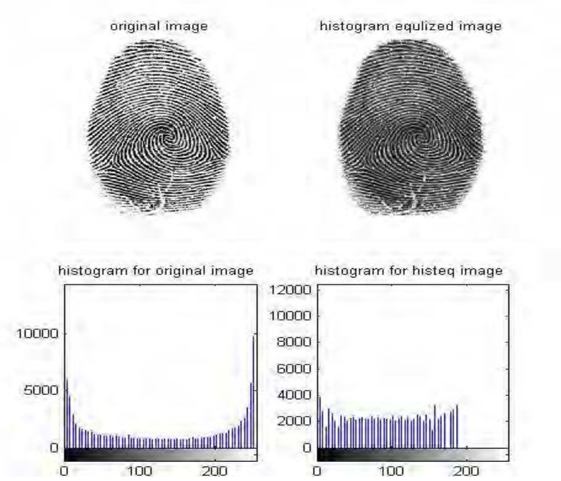

Fig 18 :

2. WIENER FILTERING:

3.1 Why is it used ?

Wiener filter is used to filter out noise that has corrupted a signal . This technique assumes that if noise is present in the system ,then it is considered to be additive white Gaussian noise. It is used in image restoration . Within the class of linear filters ,the optimal filter for retoration in the presence of noise is given by wiener filtering. Wiener filtering are characterized by the following :

3.2 How it works :

Assumption: signal and noise are stationary linear stochastic process with known

Power spectral characteristics or known autocorrelation and cross correlation. Requirements: the filter must be physically realizable.

Performance criteria: minimum mean square error.

The filter is based on local statistics estimated from a local neigh borhood ŋ of size 3x3 of each pixel ,and is given by

$w(n1,n2) = \mu + (\sigma^2 - v^2) / \sigma^2 * (I(n1,n2) - \mu)$

where v^2 is the noise variance, μ and σ^2 are the local mean and variance and I represents the gray-level intensity in n1; n2 ϵ ŋ Wiener filter lowpass-filters a grayscale image that has been degraded by constant power additive noise.

The adaptive filter is more selective than a comparable linear filter, preserving edges and other high-frequency parts of an image. In addition, there are no computations and implements the filter for an input image. wiener, however, does require more computation time .

3.3 RESULTS 2 : Wiener filter uses a pixel wise adaptive Wiener method basedon statistics estimated from a local neighborhood of each pixel. Wiener filtering, uses neighborhoods of size m-by-n to estimate the local image mean and standard deviation .

The Wiener filter (a type of linear filter) applies to an image adaptively, tailoring itself to the local I mage variance. Where the variance is large, wiener performs little smoothing . Where the variance is small, wiener performs more smoothing. This approach often produces better results than linear filtering.

Experimental results show variations in removal of noise . If m-by-n is high smoothing is also high and if it is low smoothing is also low .
Advantage in this method is noise can be removed from a fingerprint as that was not possible in the previous histogram equalization . Figure 19, fig 20, fig 21 shows the wiener filtered images of 5,7, 3 m-by-n

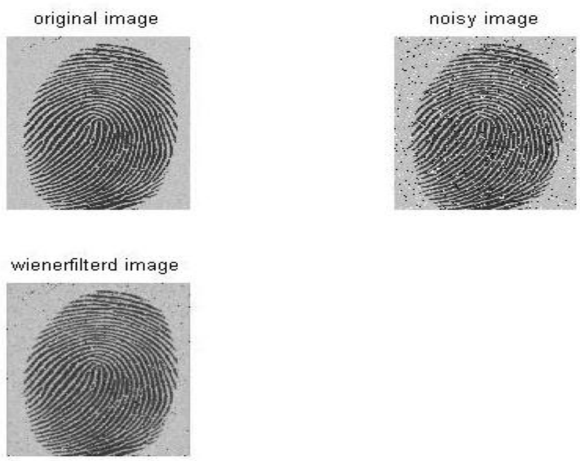

Fig 19 :

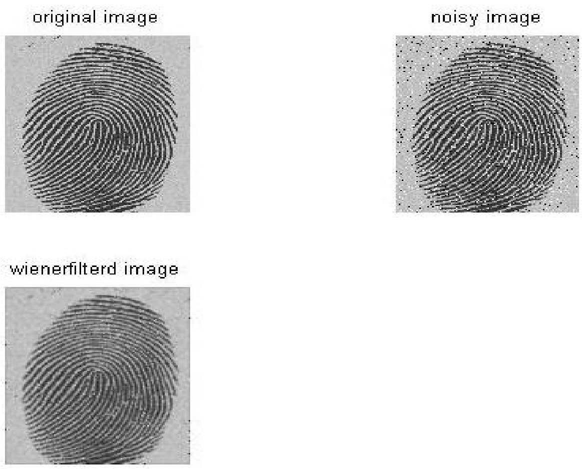

Fig 20 :

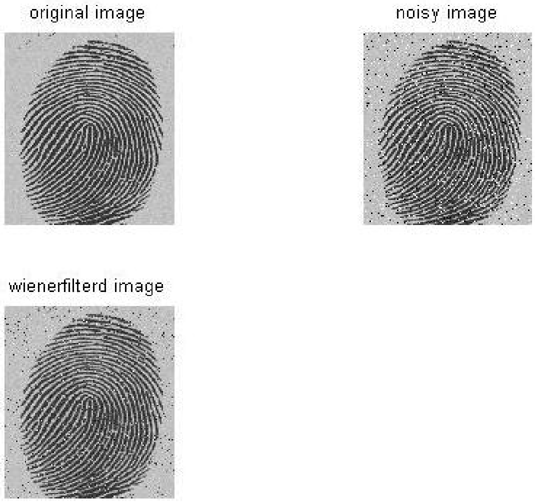

Fig 21:

4. BINARIZATION AND THINNING :

The operation that converts a gray-scale image into a binary image is known as binarization .Pixels with the value 0 are displayed as black; pixels with the value 1 are displayed as white.Thinning means reducing binary objects or shapes in an image to strokes that are a single pixel wide . Finger print ridges are fairly thick , it may be desirable for subsequent shape analysis to thin the ridges so that each is one pixel thick. Thinned (one pixel thickness) ridgelines are obtained using morphological thinning operations .

Morphology **:** It is a tool for extracting image components that are useful in the representation and description of region shape, such as boundaries, skeletons and convex hull.

4.1 Why is it used ?

Binarization and thinning process are preceded by a smoothing operation .By performing binarization to fingerprints, ridges are clearly visible to detect and it is always preceeded for thinning operation.

4.2 How it works : Binarization can be carried out using an adaptive thresholding. Each pixel is assigned a new value (1 or 0) according to the intensity mean in a local neighborhood of (mxn pixels) .

Thinning **:**One of the most common uses of thinning is to reduce the thresholded output of an edge detector such as the Sobel operator, to lines of a single pixel thickness, while preserving the full length of those lines (i.e. pixels at the extreme ends of lines should not be affected). A simple algorithm for doing this is the following:

Consider all pixels on the boundaries of foreground regions (i.e. foreground points that have at least one background neighbor). Delete any such point that has more than one foreground neighbor, as long as doing so does not locally disconnect (i.e. split into two) the region containing that pixel. Iterate until convergence.This procedure erodes away the boundaries of foreground objects as much as possible, but does not affect pixels at the ends of lines. This effect can be achieved using morphological thinning by iterating until convergence with the structuring elements shown in Figure 1, and all their 90° rotations ($4\times2 = 8$ structuring elements in total).In fact what we are doing here is determining the octagonal skeleton of a binary shape --- the set of points that lie at the centers of octagons that fit entirely inside the shape, and which touch the boundary of the shape at least two points. See the section on skeletonization for more details on skeletons and on other ways of computing it. Note that this skeletonization method is guaranteed to produce a connected skeleton.

0	0	0
	1	
1	1	1

	0	0
1	1	0
	1	

fig22: Structuring elements for skeletonization by morphological thinning. At each iteration, the image is first thinned by the left hand structuring element, and then by the right hand one, and then with the remaining six *90°* rotations of the two elements. The process is repeated in cyclic fashion until none of the thinnings produces any further change. As usual, the origin of the structuring element is at the center.

fig 23 shows the result of this thinning operation on a simple binary image.

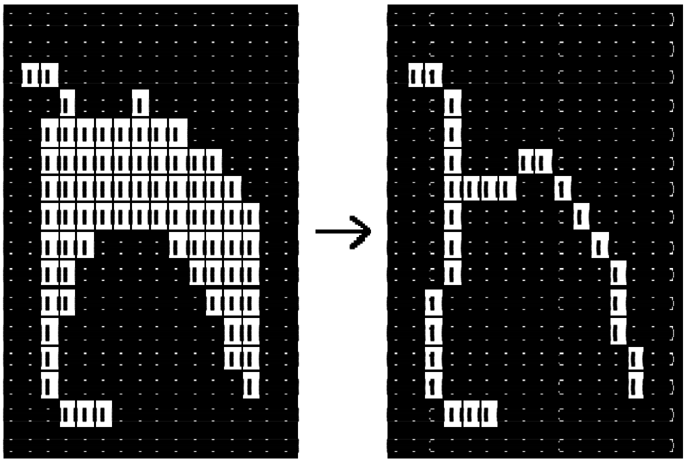

fig 23 **:**Example skeletonization by morphological thinning of a simple binary shape, using the above structuring elements. Note that the resulting skeleton is connected.

4.3 RESULTS 2 : Binarization may cause loss of information because binarization is carried out using an adaptive thresholding.From fig 24 we can observe that noise is removed from binarized fingerprint butwhen coming to a thinned image of fig 24 shows that two typical kinds of noise,which can appear in a thinned binary image: false ridgeline connections andgaps within a true ridgeline. False ridgeline connections are almost perpendicular tothe local ridge direction, and empirically found to be of length less than 10 pixels.

So detection of ridges cannot be stopped at binarization and thinningStage . They are used as intermediate steps in some enhancement algorithms .

Fig 24:

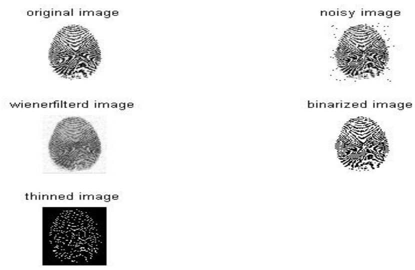

Fig :25

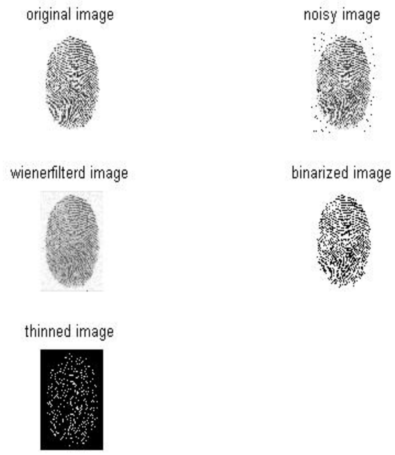

Fig 26:

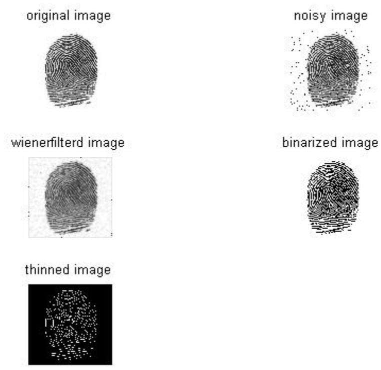

Fig 27:

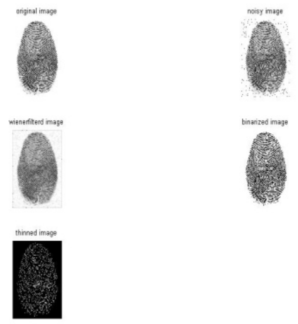

Fig 28:

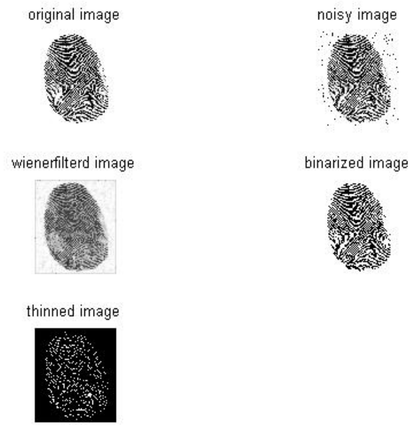

Fig 29:

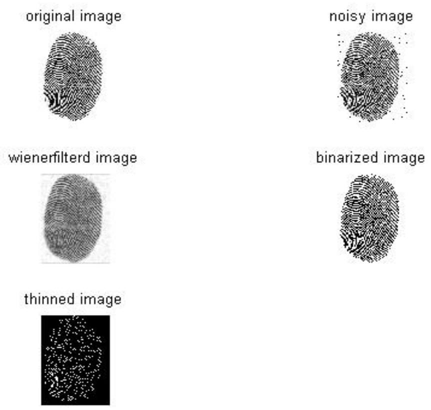

Fig 30:

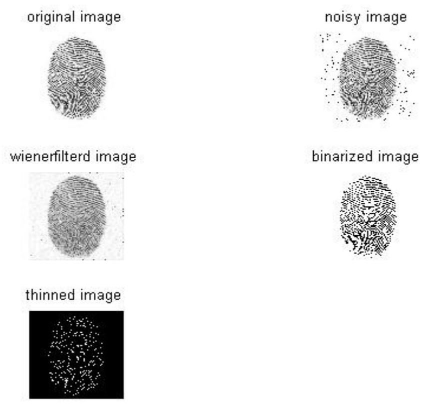

Fig 31:

3. ANISOTROPIC FILTERING:

It is a filter which is used for filtering in a particular direction .

3.1 Why is it used ?

It is used to remove noise from a fingerprint image . Because a fingerprint will have ridges (lines) oriented in different directions . So to filter noise along the ridges this anisotropic filter (directional dependent) is used .Suppose if an isotropic filter is used for this purpose filtering will be done in all directions .

3.2 WORKING:

This paper work presents a second approach for finger print enhancement using a unique anisotropic filter. To design this anisotropic filter first orientation should be obtained for the finger print ridges by using Hough Transform.

The filter used is Gaussian filter and it is designed with different variances in X direction and Y direction as in figure. With the orientation obtained for the finger print ridges the Gaussian filter is rotated with that particular orientation . So when this filter is applied to a ridge line ,the kernel appears as an ellipse. Therefore smoothing is performed along ridges but not across a ridge line The designed anisotropic filter cannot be applied directly to an entire finger print image ,because a finger print pattern will have ridge lines oriented in different pattern . If we observe the finger print image we find that some ridge lines are oriented in some direction in a block wise order. For this purpose the whole image is divided into blocks . Each block will have ridge lines with some particular orientation . Then Hough transform can be applied to a block which gives orientation and with that orientation the filter is rotated and in this way the noise can be removed along the ridge lines.

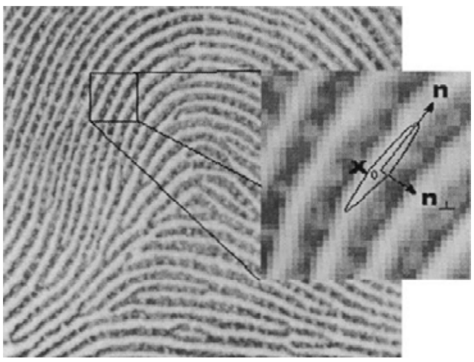

Fig 32: anisotropic filter

4 .RESULTS: Experimental results show that Gaussian anisotropic filter was successful in removing noise from a finger print while preserving the ridges .When this method is compared with previous methods, background noise is completely removed , information loss is not there , false ridges are also filtered , it is not based on statistics estimated from a local neighborhood of size mxn of each pixel i.e noise removal was dependent on variance. fig 35 to 43 shows that noise is completely removed .The results inturn will lead to improvements in matching performance .

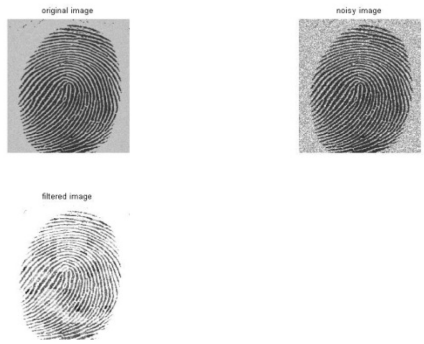

fig 35: anisotropic filtering of fingerprint

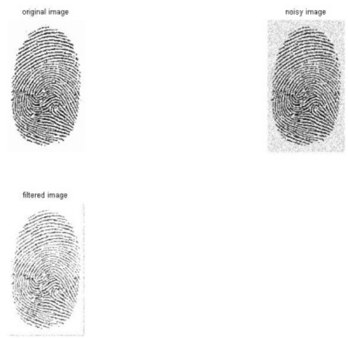

fig 36: anisotropic filtering of fingerprint

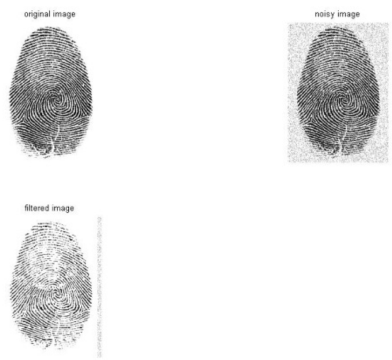

fig 37 : anisotropic filtering of fingerprint

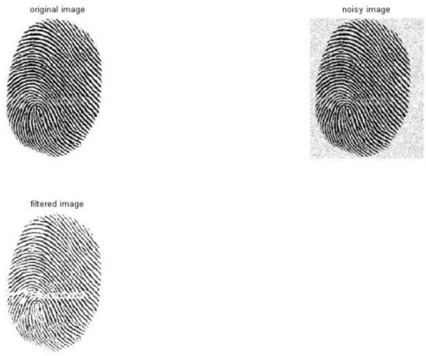

fig 38 : anisotropic filtering of fingerprint

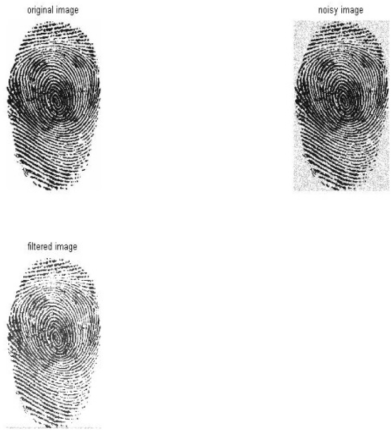

fig 39: anisotropic filtering of fingerprint

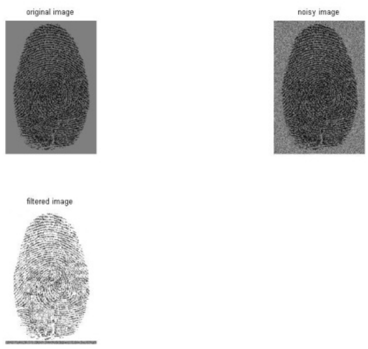

fig 40 : anisotropic filtering of fingerprint

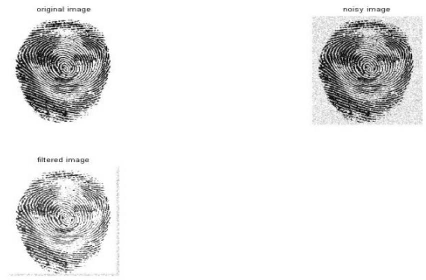

fig 41 : anisotropic filtering of fingerprint

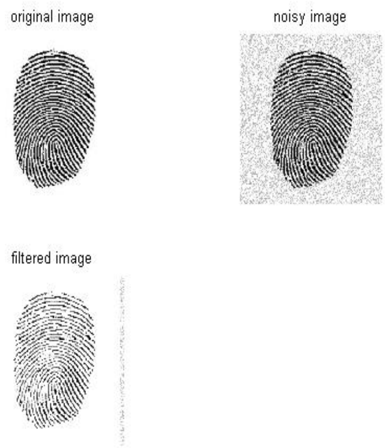

fig 42 .A: anisotropic filtering of fingerprint

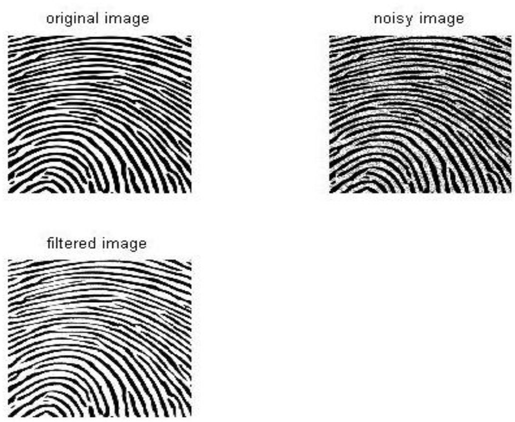

fig 42.B: anisotropic filtering of fingerprint

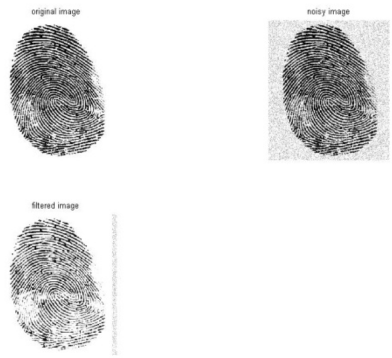

fig 43 : anisotropic filtering of fingerprint

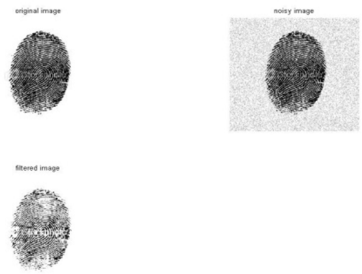

fig44: anisotropic filtering of fingerprint

10. CONCLUSION:

This paper work was carried on removing noise from a fingerprint Image . Two approaches were implemented . First method includes ,histogram equalization, binarization and thinning ,but this method had some demerits like noise was not removed by histogram equalization,instead it was enhanced ,binarization resulted in loss of informationthinning resulted in generation of false ridges which was noise and wiener filteringnoise removal was depending on statistics estimated on local neighborhood of sizemxn .Gaussian anisotropic filtering works on gray scale fingerprint image which is second approach over comes above draw backs and was successful in noise removal .Experimental results in this work show that algorithm is conceptually simple, faster and efficient.

11. REFERENCES

[1] Maio, . & Maltoni, D. (1997) Direct Gray-ScaleMinutiae Detection in Fingerprints. IEEE Transactionson Pattern Analysis and Machine Intelligence 19: 27–40merit : conceptually complexdemerit : better interms of efficiency&robustness .

[2] Gonzales, R.C. & Woods, R.E. (1993) Digital ImageProcessing. New York, USA:Addison-Wesley.

[3] Hong, L., Wan, Y. & Jain, A. (1998) Fingerprint ImageEnhancement: Algorithm and Performance Evaluation.IEEE Transactions on Pattern Analysis and MachineIntelligence 20: 777–789.merit : improves goodness and accuracy .demerit : dependence on ridge frequency .

[4] Greenberg, S., Aladjem, M., Kogan, D. & Dimitrov, I.(2000) Fingerprint Image Enhancement using FilteringTechniques. 15th International Conference on patternRecognition, Barcelona, vol. III, pp. 326–329. merit : enhancement performance is good .demerit : computational time is high .

[5] Balasubramanian .K and Bapu . Extracting minutiae from finger prints using image inversion and Bihistogram equalizationmerit : preservation of brightness and contrast . demerit : requires statistical knowledge .

[6] Limin Liu . Ridge orientation and verification algorithm for finger prints Enhancement .Journal of Universal computer science, vol .12, no.10(2006) .merit : combines both isotropic and anisotropic techniques . demerit : gradient based approach may not be reliable or poor quality images.

[7] Lin Hong ,Anil Jain ,S.Panakanti Ruud Bolle . Finger print Enhancement .merit : improves performance of online fingerprint verification system .demerit : applicable only if true ridges are recoverable .

Authors Biography:

[1].G.NAGENDRA is working as an HOD&associate professor in ECE department at DR.k.v.subbareddy institute oftechnology,Kurnool.Hecompleted M.TECH(communication and signal processing) from SK UNIVERSITY,ananthapur.he completed B.TECH degree in ECE from JNTUH.his areas of researchintrestesincludeimageprocessing,digitalsignalprocessing,embedded systems,mobilecommunicatios and Artificial neural networks

[2] VARADALA SRIDHAR is from HYDERABAD, ANDHRAPRADESH, and BORN on 25th JAN 1985. Completed M.TECH in ECE with specialization (WIRELESS AND MOBILE COMMUNICATION SYSTEMS) from vardhaman college of engineering affiliated by JNTUH in 2011.he has completed M.Sc (IT)from Nagarjuna University, guntur, AndhraPradesh.and B.TECH in ECE from vidya jyothi institute of technology affiliated by JNTUH in 2007. Currently he is working as an Assistant professor in ECE department at Vidya Jyothi Institute of Technology, Hyderabad from 2010. His areas of research interests include Wireless and Mobile communications systems,Digitalsignalprocessing,Imageprocessing,Telecommunications,communicationsystems,Signalprocessin g, Embeddedsystems.He has published international journals papers. He is Lifetime Membership of ISTE, IETE.

[3] MADRI.PRAMEELAMMA is working as an Assistant.professor in Department of Computer Science and Engineering for malla reddy college of engg(MRCE). She completed M.Tech (Computer Science) from J.N.T. University, Hyderabad. She completed B.Tech (C.S.E) from R.G.M.C.E.T, Nandyal, Kurnool. Her area of research includes Image Processing, Data Mining and Network Security.

[4] MOHAMMAD ZUBAIR is working as an Asst.professor in Department of Electronics and Communication Engineering at DR.KV.SRIT (DR.KV SUBBAREDDY INSTITUTE OF TECH). He completed M.Tech (DSCE) and B.Tech (ECE) from J.N.T. University, ANANTAPUR. His area of research includes Digital Image Processing, Embedded systems, Neural Networks and Wireless mobile communications