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A NEW DEVELOPED FUZZY INFERENCE TECHNIQUE FOR IMAGE ENHANCEMENT

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ABSTRACT: - Image restoration is a process of improvement of corrupted or noisy image for obtaining a clean original image. Numbers of restoration methods were utilized for performing image enhancement process. In such works there is lack of analysis in selecting top similar local patches and Gaussian noisy images. The quality of the any 2-dimensional image is an important one for a reliable matching process. In this paper a heuristic image restoration technique is proposed to obtain the noise free images. This searching technique is composed of 2-steps, one is core processing and other is post processing. In core processing the local and global feature of each pixel of the noisy image are extracted and restored the noise free pixel value by exploiting the extracted feature of this method. The contrast of the image can be enhanced at the pre-processing stage of fingerprint matching. Contrast is the difference between two neighbouring pixels. In this paper we describe a fuzzy model in approach which may be used for reducing the noise and increasing the brightness of the ridges. Fuzzy filter values are analyzed for better results are produced in the image domain. The probabilities of gray values are determined from the position of the input image pixel. The result indicates the good performance of the proposed fuzzy histogram.

In this paper we proposed a new technique for detection and removal of impulse noise in grey scale digital images. Proposed method works in 2 steps, in its step we detect noisy pixels using fuzzy reasoning with lowest uncertainty and in 2nd step we replace noisy pixels with a heuristic median filter. Our heuristic median filter is combined with human knowledge for selecting best replacement. We analyze this method with PSNR metric values and visual comparison. The results of this method are efficient enough for noise reduction and image restoration in high level noisy image.

Human beings made decisions based on rules. All decisions are made based on computer if else then statements .Rules are associated with ideas or logic and related with each other. However the decisions and means of decisions are selected and replaced by fuzzy selectors and rules are replaced by fuzzy rules. Fuzzy rules operate using series of if else then statements.

Fuzzy rules define fuzzy patches membership functions which are key idea in fuzzy logic. A machine is made smart using a concept designed by Kosho called fuzzy approximation theorem (FAT) it states generally that a finite no of patches can cover a curve. If patches are large rules are slopy, if patches are small then rules are fine. So the rule implemented here is known as Fuzzy inference ruled by else action (A reasoning strategy) FIRE rule.

The FIRE rule is coupled with new pseudo fuzzy rule base that is represented by a set of simple logical operations. The FIRE mechanism is popular for study noise removal whereas pseudo fuzzy rule base simplifies the complicated computation and evaluation of a complex structured rule base in fuzzy filtering. In addition to the proposed filter were 2 inter related fuzzy membership functions to increase addictiveness towards local noise statistics which is true in compared restoration performance. Simulation results show effectiveness of proposed filter.

Keywords: - Impulse noise, pseudo fuzzy rule base fuzzy filter, nonlinear filter, image denoising restoration.

1. INTRODUCTION

The purpose of image enhancement is a prominent method for personal identification. The image enhancement algorithm can improve the clarity of images by degrading the pitfalls. The singular point region is the region where the ridge position is higher than normal structure. Like Gabor filter enhances the image on its orientation, but it is difficult to be accurate at the ridge position as we know it is used to remove blurriness. Filter estimation may be used to enhance the quality of the image. Linear filters are used for noise removal, edge detection, segmentation etc. Histogram processing is a non-linear contrast enhancement technique. The histogram of the original image is redistributed to produce a uniform population density of the image. The different filter masks are used in the enhancement algorithm, but the resultant image may not be smooth and the unwanted pixels are also present. In the fingerprint image system, Gaussian noises occur during finger pressure. The proposed algorithm reduces the noises and the ridges are extracted in a smooth manner. In the following sections, we describe in detail our enhancement algorithm. Section 2 addresses the fingerprint enhancement techniques with filter mask. Fuzzy statistics on digital image and its process is given in section 3. Experiment result of fingerprint images with Histogram Equalization and its PSNR (Peak Signal to Noise Ratio) values are given in section 4. Section 5 contains the summary of the fingerprint enhancement method.
(C D F) = Cumulative distribution function is associated with a random variable X is defined as the probability that the outcome of an experiment will be one of the outcome for which X<=x, where x is a given number.
Properties of CDF:-
Case 1:
1. The distribution function F(x) is bounded between the values 0 & 1.
2. F (-∞)=0. This property follows from the fact that F(-∞)includes no possible events due to this fact P(X≤ - ∞) will always be 0.
Case 2:

1. This property follows from the fact that F(∞) include all possible events due to this fact that P(X≤∞) will always be 1.
2. Cumulative distributive function F(X) is a monotonic non decreasing function of dummy variable x that is F(x1)≤F(x2), if x1<x2.
   What is Probability Density Function (PDF):
   The derivative of Cumulative distribution Function (CDF) with respect to some dummy variable is called probability Density Function (PDF).

2. IMAGE ENHANCEMENT TECHNIQUES

The objective of image enhancement technique is to process an input image I(x,y) and the result is more suitable for identification. The enhancement algorithm reduces the noises from the input image. The input image I(x,y) is defined as a M*N matrix, where $I_{i,j}$ represent the gray of the pixel at the ith row and jth column. The first step of the fingerprint processing is normalization. Normalization is used to remove the effect of sensor noise and finger pressure difference. The normalization $N_{i,j}$ for the image $I_{i,j}$ with mean m and variant V is given below [12],

Any function applied on 2D image can be defined as $I'_{x,y}$=f.($I_{x,y}$); F is applied as any intensity in very small scale on any image. I' is disturbed image is to be examined.

$$\mathrm{N}\,(i,j) = \begin{cases} X + \frac{R(I(i,j))-m^2}{V}, If\ I(i,j) > m \\ X - \frac{R(I(i,j))-m^2}{V}, otherwise \end{cases} \quad (1)$$

$$m = \frac{1}{N^2}\sum_{i=0}^{N-1}\sum_{j=0}^{m-1} I(i,j) \quad (2)$$

$$V = \frac{1}{N^2}\sum_{i=0}^{N-1}\sum_{j=0}^{m-1}(I(i,j) - m(i,j)^2) \quad (3)$$

The parameters R and V are the desired mean and variant values. Filtering approach is a way of pursuing the pixel values from its surrounding locations. The mean and the standard deviations of such neighbourhood is used for contrast enhancement. Median filtering has been used for smooth image, with average weighted value depending on the neighbouring pixels. Frequency transformation decomposes an image from its spatial domain intensities into a frequency domain [2]. The frequency transformation shows the frequency of pixel brightness variations, pattern change and the amplitude of the signal waveform. Frequency domains are also performed for selective removal of noise patte from an input image.

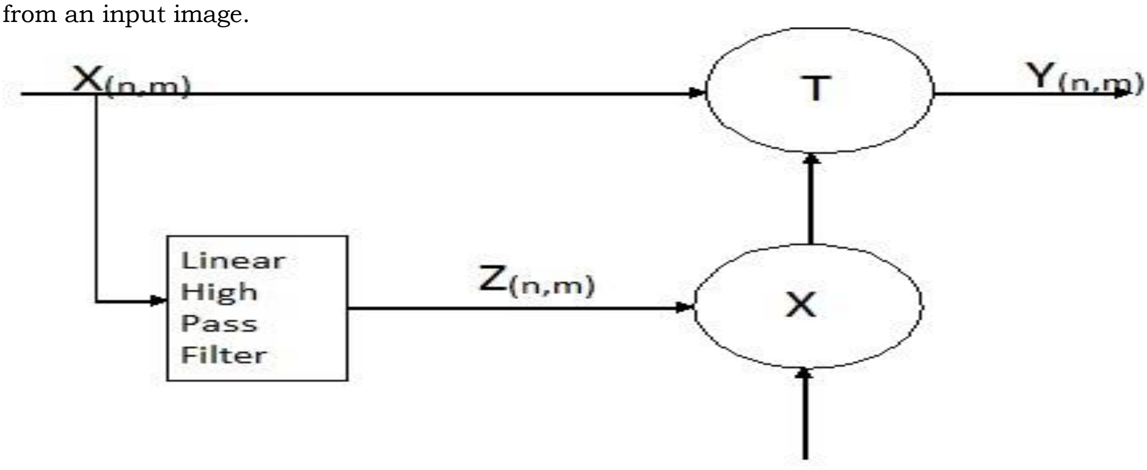


Fig-1: Linear masking for image enhancement

3. FUZZY STATISTICS ON 2-D IMAGE

Fuzzy sets are capable of representing the statistical value based on the theory of Fuzzy sets [15]. A gray scale transformation may succeed in preserving edges in one image and it may fail in another one. Fuzzy statistical values improve the quality of the input image by reducing noises and increasing the intensity slices. Fuzzy set A for digital images is defined in the ordered pairs

$\left(A \in \left\{ \left(x, A(x)\right) \; x\square U \right\} \right.$ ----------(4)

Where A(x) is called the membership function for the set of all values x in U. The membership values are permitted in the interval $0 \le X \le 1$, crisp set is consequently a special case of a Fuzzy set, with membership values restricted to $x \in \{0,1\}$. Fuzzy membership values are assigned from the following fuzzy Function. Where x and A(x) are the positive real values generated from the input histogram image. The Pseudo fuzzification means fuzzy rules are represented and evaluated by logical a operation which involves either 0 or 1 values which is based on fuzzy Reasoning method.

4. FUZZY BASED HISTOGRAM COMPUTATION-

If $X_{i,j} = \begin{cases} 1 \text{ it indicates that the pixel is bright }, \\ 0 \text{ it indicates that the pixel is dark }, \end{cases}$

The histogram of a digital image with gray levels in the range [0, L-1] is a discrete function with h[rk] = nk, where rk is the grey level value and nk is the number of pixels with gray level intensity k in the input image I(x,y)[6]. Histogram h[k] is occurrence probability (frequency) of grey level k in an image. Where n is the total number of pixels. Transforming intensities so as to obtain a desired (specified) shape of histogram of output image is called histogram mapping. $P_x(U)$ is the continuous Probability Density Function(PDF) for the given image and $P_z(U)$ is the specified(derived) PDF for output image. The equalization of the given image I(x,y) is.

Images are frequently contaminated by impulsive noise due to noisy sensors or channel transmission errors. Since high pass filters undergo masking scheme becomes high sensitive to noise. There are many types of impulsive noise such as random noise. If x(i,j) be grey level of an original image X at pixel location(i,j) and [n min, n max] bde dynamic range of X. Suppose Y(i,j)be the gray level of noisy image Y at pixel(i,j) and then random valued impulsive noise may be defined as

$$Y_{i,j} = \begin{cases} X_{i,j} \text{ with } 1 - P, \\ R_{i,j} \text{ with } P \quad , \end{cases}$$

$R_{i,j} \in [n_{min} n_{max}]$, p is noise ratio, whereas for fixed valued impulsive noise better is salt and pepper noise $R_{i,j} \in [n_{min} n_{max}]$.It is usually seen that removal of salt and pepper is easier in compared to random valued impulsive noise. $Y_{i,j}$j can be any value from n_{min} to n_{max}.

5. PROPOSED METHOD FOR IMAGE ENHANCEMENT

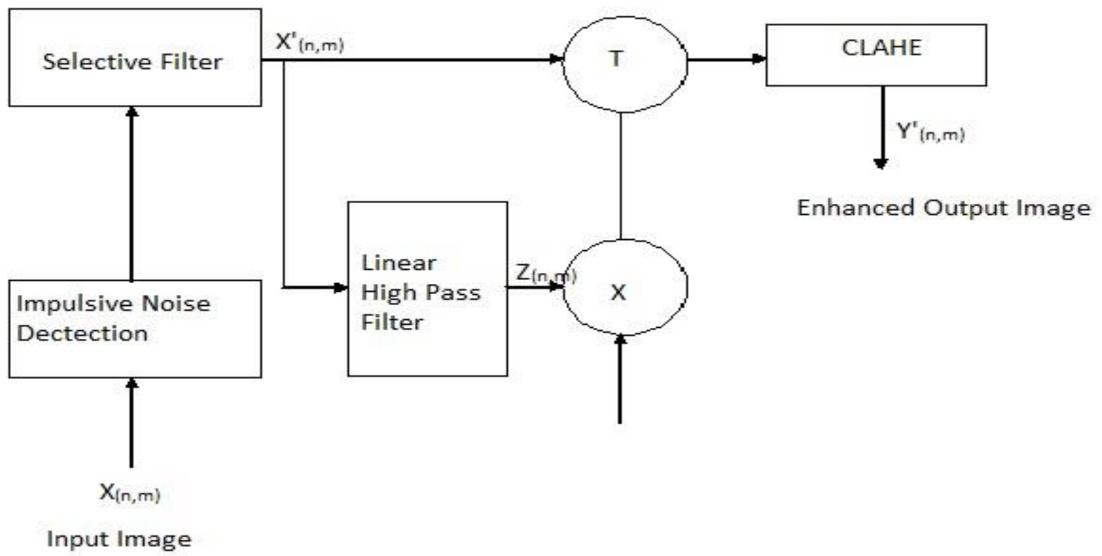


Fig-2: Proposed Model for Image Enhancement

The proposed algorithm consists of 3 steps as impulse detection, filtration and image contrast enhancement.

(a) Only those pixels that are classified as corrupted in detection phase that are subjected to filtration. It employs a second order difference based impulse detection mechanism at the location of the testing pixel. The mathematical formulation can be modelled as

$$Y'_{i,j} = \begin{cases} Y_{i,j} \ \ when\ d_{i,j} = 1, \\ Z_{i,j}\ when\ d_{i,j} = 0 \end{cases},$$

If $d_{i,j}$ is zero then replace thr $I_{i,j}$ pixel with average or mean value of neighbourhood pixels otherwise remain as it is.Repeating above steps for 3×3 window matrix from top-left to bottom-right corner of corrupted image.

(b) i) The window Y^T is selected is of size 5×3 cantered at(i,j)of Y and sub window Y^w of size 3×3 centred at (i,j) of Y^T .

ii) The first and second order difference are calculated in vertical manner and decision parameter is determined, Compute the first order 3x4 difference matrix

$fd_{i+k,j+l} = Y^T_{i+k,j+l} - Y^T_{i+k,j+l-1}$ where, r= -1,0,1 and s= -1,0,1,2

iii)Computer the second order 3x3 difference matrix sd from fd.

$sd_{i+r,j+s} = fd_{i+r,j+s+1} - fd_{i+r,j+s}$ where r=-1,0,1 and s= -1,0,1

iv) Compute decision parameter'd'

$$d_{i,j} = \begin{cases} 0 \ \ if\ |sd_{i,j}| > \theta\ , \\ \ \ 1\ otherwise \end{cases}$$

(c) The filtered image x' is fed with high pass filter to segregate high frequency components of the image From smooth details of the image. Choosing a gain factor for intensifying the image. This can be modelled in form of

$Y_{(n,m)} = X'_{(n,m)} + \delta\, Z(n,m)$

where $z(n,m)$ *is corrected signal computed as output.*

$Z_{(n,m)} = 4\,X'_{(n,m)} - X'_{(n-1,m)} - X'_{(n+1,m)} - X'_{(n,m-1)} - X'_{(n,m+1)}$

Followed by selective filtration similar to steps described earlier. The threshold values are assumed as θ . θ Values are taken by applying probability density functions. All the steps in 2nd iteration is repeated for each test window column wise from top left to bottom right corner of the image obtained from (a) to obtain the final filtered image . After impulsive noise is removed the chance of noise amplification is minimised so now it is suitable for image enhancement using unsharp masking and contrast limited Adaptive histogram equalization technique(CLAHE).

δ *is + ve scaling factor means controlling agent* , the filtered image X' is applied with input for CLAHE to obtain the final enhanced output.The proposed scheme tries to prevent application of impulsive noise and tries to prevent amplification of impulsive noise and tries to provide better visual contrast about the image details. Pdf technique is used in pattern classification problems from a long time in the areas of computer vision, image processing, signal processing and various related fields. The proposed impulsive detector is shown in fig 3.

Fig 3

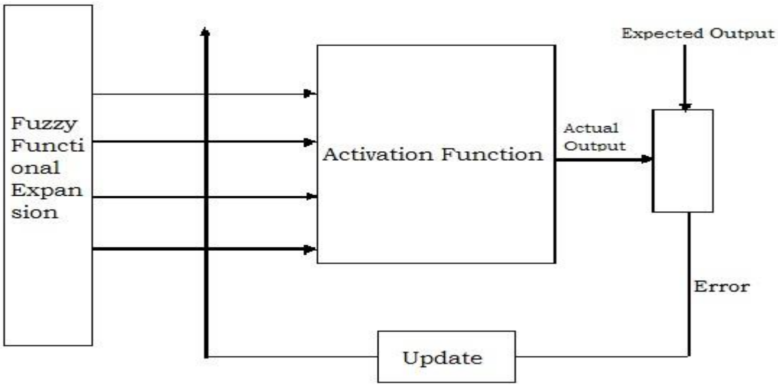


Fig-3: Fuzzy Structure for Adaptive Threshold Selection

The input image is covariance of noisy image. The input is functionally expanded for application. To determine error we compare actual output of network with desired output. As per error value we update θ *value.*

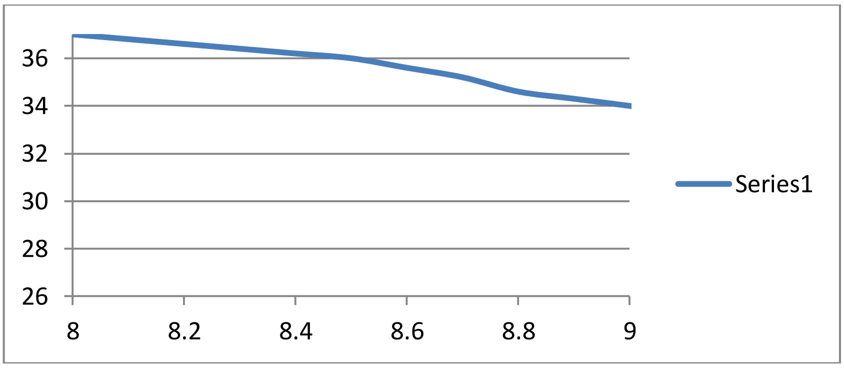
We take an image like black pepper that is corrupted with impulsive noise varying from .01 to .3 in a range.05. θ *value varies from* 0 *to* 1 *in a step of* .01 *and MSE value is calculated as MSE.*

So $MSE = \frac{1}{MN}\sum_{i=1}^{M}\sum_{j=1}^{N}\left(X_{i,j} - Y_{i,j}\right)^2$

Where M×N is size of image $X_{i,j}$ & $Y_{i,j}$ which represents the pixel values at (i,j) th location of original image and restored image is produced. The min MSE & threshold optimum recorded. We use coefficient of variance which is ratio of standard deviation and mean which can be easily corrupted from noisy image available. Since we are not applying filtering to healthy pixels we avoid blurring effect which we expect for better enhancement. Then we can easily apply Histogram technique for edge protection. The amplification factor

δ *dependes on application where we are and desired level of image details*

For experimental use set $\delta = .5$.



6. SIMULATION & RESULTS

To demonstrate the performance of proposed image enhancement scheme simulation results is being discussed under 2 heads , one is impulsive removal and Image contrast enhancement.

6.1 Impulsive noise removal- The superiority of proposed impulsive detection method is demonstrated here is peak signal to Noise ratio (PSNR).

$$PSNR = 10\log_{10}\left(255^2/MSE\right)dB$$

In order to confirm high performance of proposed scheme we demonstrate some of the simulation results like lena image, contaminated noise ranging from .01 to .3.It is processed with varying filtering technique such as median filter, Two

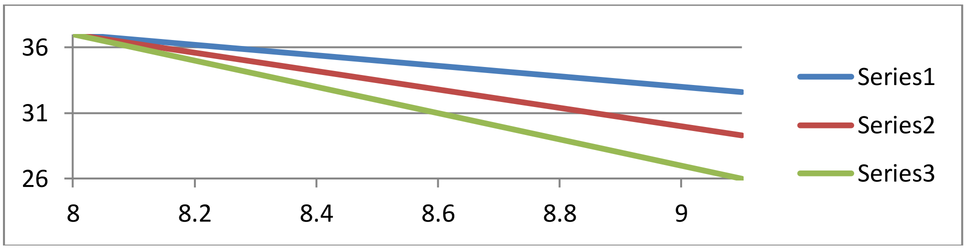
.

Output non linear filter, fuzzy filter, double derivative filter, non linear filter, median rational hybrid filter, FLANN based adaptive filter etc. Fig 5 shows PSNR comparison between the proposed scheme and existing scheme.

6.2-Image Contrast Enhancement

The performance of proposed algorithm is compared with Lena image and clown image. Performance of Lena image is shown below.as usual there is no loss of quantitative pixels in performance evaluation. No ideal image can be used a reference though perceptual quality evaluation is not a deterministic process

The image intensity is transformed with the specified Probability Density. To be specific we have to undergo objective measurements for comparing results for subjective tests. The proposed algorithm use contrast enhancements in controlled manner along with reduced chance of noise amplification Produced in the output domain.



7. DE FUZZIFICATION

De-fuzzification process is performed with the fuzzy statistical value for achieving the enhanced specification image. The following stages are performed during the fuzzy histogram process for the fingerprint enhancement. In the fuzzy maximization process, the discrete fuzzy gray intensity values are cumulated and the result is better than the classical Histogram Equalization (HE).

8. EXPERIMENTAL RESULT & SIMULATION

In this section, we demonstrate the experiment for removing the blur background pattern from the input fingerprint image. The original arch fingerprint image is in figure 3(a) and its histogram equalized image with PSNR = 38.1590 is in figure 3(b). Figure 3(c) gives the proposed fuzzy histogram fingerprint image with clear background (valleys)). The PSNR value for the proposed method is 34.4963. The fuzzy histogram graph is given in figure 3(d). Here the noises are suppressed and the ridges are clearly identified. Similarly in figure 4(a) the original whorl fingerprint image is given. The histogram equalization image with PSNR = 37.8282 is given in figure 4(b). Figure 4(c) shows the fuzzy histogram fingerprint image with PSNR value 30.7969 and its graph is in figure 4(d).

Enhanced Image Model

9. CONCLUSION

Our paper describes the concept of fuzzy histogram processing technique for the removal of impulse noise it is capable of suppressing high density impulse noise, at the same time preserving fine details edges and textures in the underlying image. A new pseudo Fuzzy inference mechanism filter that utilizes provides a different approach on histogram specification for image enhancement. The filtration is performed selecting only on detected pixels segregating noisy pixels from noise free pixels. Avoiding linear healthy pixels with mean value of neighbourhood pixels we preserve image details. Though exhaustive this fuzzy histogram generates intensity values, which may be used to improve the contrast of the input image. In the traditional filtering methods can not deal with the narrow intensity gray values. This method solves the problem of narrow and wide gray range images. it is observed that the proposed algorithm is practically useful for superior performance along with easier hardware implementation

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