1. Research Papers Published in International Journals
   i. A Novel Algorithm for removing Impulse noise from highly corrupted noise
      Aijaz Ur Rahman Khan, Kavita Thakur
      European Scientific Journal (ESJ), October Special Edition, Vol. 8, No. 24, October
      2012, pp-133-144, ISSN: 1857-7881(print), ISSN: 1857-7431(online), published by
      European Scientific Institute.
   ii. An efficient Fuzzy Logic based Edge Detection Algorithm for Gray Scale Image
      Aijaz Ur Rahman Khan, Dr. Kavita Thakur
      2, Issue 8, August 2012, pp 245-250, ISSN: 2250-2459 (online), ISO 9001:2008 Certified
      Journal.

2. Research Papers Presented in International conferences
   i. Simple and fast edge detection method for high contrast and low detail image.
      Aijaz Ur Rahman Khan and Kavita Thakur
      An International conference on Eco friendly technologies in image processing and
      remote sensing for sustainable growth, Abstr no. 514, pg no 224, 2013, February, 8-9,
A NOVEL ALGORITHM FOR REMOVING IMPULSE NOISE FROM HIGHLY CORRUPTED IMAGE

Aijaz Ur Rahman Khan
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Abstract
Various switching-based median filter have been proposed in the literature for restoration of extremely corrupted images by impulsive noise (Salt and pepper noise). Progressive switching median filter (PSMF) and Boundary discriminative noise detection (BDND) median filter are some of these. It is well known that standard median filter (SMF) is not suitable for removing impulse noise from highly corrupted images. The poor efficiency of this filter is due to the fact that it is not able to discriminate the noisy pixel from noiseless pixel. The proposed method uses noise detection stage and then adaptive window shaped filtering stage for the restoration of images contaminated by impulse noise. The performance of the proposed method is demonstrated through computer simulation in comparison with the PSMF method and standard median filter.

Keywords: Impulse Noise, Median Filter, Max-Min Filters, Morphological, Neighborhood.

Introduction
Impulse noise is the main source of image degradation which occur during acquiring the image or transmitting through air. Hence restoring the corrupted image by suppressing the impulse noise is very crucial task in image processing field. Several non linear filters have been proposed for the restoration of images corrupted with impulse noise. Median filters and its variants are some of the early proposed method for removing the impulse noise[1-7]. Later on different adaptive median filter[8-10] have also been proposed to restore the image corrupted with high density impulse noise. The advantage is that they can suppress the impulsive noise without edge blurring. In conventional median filter, the median operation is
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performed to each pixel unconditionally without considering whether a pixel is corrupted or uncorrupted which would inevitably alter the pixel values and remove signal detail of those uncorrupted pixels. Therefore a noise detection process to discriminate the uncorrupted pixel from the corrupted ones prior to applying non linear filtering is highly desirable. Therefore later methods[11] are usually of two stages, with impulse detector as first stage where corrupted pixel are detected and located whereas impulse filter as second stage at which the corrupted pixel only are filtered and thus avoiding the modification of uncorrupted pixel. The scanned images, images stored in the memories, and transmitted images contain noise in the form of dark dots and white dots. This disturbance is caused due to the scanning process, memory fault, and error in transmission [12-13]. The main drawback of standard median filter is that it is effective only for low noise densities and as the noise densities increases it starts exhibiting poor performance. Therefore a novel filter design is required for image processing which not only suppress the noise considerably but also preserve the high frequency content of image[14].

Objective Of The Paper

For removing high density impulse noise, various algorithms have been proposed in the literature. It is well known that linear filtering techniques are not good for removing impulse noise because their performance is poor in removing high frequency noise and it also blurred the edges. There is a need to develop a filter which are not only effective in removing impulse noise but also preserve the edges or high frequency area of image. Therefore the use of nonlinear filtering techniques came into existence and a class of widely used non-linear digital filters is median filters and morphological filters. Both the filters are good to remove impulse noise as well as preserving the edges under low noise density condition. The median filter is the best known order statistic filter which work by replacing the central pixel value with the value obtained by computing the median of neighboring pixels. Median filter is well known to remove the impulse (Salt and pepper) noise while the max filter can remove the pepper noise efficiently, similarly min filter can easily remove the salt noise.

Impulse Noise Detection

For the proposed filter to work efficiently, an impulse noise detection stage prior to applying filtering technique[15,16] is much needed. Impulse noise detection scheme detect whether the considered pixel is corrupted or uncorrupted pixel. Any pixel whose values
changes drastically to 255(salt) or 0(pepper) or any other value which is much higher than in neighboring pixel values are considered as noisy pixels. Only the noisy pixel undergoes filtering operation and replaced with the new value, leaving the uncorrupted pixel intact.

The Proposed Filter

The pixel value of the image corrupted with impulse noise differs significantly from that of the neighborhood pixel. This type of noise can be removed in spatial domain. In spatial domain, median filter, max filter, min filter are non linear filter which are used to remove impulse noise. If we use these non linear filter in a modified way then we can achieve better impulse noise suppression. Considering these entire thing, this hybrid filter is designed.

Block diagram of proposed filter is shown in Figure 1. First a 3X3 window is run across the noisy image from left to right and top to bottom. The detection of corrupted or uncorrupted pixel is governed by checking whether the central pixel value of the selected window lies between the maximum and minimum values within the window. This is because the pixel corrupted by impulse noise can take maximum and minimum values in the range (0, 255) if the value of considered pixel lie within this range then this is an uncorrupted pixel and left unchanged. But if the value of considered pixel doesn't lie within this range then it is a corrupted pixel and need filtering operation. This corrupted pixel is replaced with a new value obtained by applying three non linear operation, median operation, max operation, min operation in a modified shaped window. Since the Median filter reduces both salt and pepper noise while max and min filter remove pepper noise and salt noise respectively, therefore by applying all the three operation and then taking the average of all the three output gives a very effective noise removing algorithm. Modification of window shape as per the noise free pixel present in the selected window is described in section 5.

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X - Pixel values which are noisy and hence not considered in processing

Fig. 1: Block diagram of proposed filter

The Max, Median and Min filters are defined as

\[ \hat{f}(x, y) = \max_{(s,t) \in S_{xy}} \{ g(s, t) \} \]

\[ \hat{f}(x, y) = \text{median}_{(s,t) \in S_{xy}} \{ g(s, t) \} \]

\[ \hat{f}(x, y) = \min_{(s,t) \in S_{xy}} \{ g(s, t) \} \]

Where \( \hat{f}(x, y) = \) Restored Image

\( S_{xy} = \) Set of coordinates in rectangular window of size \( m \times n \), centered at point \( (x, y) \)

Modification of Window Shape:

In this proposed method the size and shape of window is very crucial. The size of window is chosen as odd dimension. It can be started from \( 3 \times 3 \) and goes up to up to \( 9 \times 9 \) dimension. Since through extensive experiment it is observed that \( 3 \times 3 \) window gives better result.
than other dimension therefore, the size of the window is chosen as 3×3 size. The size of the window is fixed throughout the filter process. But it is a shape of the window that changes as per the number of uncorrupted pixel within the selected window.

![Figure 2: Modification of Window shape](image)

As shown in Figure 2 only the shape of the window is modified as per the uncorrupted pixel obtained within 3×3 window and therefore this shape is dependent upon the noise free pixels present in the neighborhood of the processing pixel. Depending on number of noise free pixel in a 3x3 window, a 3x3 window can take any shape out of possible 2⁹ different possible shapes.

![Figure 3: Some possible shapes of 3x3 Windows](image)

Steps Of Algorithm

Step 1. Input the noisy image.
Step 2. Apply padding to avoid boundary problem.
Step 3. Run a 3x3 window.
Step 4. Detect the impulse noise pixel.
Step 5. Modify the Shape of the window on the basis of neighboring corrupted pixel.
Step 6. If all the neighborhood pixels within the window are same (either 0 or 255), then retain the current pixel value intact.

Step 7. If central pixel is not corrupted then retain the pixel value intact.

Step 8. If the central pixel is noisy then proceed it with the proposed filter.

Step 9. Replace the noisy pixel with the processed value.

Step 10. Repeat step 3 to step 9 until the whole image is scanned.

Performance Parameter

In order to measure the efficiency of proposed filter, it is compared with Standard median filter (SMF) and Progressive switching median filter (PSMF) by computing the Mean Squared Error (MSE), Peak Signal-to-Noise Ratio (PSNR) and CPU execution time.

\[
\text{MSE (in units)} = \frac{1}{MN} \sum_{i=0}^{M-1} \sum_{j=0}^{N-1} \| g(x, y) - f(x, y) \|^2
\]

\[
\text{PSNR (in dB)} = 10 \log_{10} \left( \frac{\text{Max}^2}{\text{MSE}} \right)
\]

Experimental Results

The proposed algorithm works on the basis of fixed size (3x3) but the adaptive shape window. The cameraman image is taken as a test image and it is been corrupted to various percentages of impulse noise. Since the main objective of this algorithm is to suppress the noise and noise suppression can be identified by the parameter MSE. The proposed algorithm is tested on cameraman image corrupted with various noise percentages. Proposed algorithm is compared with the standard method which is given in IP tool box of Matlab and with PSMF method [17]. All the algorithm was implemented in MATLAB® Version 6.5 with system configuration of 3.0 GHz processor speed and 512 MB RAM.

The results were taken with the parameters like PSNR, MSE, and CPU Time which are shown in Table 1, Table 2, Table 3 and Table 4. From Figure 3, Figure 4, and Figure 5, it is observed that the proposed algorithm outperforms the standard method and PSMF method algorithm.
<table>
<thead>
<tr>
<th>Impulse Noise (in percentage)</th>
<th>PSNR for Proposed method</th>
<th>PSNR for standard method</th>
<th>PSNR for PSMF method</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>28.94</td>
<td>25.72</td>
<td>26.88</td>
</tr>
<tr>
<td>20</td>
<td>27.6</td>
<td>23.61</td>
<td>25.16</td>
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<tr>
<td>50</td>
<td>26.5</td>
<td>20.62</td>
<td>23.18</td>
</tr>
<tr>
<td>40</td>
<td>25.3</td>
<td>17.39</td>
<td>20.95</td>
</tr>
<tr>
<td>50</td>
<td>23.77</td>
<td>14.28</td>
<td>18.62</td>
</tr>
<tr>
<td>60</td>
<td>21.27</td>
<td>11.48</td>
<td>15.28</td>
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<td>70</td>
<td>17.34</td>
<td>9.32</td>
<td>9.3</td>
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<tr>
<td>80</td>
<td>13.04</td>
<td>7.55</td>
<td>7.64</td>
</tr>
<tr>
<td>90</td>
<td>8.99</td>
<td>6.15</td>
<td>6.25</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Impulse Noise (in percentage)</th>
<th>MSE for Cameraman Image</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>1984.0</td>
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<tr>
<td>20</td>
<td>4118.5</td>
</tr>
<tr>
<td>50</td>
<td>6167.8</td>
</tr>
<tr>
<td>40</td>
<td>8140.1</td>
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<tr>
<td>50</td>
<td>10055.0</td>
</tr>
<tr>
<td>60</td>
<td>12174.0</td>
</tr>
<tr>
<td>70</td>
<td>14217.0</td>
</tr>
<tr>
<td>80</td>
<td>16042.0</td>
</tr>
<tr>
<td>90</td>
<td>18184.0</td>
</tr>
</tbody>
</table>
Table 3: MSE comparison of Proposed, Proposed, Standard method and PSMF method

<table>
<thead>
<tr>
<th>Impulse Noise (in percentage)</th>
<th>MSE for Cameraman Image (256 X 256)</th>
<th>MSE for standard method</th>
<th>MSE for PSMF method</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MSE for Proposed method</td>
<td>10</td>
<td>171.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20</td>
<td>278.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>30</td>
<td>353.8</td>
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<tr>
<td></td>
<td></td>
<td>40</td>
<td>514.13</td>
</tr>
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<td></td>
<td></td>
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<td>878.83</td>
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<td></td>
<td>60</td>
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<td>7507.2</td>
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<td></td>
<td></td>
<td>80</td>
<td>11245</td>
</tr>
<tr>
<td></td>
<td></td>
<td>90</td>
<td>15527</td>
</tr>
</tbody>
</table>

Table 4: CPU time comparison of Standard and PSMF

<table>
<thead>
<tr>
<th>Impulse Noise (in percentage)</th>
<th>CPU time for Proposed method (in second)</th>
<th>CPU time for Standard method (in second)</th>
<th>CPU time for PSMF method (in second)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10</td>
<td>0.13</td>
<td>0.17</td>
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<td>20</td>
<td>0.17</td>
<td>0.71</td>
</tr>
<tr>
<td></td>
<td>30</td>
<td>0.07</td>
<td>0.89</td>
</tr>
<tr>
<td></td>
<td>40</td>
<td>0.08</td>
<td>0.93</td>
</tr>
<tr>
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<td>0.08</td>
<td>1.04</td>
</tr>
<tr>
<td></td>
<td>60</td>
<td>0.10</td>
<td>1.04</td>
</tr>
<tr>
<td></td>
<td>70</td>
<td>0.09</td>
<td>1.04</td>
</tr>
<tr>
<td></td>
<td>80</td>
<td>0.12</td>
<td>1.05</td>
</tr>
<tr>
<td></td>
<td>90</td>
<td>0.15</td>
<td>1.04</td>
</tr>
</tbody>
</table>

Figure 3: PSNR Comparison for proposed, standard and PSMF method

Figure 4: MSE Vs Impulse Noise for cameraman (256 X 256) image
Figure 5: MSE Vs Impulse Noise for cameraman (256 X 256) image

Proposed Filter Output For Various Noise Densities:

Cameraman image is impregnated with impulse noise percentages of 10 to 90. The visual results obtained using the three algorithms are summarized in the Table 5. From these tables we can observe that the performance of proposed method for removing impulse noise is better than the Standard median method and PSMF method.

Table 5: Visual Result of all the three method with different Impulse noise densities

<table>
<thead>
<tr>
<th>Original Image with Impulse Noise</th>
<th>Standard Median Method</th>
<th>PSMF Method</th>
<th>Proposed Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Noise=10%</td>
<td></td>
<td></td>
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</tr>
<tr>
<td><img src="image1.png" alt="Image" /></td>
<td><img src="image2.png" alt="Image" /></td>
<td><img src="image3.png" alt="Image" /></td>
<td><img src="image4.png" alt="Image" /></td>
</tr>
<tr>
<td>Noise=20%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><img src="image5.png" alt="Image" /></td>
<td><img src="image6.png" alt="Image" /></td>
<td><img src="image7.png" alt="Image" /></td>
<td><img src="image8.png" alt="Image" /></td>
</tr>
<tr>
<td>Noise=30%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><img src="image9.png" alt="Image" /></td>
<td><img src="image10.png" alt="Image" /></td>
<td><img src="image11.png" alt="Image" /></td>
<td><img src="image12.png" alt="Image" /></td>
</tr>
</tbody>
</table>
Conclusion

These are the results which are obtained by applying three different algorithms to the image corrupted by different impulse noise density. By these results it is evident that the restored images obtained after processing the noisy images using proposed algorithm is free from impulse noise to the maximum extent.

References


An Efficient Fuzzy Logic Based Edge Detection Algorithm for Gray Scale Image

Mohit Kumar Bharti, Jr Rahman Khan

Abstract: Various edge detection algorithms have been proposed in the literature for extracting the edges from the image. After emerging the fuzzy logic concept, a lot of researchers in image processing shifted their attention towards the fuzzy logic concept and its applicability in the field of image processing. This paper presents a fuzzy rule-based algorithm which is capable of detecting edges efficiently from the gray scale images. The performance of the proposed method is demonstrated through computer simulation in comparison with the existing Sobel and Prewitt edge detector.

Key words — fuzzy logic, edge detection, fuzzy sets, threshold, membership function

I. INTRODUCTION

Edge Detection has been very useful low-level image processing tool for image analysis in computer vision and pattern recognition field. In an image, edges carry essential information of an object of interest in an image, as they separate dissimilar regions in an image. Specific linear time-invariant (LTI) filters are the most common procedure applied to the edge detection problem and the one which results in the least computational effort. In the case of first-order filters, an edge is interpreted as an abrupt variation in gray level between two neighbor pixels. The goal in this case is to determine in which pixels in the image the first derivative of the gray level as a function of position is of high magnitude. By applying the threshold to the new output image, edges in arbitrary directions are detected. Early edge detection methods, such as Sobel and Prewitt detectors [1, 2], were based on the concept of spatial derivative filtering, where local gradient operators are used to detect edges of certain orientations only. Derivative filters suffer when the edges are blurred and noisy and are not robust. Anand and Bhattachary [3] proposed an algorithm that finds edges at the zero-crossings of the Laplacian of an image. Canny [4] proposed a method to counter noise problems from gradient operators, where the image is convolved with the first order derivatives of Gaussian filter for smoothing in the local gradient detection followed by edge detection by thresholding.

Most edge detector detect edges by applying local first order and second order derivative operators followed by some noise removal algorithm to reduce the noise. SUSAN edge detector [5] is a non-linear technique to find the edges. Such technique have also gained popularity. Hon and Kuo [6] have used simple arithmetic and logical operation to find the edges in an image tiling and Bunko [7] have presented a novel scan line approximation method of edge detection. Their algorithm showed superior segmentation quality and computational cost to many region-based algorithms. Czarnecki [8] computes the difference between central pixel and surrounding pixel and uses the highest value among these for detecting the edges. Geman [9] applied a 5x5 window to reduce the noise efficiently while does not increasing the width of the edges which always happen in case of taking 3x3 window. Since this detector uses a self-adjusting threshold, therefore it is capable of detecting the edges in the area of variable grayscale background.

In the past few years, fuzzy logic emerged as a different yet powerful tool to decision making [10, 11, 12]. In 1995 Zadeh proposed the concept of fuzzy logic and soon fuzzy concept gained popularity in the image processing field. Many techniques have been proposed by researchers for fuzzy logic-based edge detection [12, 13, 14]. Zhao [15], proposed an edge detection technique by dividing the image into 3-fuzzy partitions (regions) and then finding the maximum entropy to give the best edge. He also derived the necessary condition to maximize the entropy function. Based on these condition three-level thresholding is obtained. Bloch [16] proposed morphological operation based fuzzy set to detect the edges. Russo and Ramponi [17] utilized fuzzy rule-based operators built on IF-THEN-ELSE rule-based architecture for edge detection. The drawback of these algorithms is that they have neglected the global information. In most of these methods [12, 13], the neighboring pixel around a center pixel are assumed in some choices and then using some appropriate membership function, fuzzy inference system is designed which extract the edges from the images.
Mesherski [11] grouped all the adjacent pixel around a considered pixel in 8 different sets then he determined the membership value for each group by applying some bell-shape function then by using these membership values and fuzzy rule, existence of the edge pixel is determined.

In the proposed work an algorithm based on fuzzy logic rules are developed for detecting edges from an image. In order to avoid the complexity, scanning mask of 3×3 pixels window is used. A fuzzy inference based system has been designed under MATLAB platform to detect the edge. A rule-base consisting of 16 rules has been developed to detect the pixel under consideration in a 3×3 window as White, Edge or Black.

II. DESIGN OF FUZZY INFERENCE SYSTEM

In order to detect the edge in the image, a fuzzy inference system has been designed which take different pixel value as inputs, fuzzified these inputs i.e. convert it into fuzzy plane and then using some predefined rule mask the considered pixel as edge, Black, White-Maxima method is chosen as the defuzzification method and the output of the system is calculated as the centroid of the resulting membership functions. Block diagram of proposed method is shown in fig 1.

A. Window mask

Fuzzy inference system for this algorithm has four inputs and one output. Since in this algorithm 3×3 window mask is used for scanning purpose, therefore four pixel values obtained by this mask is used as four inputs.

Figure 1 Block Diagram of proposed method.
A 2x2 mask used in this algorithm is shown in Fig. 2. Here since P1 is black and P2, P3, P4 are white therefore as per the rule shown in Table 2 the output pixel P4_out is marked as white.

![Figure 2: Window Mask](image)

**B. Membership Function**

The choice of membership function is problem dependent. In this algorithm Triangular Membership functions is used for input as well as for output.

The standard Triangular membership function is defined as

$$TF(x; a, b, c) = \begin{cases} 0 & x \leq a \text{ or } x \geq c \\ (x-a) & a < x < b \\ (b-a) & b < x < c \\ (c-x) & c < x < (c-b) \\ (c-b) & b \leq x \leq c \\ \end{cases}$$

And its shape is shown in figure 3.

![Figure 3: Shape of Triangular Function](image)

**C. Fuzzy sets**

The input pixels are divided into two fuzzy sets i.e. Black & White while the output pixel is divided into three fuzzy sets i.e. Black, Edge, and White. Membership function associated with input fuzzy sets and output fuzzy set is shown in figure 4 and figure 5.

![Figure 4: Input Pixels Fuzzy Set](image)

![Figure 5: Output Pixels Fuzzy Set](image)

**All the parameters for input and output fuzzy set is summarized in a Table I**

<table>
<thead>
<tr>
<th>Fuzzy Input</th>
<th>Linguistic variable for pixel</th>
<th>Range</th>
<th>Parameter</th>
<th>MF</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td>Black</td>
<td>[0 255]</td>
<td>[0 255 255]</td>
<td>Triangular</td>
</tr>
<tr>
<td></td>
<td>White</td>
<td>[0 255]</td>
<td>[0 255 255]</td>
<td>Triangular</td>
</tr>
<tr>
<td>P2</td>
<td>Black</td>
<td>[0 255]</td>
<td>[0 255 255]</td>
<td>Triangular</td>
</tr>
<tr>
<td></td>
<td>White</td>
<td>[0 255]</td>
<td>[0 255 255]</td>
<td>Triangular</td>
</tr>
<tr>
<td>P3</td>
<td>Black</td>
<td>[0 255]</td>
<td>[0 255 255]</td>
<td>Triangular</td>
</tr>
<tr>
<td></td>
<td>White</td>
<td>[0 255]</td>
<td>[0 255 255]</td>
<td>Triangular</td>
</tr>
<tr>
<td>P4</td>
<td>Black</td>
<td>[0 255]</td>
<td>[0 255 255]</td>
<td>Triangular</td>
</tr>
<tr>
<td></td>
<td>Edge</td>
<td>[0 255]</td>
<td>[130 130 190]</td>
<td>Triangular</td>
</tr>
<tr>
<td></td>
<td>White</td>
<td>[0 255]</td>
<td>[247 255 255]</td>
<td>Triangular</td>
</tr>
</tbody>
</table>

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III. PROPOSED ALGORITHM

The algorithm begins with sliding a 7x7 window on whole image pixel by pixel row wise from left to right and top to bottom. After this, these 4-pixel undergoes different fuzzy condition as shown in Fig. 6 and change the value of p4.

![Figure 6 Fuzzy Conditions](image)

Fuzzy inference system test the condition of each pixel using Rule-base given in Table 7 and mark the pixel as edge, white or black pixel.

TABLE 7 Fuzzy Rule

<table>
<thead>
<tr>
<th>Fuzzy Input</th>
<th>Fuzzy Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td>P2</td>
</tr>
<tr>
<td>B</td>
<td>B</td>
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Following are the steps of algorithm:
1. Input the P1, P2, P3, P4 pixel from the scanned window to FIS system and fuzzified it into different degree of Black and White.
2. Then apply Fuzzy minimum operator (MIN) for calculating firing strength.
3. Fire the fuzzy rule for each crisp input.
4. Apply the MAX operator (s-norm) to get the aggregate resultant output.
5. Apply the Defuzzification step using centroid method.
6. Get the crisp P5out pixel which may come under White, Black or Edge category.
7. Compute the first derivative and threshold it to get the edge of the image.

IV. RESULT AND DISCUSSION

The proposed fuzzy edge detection algorithm was simulated using MATLAB Ver 6.5 on a system having dual core processor and 2GB of RAM. The performance of proposed method is compared with the sobel and prewitt operator. Two set of test images and are shown in figure 9 and figure 10. One set comprises of standard grayscale images and the result of sobel operator(b), prewitt operator(c) and proposed edge detector(d). While the second set comprises of grayscale images taken by author himself and the respective results.

It was observed from the result that the performance of proposed edge detection algorithm is better than sobel and prewitt operator in finding distinct edges from the image and thus able to provide better visual appearance of edges which is not possible in case of sobel and prewitt operator. Moreover since this method uses 3x3 window for mask operation and has 16 rule base, therefore it has less computational complexity as well.
Figure 9. Original Image (a), Sobel(b), Frame(c) Proposed Fuzzy Method (d).
REFERENCES

Proceedings of Shasstrarth, An International Conference held at Rungta College of Engineering & Technology on 8th & 9th February 2013.

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Abstract

In an image, edges are the regions where there is a sudden change in intensity. These features play an important role in object identification method used in machine vision and image processing system. Each different edge detection method has its own advantages and disadvantages for example some methods detect part of real edges and some part of unreal edges while some methods are computationally expensive and some method are computationally efficient. This paper presents a novel method for edge detection in image which is based on simple row addition and division operation. Since this method is based on simple addition and division, it is simple efficient and fast. Experimental result on various images shows that it is able to detect prominent edges efficiently.

Keywords -- Edge Detection, Gradient Operator, Filter, Sobel, arithmetic operation
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INTERACTION PROGRAM

CERTIFICATE OF PARTICIPATION

This is to certify that

Dr./Ms./Shri Aijaz Ur Rahman Khan, Research Scholar/Post doc from School of Studies in Electronics, affiliated to Pt. Ravishankar Shukla University, Raipur participated in the Interaction Program (Science and Life Sciences) held from 23.03.2013 to 25.03.2013

Course Coordinator  
Director  
Vice-Chancellor