Comparative Study of High Density Impulse Noise Removal Method

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Abstract—This Paper Presents Comparative Study of High Density Impulse Noise Removal method. Impulse noise is interference information pixels which result the black and white dots are spread distributed on the image. This type of noise can be caused by analog-to-digital converter errors, bit errors in transmission. Modified Mean-Median & ROM (MMM&R) filter that used to reduce impulse noise. Mean and Median filter are only applied for free-noise pixel on the 3x3 windows that has been sorted from the smallest to the largest value.

Keywords—PSNR-peak signal to noise ratio, ROM-Rank order mean, MMM &R-modified mean median &ROM filter.

I. INTRODUCTION

Original image data can be corrupted by noise. In Impulse noise dark and bright spots spread on the image which is also known as salt-and-pepper noise. Salt-and-pepper noise, the noisy pixels can take only the maximum and the minimum values in the dynamic range i.e. When \( R(i, j) = \{ N_{\text{min}}, N_{\text{max}} \} \)

The purpose of our research is to achieve good quality of Impulsive noise filter. In many cases we need following attention.

1. The filtering result (Visualization) can be Achieve smooth and clear.
2. The filtering process is applied on the noisy pixel, without engaging the original pixel.
3. To obtain fast computation time, filtering process is to be done efficiently.

II. IMPULSE NOISE

Impulse noise is an interference information pixel which result the black and white spot are spread evenly distributed on the image i.e. black and white dot or pixels are mixed with original pixels. This type of noise can be caused by analog-to-digital converter errors, bit errors in Transmission.

Salt-and-pepper impulse noise model, if data pixel corruption has two fixed values, 0 and 255 (for gray level image 8 bits).

(a) (b)

Figure 2.1: (a) Original image (b) Image corrupted with impulse noise

Let \( Y(i, j) \) : Gray level of an original image
\( X(i, j) \): Gray level of noisy image \( X \) at a pixel location \( (i, j) \)

\([N_{\text{min}} N_{\text{max}}]\): Dynamic range of \( Y \)

Impulsive noise may be defined as:

\[
X(i, j) = \begin{cases} 
Y(i, j) & \text{with } 1 - p \\
R(i, j) & \text{with } p 
\end{cases}
\]

\(R(i, j)\) is the substitute for the original gray scale value at the pixel location \( (i, j) \)

Impulse noise has the property of either leaving a pixel unmodified with probability 1 - \( p \) or replacing it altogether with probability \( p \).
III. MODIFIED MEAN-MEDIAN & ROM FILTER METHOD

Figure 1 shows block Diagram of filtering system consist of Impulse noise prediction, noise detector, Pre-filtering using MMM&R, Rank Order Mean Filter and pixel reconstruction. The detail Information in every block is explained on the following subsections.

IV. IMPULSE NOISE DENSITY PREDICTION

Impulse Noise Density Prediction \( (p) \) is density of noise pixels which mixed with original pixel or image The output options of the pre-filtering forwarded to the pixel reconstruction or the output of the pre-filtering should be placed into ROM.

V. NOISE DETECTOR

Noise detector detects the matrix elements of \( f_n(x, y) \) is the noisy pixel or not. If the matrix element \( f_n(x, y) \) is the noise, its data filtered by pre-filtering.

VI. PRE-FILTERING

We set the value of each noise element where "salt or 255" on be replaced by "0". After that filtering process is conducted. In Modified Mean Median & Rom (MMM & R) filter we use 2-D windows(Size 3*3). Eliminate the 0 from the window(3*3) and find the median of the remaining pixels.

<table>
<thead>
<tr>
<th>No</th>
<th>Impulse Noise Density ( (P ) in %)</th>
<th>Impulse Noise prediction ( (\hat{P} ) in %)</th>
<th>Absolute error ( (AE ) in %)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10</td>
<td>10.0695</td>
<td>0.6950</td>
</tr>
<tr>
<td>2</td>
<td>20</td>
<td>19.9765</td>
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<td>9</td>
<td>90</td>
<td>90.0262</td>
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</table>

VII. RANK ORDERED MEAN (ROM) FILTER

Rank Order Mean (ROM) filter is used to improve the quality of Pre-filtering process especially on the high corrupted noise. ROM only works on \( (p^> 50\%) \). ROM works on the average value from eight pixels (excluding pixel being observed).

VIII. PIXEL RECONSTRUCTION

The last stage of the filtering process is the pixel reconstruction. Pixel reconstruction is the process of free-noise pixel and the pixel that has been filtered on each coordinate. The Mathematical illustrates this process is as
\[ f_{0}(x,y) = \begin{cases} f_{d}(x,y) & \text{if noise pixel} \\ f_{n}(x,y) & \text{if free noise pixel} \end{cases} \]

Denoted:

- \( f_{d}(x,y) \) is the final output filter
- \( f_{d}(x,y) \) is the noise pixel that have been filtered
- \( f_{n}(x,y) \) is the pixel is indicated as the free noise pixel

Fig 3 Lena image filtering result for impulse noise density (p=50%)
### COMPARISON RESULT OF PSNR VALUE (DECIBEL) IN THE LENA IMAGE (GRAY SCALES)

<table>
<thead>
<tr>
<th>Method</th>
<th>Noise density P in (%) for lena Image</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10</td>
</tr>
<tr>
<td>Hybrid</td>
<td>22.29</td>
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<tr>
<td>DPF</td>
<td>36.24</td>
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<tr>
<td>ASMBF</td>
<td>38.05</td>
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<td>DBA</td>
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<td>LMM</td>
<td>42.93</td>
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<tr>
<td>Our Method</td>
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### COMPARISON RESULT OF COMPUTATION TIME (SECONDS) IN THE LENA IMAGE (GRAY SCALES)

<table>
<thead>
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<th>Method</th>
<th>Noise density P in (%) for lena Image</th>
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<td>Our Method</td>
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### IX. SIMULATION RESULT AND ANALYSIS

We use Lena image gray color (8 bits) with the size (512x512) to test the simulation result. Specifications computer are CPU 2.40 GHz and RAM 2 GB that have been used for testing the performance of our filtering result.

To measure percentage of error in the noise prediction can be calculated by

\[ AE_p = \frac{|\hat{p} - \hat{p}|}{p} \times 100\% \]

The average of percentage error can be calculated by

\[ \bar{AE}_p = \frac{1}{n} \sum_{i=1}^{n} AE_p(i) \]
Denoted:

\( \hat{P} \) is impulse noise prediction

\( p \) is the actual value of impulse noise (%)

\( AE_{\hat{P}} \) is Absolute error of \( p \)

\( \overline{AE}_{\hat{P}} \) is average of absolute error of \( p \)

\( n \) is total data sample.

\( PSNR \) (Peak Signal to Noise Ratio) can be calculated

\[
PSNR = 10 \log \left( \frac{(L-1)^2}{MSE} \right)
\]

Where \( L \) = No. of Gray Scales.

Where MSE is MEAN SQUARE ERROR defined as

\[
MSE = \sqrt{\frac{\sum_{i=1}^{M} \sum_{j=1}^{N} (\mu_{ij} - m_{ij})^2}{M \times N}}
\]

X. CONCLUSION

Our research paper presents Analysis and compression of High Density impulse noise removal Method. In Linear Mean-Median filter, linear value is measured between mean and median values of the free-noise pixel that have been able to reduce High Density impulse noise. To reduce impulse noise across in varying ranges of noise 10% up to 90% Linear Mean-Median filter. Method is better than other method. Linear Mean-Median filter shows better image quality than DBA, Hybrid, TVL-1, DPF, ASMBF, NEPF and FMLAWK.

REFERENCES


