Image Denoising using Bacterial Foraging Optimization Technique

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Digital image processing, analysis and techniques are used today in many areas such as Scientific, Bio-Medical and Military etc. All the applications stress on improvement of quality or appearance of images, which suffers from noise during transmission. Noise in the acquired image is partly signal dependent. Removal of such noise is a vital role that an image processing system has to play during transmission. Number of researchers used soft computing approach such as Filters and Neural Networks to remove noise. In this paper, a novel technique is developed to apply Bacterial Foraging Optimization technique in conjunction with the expressions developed to minimize the noise. Bacterial Foraging is an evolutionary optimization technique conceived in recent time has many advantages over Genetic Algorithm. Bacterial Foraging Optimization Technique is yet to find its application in digital image processing. The technique developed in this paper can be used as a generalized soft computing tool in image processing.

1. INTRODUCTION

Due to advancement in digital image processing, the conversion of image from one form to another, such as digitizing, transmitting, scanning etc. suffers from degradation due to imperfections through noise. In case of Signal to Noise Ratio(SNR) degraded images, improvement can be done by means of restoration or enhancement techniques. Restoration may be viewed as application of effective inversion of degrading phenomenon. This requires a priori knowledge of degradation process. Lack of knowledge in prior model needs to apply other processes called 'Image Enhancement'. Enhancement improves appearance of an image by suppressing the unwanted features and improving the dominant features. The unwanted effects are due to recording error or transmission noise superimposed through channel or may be a combination of both. All such noisy images can be modeled by using Equation 1, where, \( f(x, y) \) is the noisy image, \( f(x, y) \) is the original image and \( \eta(x, y) \) is the additive noise that corrupts the original image.

\[
\hat{f}(x, y) = f(x, y) + \eta(x, y)
\]  

Digital noise falls mostly in the category of Gaussian noise or Impulse noise. Presence of noise creates an arbitrary change in the pixel value as compared to its neighboring pixels, thus, degrading the performance of image. Removing of Gaussian noise involves smoothing inside the distinct region image may be either constant or linearly varying gray level. Filters prove their identity to remove noise. The basic principle of noise removal is, to detect the impulse pixels and replace them with their estimated values, while leaving the other pixels unchanged [1-3]. Most basic impulse detectors are based on two state methods to find pixels that are significant outliers when compared to the neighbors. Some denoising methods like two-state SD-ROM and CSAM filters [4] are easily customizable, but they suffer from a more complex criterion of judging whether a pixel is an impulse [5-6]. In the changing scenario of digital communication technology, demands for high picture quality are growing day by day. existing. Receiving of original image is an essential requirement in the present day wireless scenario. So far reported techniques, expressions and models lack the required accuracy to certain
Table 1
Comparison of BFO with other methods

<table>
<thead>
<tr>
<th>Method</th>
<th>Lena image; p=40%</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 x 3 Median Filter [6]</td>
<td>26.21 db</td>
</tr>
<tr>
<td>5 x 5 Median Filter [6]</td>
<td>27.61 db</td>
</tr>
<tr>
<td>SD-ROM without training[8]</td>
<td>28.30 db</td>
</tr>
<tr>
<td>SD-ROM with training<a href="Iterations">8</a></td>
<td>29.19 db</td>
</tr>
<tr>
<td>Median Filter with Adaptive Length[9]</td>
<td>27.75 db</td>
</tr>
<tr>
<td>Sun and Neuve Switching Scheme[10]</td>
<td>27.97 db</td>
</tr>
<tr>
<td>Rank Conditioned Rank Selection Filter[11]</td>
<td>27.72 db</td>
</tr>
<tr>
<td>Triilateral filter[6]</td>
<td>31.36 db</td>
</tr>
<tr>
<td>Proposed method</td>
<td>57.24 db</td>
</tr>
</tbody>
</table>

2. RESULTS AND DISCUSSIONS

The performance analysis of the Bacterial Foraging Optimization Technique has been done by testing it with the standard Lena image (512x512) cropped into 80x80 as shown in Figure 1(a). The proposed method restores the image and also calculates the Peak Signal to Noise Ratio (PSNR) given by [6].

\[
PSNR(f) = 10 \log_{10} \left( \frac{255^2}{\sum_{i,j=1}^{m,n} (f_{i,j} - \hat{f}_{i,j})^2} \right) \text{db} \quad (3)
\]

The results of the proposed method have been compared with the existing techniques of denoising. Table 1 summarizes these results. It is observed that with a random noise of 40%, the maximum PSNR achieved by other methods is 31.26 db [6]. But with the proposed technique using the same test Lena image, the PSNR obtained is 57.24 db.

Table 2 gives the summary of the results. The Peak signal to Noise Ratio achieved in each case along with the time taken for the iterations in each of the cases is mentioned in Table 2. It is observed that as the density of noise increases, the peak signal to noise ratio decreases.

A Pentium IV, 3.6 GHz, 256 MB RAM system has been used for getting the results. Due to global search approach, this algorithm gives promising results as seen in the restored images.

3. CONCLUSION

The paper presents a new approach to use Bacterial Foraging Optimization Technique to improve PSNR of images. The result shows promising improvement in the accuracy, while drastically reducing the computational time. The code developed is generalized in nature and proves its identity as a tool for enhancement. Bacterial Foraging technique due to its parallel architecture, probabilistic and deterministic nature, will be useful to solve many applications. Bacterial Foraging Optimization Technique proves to be a robust approach for automatically suppressing the noise yielding a better signal to noise ratio. This method will go a long way in C(Iterations)AD tool development for image processing.
REFERENCES


Swapna Devi received the B. Tech degree in Electronics and Communication Engineering from North Eastern Regional Institute of Science Technology, Arunachal Pradesh, India. Master of Engineering degree from Regional Engineering College (Presently NIT), Rourkela, Orissa, India. Presently, she is an Assistant Professor in the Department of Electronics and Communication Engineering at National Institute of Technical Teachers Training and Research, Chandigarh, India. She has published 67 research papers in various International and National Journals and Conferences.

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