British Journal of Mathematics & Computer Science
1(2): 112-120, 2011

SCIENCEDOMAIN *international*
www.sciencedomain.org

Identification and Removal of Impulsive Noise from Corrupted Images Using Hypergraph Model

D. Aradhana[1*], K. G. Karibasappa [2], A. Channa Keshav Reddy[3] and K. Karibasappa[4]

[1]Ballari Institute of Technology and Management, Bellary, Karnataka, India
[2]B.V.B.College of Engineering & Technology, Hubli-31, Karnataka, India
[3]Jawaharlal Nehru Technological University, Hyderabad, Andhra Pradesh, India
[4]Dayanand Sagar College of Engineering, Bangalore, Karnataka, India
.

Research Article

Received 21st January 2011
Accepted 5th February 2011
Online Ready 1st March 2011

Abstract

Image noise is unwanted information of an image. Noise can occur during image capture, transmission, or processing and it may depend or may not depend on image content. In order to remove the noise from the noisy image, prior knowledge about the nature of noise must be known otherwise noise removal causes the image blurring. Identifying nature of noise is a challenging problem. Many researchers have proposed their ideas on image denoising and each of them has its assumptions, advantages and limitations. In this paper, we are proposing a new algorithm for identifying and removing the impulsive noise using Hypergraph concept.

Keywords: Hypergraph, noise, neighborhood, segmentation, homogeneous regions;

1 Introduction

Image noise is unwanted information of an image (Mcandrew, 2009). Noise can occur during image capture, transmission, or processing and it may depend or may not depend on image content. Presence of noise is manifested by undesirable information, which is not at all related to the image under study, but in turn disturbs the information present in the image. It is translated into values, which are getting added or subtracted to the true gray level values on a gray level

** Corresponding author: Email: aradhanabm@gmail.com*

pixel (Rosenfel, 1982). These unwanted noise information can be introduced because of so many reasons like: acquisition process due to cameras quality and restoration, acquisition condition, such as illumination level, calibration and positioning or it can be a function of the scene environment. Noises are mainly classified into three main types (Beaurepaire, 1997), these are:

Additive noise: It is also called as Gaussian noise (Rital, 2010). It is a channel model in which the only impairment to communications a linear addition of wideband or white noise with a constant spectral density and a Gaussian distribution of amplitude. Wide band Gaussian noise comes from many natural sources.

Multiplicative noise: This type of noise is also called as speckle noise. Multiplicative noise is a type of signal-dependent noise where brighter areas of the images appear noisier. A popular class of image restoration methods is based on local mean, median, and variance. Multiplicative noise degrades the quality of the images and affects the performance of important image processing techniques such as preprocessing, segmentation, and classification. It can be modeled by random values multiplied by pixel values.

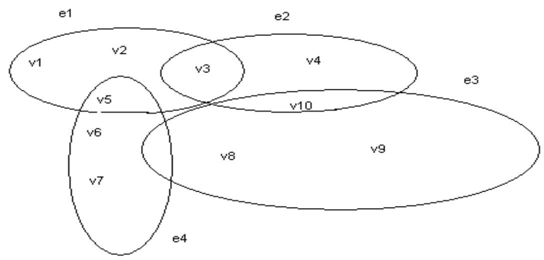
Impulsive noise: It is one such noise, which may affect images at the time of acquisition due to noisy sensors or at the time of transmission due to channel errors or in storage media due to faulty hardware. This is also called salt and pepper noise (Balasubramaniam, 2008). It is typically caused by malfunctioning of the pixel elements in the camera sensors, faulty memory locations, or timings errors in the digitization process, so its appearance is randomly scattered white or black or may be both over the image.

Noise elimination is a main concern in computer vision and image processing. Removal of image noise is a challenging problem because noise removal causes the image blurring. Image de-noising is a process of removing the noise from a noisy image using suitable filter (Motavani, 2004). In order to use appropriate filter, it is necessary to identify the type of noise present in the degraded noise image. To correct some degradation in the image, the nature of a priori information is important (Chehdi, 1993; Chehdi and Sabr, 1993). Degradation correction methods can be classified into three groups.

- First group of methods uses no knowledge about the nature of the degradation
- Second group assumes knowledge about the properties of the image acquisition devices and the condition under which the image was obtained.
- Third group uses knowledge about the objects that are sought in the image which may simplify the task.

2 Adaptive Image Hypergraph

The hypergraph is defined as follows: H = (N, E) where N = {v1,v2,..,vn} and E= (e1, e2,….,en) (Motavani, 2004)(Yue-Wei,2010). The set V is called the set of vertices and E is the set of hyper edges. Connection between any vertices and any number of vertices i.e, each hyper edge is a subset of V. Figure 1 gives an example for hypergraph. Here the set of vertices V={v1, v2, v3, v4, v5 v7, v8, v9, v10} and the set of hyper edges E = { e1, e2, e3, e4 } where e1={ v1, v2, v3, v5 }, e2={ v3, v4, v10 }, e3={ v8, v9, v10 } and e4={ v5, v6, v7 }.



A digital image of two dimensional functions can be represented by using the hypergraph concept as follows:

$$I : V \subseteq N^2 \rightarrow P \subseteq N^n$$

Where n ≥ 1, P is the intensity level and the vertices V is called pixels. Let d be the distance on intensity level P, then neighborhood relation on the image can be defined as

Γα, β (v) = $\{v^{|} \in V, v \neq v \mid d(I(v), I(v^{|}\}\} < \alpha, and\ \ d\ \ (v, v^{|}) \leq \beta\}\quad \forall v \in V$

So, we can associate each image I to a hypergraph called image adaptive neighborhood hypergraph.

Hα,β(I) = $(V, (\{v\} \cup$ Γα,β(v) (v)) $v \in V$)

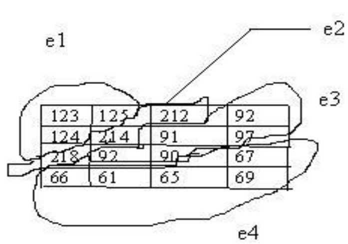


Figure 2: Image adaptive neighborhood hypergraph

3 Methodologies

The proposed algorithm identifies the noise affected to the images by segmenting the images using the technique called image adaptive neighborhood hypergraph (Lee-Kwang, 1995) and removes the impulsive noise using the min-max technique (Satpathy 2010).

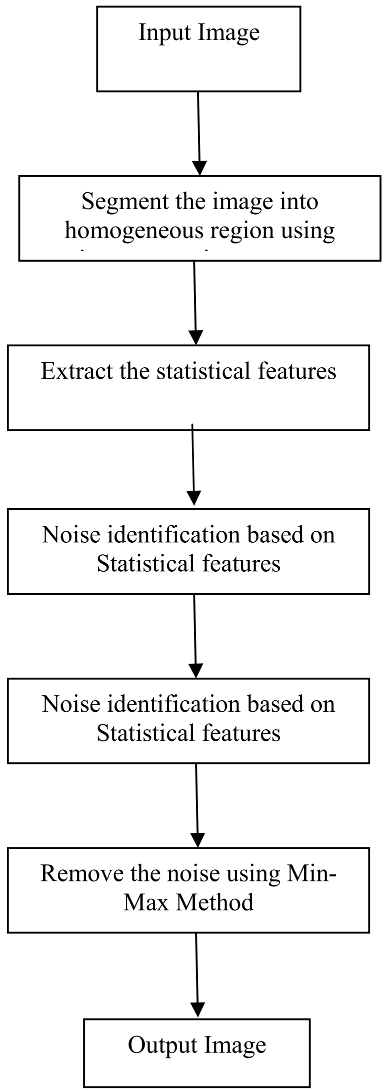


Figure 3. flow chart for identifying noise in a image

3.1 Algorithm

1. Read the Image I, affected by noise
2. Segment the image into homogeneous region using the image adaptive neighborhood Hypergraph.
3. Extract the Dynamics D (i) where $1 < i < N$ for each of the N homogeneous regions.
4. If Mean (D (n) / max (D (n)) > λ where λ=0.9 then the Nature of noise is impulsive noise.
5. If the noise affected to the image is impulsive then
   i. Select the sliding window with size n, where n = 3 or 5 and center pixel of the window is the pixel which is testing for impulse
   ii. If the testing pixel p falls in any one of the following category replace the pixel by median of the window.
      a) Test pixel p value less than all the pixel values of w
      b) Test pixel p value greater than all the pixels of window
   iii. Repeat the step (ii) for all the pixels of the input image I.

4 Results of image adaptive neighborhood hypergraph algorithm

The proposed algorithm was implemented in MATLAB. Performance of the algorithm has been tested by Peak Signal to Noise Ratio, which is shown in Figure 4. An image like LENA.jpg and CAMERAMAN.jpg with size 256X256 were used for testing the algorithm with varies percentage of impulse noise and the results are shown in Figure 5. The output image i.e., denoised image looks Moderate for visual if the noise affected to the input image is up to 40% (figure 6). If the noise in the input image greater than 40%, performance of the algorithm is poor in the case of visual effect as well as Peak signal-to-noise ratio (PSNR).

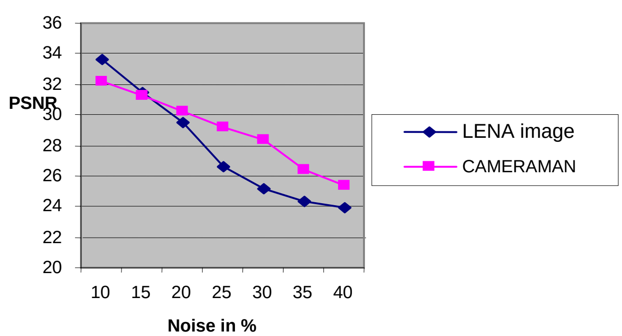
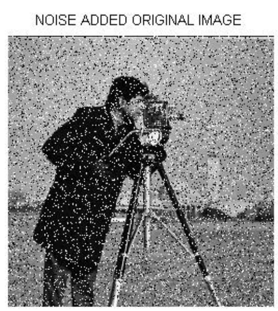


Fig. 4. Impulsive noise v/s PSNR of output image

(a) (b)

Fig. 5. Original Images (CAMERAMAN.jpg and LENA.jpg)



(c)

(d)

(e)

(f)


RESULT IMAGE

(g)


RESULT IMAGE

(h)


RESULT IMAGE

(i)


RESULT IMAGE

(j)


RESULT IMAGE

(k)

Fig. 6. (c) to (f) Input images with varies noise 15%, 25%, 40% respectively for both CAMERAMAN and LENA images, (g) to (l) are the output images for (c) to (f) respectively

5 Conclusion

We used the image of LENA.jpg and CAMERAMAN.jpg in this paper, to analyze the proposed new algorithm which identifies the noise in the images by segmenting the images using the technique called image adaptive neighborhood hypergraph and removes the impulsive noise using the min-max technique. Examples demonstrate the quality of results which can be obtained as compared to classical techniques with the same order of complexity.

References

Balasubramaniam, Sridhar. (2008). Noise type and statistical parameters identification in Computer Vision Project Report.

Beaurepaire, L., Chehdi, K., Vozel, B. (1997). Identification of the nature of noise and estimation of its statistical parameters by analysis of local histograms. In Proc. ICASSP'97, Munich.

Chehdi, K. (1993). Automatic identification of noise for an optimal filtering. In Proc. IEEE CCSP 93, pp 474-477.

Chehdi, K., Sabr, M. (1992). A new approach to identify the nature of the noise affecting an image. In Proc. IEEE ICASSP 92, volume III: pages 285-288.

Lee-Kwang, Hyung, Lee, Keon-Myung. (1995). Fuzzy hypergraph and fuzzy partition. IEEE Transactions on Systems, Man and Cybernetics, 25(1), 196-201.

Mcandrew, A. (2009). Introduction to Digital Image Processing with MATLAB Course Technology Cengage Learning India Edition.

Motavani, M.C., Gadiya, M.C., Motawani, R.C., Harries, F.C. (2004). Survey of Image Denoising Techniques. In GSP Santaclara.

Rital, S., Bretto, A., Cherfi, H.H., Aboutajdine, D. (2010). A combinatorial based Technique.

Rosenfeld, A. (1982). Digital Image Processing. Academic Press, San Diego.

Satpathy, S.K., Panda, S., Nagawanshi, K.K., Ardil, C. (2010). Image Restoration in Non Linear Filtering Domain using MDB approach. Int. J. Signal Processing, pp 45-49.

Yue-Wei, Lin, Fang, Bin, Deng, Qing-Qing. (2008). Image segmentation using fuzzy Hypergraph Model in Proceedings of 2008 International Conference on Wavelet Analysis and Pattern Recognition, Hong Kong, 30-31.