Identification and Removal of Impulsive noise using Hypergraph Model

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***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 other wise 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 [1] 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.. 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 pixel. 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, these are

Additive noise: It is also called as Gaussian noise. This involves a linear addition of white noise to the original image, i.e., it does not depend on the intensity value of the image.

Multiplicative noise: This type of noise is also called as speckle noise. It can be modeled by random values multiplied by pixel values

Impulsive noise: This is also called salt and pepper noise. It is caused by sharp, sudden disturbances in the image signal, 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 [2] is an process of removing the noise from an noisy image using suitable filter. 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. 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 [2] is defined as follows: $H = (N, E)$ where $N = \{ v_1, v_2, .. v_n \}$ and $E = (e_1, e_2, .. e_n)$. The set V is called the set of vertices and E is the set of hyperedges. Connection between any vertices and any number of vertices i.e, each hyperedge is a subset of V. Figure 1 gives an example for hypergraph. Here the set of vertices

$V=\{v_1, v_2, v_3, v_4, v_5\ v_7, v_8, v_9, v_{10}\}$ and the set of hyperedges $E = \{ e_1, e_2, e_3, e_4 \}$ where $e_1=\{ v_1, v_2, v_3, v_5 \}$, $e_2=\{ v_3, v_4, v_{10} \}$, $e_3=\{ v_8, v_9, v_{10} \}$ and $e_4=\{ v_5, v_6, v_7 \}$.

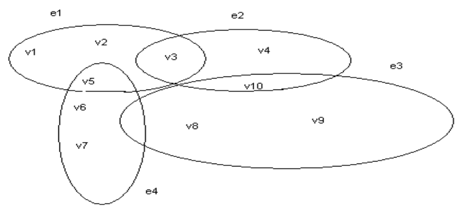


Figure 1 : Hypergraph

A digital image of two dimensional function can be represented by using the hypergraph concept as follows: $I : V \subseteq N^2 \rightarrow P \subseteq N^n$ where $n \geq 1$, 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

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

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

$$H_{\alpha,\beta}(I) = (V, (\{v\} \cup \Gamma_{\alpha,\beta}(v)\ (v)) \quad v \in V\ )$$

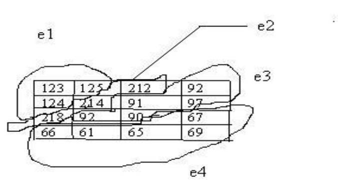
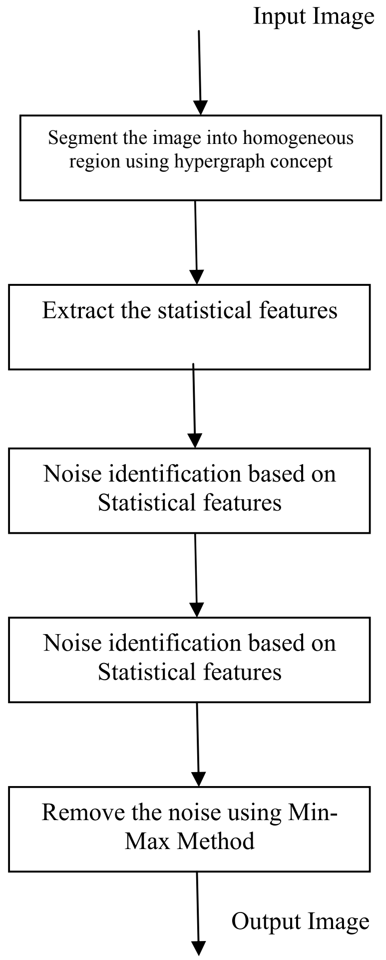


Figure 2: Image adaptive neighborhood hypergraph

3. Methodology

The proposed algorithm identifies the noise affected to the images by segmenting the images using the technique called image adaptive neighborhood hypergraph and removes the impulsive noise using the min-max technique.[4]



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 then all the pixel values of w

b) test pixel p value greater then all the pixels of window

iii Repeat the step (ii) for all the pixels of the input image I

4. Results and Discussion

The proposed algorithm is implemented in MATLAB. A different image like LENA and FLOWER with size 256X256 are used for testing the algorithm with varies percentage of impulse noise and the results are shown in Figure 3. Performance of the algorithm has been tested by Peak Signal to Noise Ratio, which is shown in Figure 3. The output image i.e., denoised image looks Moderate for visual if the noise affected to the input image is up to 40%(shown in figure 5). If the noise in the input image greater then 40%, performance of the algorithm is poor in the case of visual effect as well as PSNR .

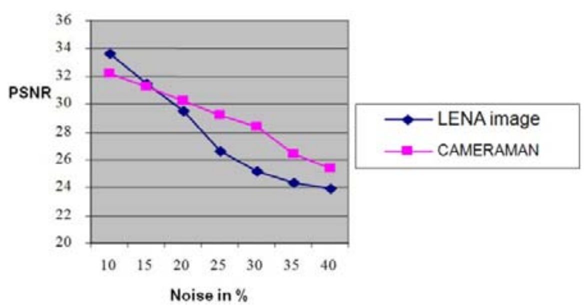


Figure 3: Impulsive noise v/s PSNR of output image

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Figure 4. Original Images

(c)

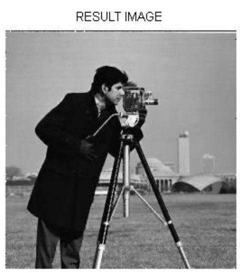
(d)

(e)

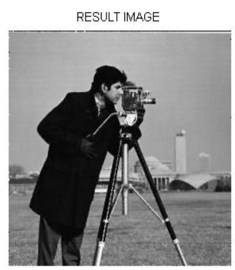
(f)

(g)

(h)



(i)



(j)

(k)

(l)

(m)

(n)

Figure 5: (c) to (h) Input images with varies noise 15%, 25%, 40% respectively for both Cameraman and LENA images, (i) to (n) are the output images for (c) to (h) Respectively