Study of Various Types Noise and Text Extraction Algorithms for Degraded Complex Image

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Abstract: ***This paper presents an approach to the text detection of degraded complex images like News-papers, blogs, and web-pages. A degraded complex image like means image was affected by a different type of noise like salt and pepper noise, random valued impulse noise, speckle noise, and Gaussian noise, etc.There an extremely large demand for storing the text from complex degraded images into a computer-readable form for future use.***

The image is consists of black as foreground and white as background. Binarization is one of the methods used for the separation of pixel values in Image. Thresholding is a perfectly-known technique used for binarization of degraded document images. Thresholding is dividing into the three types global, local and hybrid thresholding technique. The hybrid thresholding technique is a combination of global and local techniques. In a document with noise document, global thresholding is failed while shows the best result for uniform contrast image. In this case, local and hybrid thresholding has good techniques over available techniques.

Keywords: Text detection, Filters, Binarization, Thresholding, binary images, Brownian Noise (Fractal Noise) Rayleigh Noise, Gamma Noise, Poisson-Gaussian Noise,salt and pepper noise, random valued impulse noise, speckle noise ,Gaussian noise and Structured Noise.

1. INTRODUCTION

This paper presents an approach for the detection of text from the degraded complex image. Variable background, shades, non-uniform brightness, and blur are types of degradation due to various types of noise [1-2].Many degraded complex image binarization methods have been proposed in the review of the literature [3-4]. Selecting an efficient method for binarization is a difficult task due to the presence of various noise in complex image

Degraded complex image is gatherings of black as foreground and white as background. Binarization is one of the methods for disjointing of pixel values in a degraded complex image. Thresholding is a highly known technique used for binarization of degraded document images. Thresholding is dividing into the global, local and hybrid thresholding technique. In a document with noise document, global thresholding is failed while shows the best result for uniform contrast image. In this case, local and hybrid thresholding has good techniques over available techniques.

The color used for the document in the image is the foreground color whereas the remaining of the image is the background color and we can say that two colors are used for a binary image one is black and the other is white conversely any two colors can be used. Binary images [5] repeatedly used in image processing to masks or the outcome of some operations of thresholding. Few input/output devices, for example, laser printers, bi-level computer displays, are capable to handle bi-level images. Binary images are formed from color images by dissection. A binary image [6] is a digital image that has impartial two feasible values meant for every pixel that is used for a binary image i.e. black and white.

The degraded complex image was affected by a different type of noise like Brownian Noise (Fractal Noise) Rayleigh Noise, Gamma Noise, Poisson-Gaussian Noise, salt and pepper noise, random valued impulse noise, speckle noise, Gaussian noise, and Structured Noise, etc as shown below. Noise is very very difficult to remove it from the complex images without the proper understanding of the noise model.

The paper is organized as follows: in section 2, overview of different types of noise. Section 3, presents the binarization techniques and their application. Section 4, discusses about the literature review on text extraction and finally section 5 research gap and section 6 conclusion.

2.NOISE TYPES:

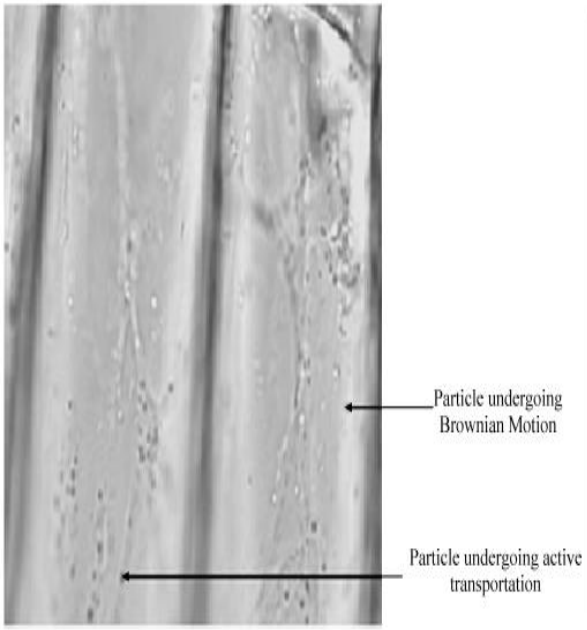


Figure 1.Brownian Noise (Fractal Noise)[7]

Figure 2.Lena image [8]of Speckle noise with variance 0.04

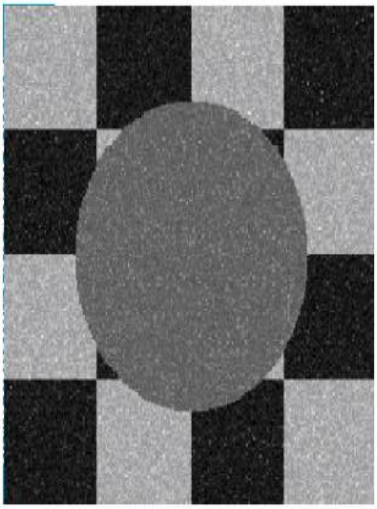


Figure 3.Rayleigh Noise [9]

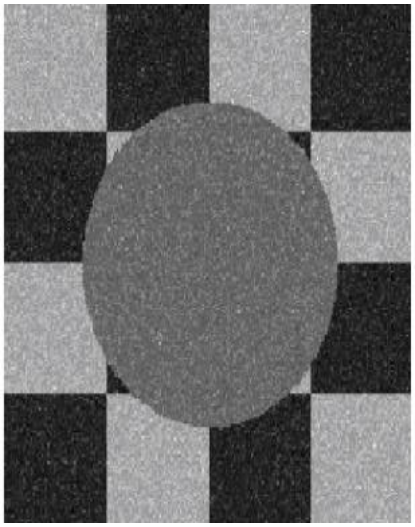
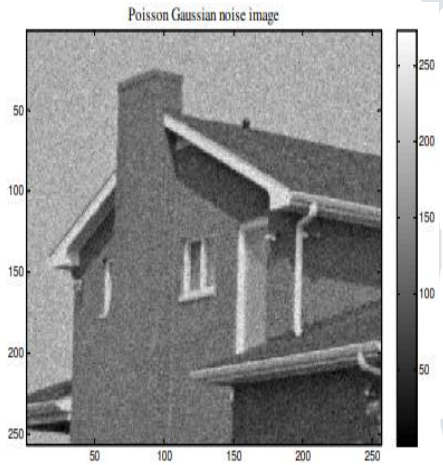


Figure 4. Gamma Noise [9]



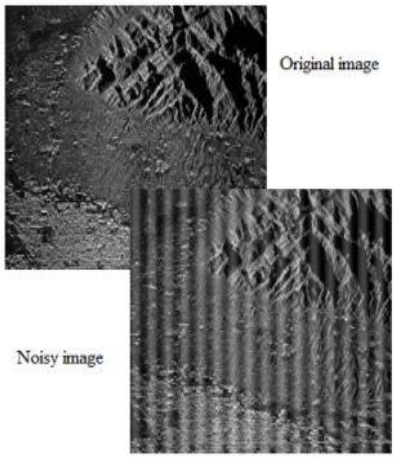


Figure 5. Poisson-Gaussian Noise House Image [10] Figure 6. Structured Noise [11]

Gaussian Noise

It is also called internal noise because it arises within a device like an amplifier or receiver. It affected the gray values in a complex image. Gaussian noise is represented by its PDF concerning gray value as given below equation.

$$P(g) = \sqrt{\frac{1}{2\pi\sigma^2}} e^{\left(\frac{g-\mu}{2\sigma^2}\right)^2} \quad (1)$$

where g=gray value, σ = standard deviation and μ = mean

In the Gaussian noise mean value zero, the variance is 0.1 and 256 gray levels in its PDF which shown in figure 8.

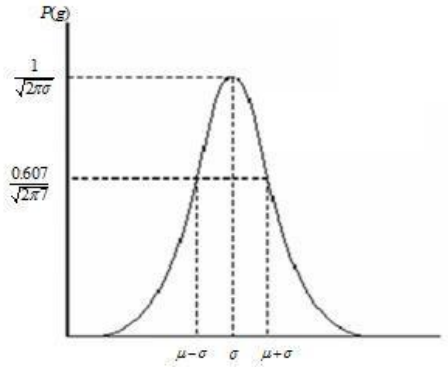


Figure 7. Gaussian noise PDF

Gaussian noise curve looks like in bell-shaped because of equal randomness.PDFof this noise varies from 70 to 90% noisy pixel values of the degraded image in between $\alpha - \sigma$ and $\alpha + \sigma$.

White Noise

This type of noise measured noise power. The noise power spectrum is constant in white noise. This noise power is equivalent to the power spectral density function. The statement of the paper "Gaussian noise is the same as white noise" is inappropriate [12].

However Gaussian property neither reveals the white sense. The range of total noise power is -∞ to +∞ available in white noise in the frequency domain. Noise power is infinite in case of white noise. This fact is fully true because the light emits from the sun have all the frequency components

In white noise, correlation is not possible because every pixel values are different from their neighbors. That is why autocorrelation is zero.

Brownian Noise (Fractal Noise)

The color image has color noise with a different name like Brownian noise or pink noise or flicker noise or 1/f noise. In Brownian noise, power spectral density is proportional to the square of frequency over an octave.

Brownian Noise (Fractal Noise) is due to the random movement of a particle in fluids. This type of noise caused by the natural process and it is different from Gaussian noise[13-17].

The power spectrum of fractal noise is delay continuously due to an increase in frequency. Mathematical representation of fractal noise as a zero-mean Gaussian process (B_H).

$$B_H(0) = 0 \tag{2}$$

Impulse Valued Noise (Salt and Pepper Noise)

This noise is also known as drop noise because this noise drops original values and also called as salt and pepper noise. This type of noise will not distort a complete image rather than affect only a few pixel values of a complex image. Regarding complex image there is chance neighbors pixel value does not change [18-19].

This can be explained with the help of the below example. Let is consider 3x3 image matrices. Assume the central value of matrices is degraded by Pepper noise. As central value is changed from 202 to zero value. It is mean noise inserted in dead pixel either white or dark. This type of noise introduced in data transmission[20].

244	201	211
96	212	
212	96	201

→

244	201	211
	0	46
212	96	201

Figure 8.3x3 image matrices

The inserted dead pixel in the image is due to the analog to digital conversion on the data transmission process. The PDF of this noise is shown below.

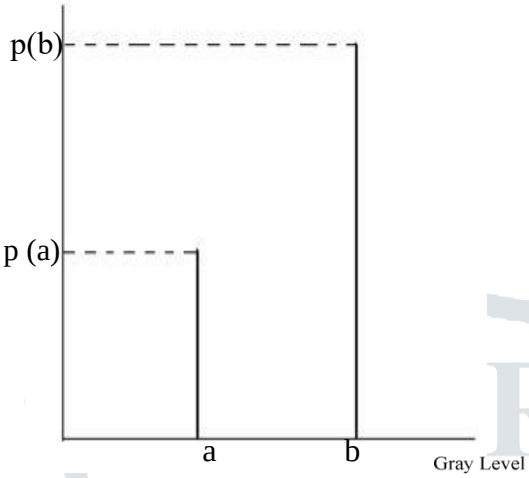


Figure 9.The PDF of Salt and Pepper noise

When mean is zero and variance is 0.5 then there are two spikes one is for brightening region called region 'a' and another for the dark region called as region 'b' and we have observed that PDF value is max and min in the region 'a' and region 'b'[18].

Periodic Noise

This noise is produced from electronics interferences. This noise has two special characteristics

1.Spatially dependent

2.Sinusoidal at multiples of a specific frequency.

It's looking in form of conjugate spots in the frequency domain. It can be suitably removed by using a band-reject filter or notch filter.

Quantization noise

Quantization noise existence in the amplitude quantization process. It generally presents digital data transmission. In this type of noise, the signal to noise ratio (SNR) is between minimum and maximum pixel value, Pmin and Pmax respectively.

The SNR is given as

$$SNR_{dB} = 20 \log_{10}(P_{max} - P_{min}) / \sigma_n \quad (3)$$

Where σ_n = Standard deviation of the noise, when input is full amplitude sine wave SNR becomes

$$SNR = 6n + 1.76 \text{ dB} \quad (4)$$

Where n is a number of bits.

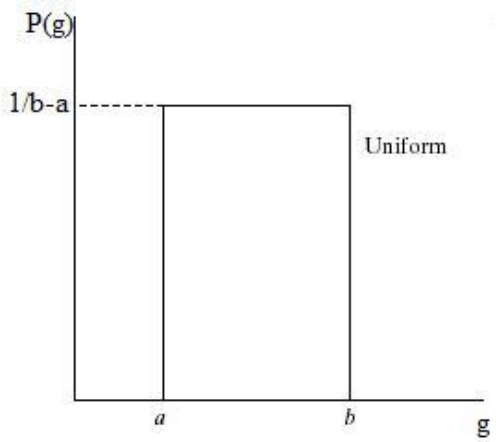


Figure 10. Uniform noise PDF

$$P(g) = \begin{cases} \frac{1}{b-a}, a \le g \le b \\ 0, \quad otherwise \end{cases} \quad (5)$$

$$\text{mean } \mu = \frac{a+b}{2} \quad (6)$$

$$\text{variance } \sigma^2 = \frac{(b-a)^2}{2} \quad (7)$$

Speckle Noise

This noise is also known as multiplicative noise. This is the type of noise seen in the coherent images like laser and radar. Speckle noise can occur similarly in an image as Gaussian noise and its PDF follow the gamma noise.

$$F(g) = \frac{g^{\alpha-1} e^{-\frac{g}{a}}}{\alpha-1! a^{\alpha}} \quad (8)$$

Photon Noise (Poisson Noise)

This type of noise is seen due to the statistical nature of x-rays, gamma rays and visible lights which is an electromagnetic wave. This type of source emitted no of photons per unit time and created random fluctuation of photons. Photon noise is also known as quantum noise or short noise. Photon noise represented by the Poisson distribution as below.

$$P\left(f_{(pi)} = k\right) = \frac{\lambda_i^k e^{-\lambda}}{k!} \quad (9)$$

Poisson-Gaussian Noise

This noise occurs as a result of Magnetic Resonance Imaging (MRI). There is jointly two noise model known as Poisson-Gaussian noise model. These two models identify the quality of MRI in terms of appearances and strength [22].

The Gaussian noise model can be given by

$$Z(j,k) = \alpha * P_{\alpha}(j,k) + N_{\alpha}(j,k) \quad (10)$$

Where, P_α=Poisson-distribution

N_α= Gaussian distribution

$Z(j,k)$=noisy image based on Poisson-Gaussian model [23-24]

Structured Noise

Structured noise has the following nature

- Periodic
- Stationary
- Non-Stationary
- Aperiodic

If structured noise is stationary then it has fixed amplitude, frequency, and phase. Structured noise occurs due to interferences in various electronic components[25]. If structured and non-structured both are present in the communication system then such type of noise also known as rank noise.

$$y_{(n)} = x_{(n,m)} + v(n) \tag{11}$$

$$y_{(n)} = H_{(n,m)} \cdot \theta(m) + s_{(n,t)} \cdot \phi_{(t)} + v_{(n)} \tag{12}$$

Where n = rows

m = columns

y = received image

H = Transfer function of linear system

S = Subspace

t = rank in subspace

φ = underlying process exciting the linear system (S)

θ = signal parameter sets initial conditions or excites

$v_{(n)}$ =vector random noise

Gamma Noise:

This type of noise present in laser scan based images. It follows the Gamma distribution[26-27].

$$P(y) = \begin{cases} \frac{a^b g^{b-1} e^{-ag}}{(b-1)!}; if\ g \geq 0 \\ 0; if\ g < 0 \end{cases} \tag{13}$$

where mean μ=$\frac{b}{a}$

variance $\sigma^2 = \frac{b}{a^2}$

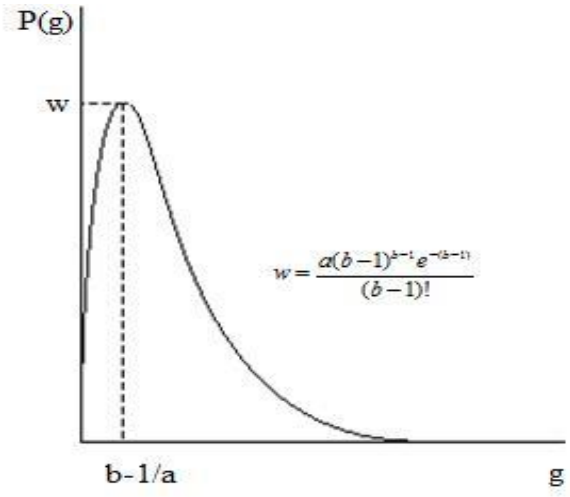


Figure 11.Gamma distribution

Rayleigh noise

This noise occurs in radar images.Its probability density function(PDF) is given below[26].

$$P(g) = \begin{cases} \frac{2}{b}(g-a)e^{-\left(\frac{g-a}{b}\right)^2}; \text{if } g \geq a \\ 0; g < a \end{cases} \quad (14)$$

where mean $\mu = a + \sqrt{\frac{\pi b}{4}}$

variance $\sigma^2 = b\frac{(4-\pi)}{4}$

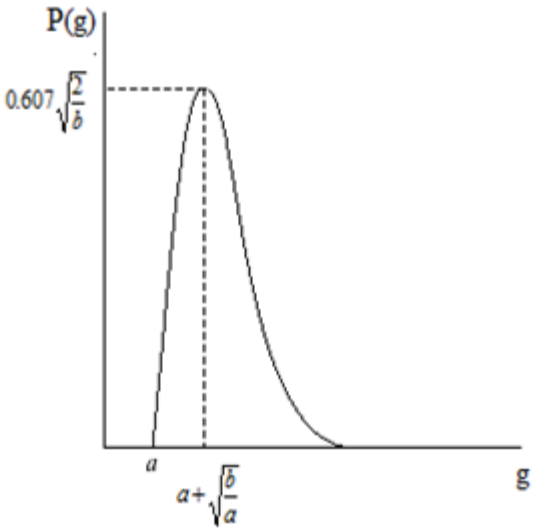


Figure 12. Rayleigh distribution

3. BINARIZATION TECHNIQUES AND APPLICATION

In Image processing understanding of the different types of noise is very important because without knowledge of the different types of noise it is difficult to apply denoising methods. Noise can be represented by probability density function PDF with mean and variance parameter. The input image is degraded by any type of noise.

Many approaches in addition to techniques were established to improve the quality of degraded documents images. Binarization is found one of the best important pre-processing phases which consist to separate foreground and background of documents images. It is used to converts a gray-scale based image into a binary-based image. Various image denoising techniques are used to remove the noise from the complex degraded image. Binarization is one of the important techniques used in image processing for text extraction from degraded complex images. Binarization is the process of converting a complex degraded image into a binary image.

Figure: 1: Input image

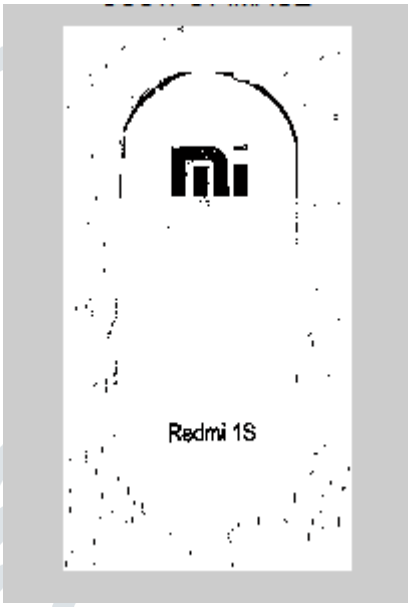


Figure: 2: Binarized image

Figure 1 has shown the input image for binarization and Figure 2 has shown the binary image for the same.

In this paper, our aims are detecting textual regions from the degraded complex image and separating it from the graphics portion or non-textual portion of a complex image. Weak and random detection of text from these degraded complex images and is a difficult problem. Text extraction has an enormous number of applications :

- Reading foreign language text - One of the common problems faced by a person in a foreign land is that of communication, understanding road signs, signboards, etc. The proposed method aims to lighten such problems by extracting the textual data from the complex image which are clicked by a camera

- Archiving documents - Archives of paper documents in offices or other printed materials like magazines and newspapers can be electronically converted for more efficient storage and instant delivery to home or office computers.

- Text searches in Images - Searching in images provide inaccurate result because search operation is not performed on the content of the image. Text extraction from the complex image would efficient searching method by extracting textual region from the complex image.

Binarization can be classified into three main types: global binarization, local binarization, and hybrid binarization methods.

1. **The global thresholding technique**
   - This method used to find out the optimal threshold for the entire image.
   - This method fails in complex backgrounds, such as non-uniform color and document affected by the noise.
   - These methods are generally not used for degraded document image
2. **The local binarization techniques**
   - This method set different thresholds for different target pixels depending on their local information.
   - This method sensitive to background noises.
3. **Hybrid binarization approach**
   - This method combines global and local thresholding
   - In first step global thresholding used to categorize a part of the background of the degraded complex image and saveother part which is foreground.

A second step aims to refine the image obtained by the previous step to obtain a good result by applying an adaptive thresholding technique.

4. LITERATURE REVIEW

Gorman et al.(1995) [28]

- In this paper, page segmentation methods are divided into three groups:
  1. top-down
  2. bottom-up
  3. hybrid approaches

D. Wang et al.(1989)[29]&T. Pavlidiset al.(1992)[30]

- Bottom-up techniques in general use merging and grouping of characters.
- Merging recursively to words and then to text lines to paragraphs.
- Widely used bottom-up techniques are
  1. Mathematical morphology.
  2. Run-length smoothing algorithm.
  3. Region growing based methods..

Bolan Su et al. (2012) [31]

- This paper has studied a document image binarization structure that makes utilization of the Markov Random Field model.
- Structure isolates the document image pixels into three classes i.e. document background text, document foreground text, and uncertain pixels.
- Uncertain pixels belong to foreground and background categories by incorporating MRF model and boundary information.

Patvardhan et al. (2012) [32]

- This paper has studiedthat images may contain complex background i.e. shading or denoising.

- The binarization method is suitable for OCR using a discrete curvelet transform.
- Curvelet transform is used to eliminate complex image background, white Gaussian noise and gives improved binarized document image.
- The Curvelet transform also used to enhance text shape still in the presence of noise.

Marian Wagdy et al. (2013) [33]

- This paper has implemented a quick and proficient document image clean up and binarization technique based on
  1.Retinex hypothesis
  2.Global thresholding.
- This methodused both local and global thresholding with the concept of retinex theory.
- Retinex theory efficiently improve the degraded and poor quality document image.
- This techniqueconquers the limitations of the related global threshold techniques.

Abdenour Sehad et al.(2013) [34]

- This paper suggested an adaptive threshold-basedtechnique.
- It has been calculated by using a descriptor centered on a co-occurrence matrix.
- This technique utilizing a set ofancient degraded documents offered by a national library**.**

Ioannis Pratikakis1 et al. (2013) [35]

- This paper focused on recent developments in document image binarization for both machine-printed documents and manually written record images.
- Exploiting assessment execution measures that obey document image investigation and recognition.

Ranganathan *et al*. (2015) [36]

- This paper consists of a simple and efficient binarization method for the degraded document image.
- The technique is used to accept the high inter and intra intensity variation in the degraded document image.
- Binarization is a method of converting the complex image into a binary value based image containing text as foreground and another as background.
- Performance of the character recognition system is completely depends on binarization quality.
- This method is based on spatial domain techniques:

1. Laplacian operator.
2. Adaptive Bilateral filter
3. Gaussian filter

5.GAPS IN LITERATURE

Many techniques have been proposed for document binarization as shown in the literature review. It has been founded from the existing research is that no method is perfect for every case. Therefore still some research is required in this field of computational.intensive image [37] binarization.

Below are the few important limitations of this research work:-

- Researchers have used different filters to reduce the noise from the image.
- Specific filter will be used for unique noise as there is a different type of noise present in the complex image and video[38].

6. CONCLUSION

This paper has concentrated on the degraded document text binarization technique. Binarization is an application of image processing. The main reckonable objective of this paper is too focused on the drawbacks of algorithms for degraded text binarization. It has been found that each technique has its advantages and disadvantages; no technique is found best for every circumstance. The main limitation of prevailing work is found to be a different type of noise like such as Gaussians, salt & pepper and speckle. In the upcoming, we will propose a efficient algorithm that will use a simple and consistent methodology to improve the performance. We will propose a new algorithm that will use nonlinear magnification as a preprocessing technique to improve the results.

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