Noise Invariant Content Based image retrieval using CDH

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Abstract

This paper presents a noise invariant image analysis using image histograms which can be used for retrieval of similar images. Noise can be defined as degradation in the pixel values. The sources of noise in digital images arise during either image acquisition or transmission. Therefore, robust noise invariant analysis and comparison of images is important for digital image libraries and multimedia databases. The paper uses a form of Histogram known as Color Difference Histogram (CDH) for Content Based Image Retrieval. The main essence of CDH is that it takes into account the perceptually uniform color difference between two points under different background in accordance with the color and the edge orientations. Results show that CDH is noise invariant upto 40% of Gaussian and 50% of Uniform noise. It gives accurate results even if the query image is degraded by additive noise components.

Keywords- Noise models; image retrieval; Gaussian noise; Uniform noise; CDH

I. INTRODUCTION

Because of increasing size of image database, retrieval of desired image becomes essential. Traditionally images were retrieved through simple process of text based search known as Text Based Image Retrieval [1]. These methods suffer with the problem of never ending annotations and less accurate results. In order the remove these shortcomings we moved towards Content Based Image Retrieval (CBIR) [2]. CBIR is the process of retrieving images from a collection on the basis of features such as colour, texture and shape automatically extracted from the images themselves. It means that the search makes use the content of the image itself.

In CBIR System searches the similarities in the images. These similarities are usually the images features such as color, texture and shape. The content from the images can be extracted as various content features such as Mean color, Color Histogram [3], Color moments [4], Color correlograms[5] etc. This is done to take the responsibility of forming the query away from the user. Now each image will now be described by its own features.

Out of various methods used for feature extraction Histograms are proved to be one of the most successful image comparison tool for retrieval purposes [6]. Histograms If two images have similar histograms they are considered to be visually similar and vice-versa. In general the Histograms plots the frequency of each color in an image.

It has been observed that the performance of the CBIR techniques is affected by the presence of noise in the images. That is the Histograms are sensitive to additive noise and thereby reduces the accuracy of the retrieval system. But in case of digital imaging it is nearly impossible to avoid noise. Therefore it is necessary to develop a robust system which can perform equally well in presence of noise component in the images.

The occurrence of noise in digital images is degradation occurred during image acquisition process or during image transmission. The sensors used for capturing images can give undesired output due to variety of reasons such as environmental condition during image acquisition or by the quality of the sensing element themselves. The principal reason of noise is due to interfering in the channel which is used for the images transmission [7].

$$g(x,y) = f(x,y) + \eta(x,y)$$

Where, $f(x, y)$ is the original image pixel, $\eta(x, y)$ is the noise term and $g(x, y)$ is the resulting noisy pixel

Equation (1) represents a general equation of an image with additive noise.

In this paper we present a Histogram based image retrieval method called Color Difference Histogram, [8] which practically is unaffected up till 40% of Gaussian noise and 50% of Uniform noise. The main aim of the paper is to present an algorithm which exploits both the color and texture features of an image in one histogram and is invariant to the additive noise in the query images.

II. NOISE MODELS [9]

Following are the various Noise models:

A. Unifrom Noise:

When a 3-dimensional scene is captured as a 2-dimensional image the pixel values are quantized into different level, this process is known as quantization. The noise cause by quantizing the pixels of image to a number of distinct levels is known as quantization noise or uniform noise. It has approximately uniform distribution. Uniform noise can be used to generate any different type of noise distribution. This noise is often used to degrade images for the evaluation of image restoration algorithms. This noise provides the most neutral or unbiased noise.

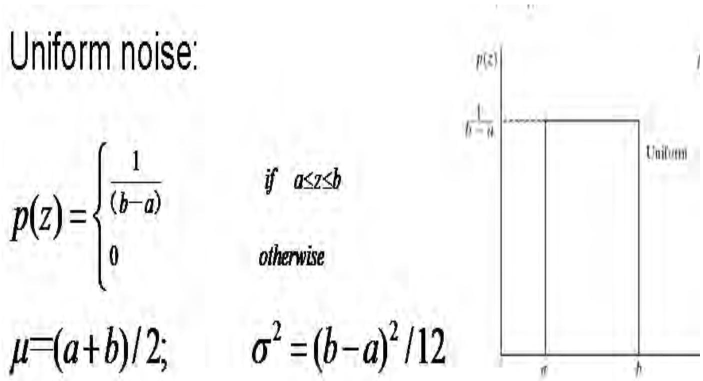

Figure 1 Probability Density Function of Uniform Noise

B. Gaussian Noise:

This noise has a probability density function of the normal distribution. It is also known as Gaussian distribution. It is a major part of the read noise of an image sensor that is of the constant level of noise in the dark areas of the image.

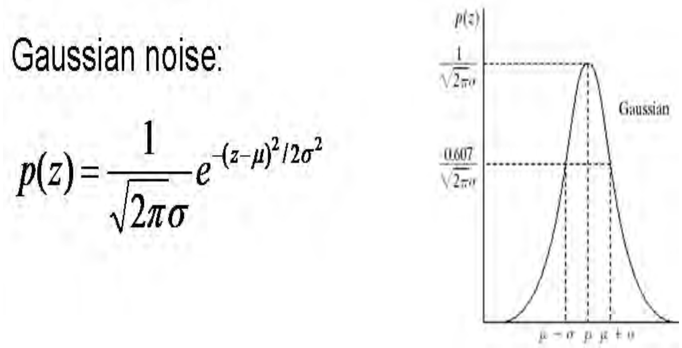

Figure 2 Probability Density Function of Gaussian Noise

Salt and Pepper Noise:

The salt-and-pepper noise are also called shot noise, impulse noise or spike noise that is usually caused by faulty memory locations, malfunctioning pixel elements in the camera sensors, or there can be timing errors in the process of digitization. In the salt and pepper noise there are only two possible values exists that is a and b and the probability of each is less than 0.2. If the numbers greater than this numbers the noise will swamp out image. For 8-bit image the typical value for 255 for salt-noise and pepper noise is 0. [10]

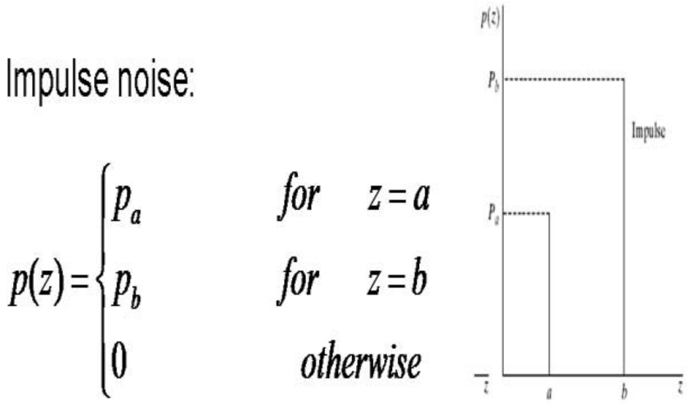

Figure 3 Probability Density Function of Impulse noise

C. Rayleigh Noise

Radar range and velocity images typically contain noise that can be modeled by the Rayleigh distribution.

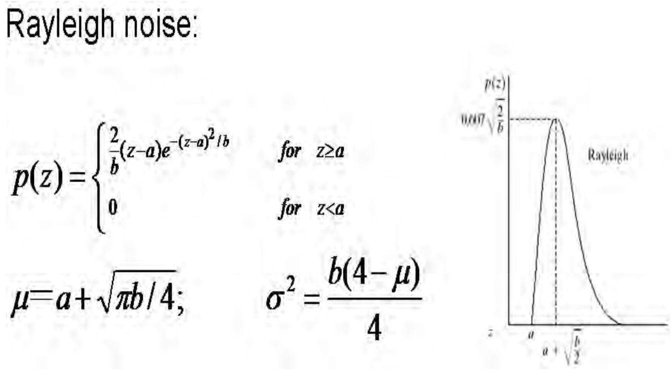

Figure 4 Probabilty Density Function of rayleigh Noise

D. Gamma Noise

The noise can be obtained by the low-pass filtering of laser based images.

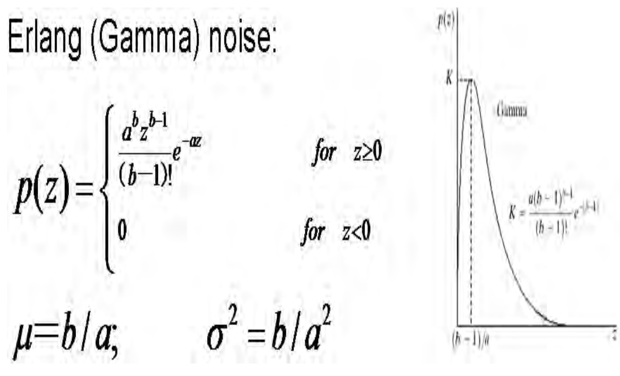

Figure 5: Probabilty Density Function of Gamma Noise

III. COLOR DIFFERENCE HISTOGRAM

The essence of CDH is to combine the color and the texture feature extraction in a single algorithm to make programming effort easier and less time consuming. Some algorithms can ultimately combine color and texture together these include the color edge co-occurrence histogram integrative co-occurrence matrices, the Texton co-occurrences matrix, the micro-structure descriptor and the multi-Texton histogram [11].

This paper uses a histogram generation algorithm known as CDH. The beauty of the algorithm is that it adopts the perceptually uniform color difference between two points under different color and edge-orientation backgrounds for image representation. In simple words it combines both color and edge orientation present in a digital image as the feature for comparison [12, 13].

The following points illustrate the method of plotting Color Difference Histogram.

a) Convert the image From RGB to L*a*b* space.
b) Compute edge Quantization in L*a*b* space.
c) Compute Color Quantization in L*a*b* space
d) Compute 108-dimensional feature vector from the results obtained in step (a) and (b).
e) Plot the Histogram

IV. EXPERIMENTAL RESULTS

A. Datasets:

The database used consists of 200 images divided into 10 groups. Each group consists of 20 similar images. Initially the representatives are selected by visually examining the images in the groups. The experiment is conducted on two noise models namely Gaussian and uniform noise, and fed as an input image to the system. It is assumed that the query image is degraded by only additive noise component.

Figure 6-8 shows the process of retrieving similar images using CDH. Figure 9 and 10 shows the addition of noise in the query image through Adobe Photoshop. Figures from 11-14 shows various corrupted images and there corresponding Color Difference Histograms.

We here assume that the query image is degraded only by the additive noise term. All other forms of degradations are considered to be negligible.

B. Snap Shots:

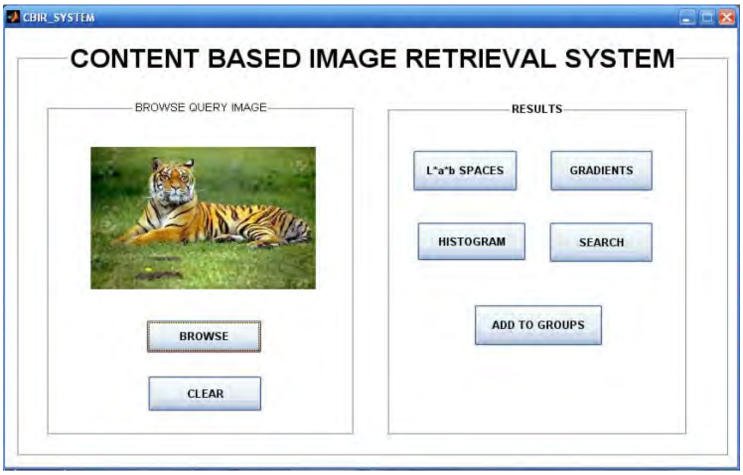

Figure 6 Browsing a noise free query image

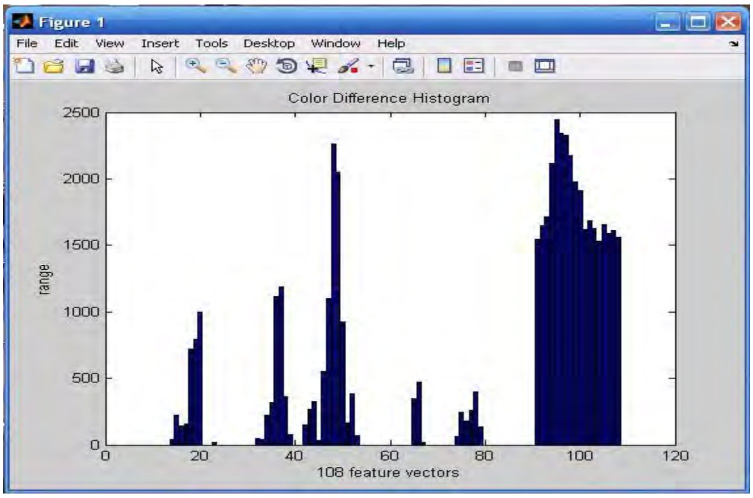

Figure 7 Color Difference Histogram of Query Image

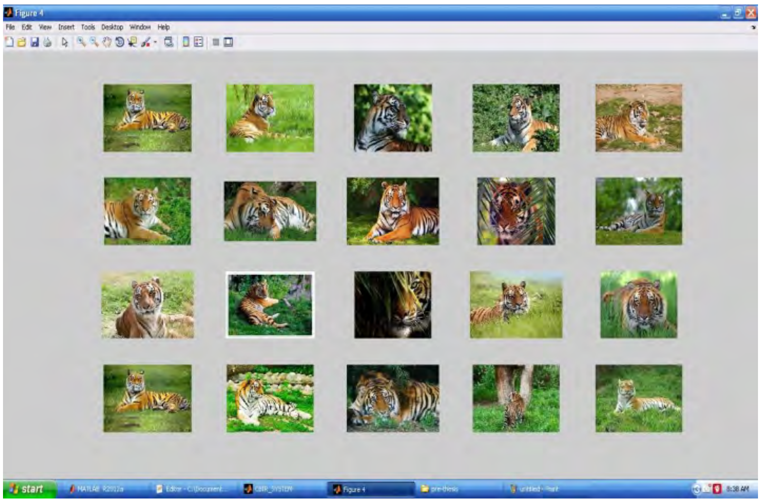

Figure 8 Searched Results

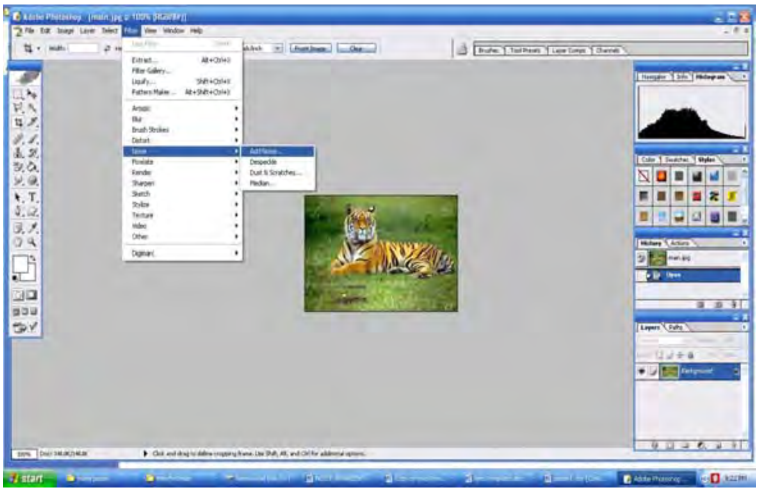

Figure 9 Editing Query Image in Adobe Photoshop

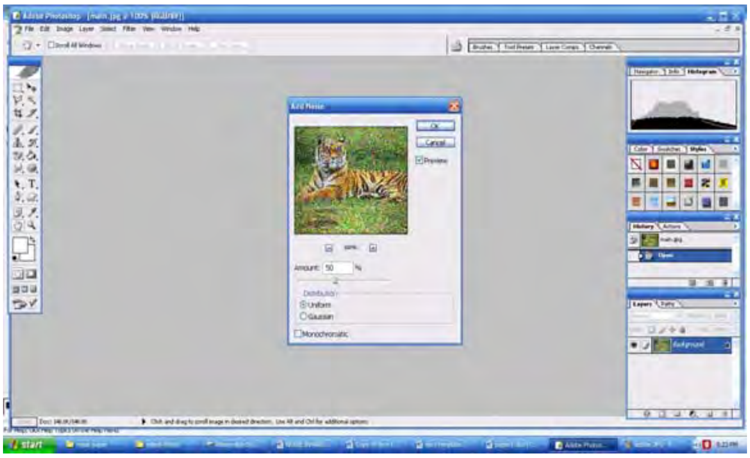

Figure 10 Adding 50% Uniform Noise

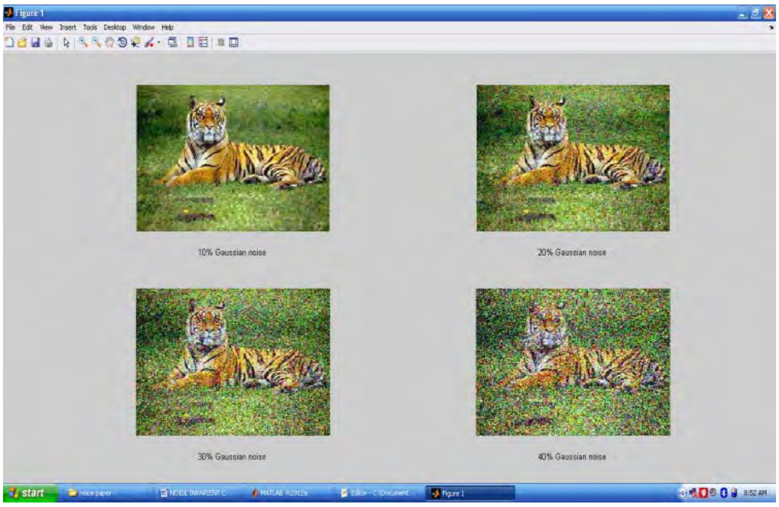

Figure 11 Query images with 10, 20, 30 and 40% Gaussian Noise

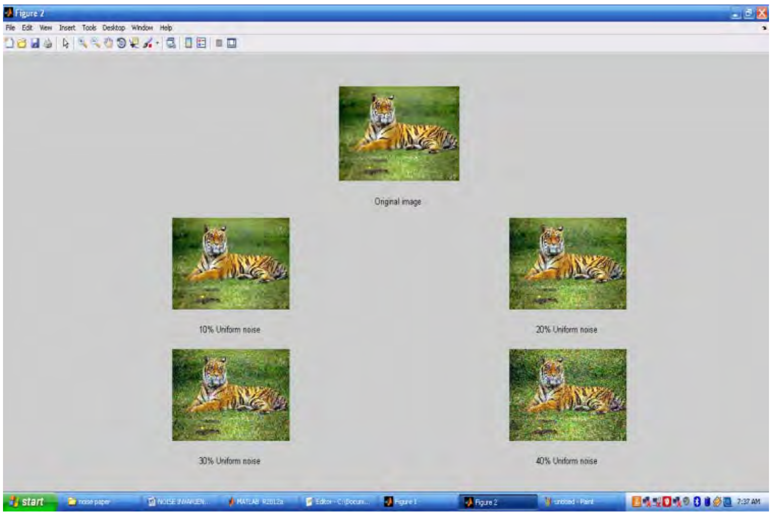

Figure 12 Query images with 10, 20, 30, 40 and 50% of Uniform Noise

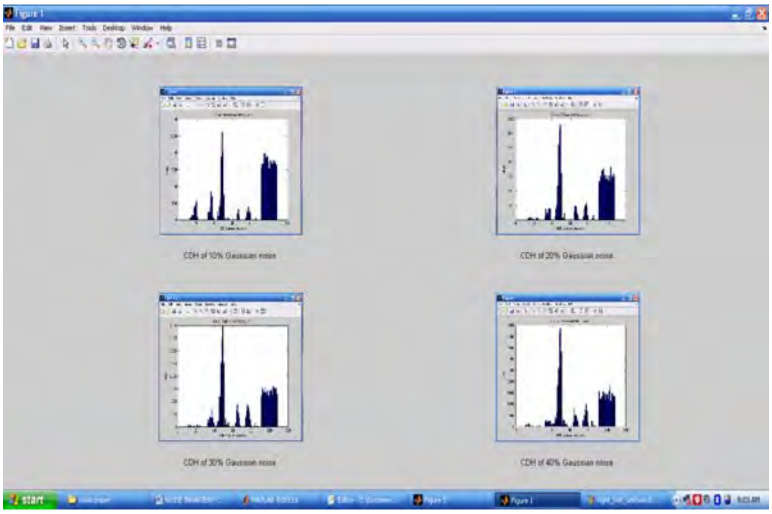

Figure 13 CDH of query images with Gaussian Noise

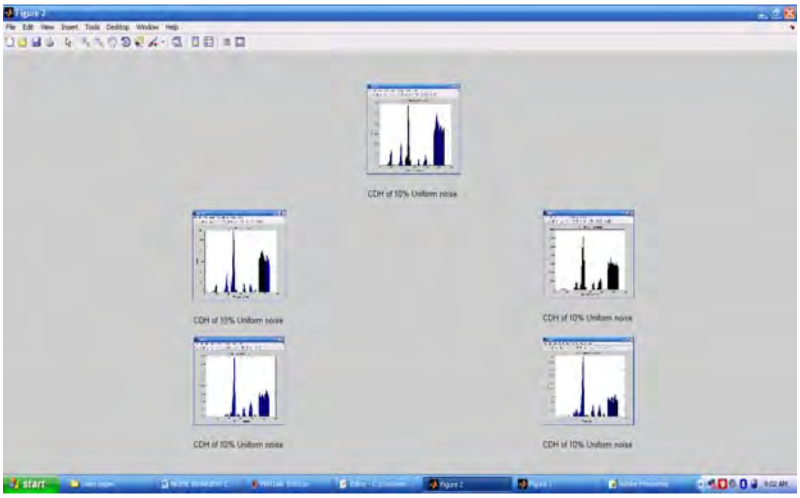

Figure 14 CDH of Query image with Uniform Noise

V. CONCLUSION

The paper presents an approach which is invariant to 40% Gaussian and 50% of uniform noise in the query image. The aim of the paper is to present a novel method which can handle noise degraded query image for retrieval purposes. The color difference histogram uses L*a*b* color space which is perceptually uniform to human visual system. It can recognize upto 90 colors that are extracted from the image as a 90-dimensional color vector and plotted as histogram keeping the orientation constant. Similarly it calculates 18-dimensional edge vector together with color vector it generates a 108-dimensional vector which is robust enough to retrieve visually similar images from the database even if the query image is degraded by noise component

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