Image Enhancement Of Under Water Images Using Structured Preserving Noise Reduction Algorithm

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Abstract**—**This paper presents SUSAN (Structure Preserving Noise Reduction algorithm) for gray scale images contaminated by traditional median noise. Remote sensing images are affected by different types of noise like Gaussian noise, Speckle noise and impulse noise. These noises are introduced into the under water images during acquisition or transmission process. In this paper traditional median filter and structured preserving noise reduction Algorithm is used for reduce the noise rate, when compare to this filter and SUSAN Algorithm, Structured Preserving Noise Reduction gives better results.

Keywords**—**Traditional median filter, structure preserving noise reduction algorithm.

I. Introduction

Noise can be systematically introduced into images during acquisition and transmission process. There are several ways through which noise can be introduced into an image depending on how the image is created. Noise can be defined as any disturbance that changes the original signal information. Image noise is a random, usually unwanted variation in brightness or color information in an image[1]. Image data recorded by sensors on a satellite or aircraft contain errors related to geometry and brightness values of the pixels. These errors are corrected using suitable(filters) mathematical models. There are so many filters can be used to reduce noise 1) Weighted Median Filter 2) Standard Median Filter 3)Adaptive Median filter. Weighted Median Filter(WMF) is more flexible in preserving the image structure than a median filter. Weighted Median Filter(WMF) is a natural extension of the median filter and has the same advantage of the median filter. Median filter is a simple and powerfu non-linear filter, based order statistics and easy to implement method of smoothing image.

That is reducing the amount of intensity variation between one pixel and the next. It is often used to reduce noise in images[2]. Standard Median Filter(SMF) is a non-linear, low pass filtering method which can be used to remove speckle noise from an image. Standard Median Filter(SMF) is a simple rank selection filter that attempts to remove noise from image by changing the luminance values of the center pixel of the filtering window[3]. Adaptive Median Filter(AMF) has been applied widely as an advance method compared with standard median filter. Adaptive Median Filter perform spatial processing to determine which pixels in an image have been applied by impulse noise. Adaptive Median Filter classifies pixels as noise by comparing each pixel in the image to its surrounding neighbour pixel. The size of the neighborhood is adjustable as well as the threshold for the comparisson[4]. Adaptive Median Filter(AMF) is designed to eliminate the problems faced by the standard median filter. In this paper traditional median filter and Structured Preserving Noise Reduction Algorithm is used for reduce the noise rate, when compare to this filter with proposed algorithm.

II. Methodology

Noise removal is one of the techniques in image processing. Here our proposed work is represented the architecture shown the fig-1.

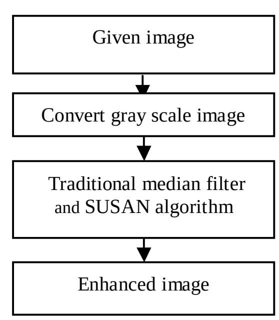

Fig-1 system architecture.

2.1 NOISES IN IMAGES

There are various types of noise in image that can corrupt images. Some of the noise are gaussian noise, speckle noise and salt and pepper.

A. GAUSSIAN NOISE

This type of noise is also called the normal noise is randomly occurs as white intensity values. Gaussian distribution noise can be expressed by

$$P(x) = 1/ (\sigma\sqrt{2\pi}) * e^{(x-\mu)2} /2\sigma^2$$

When P(x) is the Gaussian distribution noise in image, μ and σ is the mean and standard deviation respectively.

B. SPECKLE NOISE

Speckle noise is a ubiquitous that limits the interpretation of optical coherence of remote under water image. The noise can be expressed by

$$J = I + n*I$$

Where J is the distributed speckle noise image, I is the input image and n is the uniform image.

C. SALT & PEPPER NOISE

This type of noise contains random occurrences of both black & white intensity values, and often caused by threshold of noise image. Salt & Pepper distribution noise can be expressed by

$$P(x) = \begin{cases} p1, & x = A \\ p2, & x = B \\ 0, & otherwise \end{cases}$$

Where P_1, P_2 are the Probabilities Density Function (PDF) p(x) is distribution salt and pepper noise in image and A, B are the array size image. In this paper salt & pepper noise in image is randomly occurred in white and black pixels of an image[5]. The main challenge in removing salt & pepper noise from image is due to the fact that image data as well as the noise, share the same small set of values, which complicates the process of detecting and removing the noise.

2.2 TRADITIONAL MEDIAN FILTER

There have been several variation on the median filter for example the Weighted Median Filter(WMF) selectively gives the neighbouring pixels multiple entries to the ordered list, usually with the centre pixels of the neighbourhood contributing more entries. The higher the weighting given to the central pixels, the better filter is at preserving corners, but less the smoothing effects [2]. The other methods include the Standard Median Filter (SMF) and Adaptive Median Filter (AMF). Standard Median Filter(SMF) is a non-linear, low pass filtering method which can be used to remove speckle noise from an image. Standard Median Filter(SMF) is a simple rank selection filter that attempts to remove noise from image by changing the luminance values of the center pixel of the filtering window[6]. Adaptive Median Filter(AMF) has been applied widely as an advance method compared with standard median filter. Adaptive Median Filter perform spatial processing to determine which pixels in an image have been applied by impulse noise. Adaptive Median Filter classifies pixels as noise by comparing each pixel in the image to its surrounding neighbour pixel. The size of the neighborhood is adjustable as well as the threshold for the comparisson.

Adaptive Median Filter(AMF) is designed to eliminate the problems faced by the standard median filter[7]. Median Filter is one of the most popular nonlinear filters for removing salt & pepper noise [5]. Median filter is the non-linear filter which changes the image intensity value if the spatial noise distribution in the image is not symmetrically within the window. It is useful for removing isolated lines or pixels while preserving spatial resolutions. Median filter is a spatial filtering operation, so it uses a 2D mask that is applied to each pixel in the input image. To apply the mask means to centre it in a pixel, evaluating the covered pixel brightness and determining which brightness value is the median value. The pixel with the median magnitude is used to replace the pixel.

Median filter = (x1, x2, x3.....xn) = median(x1, x2, x3...xn) There are two classes of median filter such as 1-dimensional and 2-dimensional. We will primarily interest in the 1-D case. In the 1-D case we have an input stream of values x_0, x1, x2 ... which is encoded as 1 bit integers. We denote the window centre on the *i* th value as $W_i = \{x_{i-N} \ldots x_i \ldots x_{i+N}\}$ on each step, oldest element x_{i-N} must be eliminated as new element x_{i+N} arrives [8]. In this paper traditional median filter and SUSAN noise filtering Algorithm is used for reduce the noise rate, when compare to this filter and algorithm SUSAN gives better results.

2.3 SUSAN ALGORITHM

The SUSAN operator was first introduced by smith [11]. SUSAN noise reduction uses nonlinear filtering to reduce noise in an image while preserving the structure of an image. It is a simple and effective approach in image processing specifically edge detection, corner detection, and structured preserving noise reduction. The noise reduction method uses this region as the smoothing neighbourhood. The resulting method is accurate, noise resistant and fast. The SUSAN noise reduction filter achieves this by applying a correlation function to calculate the similarity of the brightness of a pixel to be filtered with a neighbourhood defined by fixed d convolution mask.

$$c(p,p_0) = \left(\frac{I(p)-I(p_0)}{t}\right)^2$$

In this equation $c(p,p_0)$ represents the Gaussian correlation function where called the nucleus $p_0 = (x_0,y_0)$ is the pixel which is going to be filtered, p = (x, y) is a pixel which belongs to the convolution mask around the nucleus, and t is the brightness threshold which controls the width of the Gaussian. In the spatial domain, SUSAN filter also makes use of a Gaussian weighting. Over all equation of the filter is given by

$$I`p_0 = \frac{\sum_{p \neq p_0} I(p).e^{-\frac{r^2}{2\sigma^2}-\left(\frac{I(p)-I(p_0)}{t}\right)^2}}{\sum_{p \neq p_0} e^{-\frac{r^2}{2\sigma^2}-\left(\frac{I(p)-I(p_0)}{t}\right)^2}}$$

I(x, y) is the brightness of the pixel before filtering, I`(x, y) is the filtered brightness, and σ determine the spatial Gaussian weighing [9][10]. The salt and pepper noise was created by choosing a fraction of the image to corrupt and then setting the pixels to be corrupted to random brightness in the range 0 to 255. The filter clearly integrates the best aspects of the existing noise reduction and it gives the very good results.

III. DATASET DESCRIPTION

The underwater objects are generally blurred due to various factors such as light absorption, light reflection, light blending, light scattering and denser medium of light [6,7]. These factors cause the poor visibility of light under the sea. In addition to these factors Power efficiency is also becomes challenging issue for achieving the good visibility over underwater [8]. Most of the computer vision method based on stereo triangulation cannot be employed directly on underwater [9]. When capturing image using sensors, the resulting image may contain noise from dirtiness on the image data acquisition process. So in this paper, we are analysing a under water images. It should be downloaded from www. Google.com. The sample image is listed given below.

Fig-1 Sample image

IV. RESULTS

The figure -2 shows the experimental results of the proposed work. The proposed work is done using MATLAB. 2010version.

Fig-2 Gray scale image

Fig-3 Results of Median Filter

Fig-4 Results of SUSAN Algorithm

V. CONCLUSIONS

This paper has described a new principle of noise reduction while preserving the image structure. Under water image when captured usually have Gaussian noise, speckle noise and salt & pepper noise. SUSAN filter works well at reducing noise while preserving the underlying structure of an image although it does have difficulty in certain situation. SUSAN performed large amount of noise, it completely to reduce either small or large amount of “Salt & Pepper” noise.

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