A NEW APPROACH FOR DENOISING UNDERWATER IMAGES

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ABSTRACT
Digital image processing is a part of digital signal processing. Digital image processing has many significant advantages over analog image processing. Image processing allows a much wider range of algorithms to be applied to the input data and can avoid problems such as the build-up of noise and signal distortion during processing of images. In this paper underwater images of ship are taken. different types of noise like salt & pepper, Gaussian and speckle noise are taken and further denoised by filters. Performance of each filter with common types of noise is analyzed by a technique of comparing the mean square error difference and entropy.

KEYWORDS: *Entropy, mean square error difference, speckle noise, salt & pepper noise.*

I. INTRODUCTION

The Earth is an aquatic plant with more than 80% of the surface covered with water, has attracted many earth observers to understand what is lying below water using sonar techniques. SONAR (SOnar NAvigation and Ranging), initially used in submarines during World War II, is increasing being used in earth observations along with various civilian applications, sea-bed imaging, depth sounding and fish-echolocation. Sonar information collected while searching for, or identifying, underwater surfaces is often presented to the operator in the form of a two dimensional images. Sonar images are created using a fan-shaped sonar beam that scans a given area by moving through the water to generate points, which forms high resolution sonar image of the given area. The sonar images thus acquired are often disturbed by various factors like the transmission of limited range of light, disturbance of lightening, low contrast and blurring of image, color diminishing during capturing and noise.The picture quality of an underwater image affected by several factors, e.g. light absorption, turbidity, structure less environment and scattering effects etc[1].

There are some common noises available in underwater images like speckle noise, salt & pepper noise and gaussian noise.[2] The principal source of noise in digital images arises during image acquisition (digitization) and transmission. The performance of imaging sensors is affected by a variety of factors such as environmental conditions during image acquisition and by the quality of the sensing elements themselves. For instance, in acquiring images with a CCD camera, light levels and sensor temperature are major factors affecting the amount of noise in the resulting image.

Image de-noising [3] is a vital image processing task i.e. as a process itself as well as a component in other processes. There are many ways to de-noise an image or a set of data and methods exists. The important property of a good image de- noising model is that it should completely remove noise as far as possible as well as preserve edges. Traditionally, there are two types of models i.e. linear model (mean or averaging filter) and non-linear model(median[5] and wiener filter)[2][9].The benefits of his document describes linear noise removing models is the speed and the limitations of the linear models is, the models are not able to preserve edges of the images in a efficient manner i.e the edges, which are recognized as discontinuities in the image, are smeared out. On the other hand, Non-linear models can handle edges in a much better way than linear models.

II. PROPOSED WORK

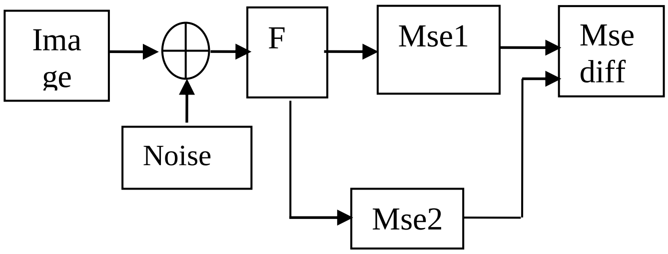

Fig 1.: Block diagram finding the mean square error difference between the mse1(mean square error of original image and filtered image) and mse2(mean square error of noisy image and original image).

There are some common noise available in underwater images like speckle noise, salt & pepper noise and gaussian noise. The principal source of noise in digital images arises during image acquisition (digitization) and transmission. For instance, in acquiring images light levels and sensor temperature are major factors affecting the amount of noise in the resulting image. In the proposed work, the underwater images are pre-processed initially. Noise is added to the pre-processed image and then filtered. Mean square error of original image and filtered image is calculated as mse1.Mean square error of noisy image and filtered image is calculated as mse2.the difference of these two mse1 and mse2 is computed as msediff. Performance of mse difference and entropy is done. This is done for different noises –salt & pepper noise, speckle noise and Gaussian noise with linear and nonlinear filters like averaging filter, median filter and wiener filter. From the above performance it can be seen that that median filter works well for salt & pepper noise and wiener filter works well for speckle noise. This method improved the quality of images as well as the performance is improved.

III. DESIGN AND IMPLEMENTATION

3.1 Design

3.1.1 Gaussian Noise

The probability density function P of a Gaussian random variable z is given by:

$$P_G(z) = \frac{1}{\sigma sqrt(2\pi)} e^{\frac{-(z-\mu)^2}{2\sigma^2}}. \quad (1)$$

where z represents the grey level, μ the mean value and **σ** the standard deviation.

3.1.2 Salt & pepper Noise

The probability density function p of a salt & pepper noise is given by

$$P(z) = \begin{cases} P_a & \text{for } z=a \\ P_b & \text{for } z=b \\ 0 & \text{otherwise} \end{cases} \quad (2)$$

3.1.3 Speckle Noise

Speckle noise is a granular noise that inherently exists in and degrades the quality of the active radar and synthetic aperture radar (SAR) images. Speckle noise in conventional radar results from random fluctuations in the return signal from an object that is no bigger than a single image-processing element. It increases the mean grey level of a local area. Speckle noise in SAR is generally more serious, causing difficulties for image interpretation. It is caused by coherent processing of backscattered signals from multiple distributed targets. In SAR oceanography, for example, speckle noise is caused by signals from elementary scatters, the gravity-capillary ripples, and manifests as a pedestal image, beneath the image of the sea waves. Modeled by random values multiplied by pixel vales of the image. It increases the mean grey level of a local area. Speckle noise in SAR is generally more serious, causing difficulties for image interpretation. It is caused by coherent processing of backscattered signals from multiple distributed targets. In SAR oceanography [5], for example, speckle noise is caused by signals from elementary scatters, the gravity-capillary ripples, and manifests as a pedestal image, beneath the image of the sea waves.

3.1.4. Mean square Error:

$$MSE=\frac{1}{MN}\sum_1^M \sum_1^N \left(f1(i,j) - f2(i,j)\right)^2 \quad (3)$$

3.1.5. Entropy:

E=-sum(p.*log2(p)) (4)

3.1.6 Peak Signal to Noise ratio (PSNR):

$$PSNR= 10 \log \frac{255\text{^}2}{MSE} \quad (5)$$

3.2 Implementation:

Autonomous Underwater Vehicles (AUVs) are programmable, robotic vehicles that, depending on their design, can drift, drive, or glide through the ocean without real-time control by human operators. Some AUVs communicate with operators periodically or continuously through satellite signals or underwater acoustic beacons to permit some level of control. AUVs allow scientists to conduct other experiments from a surface ship while the vehicle is off collecting data elsewhere on the surface or in the deep ocean. Some AUVs can also make decisions on their own, changing their mission profile based on environmental data they receive through sensors while under way.

Fig 2

Fig 3

IV. RESULTS & DISCUSSION

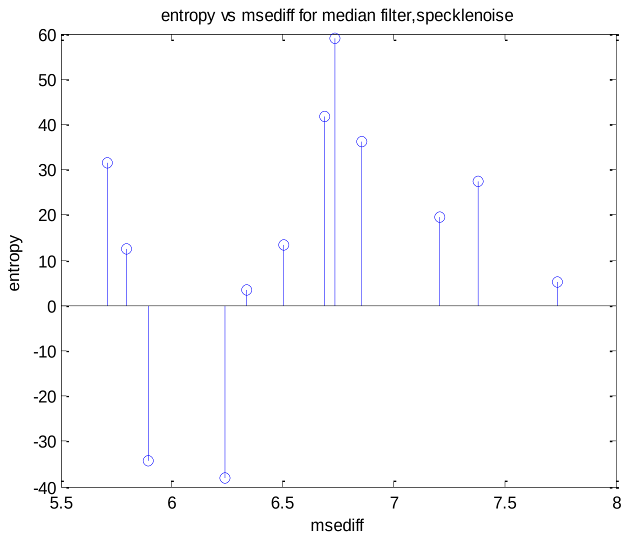

Fig 4: Entropy vs. msediff (median filter, speckle noise).

In the above figure mean square error difference is plotted with entropy. Mean Square error difference is the difference between two mse1 and mse2. Mse1 is the mean square error of original image and filtered (median filter) image and mse2 is the mean square error of original image and noisy image(speckle noise).

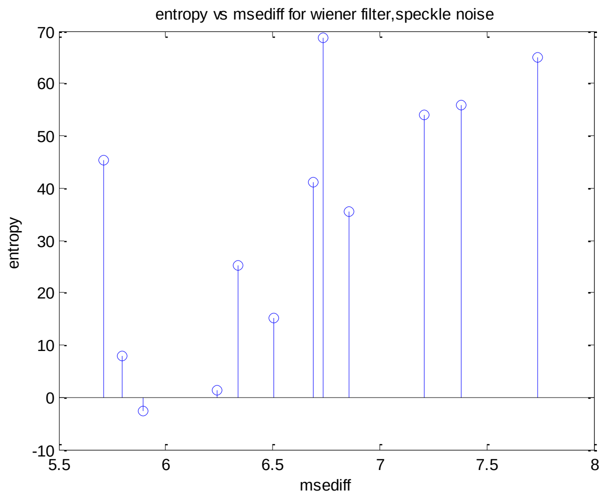

Fig 5: Entropy vs. msediff (wiener filter, speckle noise).

In the above figure mean square error difference is plotted with entropy. Mean Square error difference is the difference between two mse1 and mse2. Mse1 is the mean square error of original image and filtered (wiener filter) image.and mse2 is the mean square error of original image and noisy image(speckle noise).

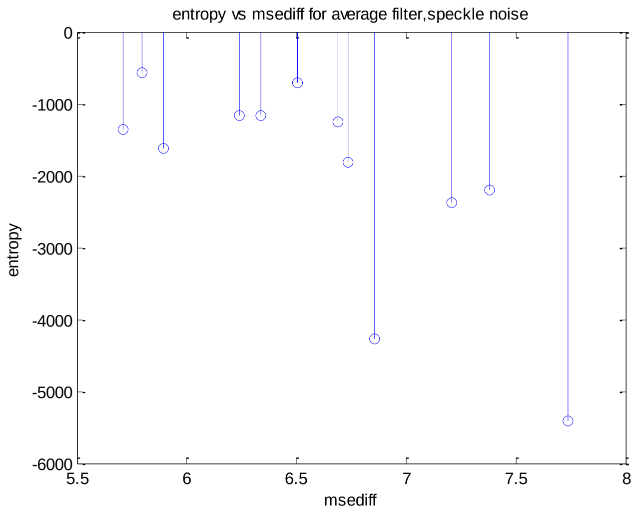

Fig 6: Entropy vs. msediff (average filter, speckle noise)

In the above figure mean square error difference is plotted with entropy. Mean Square error difference is the difference between two mse1 and mse2. Mse1 is the mean square error of original image and filtered (average filter) image and mse2 is the mean square error of original image and noisy image(speckle noise).

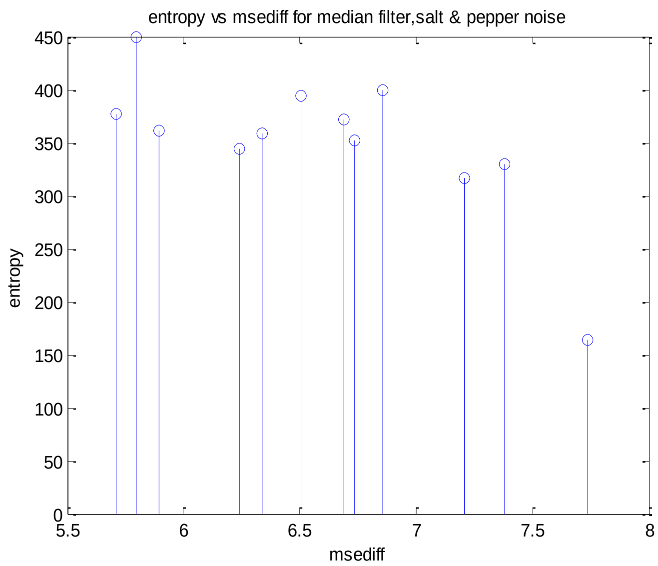

Fig 7: Entropy vs. msediff (median filter, salt & pepper)

In the above figure mean square error difference is plotted with entropy. Mean Square error difference is the difference between two mse1 and mse2. Mse1 is the mean square error of original image and filtered (median filter) image and mse2 is the mean square error of original image and noisy image(salt & pepper noise).

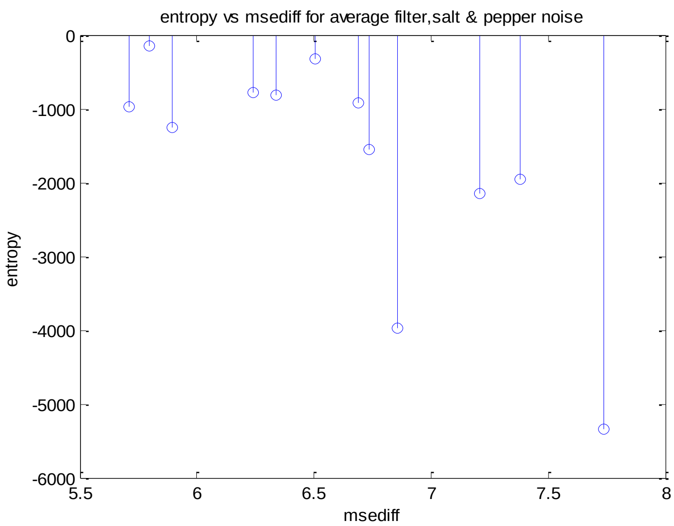

Fig 8: Entropy vs. msediff (average filter, salt & pepper)

In the above figure mean square error difference is plotted with entropy. Mean Square error difference is the difference between two mse1 and mse2. Mse1 is the mean square error of original image and filtered (average filter) image and mse2 is the mean square error of original image and noisy image(salt & pepper noise).

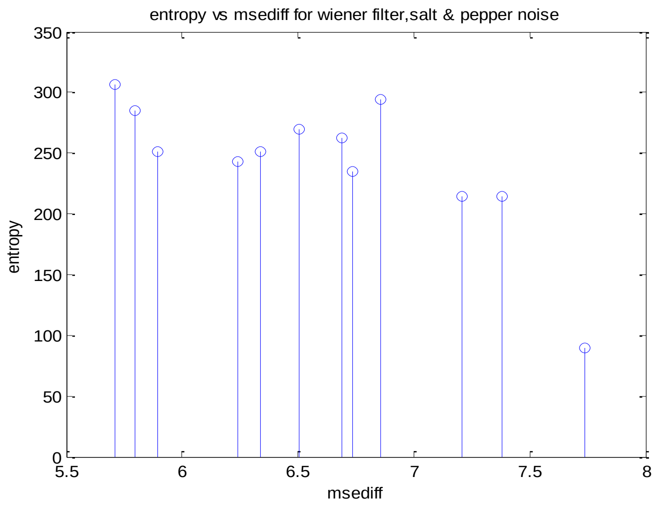

Fig 9: Entropy vs. msediff (wiener filter, salt & pepper)

In the above figure mean square error difference is plotted with entropy. Mean Square error difference is the difference between two mse1 and mse2. Mse1 is the mean square error of original image and filtered (wiener filter) image and mse2 is the mean square error of original image and noisy image(salt & pepper noise).

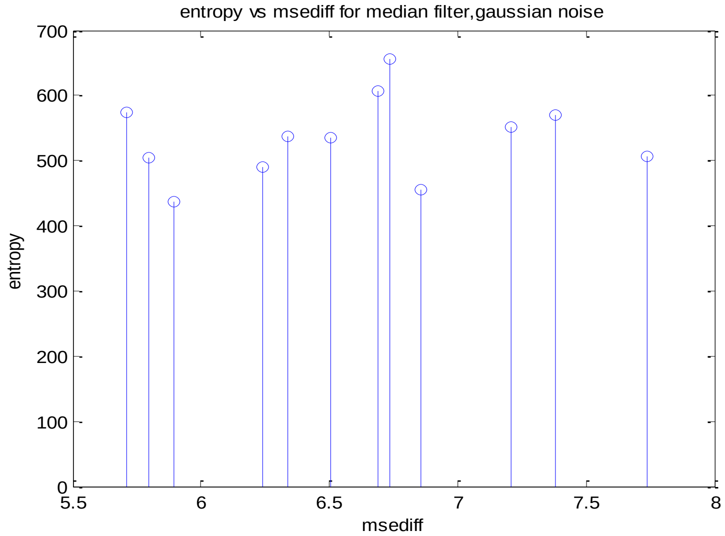

Fig 10: Entropy vs. msediff (median filter, Gaussian noise).

In the above figure mean square error difference is plotted with entropy. Mean Square error difference is the difference between two mse1 and mse2. Mse1 is the mean square error of original image and filtered(median filter) image and mse2 is the mean square error of original image and noisy image(Gaussian noise).

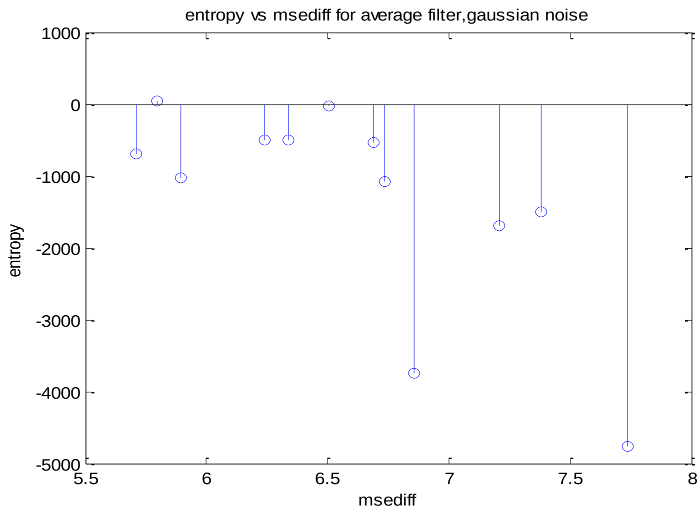

Fig 11: Entropy vs. msediff (average filter, Gaussian noise).

In the above figure mean square error difference is plotted with entropy. Mean Square error difference is the difference between two mse1 and mse2. Mse1 is the mean square error of original image and filtered (wiener filter) image and mse2 is the mean square error of original image and noisy image(Gaussian noise).

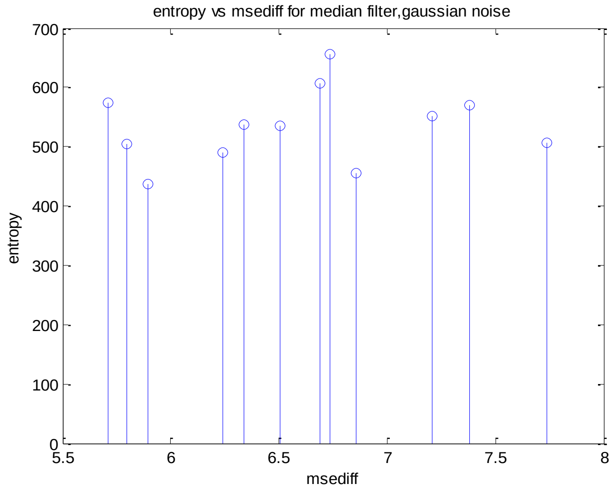

Fig 12: Entropy vs. msediff (median filter, Gaussian noise)

In the above figure mean square error difference is plotted with entropy. Mean Square error difference is the difference between two mse1 and mse2. Mse1 is the mean square error of original image and filtered(median filter) image and mse2 is the mean square error of original image and noisy image(Gaussian noise).

V. CONCLUSION

Twelve underwater images are taken as test images to perform filtering techniques to remove the common types of noise like Gaussian noise, salt & pepper noise and speckle noise. From the plots of entropy and msediff we can conclude that median filter works well for salt and pepper noise and wiener filter works well for speckle noise. This method improved the quality of images.

VI. FUTURE SCOPE

We can observe that the linear filters and nonlinear filters can remove noise from small area objects and homogeneous areas but not in heterogeneous areas. Hence adaptive filters are used.

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AUTHOR PROFILE

Azra Jeelani received the B.E. and M.Tech. Degree in Electronics & communication Engineering. Has a teaching experience of 11 years.Presently working as associate professor in M.S.Engineering College, Bangalore, India. In my teaching career I have taught subjects relation to communication and image processing.