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Classification of Noise in Sonar Images Using Artificial Neural Network.

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ABSTRACT

Noise image classification is predominant in any digital image processing algorithms, which helps in identifying the filters to smooth the image for further processing. An Artificial Neural Network (ANN) based approach is proposed in this paper for noise image classification. In order to evaluate the proposed system various types of noises such as Gaussian noise, speckle noise impulse noise and combination of Gaussian and Speckle noise are added with input images. Then statistical moment features such as mean, standard deviation, skewness and kurtosis are extracted from the noise added images. Finally, noise image classification performed by applying extracted statistical features into neural network classifier, it provides better results for noise image classification.
Keywords: sonar, neural network, statistical moment, noise identification

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INTRODUCTION

Sonar (originally an acronym for Sound Navigation and Ranging) is a technique that uses sound propagation (usually underwater, as in submarine navigation) to navigate, communicate with or detect objects on or under the surface of the water, such as other vessels. Sound Metrics imaging sonar's transmit sound pulses and convert the returning echoes into digital images, much like a medical ultrasound sonogram. The advantage is that they can "see" what's going on through dark or turbid (cloudy) water in zero visibility conditions. There are different types of noise present in SONAR such as Gaussian, Speckle and impulse [13]. The need for the

Identification is to choose the suitable filters to remove the noise [1].

Types of noise

Generally there are two types of noise present in SONAR image-

Additive Noise

Thermal noise is a random fluctuations present in all electronic systems. The additive noise is primarily caused by thermal noise (fundamental noise), which comes from the reset noise of capacitors. The mathematical model given for additive noise type is:

$$s(i, j) = n(i, j) + h(i, j) \quad (1)$$

Where $1 \leq i \leq M$; $1 \leq j \leq N$.

Let M and N be the size of the original image n(i, j), h(i, j) be the noisy image and S(i,j) is the noisy image [6].

Gaussian noise

Gaussian noise is statistical noise having a probability density function (PDF) equal to that of the normal distribution, which is also known as the Gaussian distribution. In other words, the values that the noise can take on are Gaussian-distributed [7] as illustrated in figure 1.

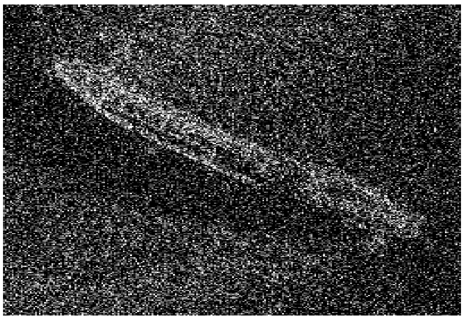

Figure 1: Gaussian noise

Impulse noise

Impulsive noise is sometimes called salt-and-pepper noise or Spike noise. An image containing salt-and-pepper noise will have dark pixels in bright regions and bright pixels in dark regions. This type of noise can be caused by dead pixels [7] as illustrated in figure 2.

Figure 2: Impulse noise

Multiplicative Noise

This noise gives a magnified view of the area and there is a higher random variation observed. On the other hand, when this noise is applied to a darker region in the image, the random variation observed is not that much as compared to that observed in the brighter areas. Thus, this type of noise is signal dependent and distorts the image in a large way. The speckle noise comes under multiplicative noise. This kind of noise is also called as the speckle noise. The mathematical model for multiplicative noise type is

$$s(i, j) = n(i, j) * h(i, j) \quad (2)$$

Where $1 \leq i \leq M$, $1 \leq j \leq N$

Let M and N be the size of the original image n(i, j), h(i, j) be the noisy image and S(i , j) is the noisy image [6].

Speckle Noise

This noise is, in fact, caused by errors in data transmission .The corrupted pixels are either set to the maximum value, which is something like a snow in image or have single bits flipped over [7] as illustrated in figure 3.

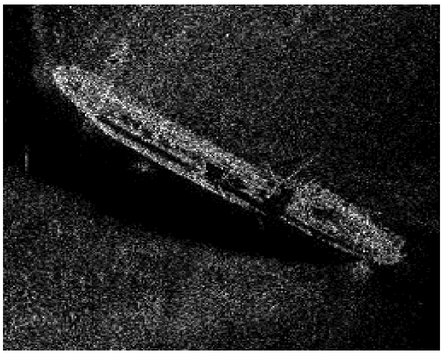

Figure 3: Speckle noise

IDENTIFICATION OF NOISES IN THE IMAGE

Statistical Parameters

There are different parameters present in a sonar images, such as Mean, Standard Deviation, Skewness and Kurtosis, which have different range for different noise and which needs to be calculated for the identification of noise in an image [10].

Mean- Average or mean value of array expand all in page'

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$$\mu = \Sigma xi / n \ (1)$$

where, xi is the ith sampled value of the variable X.

Syntax:-

M = mean(A)example
M = mean(A,dim)example
M = mean(___,type)example [5]

Standard Deviation

Standard deviation is the standardized central moment of the probability distribution:[5]

$$\sigma = \sqrt{\Sigma} \ (xi-x) \ 2/ \ (n-1)$$

Skewness

Skewness is a measure of symmetry, or more precisely, the lack of symmetry. A Distribution, or data set, is symmetric if it looks the same to the left and right of the center point. [5]

$$S = E(X-\mu)3/\sigma3$$

Kurtosis

Kurtosis is a measure of whether the data are peaked or flat relative to a normal distribution. That is, data sets with high kurtosis tend to have a distinct peak near the mean, decline rather rapidly and have heavy tails. Data sets with low kurtosis tend to have a flat top near the mean rather than a sharp peak. A uniform distribution would be the extreme case [5, 12]

$$S = E(X-\mu)4/\sigma4-3$$

Artificial Neural Network

An Artificial Neural Network (ANN), usually called "Neural Network" (NN), is a mathematical model or computational model that tries to simulate the structure and/or functional aspects of biological neural networks given in figure 4. It consists of an interconnected group of artificial neurons and processes information using a connectionist approach to computation. In most cases an ANN is an adaptive system that changes its structure based on external or internal information that flows through the network during the learning phase.

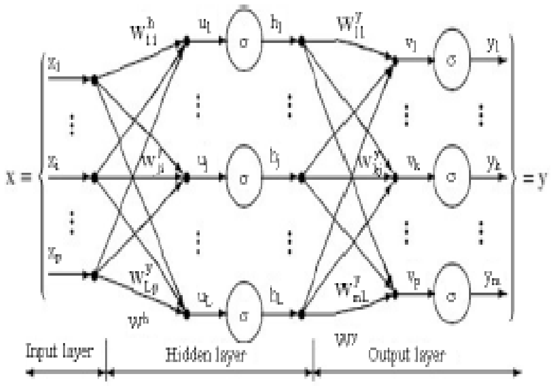

Figure 4: Multilayer perceptron

Neural networks are nonlinear statistical data modelling tools. They can be used to model complex relationships between inputs and outputs or to find patterns in data. Neural network models are essentially simple mathematical models defining a function f: X→Y. Each type of ANN model corresponds to a class of such functions. Neural network is popular because of its learning capability. Learning can be categorized as supervised, unsupervised and recurrent. The cost function C is an important concept in learning, as it is a measure of how far away we are from an optimal solution to the problem that we want to solve. Learning algorithms search through the solution space in order to find a function that has the smallest possible cost. [5]

PROPOSED METHOD

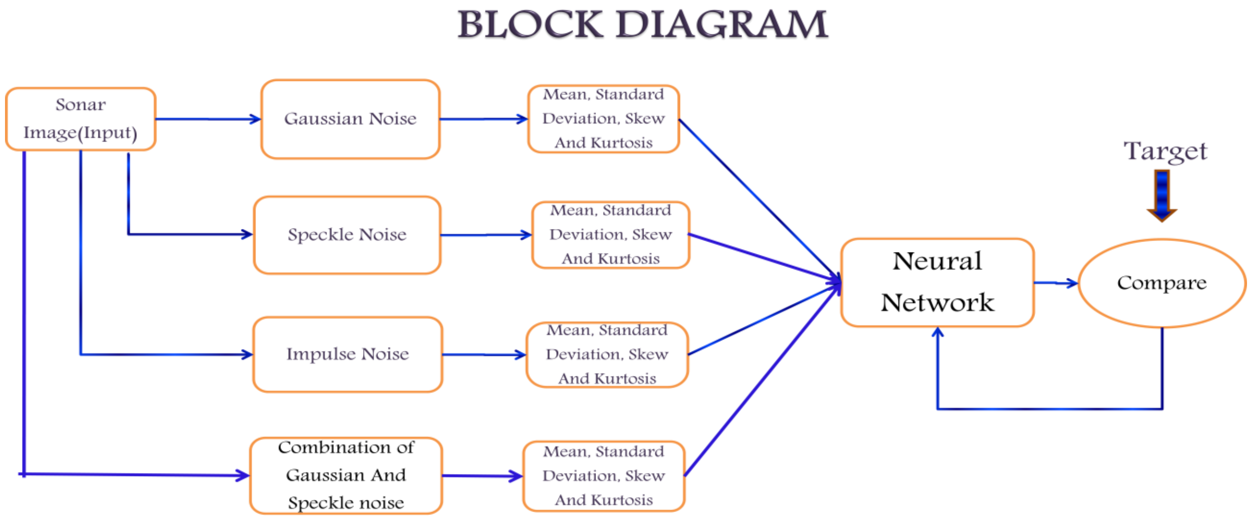

Figure 5: Proposed methodology

Sonar Image is taken as the input image in this methodology. For the input Sonar Images different noises will be added like Gaussian Noise, Speckle Noise and Impulse Noise with different index. Now for all the four noises the statistical features mean, Standard deviation, skew and kurtosis will be calculated. These all statistical parameters will be given to the Artificial Neural Network to train the network. Once the Network is trained then it can be compared with the target images and weights are adjusted as shown in figure 5.

All the statistical parameters are calculated for the different noises present in the images. This process will be done for the different index of noises, means that for different images different percentage of noise are added to it and after that all these statistical parameters will be given to the Artificial Neural Network for training purposes. Once the network is trained then we go for testing part where we are going to take a noisy image and we will calculate all the parameters for that noisy image and will be comparing all that parameters with the previously stored database and identification will be done on that basis.

RESULT AND DISCUSSION

Average Classification Accuracy = 84.3750
Percentage of Speck Noise =75
Percentage of Gaussian Noise =75
Percentage of Impulse Noise =87.5000
Percentage of Speck & Gaussian Noise =100

The given result indicates the percentage of noises present in noisy image which is classified correctly by the artificial neural network.

The use of Artificial Neural Network gives the better accuracy for the noise classification in Sonar images. The accuracy of average classification is 84.3750%, for speckle noise it is 75%, for impulse it is 87.5% and for speckle and Gaussian it is 100%. This work has been tested with the help of matlab 2013b. So, from the result the above result we can say that Artificial Neural Network is the best approach to classify the noise in Sonar image.

CONCLUSION

The use of Artificial Neural Network for noise identification gives more accuracy compared to histogram technique, the reason is here we do not need to assume anything unlike histogram technique and this method is simple in nature.

All experiments will be carried out using Matlab R2013b simulations [9]. Matlab function “imnoise” is used to generate noises in the image and use suitable syntax for Artificial Neural Network.

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