International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 5 Issue 08, August-2016

SVM based Classifier for Noise Classification in Ultrasound B - Mode Images

Sudhamshu Mohan S
IV Sem, M.Tech,
Biomedical Signal Processing and Instrumentation,
Dept. of Electronics and Instrumentation Engineering,
RVCE, Bangalore-560059.

Mr. Harsha
Asst. Professor,
Biomedical Signal Processing and Instrumentation,
Dept. of Electronics and Instrumentation Engineering,
RVCE, Bangalore-560059.

Dr. K V Padmaja
Professor and Associate Dean
Dept. of Electronics and Instrumentation Engineering
RVCE, Bangalore-560059

***Abstract* — It is a renowned fact that noise degrades the visual evaluation in ultrasound imaging. So characterization and classification of different types of noise becomes inevitable in the process of De-noising. As noise characterization in Ultrasound is subtle and empirical in nature there is no single methodology that works optimally in characterization of noise. As the principal concern of removing noise is to maintain a tradeoff between smoothness and shape preservation, which cannot be ensured, unless there is a sophisticated mechanism for handling different noise. This constraint paved way for many algorithms like Diffusion filters, Time Scaling approach etc. Which mainly smoothens the image based on the requirement which is specific to an image. There is no single methodology which is in dependent of parameters of the input image in its algorithmic approach. As a preliminary step, here is an attempt to design an autonomous system which is based on SVM Classifier in which noise is classified into different types so that each type can be dealt in an optimal way. This work will address the challenge of characterizing noise and deciding the extent of de-noising, there by caters the physician in subsequent analysis.**

Keywords— Speckle noise; Wavelets; Local Pixel Grouping (LPG); Principal Component Analysis (PCA); Diffusion Filter; Support Vector Machines (SVM); Speeded Up Robust Features (SURF); K- means Clustering.

I. INTRODUCTION

Medical ultrasound imaging has been effective for diagnostics of diseases over the past decades due to its non-invasive, harmless and cost-effective characteristics. Along with these considerable advantages, there are few oddities, prominent among them is the noise incurred during image acquisition. As this noise is inevitable, which occurs mainly because of uncontrolled interferences of echoes, which might be due to coherent source and non-coherent detector combination, also due to other motion artifacts. Due to this unavoidable scenario, many algorithms on de-speckling have been proposed.

For instance, Median filtering [1] reduces Poisson noise in images, but it fails to treat analytically the effect of the filter. Further, Lee Filter [2] even though better than Median filter, fails to remove complete noise due to high correlation. Diffusion filters like anisotropic filters, in spite of suppressing speckle noise, fails to preserve edges as it gets blurred. In Wavelet based de-noising sparsity and multiresolution properties of wavelet is harnessed, by controlling the thresholding function for the wavelet coefficients, desired level of noise removal could be achieved [4]. But deciding threshold for wavelet coefficients is a tricky task as it involves a constraint of dependency of analyzing input image parameters. For a better preservation of local structures a pixel and its nearest neighbors are modelled as a vector variable [5], whose training samples are selected from the local window by using block matching based Local Pixel Grouping based on Principal Component Analysis. This greatly helps in getting finest smoothening, but extent of smoothening is once again a concern here.

As no single method has completely able to adapt itself the extent of smoothening as well as the quality of smoothening, this is a SVM based design for self-adapting smoothening, for effective de-noising in ultrasound B-mode images. This method also makes use of a classifier which classifies the input noisy image into different noise categories like 1) Speckle Noise, 2) Random Noise and 3) Salt and Pepper Noise. Based on the output of the classifier appropriate filtering methodology is applied. For instance for dealing with speckle noise here Wavelet based de-noising scheme is selected. Similarly based on the presence of particular type of noise suitable filtering technique should be employed by keeping an eye on the noise reduction parameters like SNR, SSIM and MSE. Thus by training a set of different noised images to the classifier, noise classification can be done optimally here three different sets of images have been trained namely Speckled Images, Salt and Pepper Images and Gaussian Noised Images. As these three sets holistically considers almost all noise model behaviors as the former one is a kind of multiplicative noise, second one being Impulsive and the third is the combination of additive and multiplicative noises. As it is a renowned fact that ultrasound is affected by the variants of multiplicative noise. This approach handles variant multiplicative noises in a sophisticated way Thus by having subtle control on the type of multiplicative noise, the best and optimal filtering technique can be applied in each case.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 5 Issue 08, August-2016

II. METHODOLOGY

A. Types of Multiplicative Noise Models

There are different types of noises that can spoil the coherence of an Ultrasound Image, prominent among them are the following multiplicative noise models they are 1) Speckle Noise 2) Salt and Pepper Noise and 3) Random Noise.

1) Speckle Noise

This is a type of multiplicative noise in which, the probability density function can be modelled as follows:

$$P(x) = \frac{x^{q-1} e^{\frac{-x}{p}}}{(q-1)!\,p^{q}} - - \rightarrow (1)$$

Where x is the random variable under consideration, where p and q are the statistical parameters of the Noise distribution

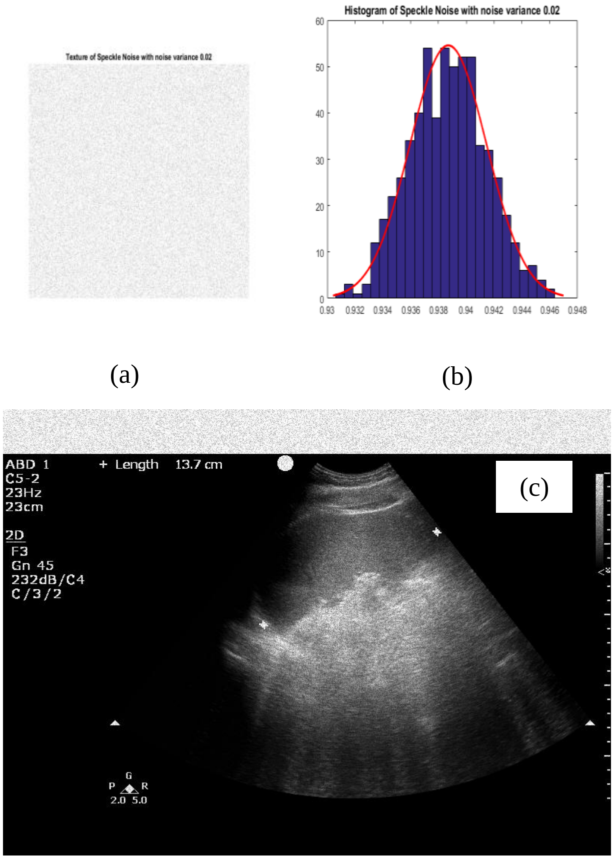


Figure 1: (a) Texture of Speckle Noise with variance 0.02, (b) Histogram for the Speckle Noise (c) Speckled Ultrasound Image

2) Salt and Pepper Noise

This can be viewed as an impulsive noise in which the noise distribution will have impulses added at some pixel locations leading to a texture that resembles salt and pepper in appearance as shown below:

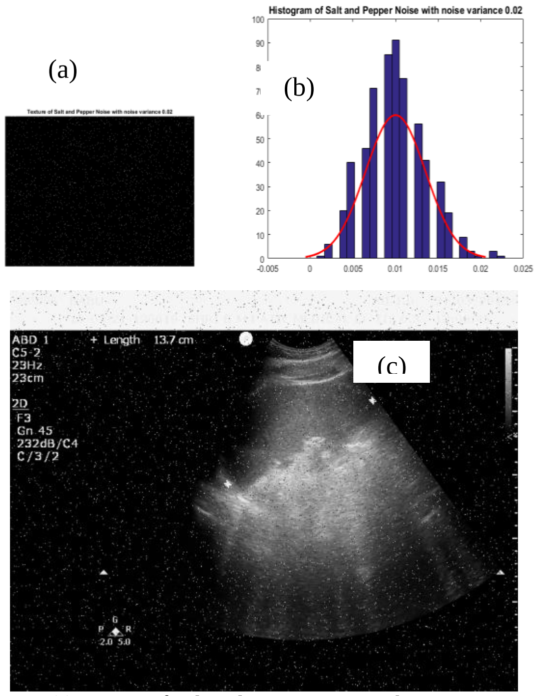


Figure 2: (a) Texture of Salt and Pepper Noise with variance 0.02, (b) Histogram for the Salt and Pepper Noise (c) Salt and Pepper Ultrasound Image

234	59	98
98	**212**	65
121	76	173

234	59	98
98	**0**	65
121	76	173

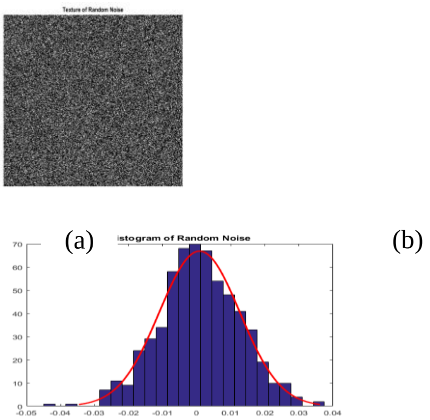
Figure 3: Pixel value corrupted by impulsive noise

3) Random Noise

This type of noise distribution follows Gaussian properties and the probability density function can be expressed as:

$$R(a, b^2) = \frac{1}{\sqrt{2b^2\pi}} e^{-\frac{(x-a)^2}{2b^2}} - - \rightarrow (2)$$

Where a is the mean and b is the standard deviation of the distribution, this is a two parameters based distribution, this is also called Normal Distribution.



International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 5 Issue 08, August-2016

(c)

Figure 4: (a) Texture of Random Noise with variance 0.02, (b) Histogram for the Random Noise (c) Random Noise Added Ultrasound Image

B. SVM Based Classifier

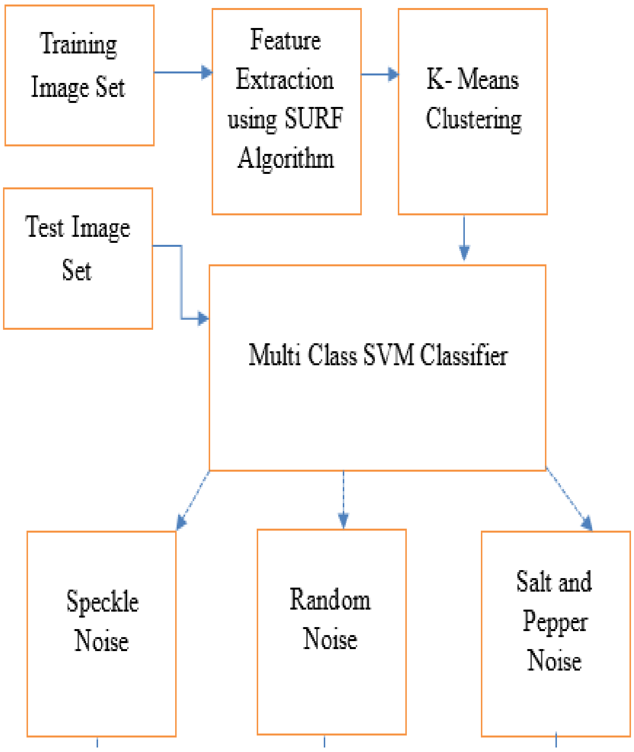


Figure 5: Block Diagram for SVM Based Classifier for Noise Classification

As the above block diagram depicts that given image set is divided into training set, which is used to train the classifier and the test set is used to check the performance of the classifier. In this work, 90 different images which is corrupted by different types of multiplicative noises are used for training classifier. These image set not only ensures that all varieties of Ultrasound B Images will be trained such that the classifier is robust and error free.

The training features that are used for training the classifier is taken from feature set extracted from the SURF {Speeded Up Robust Features} which basically extracts the feature space from Image Space using the bag of words features. Once feature space is evaluated then the best of the features in each image set is calculated, this robust feature set is then considered as the code word library, for further classification.

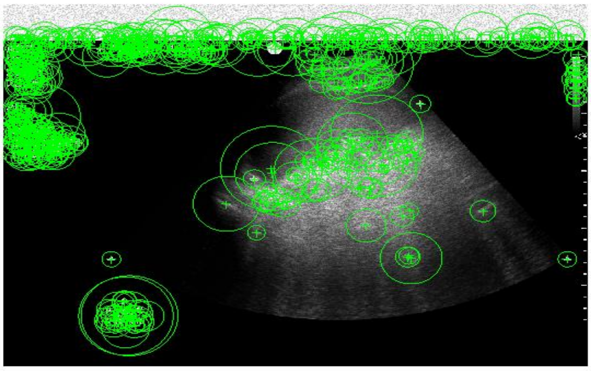


Figure 6: Feature Extraction using SURF Algorithm for a Speckled image

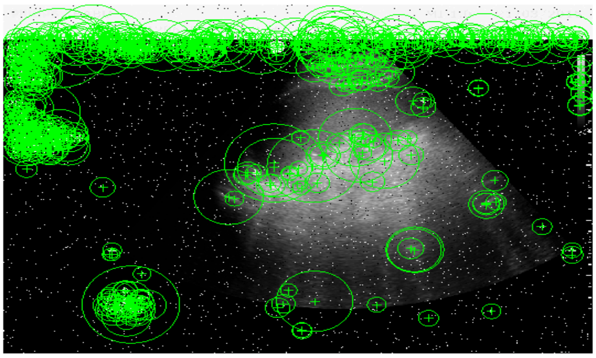


Figure 7: Feature Extraction using SURF Algorithm for a Impulse Noise corrupted image

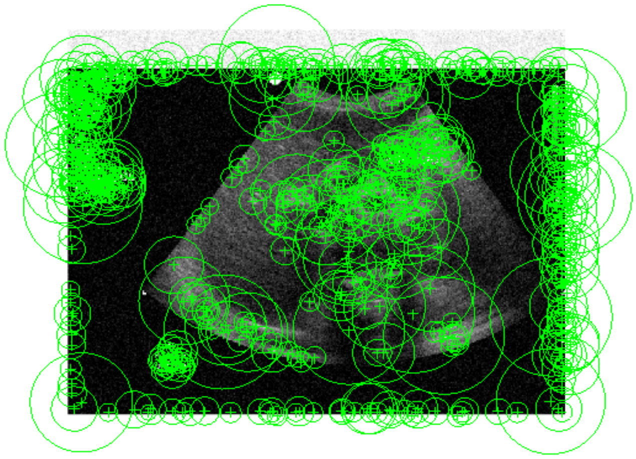


Figure 8: Feature Extraction using SURF Algorithm for a Gaussian Noise corrupted image

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 5 Issue 08, August-2016

By considering the minimal features from all the feature sets, there by this set is given as input for Clustering based on K means which is unsupervised way of grouping. Thus the feature set will have K centered features which are orthonormal. The K- means algorithm is explained below:

$$Initialize\ n_j, where\ j = 1,..,k$$

$$Repeat$$

$$For\ all\ t^p \in X$$

$$a_j^t = \begin{cases} 1 & if \left\|t^p - n_j\right\| = \min_i \left\|t^p - n_i\right\| \\ 0 & otherwise \end{cases}$$

$$For\ all\ n_j, j = 1,..,k$$

$$n_j = \frac{\sum_t a_j^t t^p}{\sum_t a_j^t}$$

$$Until\ n_j\ Converge$$

This clustered features are used for training SVM Classifier, which is a multiclass classifier.

The approach employed in this work is basically one versus many approach, in which a decision is taken based on the decision a given test feature belongs to a particular class as SVM is basically a binary classifier.

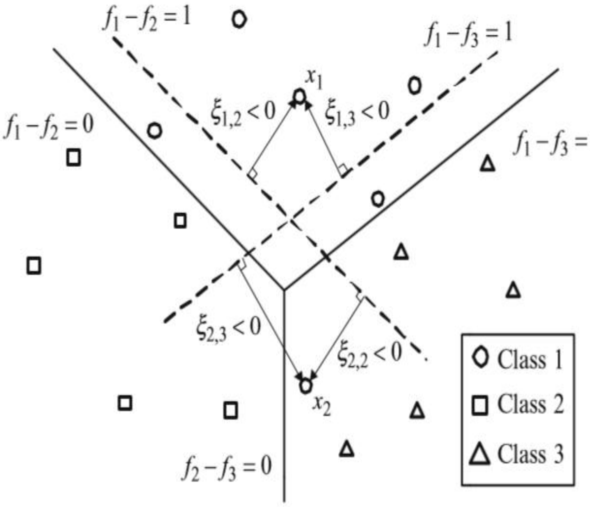


Figure 9: Multiclass SVM Classifier

Thus the output of this classifier is basically one of the following classes: 1) Speckle Noise 2) Salt and Pepper Noise or 3) Random Noise.

III. RESULTS AND DISCUSSION

This discussion fundamentally characterizes the classifier design and performance specifications.

	Predicted		
KNOWN	Random Noise	Speckle	Salt and Pepper
Random Noise	0.99	0.01	0.00
Speckle	0.01	0.99	0.00
Salt and Pepper	0.00	0.00	1.00

Table 1: Confusion Matrix for SVM Classifier

Average Accuracy	99.3%
Average Sensitivity	99.3%

Table 2: Performance Parameters of SVM Classifier

IV. CONCLUSION AND FUTURE SCOPE

Thus an efficient and optimal SVM based Classifier is designed for classifying noise for Ultrasound B mode Images.

This work can be extended by designing optimal algorithms for filtering these noise types.

V. REFERENCES

[1] Boyat, Ajay Kumar, and Brijendra Kumar Joshi. "A Review Paper: Noise Models in Digital Image Processing." *arXiv preprint arXiv:1505.03489* (2015)..

[2] Girdhar, Akshay, Savita Gupta, and Jaskaran Bhullar. "Region Based Adaptive Contrast Enhancement of Medical Ultrasound Images." *Computational Intelligence & Communication Technology (CICT), 2015 IEEE International Conference on*. IEEE, 2015.

[3] Bay, Herbert, et al. "Speeded-up robust features (SURF)." *Computer vision and image understanding* 110.3 (2008): 346-359.

[4] Kim, Donghoon, and Rozenn Dahyot. "Face components detection using SURF descriptors and SVMs." *Machine Vision and Image Processing Conference, 2008. IMVIP'08. International*. IEEE, 2008.

[5] Ng, H. P., et al. "Medical image segmentation using k-means clustering and improved watershed algorithm." *2006 IEEE Southwest Symposium on Image Analysis and Interpretation*. IEEE, 2006.

[6] Yue, Yong, et al. "Nonlinear multiscale wavelet diffusion for speckle suppression and edge enhancement in ultrasound images." *IEEE transactions on medical imaging* 25.3 (2006): 297-311.

[7] Bay, Herbert, Tinne Tuytelaars, and Luc Van Gool. "Surf: Speeded up robust features." *European conference on computer vision*. Springer Berlin Heidelberg, 2006.

[8] Liu, Yi, and Yuan F. Zheng. "One-against-all multi-class SVM classification using reliability measures." *Proceedings. 2005 IEEE International Joint Conference on Neural Networks, 2005.*. Vol. 2. IEEE, 2005.

.