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An Efficient Technique of Image Noising and De-noising Using Neuro- Fuzzy and SVM (Support Vector Machine)-A Survey

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Abstract **Medical imaging technology is becoming an important component of large number of applications such as diagnosis, research, and treatment. Medical images like X-Ray, CT, MRI, PET and SPECT have minute information about heart brain and nerves. These images need to be accurate and free from noise. Noise reduction plays an important role in medical imaging. There are various methods of noise removal such as filters, wavelets and thresholding based on wavelets. Although these methods produced good results but still have some limitations. Considering and analyzing the limitations of the previous methods our research presents neuro fuzzy and SVM as an efficient and robust tool for noise reduction.The proposed research use both mean and median statistical functions for calculating the output pixels of training patterns of the neural network and fuzzy provide promising results in terms of PSNR and MSE.**

Keywords: **Neural Network, Image De-noising, PSNR, Fuzzy Logic,SVM.**

I. INTRODUCTION

The arrival of digital medical imaging technologies such as positron emission tomography (PET), magnetic resonance imaging (MRI), computerized tomography (CT) and ultrasound Imaging has revolutionized modern medicine. Today, many patients no longer need to go through invasive and often dangerous procedures to diagnose a wide variety of illnesses. With the widespread use of digital imaging in medicine today, the quality of digital medical images becomes an important issue. To achieve the best possible diagnosis it is important that medical images be sharp, clear, and free of noise and artifacts. While the technologies for acquiring digital medical images continue to improve, resulting in images of higher and higher resolution and quality, removing noise in these digital images remains one of the major challenges in the study of medical imaging, because they could mask and blur important subtle features in the images, many proposed de-noising techniques have their own problems Artificial neural networks are composed of interconnecting artificial neurons (programming constructs that mimic the properties of biological neurons). Artificial neural networks may either be used to gain an understanding of biological neural networks, or for solving artificial intelligence problems without necessarily creating a model of a real biological system. The real, biological nervous system is highly complex: artificial neural network algorithms attempt to abstract this complexity and focus on what may hypothetically matter most from an information processing point of view. Good performance (e.g. as measured by good predictive ability, low generalization error), or performance mimicking animal or human error patterns, can then be used as one source of evidence towards supporting the hypothesis that the abstraction really captured something important from the point of view of information processing in the brain. Another incentive for these abstractions is to reduce the amount of computation required to simulate artificial neural networks, so as to allow one to experiment with larger networks and train them on larger data sets. Application areas of ANNs include system identification and control (vehicle control, process control), game-playing and decision making (backgammon, chess, racing), pattern recognition (radar systems, face identification, object recognition), sequence recognition (gesture, speech, handwritten text recognition), medical diagnosis, financial applications, data mining (or knowledge discovery in databases, "KDD"), visualization and e-mail spam filtering.

Inputs

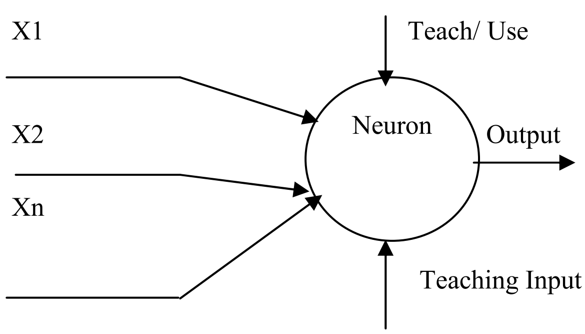

Figure 1. Simple ANN

The concept of Fuzzy Logic (FL) was conceived by LotfiZadeh, a professor at the University of California at Berkley, and presented not as a control methodology, but as a way of processing data by allowing partial set membership rather than crisp set membership or non-membership. This approach to set theory was not applied to control systems until the 70's due to insufficient small-computer capability prior to that time. Professor Zadeh reasoned that people do not require precise, numerical information input, and yet they are capable of highly adaptive control. If feedback controllers could be programmed to accept noisy, imprecise input, they would be much more effective and perhaps easier to implement. Unfortunately, U.S. manufacturers have not been so quick to embrace this technology while the Europeans and Japanese have been aggressively building real products around it. In this context, FL is a problem-solving control system methodology that lends itself to implementation in systems ranging from simple, small, embedded micro-controllers to large, networked, multi-channel PC or workstation-based data acquisition and control systems. It can be implemented in hardware, software, or a combination of both. FL provides a simple way to arrive at a definite conclusion based upon vague, ambiguous, imprecise, noisy, or missing input information. FL's approach to control problems mimics how a person would make decisions, only much faster.

The Support Vector Machine (SVM) is a state-of-the-art classification method introduced in 1992 by Boser, Guyon, and Vapnik . The SVM classifier is widely used in bioinformatics (and other disciplines) due to its highly accurate, able to calculate and process the high-dimensional data such as gene expression, and exibility in modeling diverse sources of data .SVMs belong to the general category of kernel methods. A kernel method is an algorithm that depends on the data only through dot-products. When this is the case, the dot product can be replaced by a kernel function which computes a dot product in some possibly high dimensional feature space. This has two advantages: First, the ability to generate non-linear decision boundaries using methods designed for linear classifiers. Second, the use of kernel functions allows the user to apply a classifier to data that have no obvious fixed-dimensional vector space representation. The prime example of such data in bioinformatics are sequence, either DNA or protein, and protein structure. Using SVMs effectively requires an understanding of how they work. When training an SVM the practitioner needs to make a number of decisions: how to preprocess the data, what kernel to use, and finally, setting the parameters of the SVM and the kernel [1]. Uninformed choices may result in severely reduced performance. We aim to provide the user with an intuitive understanding of these choices and provide general usage guidelines. All the examples shown were generated using the PyML machine learning environment, which focuses on kernel methods and SVMs.

II. Review Of Literature

A lot of research has been done in the field of image de-noising but yet the area of image de-noising, especially for the medical images remains to be a hot area of research. Stress has been laid to summarize the concept of different authors who has worked in this field.

Ms S. Hyder Ali, Dr. (Mrs.) R. Sukanesh, Ms. K. Padma Priya (2001)[10] proposed a new type of thresholding neural networks(TNN) with a new class of smooth non-linear thresholding functions being the activation function. Unlike the standard soft thresholding functions the new non linear thresholding functions were infinitely differentiable. The TNN based space-scale adaptive noise reduction algorithm exhibited much superior then the soft thresholding.TNN can be further used to produce over effective learning algorithms for various applications.

Rajesh Kumar Rai, Trimbak R.Sontakee (2002)[12] conducted a study on various thresholding techniques such as Sure Shrink, Visu Shrink and Bayes Shrink and determine the best one for image de-noising .Wavelet de-noising attempts to remove the noise present in the signal while preserving the signal characteristics, regardless of its frequency content. It involves three steps: a linear forward wavelet transform, nonlinear thresholding step and a linear inverse wavelet transform. Wavelet thresholding is a signal estimation technique that exploits the capabilities of wavelet transform for signal de-noising. It removes noise by killing coefficients that are insignificant relative to some threshold, and turns out to be simple and effective, depends heavily on the choice of a thresholding parameter and the choice of this threshold determines, to a great extent the efficiency of de-noising.

S.Zhang, E.Salari (2005)[5] presented a neural network based de-noising method implemented in the wavelet transform domain. In this method, a noisy image is first wavelet transformed into four sub bands, then a trained layered neural network is applied to each sub band to generate noise-removed wavelet coefficients from their noisy ones. The de-noised image is thereafter obtained through the inverse transform on the noise-removed wavelet coefficients. Simulation results demonstrate that this method is very efficient in removing the noise. Compared with other methods performed in wavelet domain, it requires no a priori knowledge about the noise and need only one level of signal decomposition to obtain very good de-noising results.

SME Sahraeian, F. Marvasti, N Sadati (2006)[6] proposed a new method based on the wavelet transform. in this method an improved TNN were introduced by utilizing a new class of smooth non linear thresholding functions as the activation function. This approach introduced best threshold in the sense of minimum MSE mean square error. TNN obtained thresholds were employed using a cycle spinning based technique to reduce the image artifacts. This method outperforms other established wavelet denoising techniques in terms of PSNR and visual quality.

Yongjian Chen, Masatake Akutagawa, Masato Katayama, Qinyu Zhang and Yohsuke Kinouchi(2007)[2] proposed a novel filter by applying back propagation neural network (BPNN) ensemble where the noisy signal and the reference one are the same. The neural network(NN) ensemble filter not only well reduces additive and multiplicative white noise inside signals, but also preserves signals' characteristics. It is proved that while power of noise is larger, the reduction of noise using NN ensemble filter is better than the improved ε nonlinear filter and single NN filter, and compared with the improved ε nonlinear filter, degradation of the capability for reduction of noise by NN ensemble due to the increase of noise power is much suppressed. Furthermore, it presented the relationship between noise reduction and bandwidth of noises. The performance of the NN ensemble filter is demonstrated in computer simulations and actual electroencephalogram (EEG) signals processing**.**

Masakuni Oshiro, Toshihiro Nishimura(2009)[13] conducted study on a Multi-Layer Back-Propagation Neural Networks (MLBPNNs) with the Epanechnikov fuzzy function and proposed to reduce the speckle, and while at the same time, enhance the lesion boundaries of the UltraSound(US) image. The main goal of the proposed method is to improve the quality of US image so as to improve the quality of the humans interpretation and the computer systems auto-edge detection. In order to automatically detect the lesion boundary by a computer system, an edge enhancement is required. Evaluating the simulation results by Peak Signal to Noise Ratio (PSNR), Normalized Mean Square Error (NMSE), Detail Variance (DV), and Background Variance (BV), the proposed method demonstrates an increased performance of reducing the speckle and enhancing the edge. The proposed method has higher PSNR than conventional methods and can remove the speckle sufficiently, so that tumour boundaries of real US breast tumor image could be preserved and detected.

Tanzila SABA, AMJAD Rehman, Ghazali Sulong(2010)[11] presented an novel approach based on the Cellular neural networks(CNN) to de- noise an image even in the presence of very high noise. Image De-noising was devised as a regression problem between the noise and signals solved using CNN. The noises are detected with surrounding information and removed. The proposed algorithm exhibited promising results from qualitative and quantitative point of view. Experimental results of the proposed algorithm exhibit high performance in PSNR and visual effects in color image even in the presence of high ratio of the noise

Dr. T. Santhanam, S. Radhika(2011)[4] explored the possibility of using an Artificial Neural Network(ANN) for image classification followed by the suitable filter classification for the removal of a specific type of noise. In this method the Multilayer perceptron(MLP), Back propagation neural network(BPNN), Probabilistic Neural network(PNN) are used to classify the noise in an image as non Gaussian white noise, Gaussian noise and salt and pepper noise. Then these noise inputs are given to MLP, BPNN, and PNN which identifies the suitable filters for the noise removal.

Yazeed A. Al-Sbou (2012)[3] presented neural network as a noise reduction efficient and robust tool. In this research the BPNN is used as a learning algorithm. This approach includes using boh mean and median stastical functions for calculating the output pixels of the NN. This uses a part of degraded image pixels to generate the system training pattern. the output of the proposed approach provided a good image de-noising performance which exhibits a promising results of the degraded noisy image in terms of PSNR, MSE and visual test.

III. Issues And Challenges While Providing Image De-Noising Technique

Medical imaging technology is becoming an important component of large number of applications such as the diagnosis research and treatment. It enables the physicians to create the images of the human body for the clinical purposes. Medical images like X-Ray, CT, MRI and PET, SPECT have minute information about the heart brain and nerves. These images suffer from a lot of short comings including the acquisition of noise from the equipment, ambient noise from the environment and the presence of background tissue, other organs and anatomical influences such as body fat and breathing motion. Noise reduction therefore becomes very important. The main techniques of image de-noising are filters wavelets and neural networks. The Neuro-Fuzzy and SVM based approach is a powerful and effective method for image de-noising. Earlier proposed methods suffered from drawbacks such as noise, artifacts and degradation. Although all the spatial filters performs well on the digital images but still suffered from some constraints such as resolution degradation these filters operated by smoothing over a fixed window and it produces artifacts around the object and sometimes caused over smoothing thus causing the blurring of image. Wavelet transform outperforms the filters because of its properties like sparsity, multi resolution and multi scale nature and proved promising as they are capable of suppressing noise while maintaining high frequency signal details. But the limitation with wavelet transform was that the local scale- space information of the image is not adaptively considered by the standard wavelet thresholding methods. Other difficulty was that the soft thresholding function was a piecewise function and does not have high order derivates. A new type of thresholding neural network was presented which outperforms the soft thresholding using wavelet transform but still does not promised a high performance in terms of PSNR, MSE and visual test.

Considering and analyzing the drawbacks of the previous methods we propose a new improved Neuro-Fuzzy and SVM approach to de-noise the medical images. This approach includes using boh mean and median stastical functions for calculating the output pixels of the Neuro-Fuzzy and SVM. This uses a part of degraded image pixels to generate the system training pattern. Different test, images noise levels and neighborhood sizes are used. Based on using samples of degraded pixels neighborhoods as input, the output of the proposed approach provided a good image de-noising performance which exhibits a promising results of the degraded noisy image in terms of PSNR, MSE and visual test.

IV. PROPOSED WORK

* Design and develop an improved algorithm for medical image de-noising using Neuro-Fuzzy and SVM.

*To remove the noise and enhance the medical image using the proposed method.

*Our enhanced Image De-noising technique algorithm is low cost and more accurate.

*Our enhanced De-noising technique algorithm assures quality of result.

*Our enhanced De-noising technique algorithm is fast and thus saves time.

*Our enhanced De-noising technique algorithm is distributed and is range independent.

V. CONCLUSION

In this paper, we propose the neuro fuzzy and SVM as a tool for image de-noising and enhancement. ANFIS and SVM will be used. The evaluation will also include both mean and median functions. The evaluation will be based on the PSNR, MSE. The proposed approach i.e., improved technique for medical image de-noising using Neuro Fuzzy and SVM will exhibit outcomes of noise reduction and image quality improvements, with different noise levels, which will qualify it to be suitable for image processing and de-noising.

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