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Possibilistic Clustering Adaptive Smoothing Bilateral Filter Using Artificial Neural Network

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***Abstract*--This research paper, we deals with the implementation of clustering environment noise load and smoothing it by filtering using bilateral and wiener filter neural network (adaptation method). The proposed method has an advantage of dealing with not only perform load but also to reduce the noise of environment. In this research paper we have used advance technique to find load considering on each Gaussian area for neural computing and filtering noise before cluster it such that, it should not disturb any other existing signal like telephone signal etc. Linear adaptation filter as OPAMP circuit used to filter noise using proposed method.**

***Index Terms*—Adaptation, wiener filter, OPAMP, Mean square error matrix, signal to noise ratio, bilateral filter, Possibilistic Clustering.**

I. INTRODUCTION

We are living in a natural environment where noise is inevitable and ubiquitous. Therefore, it is essential to use noise reduction techniques. Noise reduction techniques are a challenging problem due to some reasons. First of all, noise of nature is not constant, it depends application to application. It is therefore very difficult to develop versatile algorithms to find noise load and filter. Secondly noise reduction system may depend on the specific context and application. Thirdly, in noise reduction techniques signal must have constant structure. Currently, there are number of methods for signal filtering one of the methods is the wiener filter. Along with wiener filter a bilateral filter also used to filter out each given image, possibilistic clustering techniques used to cluster each homogeneous noise together. The wiener filter is always able to reduce noise in a signal which has high SNR value. When SNR is low convolution based filter is used, we often find noise considering, a Gaussian space and time in one fundamental dimension of learning process. The spatiotemporal nature of learning is exemplified by many of the learning task like control. Species ranging from insets to human have inherent capacity to represent the temporal structure of experience. When neural network operates in a stationary environment essential static like noise of environment can be learned by the network under the supervision of a teacher. Prior information of noise can be filter and known using synaptic connections in neural network.

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II. ADAPTIVE SMOOTHING

It builds around a linear combiner (single neuron operating in its linear mode), are design to perform continuous learning. Continuous learning as the property of interest and neural network as the vehicle of the information, a neural network adapt its behavior to the varying temporal structure of the incoming signals in its behavioral space (Gaussian space). The Adaptive Systems and Interaction group pursues advances in principles of intelligence and interaction and applications of these advances to enhance computational systems and interfaces. Our team includes groups exploring foundations of sensing, learning, and decision making, search & retrieval, and human-computer interaction.

When creating a functional model of the neuron, there are three basic components of importance. First, the synapses of the neuron are modeled as weights. The strength of the connection between an input and a neuron is noted by the value of the weight. Negative weight values reflect inhibitory connections, while positive values designate excitatory connections. The next two components model the actual activity within the neuron cell. An adder sums up all the inputs signals modified by their respective weights. This activity is referred to as linear combination. Finally, an activation function controls the amplitude of the output of the neuron. An acceptable range of output is usually between 0 and 1, or -1 and 1. Neural Network is the mathematical model of a neuron as shown in Figure

The three basic components of the (artificial) neuron are:

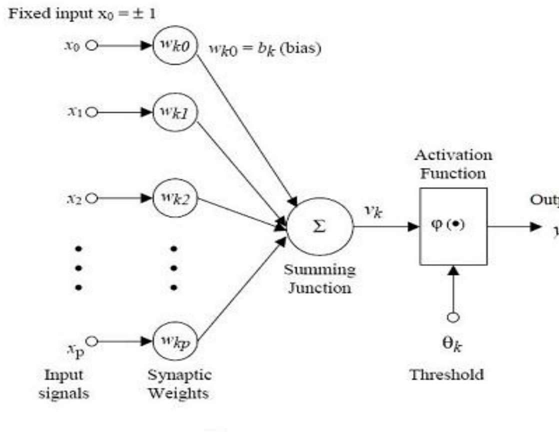


Fig. 1 Neural Nets mathematical model.

(1) The synapses or connecting links that provide weights, w_j , to the input values, x_j *for* $j = 1, \ldots m$;

(2) An adder that sums the weighted input values to compute the input to the activation function

$$V_k = W_0 + \sum_{J=1}^{m} W.X_j$$

III. Environment Noise Load Filter Performance

An ideal filter would pass all frequencies in a given band without reduction in magnitude, and totally suppress all other frequencies. Such ideal performance is not possible but can be approached with complex design, if the need warrants. Filter circuit are widely used and vary in complexity from the relatively simple power supply filter sets use to separate the various voice channels in carrier frequency receiver circuit analysis of filter is carried out based on the neural network adaptation method. Laboratory filter were assembled in accordance with the design it will be convenient to carry out the calculation on a typical filter to meet the following specification: a composite low-pass filter is to be terminated in 500ohms resistance. It must have a cutoff frequency of 1000cycles, with very high attenuation at 1065, 1250 and infinite cycle. The circuit can be operated from a pair of 9 Volt batteries, or a regulated supply of up to +/-15V. There is no need to use premium OPAMPS shown in figure 2. unless extremely low noise levels are to be measured and even then are not needed if there is a gain stage at the front end.

IV. Adaptive Wiener filter

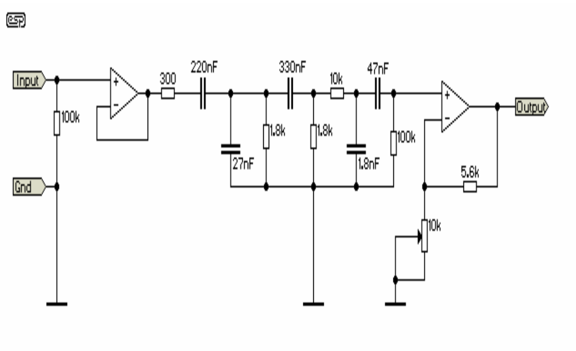


Fig 2. OPAMPS

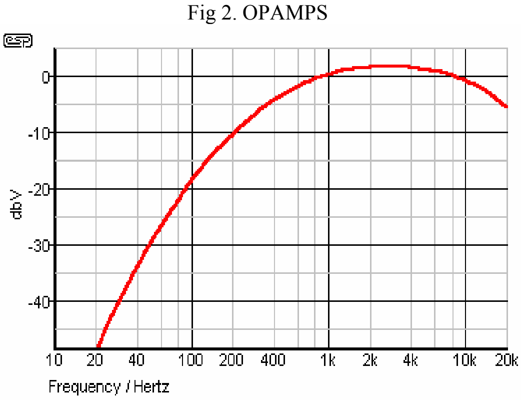


Fig 3. Frequency Response of the A-Weighting Filter

Adaptive wiener filter is a best possible filter using neural network in signal processing Its purpose is to reduce the amount of noise present in a signal by comparison with an estimation of the desired noiseless signal. Goal of the Wiener filter is to filter out noise that has corrupted a signal. It is based on a statistical approach. Consider a situation such that there is some underlying, uncorrupted signal $u(t)$ that is required to measure. Error occur in the measurement due to imperfection in equipments, thus the output signal is corrupted. There are two ways the signal can be the signal. This occurs when the equipment doesn't have a perfect, delta function response to the signal. Let $s(t)$ be the smear signal and $r(t)$ be the known response that cause the convolution. Then $s(t)$ is related to $u(t)$ by:

$$s(t) = \int_{-\infty}^{\infty} r(t-\tau)u(\tau)\,d\tau.$$

or

$$S(f) = R(f)U(f)$$

where S, R, U are Fourier Transform of s, r, and u.

The **second** source of signal corruption is the unknown background noise $n(t)$. Therefore the measured signal $c(t)$ is a sum of $s(t)$ and $n(t)$: $c(t) = s(t) + n(t)$. To deconvolve s to find u, simply divide $S(f)$ by $R(f)$, i.e $U(f) = S(f)/R(f)$. in the absence of noise n. Consider our standard equation to model a signal with noise: $y[n] = x[n] + n[n]$, We want to pass this y[n] through a filter 'h' such that we get back something that very closely resembles our original signal x. To deconvolve c where n is present then one need to find an optimum filter function $\Phi(t)$ or $\Phi(f)$---(1), which filters out the noise and gives a signal u by: $U(f) = C(f)\,\Phi(f)/R(f)$----(2). Where ~u is as close to the original signal as possible. For ~u to be similar to u, their difference squared is as close to zero as possible, i.e.

$$\int_{-\infty}^{\infty} |\tilde{u}(t) - u(t)|^2\, dt$$

or

$$\int_{-\infty}^{\infty} |\tilde{U}(f) - U(f)|^2\, df \quad \text{-----------(3)}$$

.

is minimized

Substituting equation (1), (2) and (3), the Fourier version becomes:

$$\int_{-\infty}^{\infty} |R(f)|^{-2}\, |S(f)|^2 |1-\Phi(f)|^2 + |N(f)|^2 |\Phi(f)|^2\, df \quad \text{---------(4)}$$

after rearranging. The best filter is one where the above integral is a minimum at every value of f. This is when,

$$\Phi(f) = \frac{|S(f)|^2}{|S(f)|^2 + |N(f)|^2} \quad \text{---------- (5)}$$

Now, $|S(f)|^2+|N(f)|^2 \approx |C(f)|^2$ where $|C(f)|^2$, $|S(f)|^2$, and $|N(f)|^2$ are the power spectrum of C, S, and N. Therefore,

$$\Phi(f) \approx \frac{|S(f)|^2}{|C(f)|^2} \quad \text{--------------(6)}$$

Figure 3 shows a plot of | $|C(f)|^2$. It can be seen that $|S(f)|^2$ and $|N(f)|^2$ can be extrapolated from the graph.

A. *Building the Filter*

One way to approximate the noise is "by inspection" or what is more commonly known as "guess and check". In this method, you take a close look at your received signal and your pure signal. From the above research on environment noise using adaptive filter, it can be seen that a program can be written to Wiener Filter signal from noise using Fourier Transform. There is another way to Wiener Filtering a signal shown in figure 5, but this time without Fourier Transform the data. The latter is what I set out to do with my part of programming, and this is the Mean-Squared Method and Signal to Noise ratio Matrix.

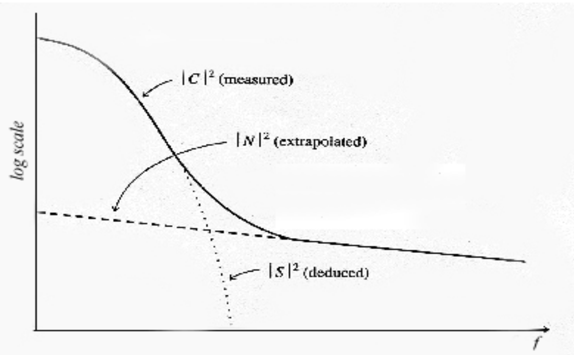
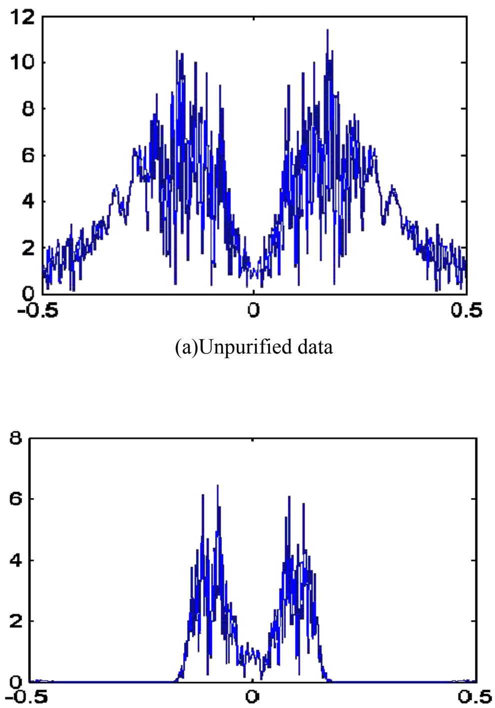


Fig 4. Plot of power spectrum of signal plut noise



(a)Unpurified data

(b) **Filtered data**

Fig. 5 unpurified and purified graph

V. Bilateral Filtering

Bilateral filtering was introduced as non linear filter which combines domain and range filtering given as input image using a continuous representation as in the output image using a continuous representation as in the output image obtained by Were space variable and is intensity the full vector in the notation is used in order to avoid confusion in what follows the convention makes is the product of the function. Which represent closeness and similarities respectively. Adaptive smooth is one special and spectral distance measures along with increasing the window size, abandoning the need to perform several iterations. Taken as such, we get the bilateral filtering implementation of which can be viewed as a genera-lization of adaptive smoothing figure 6 and 7 shows the original and filtered image. According to Gossberg introduceda model for explaining biological phenomena. The model has tree crucial properties:

1) A normalization of the total network activity. Biological systems are usually very adaptive to large changes in their environment. For example, the human eye can adapt itself to large variations in light intensities

Fig. 6 original image

Fig. 7 bilateral filter

2) Contrast enhancement of input patterns. The awareness of subtle erects in input patterns can mean a lot in terms of survival. Distinguishing a hiding panther from a resting one makes all the difference in the world.
3) Short-term memory (STM) storage of the contrast-enhanced pattern. Before the input pattern can be decoded, it must be stored in the short-term memory[11].

VI. Probabilistic Clustering

We propose a neural network implementation for clustering were each data point has a degree of possibility of belonging to the cluster. The implementation require basic element that work in parallel which can be viewed as simple neuron, with only a small number of local connection see fig 7 below given. Neurons are located on grid of point, as the number of features in the data. In the two dimensional case, each point has two features, its x and y coordinate. The system input is a set of data which are described as positively initialized value of two dimensional grid neurons. Then the diffusion like process is implemented by the network. this process usage the lateral excitation to spread activity locally, generating long-range interaction over time. Dispending on the extend of diffusion process, i.e. the time elapsed, it generates peaks over areas of growing size. A maxima selection nets usases lateral inhibition to localize the apex of those local peaks as cluster center points. This process is implemented in the neural network and yield the proposed clustering system[10].

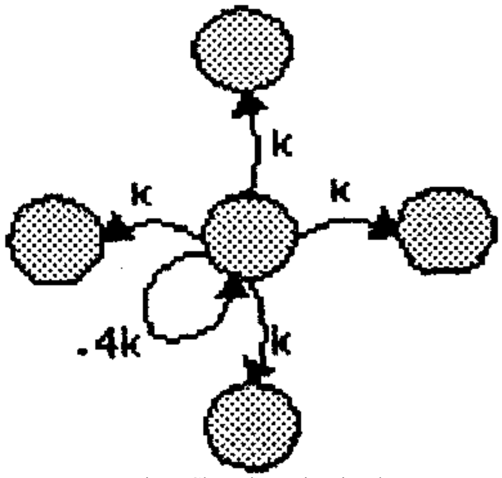


Fig 7. Clustering noise signal

VII. The Mean-Squared Method

The Mean-squared Methods uses the fact that the Wiener Filter is one that is based on the least-squared principle, i.e. the filter minimizes the error between the actual output and the desired output. To eliminate noise, this filter works by narrow the width of the distribution curve of figure 4. To do this, first the variance of the data matrix is to be found. Then, a box of certain size is passed around the matrix, moving one pixel at a time. For every box, the local mean and variance is found. And the filtered value of each pixel is found by the following formula:

$$A_{i,j} = \mu_{i,j} + \frac{\sigma_{i,j} - s^2}{\sigma_{i,j}}(N_{i,j} - \mu_{i,j})$$

Where $A_{i,j}$ is the filtered signal, $\mu_{i,j}$ is the local mean,$\boldsymbol{\sigma}_{i,j}$ is the local variance, s^2 is the noise variance of the entire data matrix, and $N_{i,j}$ is the original signal value.

From the above formula, it can be see that if the original signal is similar to the local variance then the filtered value will be that of the local mean, if the original signal is very much different from the local mean, then it will be filtered to give a higher/lower intensity signal depends on the differences. Also, if the local variance is similar to the matrix variance, which is around 1 (i.e. only noise exists in the box) then the filtered signal will be that of the local mean, which should be close to zero. But if the local variance is much bigger than the matrix variance (i.e. when the box is at the actual signal), then the signal will be amplified.

As the box moves through the entire matrix, it will calculate the solution to each pixel using the above formula, and thus *filters* the data. The techniques available to suppress noise can be divided into those techniques that are based on temporal information and those that are based on spatial information. By temporal information we mean that a sequence of images are available that contain *exactly* the same objects and that differ only in the sense of independent noise realizations. It will produce a result where the mean value of each pixel will be unchanged [9]. For each pixel, however, the standard deviation will decrease from σ to $\sigma/\sqrt{p}$. If temporal averaging is not possible, then spatial averaging can be used to decrease the noise. Within the class of linear filters, the optimal filter for restoration in the presence of noise is given by the *Wiener filter*. The word "optimal" is used here in the sense of minimum mean-square error (*mse*). Because the square root operation is monotonic increasing, the optimal filter also minimizes the root mean-square error (*rms*).

VIII. Signal-to-noise Ratio (SNR or S/N)

Defined as the ratio of a signal power to the noise power corrupting the signal. In engineering, signal-to-noise ratio is a term for the power ratio between a signal (meaningful information) and the background noise:

$$\mathrm{SNR} = \frac{P_{\mathrm{signal}}}{P_{\mathrm{noise}}}, \quad \ldots\ldots\ldots\ldots\ldots\ldots(1)$$

Where *P* is average power. Both signal and noise power must be measured at the same or equivalent points in a system, and within the same system bandwidth. If the signal and the noise are measured across the same impedance, then the SNR can be obtained by calculating the square of the amplitude ratio:

$$\mathrm{SNR} = \frac{P_{\mathrm{signal}}}{P_{\mathrm{noise}}} = \left(\frac{A_{\mathrm{signal}}}{A_{\mathrm{noise}}}\right)^2, \quad \ldots\ldots\ldots\ldots(2)$$

Where *A* is root_mean_square (RMS) amplitude (for example, typically, RMS voltage). Because many signals have a very wide dynamic range, SNRs are usually expressed in terms of the logarithmic decibel scale. In decibels, the SNR is, by definition, 10 times the logarithm of the power ratio:

$$\mathrm{SNR(dB)} = 10\log_{10}\left(\frac{P_{\mathrm{signal}}}{P_{\mathrm{noise}}}\right) = 20\log_{10}\left(\frac{A_{\mathrm{signal}}}{A_{\mathrm{noise}}}\right).$$

Since the filtering processes are linear, we can consider system response to signal and noise separately. We need to determined mean value signal and variance of the noise both at the matched filter output [12].

IX. Experimental Result

To evaluate performance, experimental result applied on sinusoidal, multi component and FM signals for a Gaussian area where each consider as neural computing area. If SNR value set to 2, wiener filter is not able to reduce noise where as convolution based filter significantly reduce the noise, set $\Delta t = 0.1$, $k = 50$.

TABLE 1: USING SNR DE-NOISING SIGNAL VALUE OF THREE SIGNAL

Sinusoidal signal	**SNR = 1**	**SNR= 2**	**SNR= 3**	**SNR= 4**	**SNR= 5**
	8.1	8.1	9.5	10.0	11.9
Multi component signal	13.5	14.4	15.67	16.4	17.0
FM	9.1	9.9	11.0	11.6	12.6

TABLE 2 USING MSE DE-NOISING SIGNAL VALUE OF THREE SIGNAL

Sinusoidal signal	**MSE= 1**	**MSE= 2**	**MSE= 3**	**MSE = 4**	**MSE= 5**
	0.07	0.06	0.05	0.04	0.03
Multi component signal	0.06	0.05	0.04	0.05	0.028
FM	0.06	0.05	0.04	0.03	0.02

X. CONCLUSION

This proposed paper, Possibilistic Clustering Adaptive Smoothing Bilateral Filter Using Artificial Neural Network was intended in studying the effect of environment noise and filter that noise, such that other signals which is existing can not disturb. We have used advance technique to find noise load and filter it considering each Gaussian area using Artificial Neural Network. As a indicator for noise load and filter, we have used wiener filter, OPAMP, convolution based filters, Mean square error matrix, signal to noise ratio concept.

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