CCET JOURNAL OF SCIENCE AND ENGINEERING EDUCATION
(ISSN 2455-5061) Vol. - 3, Page-52-57, Year-2018

Execution and Performance Evaluation of Different Noise Cancellation Techniques

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Abstract—
This paper presents a comparative analysis of the LMS, the NLMS and the SELMS algorithms in case of interference cancellation from speech signals. The LMS (Least Mean Square) algorithm ,its variant NLMS algorithm and SELMS (Sign Error Least Mean Square) algorithm are the adaptive algorithms used for noise cancellation. For each algorithm, the effects of two parameters- filter length and step size have been analyzed and the relation between them has been established. In the proposed calculation we have enhanced the procedure of commotion recognition by enhancing the edge esteem. We have utilized two edge values (most extreme and least), so it is not difficult to recognize the irregular esteemed motivation clamor. We additionally diminish the many-sided quality of computation in light of the fact that the limit qualities and middle worth are figuring all the while. Finally, the performances of the three algorithms in different cases have been compared..

Keywords— *Image denoising, Image Enhancement, LMS (Least Mean Square), NLMS (Normalized LMS) , SELMS (Sign Error Least Mean Square)*

I Introduction

Detection of noise determines that the image is corrupted by noise or not, and noise removal part remove the noise from the image while preserving the other important detail of image.Channels are better alternative to expel the clamor from the picture since they are anything but difficult to execute on equipment. The channels can be separated in two sorts: direct channel and non-straight channel. Direct channels resemble normal channel or called averaging low pass channel. Be that as it may, straight channel tends to obscure edges and different points of interest of picture, which may diminish the precision of yield. Then again non-straight sort channel like middle channel has preferred results over direct channel since middle channel evacuate the motivation commotion without edge obscuring.

Now objective is to make picture obvious for investigation. For which picture reclamation and picture improvement two major procedure needs to did.

II.Operation of Adaptive Noise Cancellation

In recent years, acoustic noises become more evident due to wide spread use of industrial equipments. An Active (also called as Adaptive) noise cancellation (ANC) is a technique that effectively attenuates low frequencies unwanted noise where as passive methods are either ineffective or tends to be very expensive or bulky. An ANC system is based on a destructive interference of an anti-noise, which have equal amplitude and opposite phase replica of primary unwanted noise. Following the superposition principle, the result is noise free original sound

ANC systems are distinguished by their different goals that lead to different architectures. If all ambient sound shall be reduced, a feedback system with its simpler architecture may

CCET JOURNAL OF SCIENCE AND ENGINEERING EDUCATION
(ISSN 2455-5061) Vol. - 3, Page-52-57, Year-2018

be used. If, as in our case, single sources of unwanted sound shall be compensated, a feed forward system is required. A feed forward system is characterized by two audio inputs per channel: one reference signal input for the sound to be removed, and second error input for the sound after the compensation.

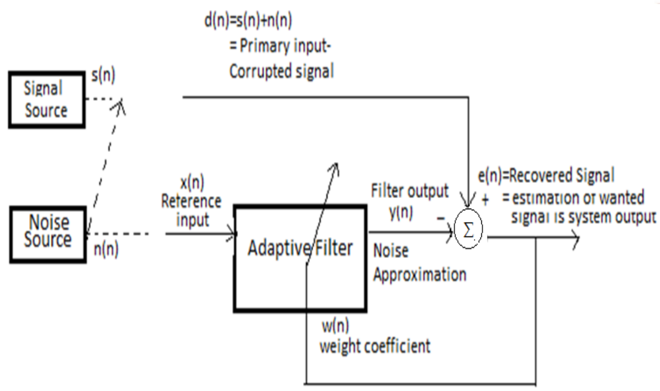


Fig.1 adaptive FIR feed forward system

An adaptive FIR feed forward system is shown in simple way in fig 2. for the selective cancellation of disturbing noise without affecting other sounds. [2] It is dual input system. The first inputs is primary signal den) which is wanted signal (say sen)) corrupted by noise (say n(n)). The second input is reference signal x(n) can be interfacing noise supposed to be uncorre1ated with the wanted signal but correlated with noise affecting original signal in an unknown way. The filter output signal yen) is an estimate of the noise signal with inverted sign. This signal and the primary signal are superposed, so that the noise signal is cancelled and error signal e(n) is the result of this superposition which constitutes the overall system output. The adaptive filtering operation achieved the best results when system output is noise free. This goal is achieved by

minimizing the mean square of the error signal [3]. The widely preferred LMS algorithm is used for the adaption of the filter coefficients.

III. **Literature Review**

- Balasubramanian Gopalan, A.Chilambuchelvan, S.Vijayan and G.Gowrison "Performance improvement of average based spatial filters through multilevel preprocessing using wavelets" [33] IEEE signal processing vol 22, no 10, OCTOBER 2015.

- In this paper Image denoising channels expected to evacuate Gaussian clamor primarily misuse a method called spatial averaging. To protect the high recurrence data and thus the denoising execution, they propose a preprocessing channel in wavelet space put before the current spatial area averaging channels.

- Harnani Hassan, Azilah Saparon "Still Image Denoising Based on Discrete Wavelet Transform" [34] IEEE @2011 ICSET.

- In this paper, an examination on reasonableness of still picture denoising in view of wavelet systems is broke down utilizing orthogonal premise wavelet. The execution of still picture denoising is broke down regarding PSNR and visual ancient rarity.

- Shanmugavadivu & Eliahim Jeevaraj "Laplace Equation based adaptive median filter for highly corrupted images" [35] International conference on Computer Communication & Informatics(ICCCI) @ 2012, 12 January.

- As an outcome, the subsequent therapeutic pictures protect straight structures while in the meantime smoothing is made along these structures. Both these cases can be portrayed by a speculation of the standard dissemination condition where the dispersion coefficient, rather than being a consistent scalar, is a component of

- picture position and expect a filter is proved to be effective in denoising even the highly corrupted images with the noise probability of 90%.

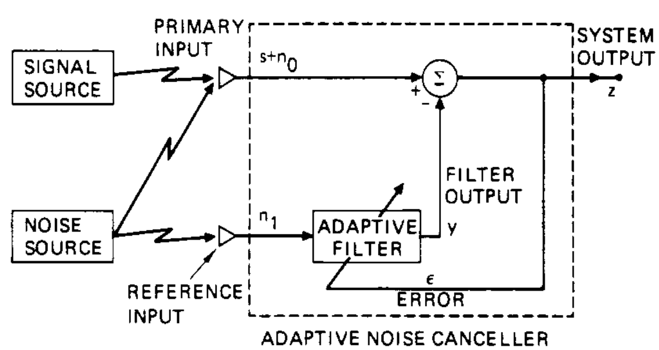
- S.Kother Mohideen, Dr. S. Arumuga Perumal, Dr. M.Mohamed Sathik [14] "Image denoising using discrete wavelet transform", IJCSNS @ 2008 vol 8, January 2008.

- projected to research the suitableness of various rippling bases and also the size of various neighbourhood on the performance of image de-noising algorithms in terms of PSNR Their paper investigates the suitableness of various rippling bases and also the size of various neighbourhood on the performance of image de-noising algorithms in terms of PSNR and also the image de-noising exploitation separate rippling remodel is analyzed. The experiments were conducted to review the suitableness totally different|of various} rippling bases and additionally different window sizes. Among all separate rippling bases, coif let performs well in image de-noising. Experimental results additionally show that changed Neigh shrink provides higher result than Neigh shrink, Weiner filter and Visu shrink.
- Sachin D Ruikar, Dharmpal D Doye [1] "Wavelet based image denoising technique" IJACSA vol 2, no.3, March 2011

This paper proposes different approaches of wavelet based image denoising methods. The extend the present technique and providing a comprehensive analysis of the projected methodology. Results supported totally different noise, like mathematician, Poisson's, Salt and Pepper, and Speckle performed. a sign to noise magnitude relation as a live of the standard of denoising was most well-liked. during this paper hard function in abstraction domain. once denoising we've to preserve distinction of the image. Image brightness in denoising unbroken same however preserves the background and also the grey level tonalities within the image. The noise term is thought of as a random development and it's unrelated, thence the common price of the noise ends up in a zero price, thus take into account correct kernel to induce denoised image The low pass abstraction filter reduces the noise like bridging the gaps within the lines or curve in an exceedingly given image, however not appropriate for reducing the noise patterns consisting of robust spike like parts. The high pass filters ends up in sharp details, it provides a lot of visible details that obscured, hazy, and poor concentrate on the first image. currently wavelets most well-liked in denoising whereas conserving all the small print of the image.

IV. Noise Cancellation:

Fig. shows the basic problem and the adaptive noise cancelling solution to it. A signal **s** is transmitted over a channel to a sensor that also receives a noise $\mathbf{n_0}$ uncorrelated with the signal. The primary input to the canceller is combination of both signal and noise $\mathbf{s+n_0}$. A second sensor receives a noise $\mathbf{n_1}$ uncorrelated with the signal but correlated with the noise $\mathbf{n_0}$. This sensor provides the reference input to the canceller. This noise n_1 is filtered to produce an output **y** that is as close a replica of $\mathbf{n_0}$. This output of the adaptive filter is subtracted from the primary input $\mathbf{s+n_0}$ to produce the system output $\mathbf{z = s+n_0-y}$ **.**



we know the characteristics of the channels over which the noise and signal was transmitted to the primary and referencesensors, it would theoretically be possible to design a fixed filter.

The filter output could then be subtracted from the primary input, and the system output would be signal alone. But the characteristics of the transmission paths are unknown and are not of a fixed nature, due to this use of a fixed filter are not feasible. In Fig. 1 the reference input is processed by an adaptive filter. An adaptive filter is that which automatically adjusts its own impulse response. Adjustment is accomplished through an algorithm. The filter can operate under changing conditions and can readjust itself continuously to minimize the error signal. In noise cancelling systems the practical objective is to produce a system output $\mathbf{z = s+n_0-y}$ that is a best fit in the least squares sense to the signal ***s.*** This objective is accomplished by feeding the system output back to the adaptive filter and adjusting the filter through an LMS adaptive algorithm to minimize total system output power. In an adaptive noise cancelling system, the system output serves **as** the error signal for the adaptive process.

The prior knowledge of the signal **s** or of the noises $\mathbf{n_0}$ and n_1 would be necessary before the filter could be designed to produce the noise cancelling signal **y**.

Assume that **s,** $\mathbf{n_0}$, $\mathbf{n_1}$ and **y** are statistically stationary and have zero means. Assume that **s** is uncorrelated with $\mathbf{n_0}$ and $\mathbf{n_1}$, and suppose that $\mathbf{n_1}$ is correlated with $\mathbf{n_0}$. The output **z** is

$$Z = s + n_0 - y \qquad \text{..........(1)}$$

Squaring, we obtain

$$Z^2 = s^2 + (n_0 - y)^2 + 2s\,(n_0 - y) \qquad \text{...............(2)}$$

Taking expectations both side of equation (2)

$$E[\,Z^2] = E[s^2] + E[\,(n_0 - y)^2] + E[\,2s\,(n_0 - y)]$$

Realizing that **s** is uncorrelated with $\mathbf{n_0}$ that

$$E[\,Z^2] = E[s^2] + E[\,(n_0 - y)^2] \qquad \text{..........(3)}$$

The signal power $\mathbf{E[s^2]}$ will be unaffected as the filter is adjusted to minimize $\mathbf{E[\,Z^2]}$. Accordingly, the minimum output power is

$$\min E[\,Z^2] = \min E[s^2] + \min E[\,(n_0 - y)^2] \qquad \text{.........(4)}$$

When the filter is adjusted **so** that **is** $\mathbf{E[\,Z^2]}$ minimized, therefore $\mathbf{E[\,(n_0 - y)^2]}$ is, also minimized. The filter output y is then a best least squares estimate of the primary noise $\mathbf{n_0}$ **.** Moreover, when $\mathbf{E[\,(n_0 - y)^2]}$ is minimized, $\mathbf{E[(z-s)^2]}$ is also minimized, since, from (1)**,**

$$z - s = n_0 - y \qquad \text{............(5)}$$

Adapting the filter to minimize the total output power is thus causing the output **z** to be a best least squares estimate of the signal **s.**

The output **z** will contain the signal **s** plus noise. From (l), the output noise is given by $\mathbf{n_0 - y}$**.** Since minimizing $\mathbf{E[\,Z^2]}$ minimizes $\mathbf{E[\,(n_0 - y)^2]}$ minimizing the total output power minimizes

the output noise power. Since the signal in the output remains constant, minimizing the total output power maximizes the output signal to noise ratio. From (3) the smallest possible output power is

$$E[\,Z^2] = E[\,s^2]$$

When

$$E[\,(n_0 - y)^2] = 0$$

At $\mathbf{y = n_0}$ and $\mathbf{z = s}$

Minimizing the output power causes the output signal to be perfectly noise free.

V.Problem Domain:

A simple audio signal is represented by the following mathematical equation:

audio =sin(2*pi*fo/fs*n);

where f_0 is the frequency of audio signal,f_s is the sampling frequency and n is the discrete time base.When white noise is added to this signal it becomes

c(n) =sin(2*pi*f0/fs*n)+noise(n)

so the problem is to extract the useful signal from this complex signal.

VI. Conclusion:

This paper has described an application in which the use of an LMS and NLMS adaptive filter is particularly appropriate. The main goal of this thesis is to investigate the application of an algorithm based on adaptive filtering in noise cancellation problem. In this paper, only the Least-Mean-Squares Algorithm has been used. Other adaptive algorithms can be studied and their suitability for application to Adaptive Noise Cancellation compared. Other algorithms that can be used include, Normalised LMS, Modified LMS and NLMS algorithm etc. Moreover, this does not consider the effect of finite-length filters and the causal approximation. The effects due to these practical constraints can be studied.

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