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An Adaptive Noise Cancellation And Comparision

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Abstract:
This paper introduce the reducing the content of noise present in the received Speech signals for wireless communication medium by using adaptive noise Cancellation (ANC) technique .It is an alternative technique of estimating signals corrupted by additive noise or interference. Its advantage lies in that, with no apriori estimates of signal or noise, levels of noise rejection are attainable that would be difficult or impossible to achieve by other signal processing methods of removing noise. Its cost, inevitably, is that it needs two inputs - a primary input containing the corrupted signal and a reference input containing noise correlated in some unknown way with the primary noise. The reference input is adaptively filtered and subtracted from the primary input to obtain the signal estimate. Adaptive filtering before subtraction allows the treatment of inputs that are deterministic or stochastic, stationary or time-variable. input for canceling periodic interference, adaptive self-tuning filter, antenna sidelobe interference canceling, cancellation of noise in speech signals, etc. Computer simulations for all cases are carried out using Matlab software and experimental results are presented that illustrate the usefulness of Adaptive Noise Canceling Technique

Key-words: ANC, MATLAB

1. INTRODUCTION:

Active noise control (ANC), also known as noise cancellation, or active noise reduction (ANR), is a method for reducing unwanted sound by the addition of a second sound specifically designed to cancel the first it needs two inputs - a primary input containing the corrupted signal and a reference input containing noise correlated in some unknown way with the primary noise. The reference input is adaptively filtered and subtracted from the primary input to obtain the signal estimate. Adaptive filtering before subtraction allows the treatment of inputs that are deterministic or stochastic, stationary or time-variable.

I. Adaptive noise Cancellation:

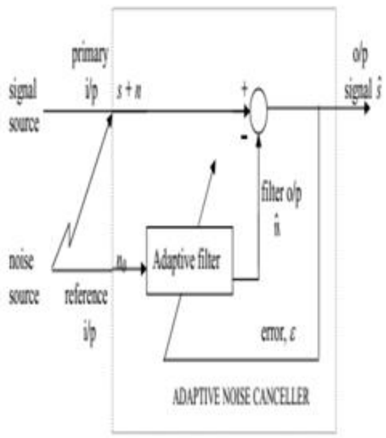

Fig.1 Adaptive Noise Canceller

As shown in the figure, an Adaptive Noise Canceller (ANC) has two inputs – primary and reference. The primary input receives a signal s from the signal source that is corrupted by the presence of noise n uncorrelated with the signal. The reference input receives a noise n_0 uncorrelated with the signal but correlated in some way with the noise n. The noise no passes through a filter to produce an output nˆ that is a close estimate of primary input noise. This noise estimate is subtracted from the corrupted signal to produce an estimate of the signal at sˆ , the ANC system output. In noise canceling systems a practical objective is to produce a system output sˆ = s + n – nˆ that is a best fit in the least squares sense to the signals.

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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 other words the system output serves as the error signal for the adaptive process.

Assume that s, n_0, n_1 and y are statistically stationary and have zero means. The signal s is uncorrelated with n_0 and n_1, and n_1 is correlated with n_0.

$$\hat{s} = s + n - \hat{n}$$

$$\Rightarrow \quad \hat{s}^2 = s^2 + (n - \hat{n})^2 + 2s(n - \hat{n})$$

Taking expectation of both sides and realizing that s is uncorrelated with n_0 and $\hat{n}$,

$$E[\hat{s}^2] = E[s^2] + E[(n - \hat{n})^2] + 2E[s(n - \hat{n})]$$
$$= E[s^2] + E[(n - \hat{n})^2]$$

The signal power $E[s^2]$ will be unaffected as the filter is adjusted to minimize $E[\hat{s}^2]$.

$$\Rightarrow \quad \min E[\hat{s}^2] = E[s^2] + \min E[(n - \hat{n})^2]$$

Thus, when the filter is adjusted to minimize the output noise power $E[\hat{s}^2]$, the output noise power $E[(n - \hat{n})^2]$ is also minimized. Since the signal in the output remains constant, therefore *minimizing the total output power maximizes the output signal-to-noise ratio.*

Since $\quad (\hat{s} - s) = (n - \hat{n})$

This is equivalent to causing the output sˆ to be a best least squares estimate of the signal s.

II. Effect of uncorrelated noise in primary and reference inputs:

As seen in the previous section, the adaptive noise canceller works on the principle of correlation cancellation i.e., the ANC output contains the primary input signals with the component whose correlated estimate is available at the reference input, removed. Thus the ANC is capable of removing only that noise which is correlated with the reference input. Presence of uncorrelated noises in both primary and reference inputs degrades the performance of the ANC. Thus it is important to study the effect of these uncorrelated noises.

Uncorrelated noise in primary input:

Uncorrelated noise in primary input

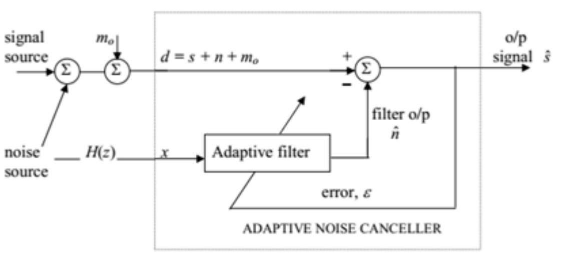


Fig. 2 ANC with uncorrelated noise m_0 in primary input

The figure shows a single channel adaptive noise canceller with an uncorrelated noise mo present in the primary input. The primary input thus consists of a signal and two noises mo and n. The reference input consists of n* h(j), where h(j) is the impulse response of the channel whose transfer function is H(z). The noises n and n* h(j) have a common origin and hence are correlated with each other but are uncorrelated with s. The desired response d is thus s + mo + n. Assuming that the adaptive process has converged to the minimum mean square solution, the adaptive filter is now equivalent to a Wiener filter. The optimal unconstrained transfer function of the adaptive filter is given by

$$W^*(z) = \frac{\delta_{xd}(z)}{\delta_{xx}(z)}$$

The spectrum of the filters input $\delta_{xx}(z)$ can be expressed as

$$\delta_{xx}(z) = \delta_{nn}(z)\,|\,H(z)\,|^2$$

where $\delta_{nn}(z)$ is the power spectrum of the noise *n*. The cross power spectrum between filter's input and the desired response depends only on the mutually correlated primary and reference components and is given as

$$\delta_{xd}(z) = \delta_{nn}(z)H(z^{-1})$$

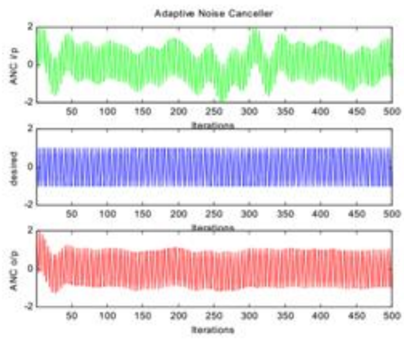
The Wiener function is thus

$$W^*(z) = \frac{\delta_{nn}(z)\,H(z^{-1})}{\delta_{nn}(z)\,|\,H(z)\,|^2} = \frac{1}{H(z)}$$

Note that $W^*(z)$ is independent of the primary signal spectrum $\delta_{ss}(z)$ and the primary uncorrelated noise spectrum $\delta_{momo}(z)$.This result is intuitively satisfying since it equalizes the effect of the channel transfer function *H*(*z*) producing an exact estimate of the noise *n*. Thus the correlated noise *n* is perfectly nulled at the noise canceller output. However the primary uncorrelated noise n_o remains uncancelled and propagates directly to the output.

Simulation Results:

(1) Adaptive Noise Canceller



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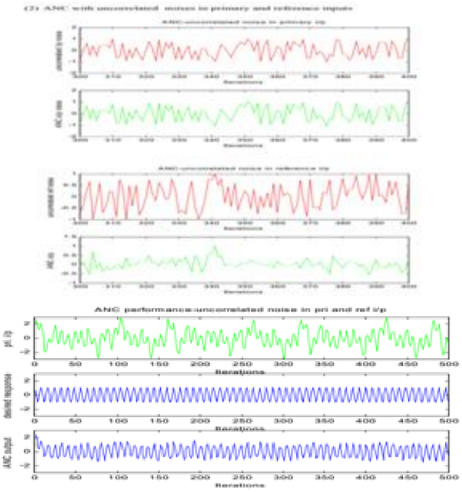

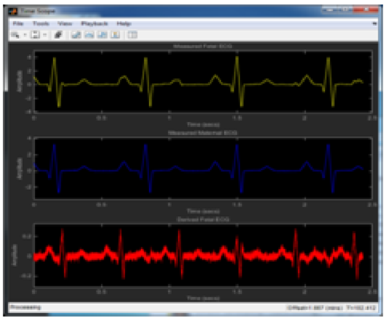

Conclusion:

Adaptive Noise Cancellation is an alternative way of canceling noise present in a corrupted signal. The principal advantages of the method are its adaptive capability, its low output noise, and its low signal distortion. The adaptive capability allows the processing of inputs whose properties are unknown and in some cases non-stationary. Output noise and signal distortion are generally lower than can be achieved with conventional optimal filter configurations. This Project indicates the wide range of applications in which Adaptive Noise Canceling can be used. The simulation results verify the advantages of adaptive noise cancellation. In each instance canceling was accomplished with little signal distortion even though the frequencies of the signal and interference overlapped. Thus it establishes the usefulness of adaptive noise cancellation techniques and its diverse applications.

Further Scope:

In this paper only explain the adaptive noise cancellation technique we can solve.

This problem by using Least-Mean-Squares Algorithm Other algorithms that can be used include Recursive Least Squares, Normalised LMS, Variable Step-size algorithm etc. Moreover, this paper does not consider the effect of finite-length filters and the causal approximatin.

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BIOGRAPHY:

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