Connexions module: m11835

ADAPTIVE INTERFERENCE (NOISE) CANCELLATION*

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Abstract

Adaptive interference (or noise) cancellers are widely used. An adaptive noise canceller adaptively filters a noise reference input to maximally match and subtract out noise or interference from the primary (signal plus noise) input.

NOTE: Automatically eliminate unwanted interference in a signal.

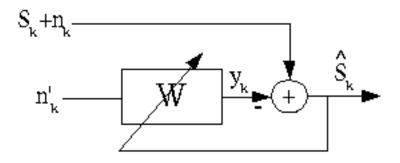


Figure 1

The object is to subtract out as much of the noise as possible.

Example 1: Engine noise cancellation in automobiles

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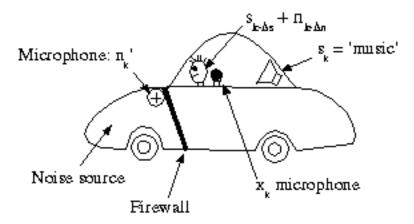


Figure 2

The firewall attenuates and filters the noise reaching the listener's ear, so it is not the same as n'_k . There is also a delay due to acoustic propagation in the air. For maximal cancellation, an adaptive filter is thus needed to make n'_k as similar as possible to the delayed n_k .

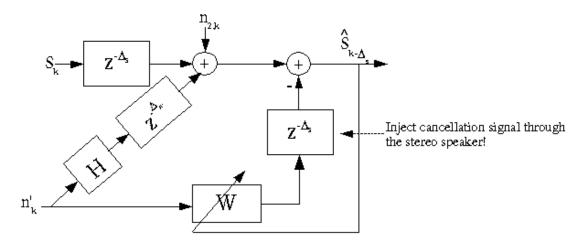


Figure 3

Exercise 1

What conditions must we impose upon the microphone locations for this to work? (Think causality and physics!)

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1 Analysis of the interference cancellor

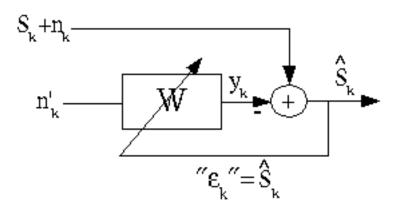


Figure 4

$$E\left[\epsilon_{k}^{2}\right] = E\left[\left(s_{k} + n_{k} - y_{k}\right)^{2}\right] = E\left[s_{k}^{2}\right] + 2E\left[s_{k}\left(n_{k} - y_{k}\right)\right] + E\left[\left(n_{k} - y_{k}\right)^{2}\right]$$

We assume s_k , n_k , and n_k are zero-mean signals, and that s_k is independent of n_k and n_k . Then

$$E[s_k(n_k - y_k)] = E[s_k] E[n_k - y_k] = 0$$

$$E\left[\epsilon_k^2\right] = E\left[s_k^2\right] + E\left[\left(n_k - y_k\right)^2\right]$$

Since the input signal has no information about s_k in it, minimizing $E\left[\epsilon_k^2\right]$ can only affect the second term, which is the standard Wiener filtering problem, with solution

$$W = R_{n'n'}^{-1} P_{nn'}$$