A Note on Averaging Circuits

Watts[1] has made an interesting analysis of averaging circuit design methods. From the fundamental definition, it follows that the transfer function $H(s)$ of such a network is given by

$$H(s) = \frac{1}{sT}\left[1 - \epsilon^{-sT}\right], \tag{1}$$

where T = the period over which the function is to be averaged.

It may be noted that the transfer function of the required network as defined by impulse response is identical to that defined by step response as proposed by Watts, and both of these turn out to be the same as (1) above. Hence, from circuit design point of view there is no advantage in the step response method. To get a good averaging circuit we have to synthesize (1) as accurately as possible. As it would involve use of a delay element the next best thing to do is to get an approximate solution.

An ordinary averaging circuit gives good result in practice not because its step response gives the impression of a good result, but because of the fact that the approximate synthesis of (1) is satisfactory. With the normally encountered wave forms and the periods over which they have to be averaged, the approximations of $H(s)$, based on the condition that sT is small, are good enough. This is evident from the following examples. As a first approximation we may neglect second and higher powers of sT in (1). This leads to

$$H(s) \simeq \frac{1}{1 + sT/2}. \tag{2}$$

This is the first circuit described by Watts. Considering terms up to the third power of sT in (1) we get

$$H(s) \simeq \frac{12}{12 + 6sT + s^2T^2}. \tag{3}$$

This corresponds to the second order system described by Watts with $W_nT = \sqrt{12}$, $\delta = 0.866$ and $K = 1$.

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[1] D. G. Watts, "Practical averaging circuits," *IEEE Trans. on Automatic Control (Short Papers)*, vol. AC-10, pp. 363–364, July 1965.

On Generating Discrete Colored Noise from Discrete White Noise

A recent correspondence of Gelb and Palosky[1] describes a technique for generating discrete colored noise. The purpose of this correspondence is to bring an earlier paper by Levin[2] to the attention of interested readers. The paper not only covers the case of Gelb and Palosky but generalizes the technique to other realizable spectra. Levin's procedure provides the correct initial conditions which does away with the transient problems encountered in such simulations.

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[1] A. Gelb and P. Palosky, "Generation of discrete colored noise from discrete white noise," *IEEE Trans. on Automatic Control (Correspondence)*, vol. AC-11, pp. 148–149, January 1966.

[2] M. Levin, "Generation of a sampled Gaussian time series," *IRE Trans. on Information Theory*, vol. IT-6, pp. 545–548, December 1960.