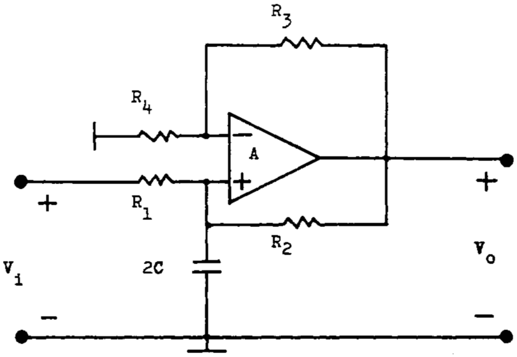

Fig. 1. Deboo noninverting integrator.

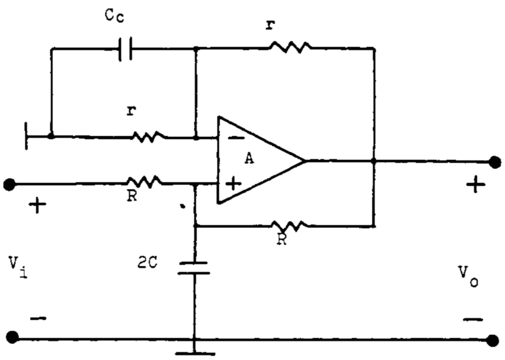

Fig. 2. Passive compensated Deboo integrator.

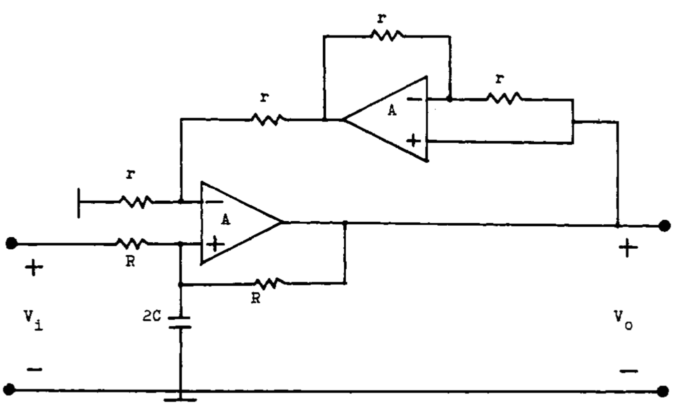

Fig. 3. Active compensated Deboo integrator.

where

$$\tau = \frac{2}{\omega_t}. \tag{13}$$

From (12) the compensated integrator Q factor is given by

$$Q_I \simeq -\frac{1}{8} \cdot |A(j\omega)|^3 = -\frac{1}{8} \cdot \frac{\omega_t^3}{\omega^3}, \quad \frac{\omega}{\omega_t} \ll 1 \tag{14}$$

Comparison of this value of the compensated Q factor with that of (9) shows that an improvement of many orders of magnitude is obtained.

III. The Active Compensated Deboo Integrator

Fig. 3 represents the novel active compensated noninverting Deboo integrator. It is required for compensation that the two op-amps used must have identical unity-gain-bandwidths ω_t (op-amps are available in a dual package). This new active compensated circuit is equivalent to the passive compensated one as it has the same transfer function given by (12). The compensated Q factor is given by (14).

Practically this active compensated circuit is better than the passive compensated one, in which the compensating capacitor C_c must be adjusted according to (11) which depends on the op-amp unity-gain bandwidth. It is well known that ω_t is sensitive to variations in temperature or power supply voltage [3]. So if these conditions are changed the passive compensation will no longer be a satisfactory solution.

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A Modified Canonic Active-*RC* Bandpass Filter with Reduced Sensitivity to Amplifier Gain-Bandwidth Product

AHMED M. SOLIMAN

Abstract—**A new configuration for activating a passive-*RC* bandpass building block to realize an inverting selective bandpass filter is described. The proposed network has the advantages of being canonic, is always stable, and has reduced sensitivity to the amplifier gain-bandwidth product.**

Recently an inverting bandpass filter has been introduced [1]. The network is based on activating a passive-*RC* bandpass building block and has reduced sensitivity to the amplifier gain-bandwidth product (*GB*).

In this letter the circuit is slightly modified such that the fractional shifts in ω_0 and Q due to the finite *GB* of the operational amplifier (OA) are reduced to $\frac{2}{3}$ of their previous values [1]. Moreover, the gain can be independently controlled by tuning a single resistor in the circuit.

The proposed structure is shown in Fig. 1 and is different from the circuit in [1] in two respects. First the voltage follower at the output is replaced by a noninverting voltage controlled voltage source of gain β, secondly the feedback is taken from the noninverting terminal of A_2 instead of the output terminal of A_2.

The voltage transfer function for the network in Fig. 1 is given by:

$$G(s) = \frac{V_0}{V_i} = \frac{-\alpha\beta T}{\left[1 + \frac{\beta}{A_2}\right]\left[1 - (\alpha + 1)\left(T - \frac{1}{A_1}\right)\right]} \tag{1}$$

where T is the open-circuit voltage transfer function of the passive-*RC* bandpass network, which is given by:

$$T(s) = \frac{sC_1R_1}{s^2C_1C_2R_1R_2 + s(C_1R_1 + C_2R_2 + C_1R_2) + 1}. \tag{2}$$

From (1) and (2) and as A_i approaches infinity ($i = 1, 2$) the transfer function reduces to:

$$G(s) = \frac{-s\alpha\beta\, C_1R_2}{s^2C_1C_2R_1R_2 + s(C_2R_2 + C_1R_2 - \alpha C_1R_1) + 1} \tag{3}$$

which realizes an inverting bandpass characteristics having:

$$\omega_0 = \frac{1}{\sqrt{C_1C_2R_1R_2}} \tag{4}$$

$$Q = \frac{\sqrt{C_1C_2R_1R_2}}{C_2R_2 + C_1R_2 - \alpha C_1R_1} \tag{5}$$

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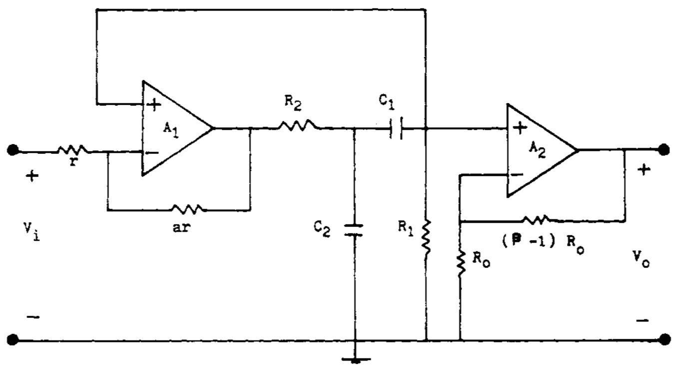

Fig. 1. A new canonic *RC* bandpass filter.

TABLE I

Bandpass Network Type	Circuit Components OA	R	C	Fractional Shifts in ω_0 and Q (for Q > 1) $\frac{\Delta\omega_0}{\omega_0}$	$\frac{\Delta Q}{Q}$
Wilson-Bedri-Bowron Circuit	2	5	3	$-\frac{4\,\omega_0}{GB}$	$\frac{4\,\omega_0}{GB}$
Soliman Circuit	2	4	2	$-\frac{3\,\omega_0}{GB}$	$\frac{3\,\omega_0}{GB}$
New Circuit	2	6	2	$-\frac{2\,\omega_0}{GB}$	$\frac{2\,\omega_0}{GB}$

$$|G(j\omega_0)| = \frac{a\beta C_1 R_2}{C_2R_2 + C_1R_2 - aC_1R_1}. \tag{6}$$

Design Equations

To ensure the stability of the network and to reduce the sensitivities, choose

$$R_2 = R, C_2 = C, C_1 = bC, R_1 = \frac{R}{b},$$
$$a = 1. \tag{7}$$

In this case the ω_0, Q and the gain at resonance of the filter are given

$$\omega_0 = \frac{1}{CR} \tag{8}$$

$$Q = \frac{1}{b} \tag{9}$$

$$|G(j\omega_0)| = \beta Q. \tag{10}$$

It is seen that b controls the filter selectivity and β controls the gain of the filter without affecting ω_0 or Q.

The effect of the finite GB of the OA on ω_0 and Q is discussed next. Assuming identical OA's and taking.

$$A_1 = A_2 = \frac{GB}{s} \tag{11}$$

where GB is the gain bandwidth product of the OA.

From (11), (2), and (7) in (1) and to a first approximation neglect higher order terms, thus the denominator polynomial of the transfer function becomes:

$$D(s_n) = \left(s_n^2 + \frac{1}{Q}s_n + 1\right) + \frac{s_n}{GB_n}\left[(\beta+2)\left(s_n^2 + \frac{1}{Q}s_n + 1\right) + 4s_n\right] \tag{12}$$

where

$$s_n = \frac{s}{\omega_0} \text{ and } GB_n = \frac{GB}{\omega_0}. \tag{13}$$

Following Budak-Petrela analysis [2], the fractional shifts in ω_0 and Q are given by:

$$-\frac{\Delta\omega_0}{\omega_0} = \frac{\Delta Q}{Q} = \frac{2\omega_0}{GB}. \tag{14}$$

It is seen that the proposed modification reduces the fractional shift in ω_0 and Q to $\frac{2}{3}$ their value in the original network [1], as summarized in Table I.

It is worth noting that the proposed structure is very general and it may employ other passive-*RC* bandpass circuits in place of the one used.

ACKNOWLEDGMENT

The author would like to express his sincere thanks to the reviewer for his useful suggestions.

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Image Detection in the Presence of Speckle

P. MOHANA SHANKAR AND H. M. GUPTA

Abstract—**Detection of binary images is considered in the presence of both speckle and additive noise. The detector performance has been evaluated in the presence of speckle as well as in the absence of it. It is observed that the presence of speckle increases the probability of error appreciably even at high signal-to-noise ratios (SNR's).**

INTRODUCTION

Objects illuminated with a beam of coherent light present a granular like structure [1], [2]. As a result of this phenomenon, commonly referred to as speckle, detection of small objects will be seriously affected. So when the information is stored in a light sensitive medium [3], [4], the signal containing the information is masked while it is illuminated with a beam of coherent light for processing. Statistical detection theory [5] may be applied for detecting such signals buried in noise. As the noise due to speckle is multiplicative as well as complex [6], a treatment analogous to the one adopted for fading channels [7] may be undertaken to study the deterioration due to speckle.

THEORY

The input plane where the information is to be stored is divided into small elemental areas of size $a \times a$, the smallest size being set by the present technology [3]. The output plane is also similarly divided. These areas can have light amplitude transmittances of 0 or 1, signifying the bits '0' and '1' respectively, as in an on-off keying scheme [7]. It is assumed that the areas can have the values 0 or 1 with equal probability. The signal is, therefore,

$$S(x,y) = \begin{cases} 1, & \text{for } \begin{matrix} |x| \leq a/2 \\ |y| \leq a/2 \end{matrix} \\ 0, & \text{otherwise.} \end{cases} \tag{1}$$

At the output plane, the received picture or signal would be noisy due to (1) additive white Gaussian noise being introduced by the optical system [8]-[10], and (2) complex multiplicative speckle noise intro-

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