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REPORT ON THE DEVELOPMENT OF 625 LINE TELEVISION GCR SIGNALS

1. Introduction

The successful implementation of a ghost canecling system requires that the transmitted video signal contain a training signal called ghost canceling reference(GCR) signal, which can be examined by a receiver to evaluate the multipath distortion suffered by the video signal in the transmission path. The challenging problem is to design a GCR signal that is amenable to fast and easy analysis by simple receiver hardware of the entire range of anticipated multipath distortion, so that the the compensating filter required to cancel the distortion can be configured accordingly.

In 1993, a ternary sequence based GCR signal, the So-called K-GCR signal for NTSC system, was selected as the national standard GCR signal by the Korean Ministry of Information and Communication, and has been broadcast in vertical blanking interval(VBI) line 20 throughout Korea. In view of the fact that the current VBI line resources in Korea are almost used up, the GCR signal is advantageous, since it occupies only a single line and the capturing process at the receiver can be accomplished using a single line memory while covering a large range of ghost delay. Also, it was recommended as the system B GCR signal in *Recommendation 1124* by ITU-R [1]. This signal can also be used in 625 line systems, not to mention 525 line systems where it is currently used [2]. In recent years, we have incorporated ghost cancelers in 36" wide screen television sets, which are now available in the market.

This document is prepared as a progress report on the development activities of GCR signals for use in 625 line television systems where we rely on computer simulation to confirm their validity. The entire chain between the transmitter and receiver is modeled in a computer, and the model that takes into account ghost parameters such as the delay, amplitude, and phase during radio frequency propagation is used to generate shosts, which are in turn fed into a least mean square deghosting algorithm. So the entire simulation serves to confirm the validity of GCR signals along with their synthesis model. Through computer simulation we have been able to verify our method of ghost generation and cancellation, as well as the GCR signals themselves. We are going to perform field tests in countries where programs for 625 line systems are broadcast, as soon as we finish up experimenting on a prototype ghost canceler, with the hope of being able to report the test results to the next ITU-R meeting.

2 GCR signals for 625 line television systems

2.1 Ternary sequence

A sequence, consisting of elements 0, +1, and −1 is said to be ternary sequence if all the sidelobes of the periodic autocorrelation function in the sequence are equal to zero except for a lag of zero shift. The GCR signal derives from a ternary sequence of length 183 constructed suing the synthesis procedure [2], and becomes of length 366 after zero insertion and lowpass filtering. But the code length can be reduced to alleviate the constraint on the preceding and following lines. The sample values of the zero-inserted ternary sequence are presented in Table 1.

On the transmission side, the GCR signals are broadcast in a VBI characteristics than their 525 line system counterparts, as specified in Table 2. To achieve an additional improvement in SNR of 3 dB at the receiver and to remove the black burst signal, negative polarity GCR signal rather than the pedestal alone is transmitted by every two frames.

The GCR signals have the attractive features such as high energy and correlation gain, minimum use of VBI(only a single line), wide correction range(-12.2 to 43.3 μs with a single line memory), fast and stable operation even in the presence of noise, economical and low implementational complexity, etc.

2.2 Specifications of GCR signals

As shown in Figure 1, the GCR signals each consist of two waveforms of opposite polarity: the two GCR signals are inserted in every other field, i.e., only in even fields. For transmission, the positive and negative polarity GCR signals are passed through a lowpass filter with an appropriate cutoff frequency, i.e., 5/6MHz(B, G/D, K), and are placed on a pedestal of 300mV. The frequency response of the lowpass filter used is shown in Figure 2. The GCR signal waveforms are normalized to take on amplitude values between 0 and 600 mV to prevent overmodulation. Table 3 shows in detail the parameters of the GCR signals.

3 Ghosting and deghosting simulation

Shown in Figure 3 is a block diagram of a ghost generation model. It consists of a double sideband AM modulator, a transmit filter, a transmission channel which is responsible for ghost phenomena, a white Gaussian noise generator, a receive filter, and a baseband demodulator where the IF up- and downconversion can be omitted without changes in the process and the interpolation /decimation is done to accommodate the sampling rate increase and decrase, respecitively. The transmit and receive filters together make up a vestigial sideband filter proper. The sampling rate in the baseband is set to be four times the color subcarrier frequency, and 1-to-4 interpolation and 4-to-1 decimation are done before modulation and after demodulation, respecitively. The numbel of samples per one line of video signal is about 1, 135. This ghost generation model is accurate and useful in that it offers us a lot of ghost-impaired video data with which a variety of deghosting algorithms can be tried and compared before committing ourselves to hardware construction.

The GCR signals offer much flexibility to those who are going to develop deghosting algorithms. It should be noted, however, that what is important in deghosting is not to compute the forward channel characteristic alone accurately, but to find out an inverse filter coefficient vector which can equalize and deghost both rapidly and accurately. Therefore the various well-known adaptive filter algorithms can be used, for example the time domain methods such as least mean square, least squares, and zero forcing, frequency domain ones, or both. What type of algorithm to adopt in a receiver in terms of the computational complexity, convergence speed, misadjustment, cost, and performance is entirely up to the manufacturer.

In this report we tried the output error least mean square algorithm where a structure consisting of FIR and IIR filters in cascade is selected and both of the filter coefficients are updated simultaneously in an iterative fashion. The number of iterations is set at 50 with the step size fixed at 10^{-8}. We have confirmed the validity of our GCR signals by computer simulations in various ghosting conditions. As an example, Figures 4(a)-(c) and (d)-(f) show the simulation results for three ghosts in the absence and presence of noise, respectively. Each of the three ghosts has the following parameters in order of delay, amplitude, and phase : $-1.8\mu s$, -23.1dB, $-50°$; $2.2\mu s$, -10.5 dB, $-20°$; and $38.9\ \mu s$, -20 dB, $70°$. The noisy case has a CNR of 30 dB. It can be seen that since the GCR signals are extracted over four frames using averaging operation, even in the presence of noise the deghosting filter coefficients look almost the same as those of the noiser free case. Although the noise is still present, the sync signals are found to be fairly free of ghosts.

4 Conclusion

We have verified that the proposed GCR signals can be used in 625 line television systems through computer simulation using the RF ghost generation model and least mean square algorithm.

We are in the process of building a prototype ghost canceler for 625 line television systems, and will conduct field tests by the year end or early next year possibly in cooperation with the Ministry of Radio, Film and TV, People's Republic of China(RTPRC). We hope that the results will be contributed at the next ITU-R meeting.

References .

[1] ITU-R Study Group 11-Working Party C, *-Recommendation ITU-R BT 1124,* July 1994

[2] H.M.Park *et al.*, "A new ghost cancellation reference signal for TV broadcasting system", *proc. IEE 3rd International Symp. Consumer Electronics,* Hong Kong, vol. 1, pp.74-79, Nov. 1994.

[3] V.P.Ipatov, "Ternary sequences with ideal periodic autocorrelation properties", *Radio Engr. Electron. Physics,* vol. 24, no. 10, pp.75-79, 1979.

TABLE 1

Ternary sequence of length 366

1	0	1	0	1	0	1	0	1	0	1	0	1	0	−1	0	−1	0	1	0
0	0	−1	0	−1	0	1	0	1	0	−1	0	1	0	1	0	1	0	−1	0
−1	0	−1	0	−1	0	1	0	1	0	1	0	1	0	−1	0	1	0	−1	0
1	0	−1	0	−1	0	0	0	1	0	1	0	−1	0	−1	0	1	0	1	0
−1	0	−1	0	1	0	0	0	1	0	−1	0	1	0	−1	0	−1	0	1	0
−1	0	1	0	1	0	1	0	−1	0	−1	0	1	0	1	0	−1	0	1	0
−1	0	0	0	−1	0	0	0	−1	0	1	0	−1	0	1	0	−1	0	−1	0
−1	0	−1	0	−1	0	1	0	−1	0	−1	0	1	0	−1	0	1	0	1	0
0	0	1	0	1	0	1	0	−1	0	−1	0	−1	0	0	0	1	0	1	0
−1	0	−1	0	−1	0	1	0	1	0	−1	0	1	0	1	0	−1	0	1	0
−1	0	−1	0	−1	0	−1	0	−1	0	−1	0	1	0	−1	0	1	0	0	0
−1	0	1	0	1	0	1	0	1	0	−1	0	1	0	1	0	−1	0	1	0
1	0	0	0	0	0	1	0	1	0	0	0	−1	0	1	0	1	0	1	0
0	0	1	0	−1	0	1	0	−1	0	1	0	0	0	−1	0	1	0	1	0
1	0	1	0	1	0	−1	0	1	0	−1	0	−1	0	1	0	1	0	−1	0
1	0	1	0	−1	0	−1	0	−1	0	1	0	−1	0	1	0	−1	0	−1	0
1	0	0	0	1	0	1	0	1	0	−1	0	−1	0	−1	0	−1	0	1	0
1	0	−1	0	−1	0	1	0	−1	0	1	0	−1	0	−1	0	−1	0	1	0
1	0	1	0	1	0														

TABLE 2

Transmission sequence of GCR signals

Field number	2	4	6	8
GCR signal polarity	+	−	+	−

TABLE 3

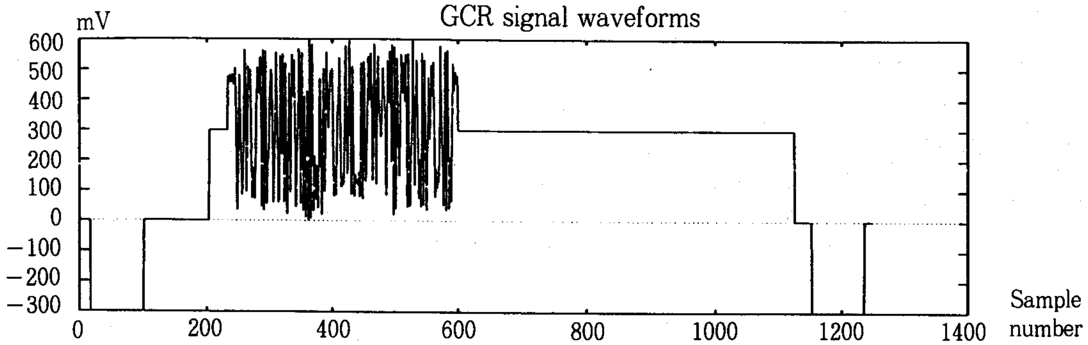
Parameters of GCR signals

Television systems	B, G	D, K
GCR signal frequency limit	5.0MHz	6.0MHz
Pedestal height	300mV	300mV
Start of pedestal	186th sample	186th sample
Finish of pedestal	1108th sample	1108th sample
Start of GCR	216th smple	216th sample
Duration of GCR	366 samples	366samples
Lowest level of GCR	0mV	0mV
Highest level of GCR	600mV	600mV

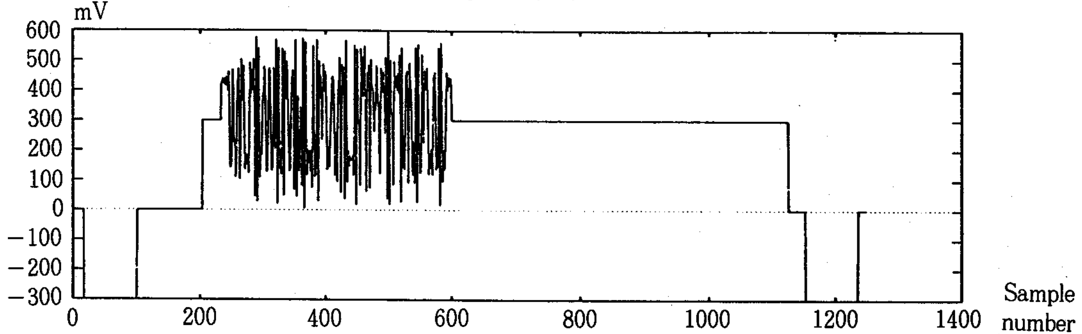
Sampling rate : four times color subcarrier frequency, i.e., $4f_{sc}$

FIGURE 1

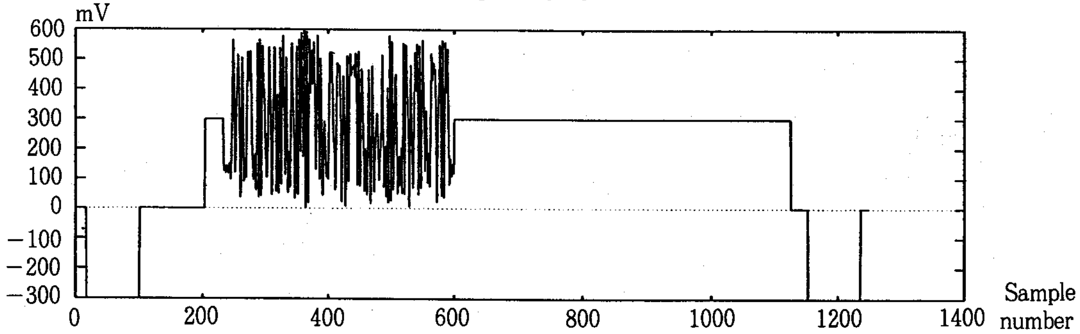
GCR signal waveforms



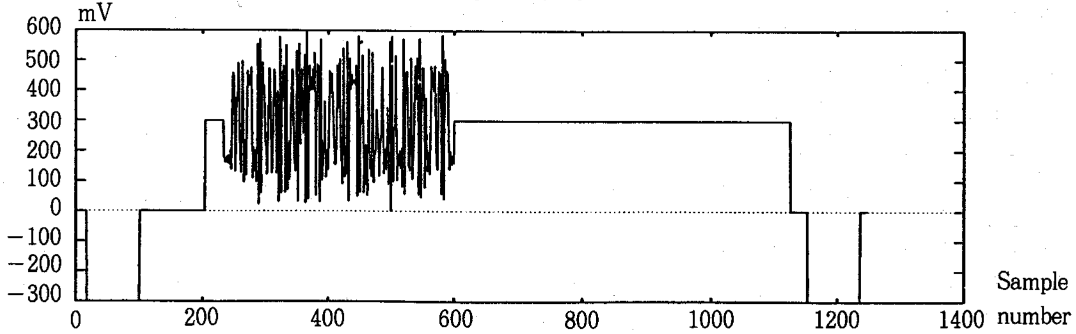
(a) Positive polarity(systems B, G)



(b) Positive polarity(systems D, K)



(c) Negative polarity(systems B, G)



(d) Negative polarity(systems D, k)

FIGURE 2

Frequency characteristics of lowpass filters

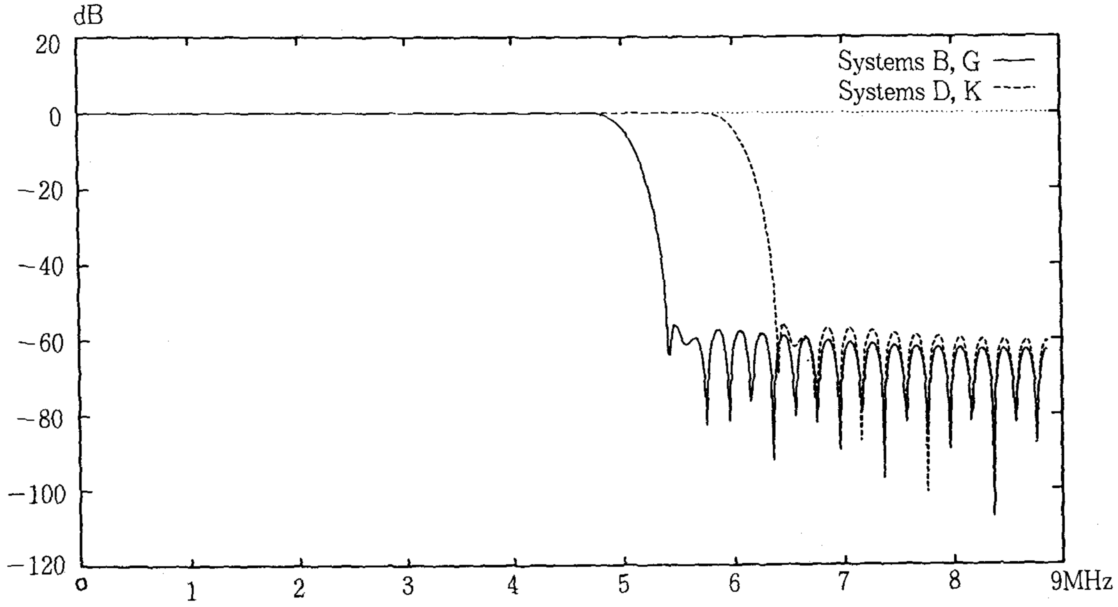


FIGURE 3

Model for simulating RF ghosts

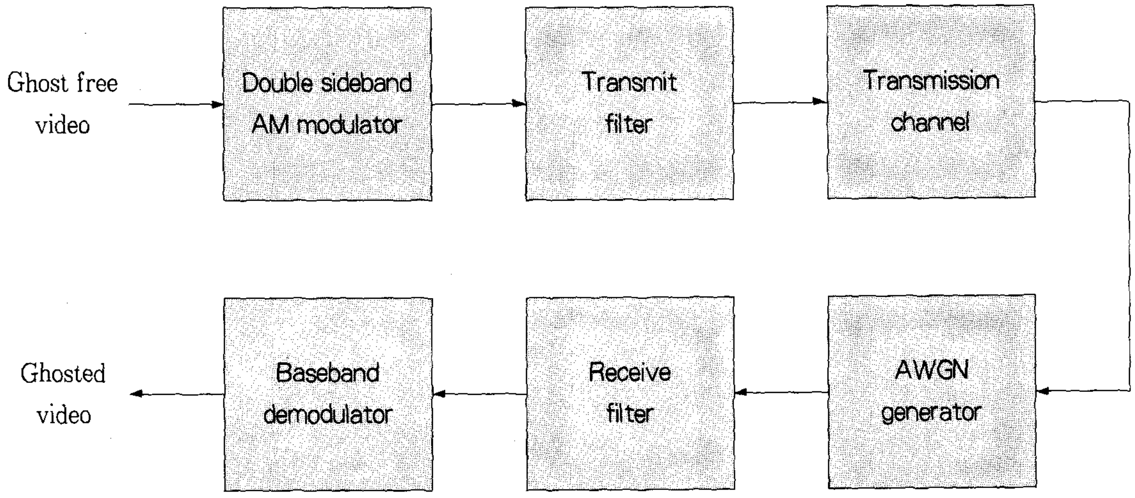
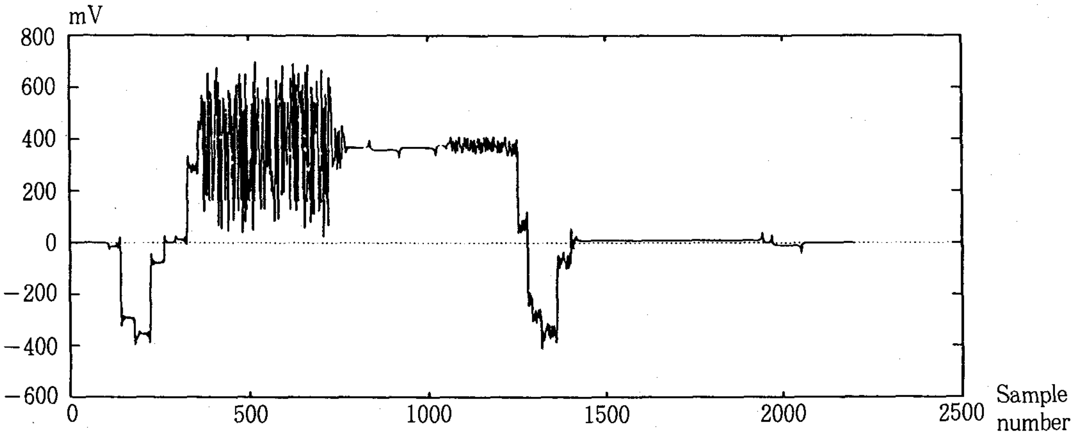
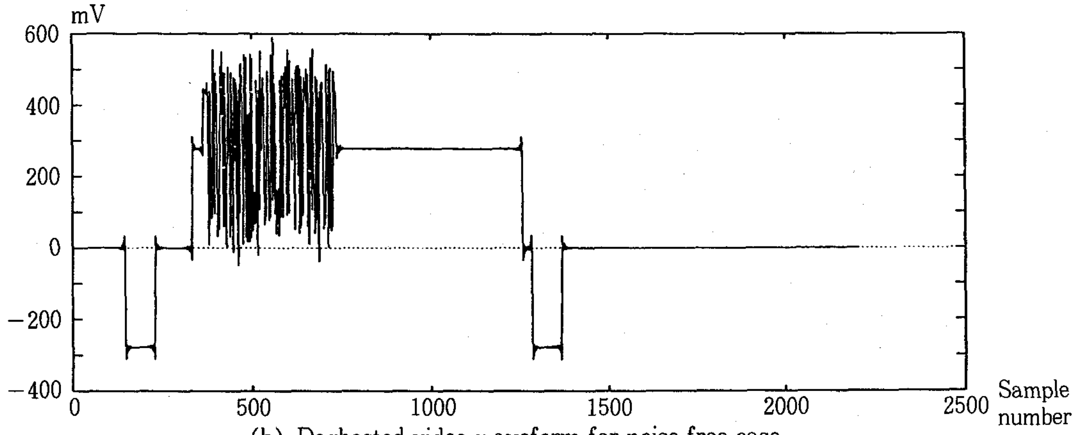


FIGURE 4

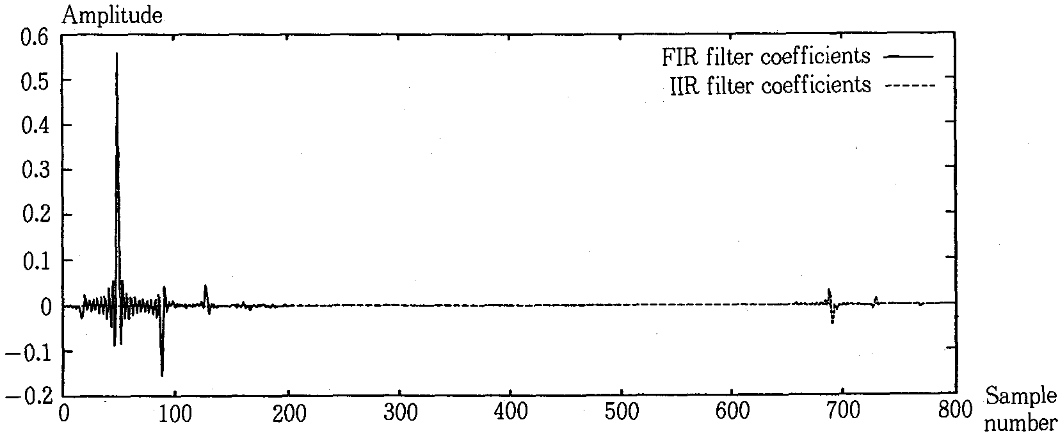
Deghosting simulation results



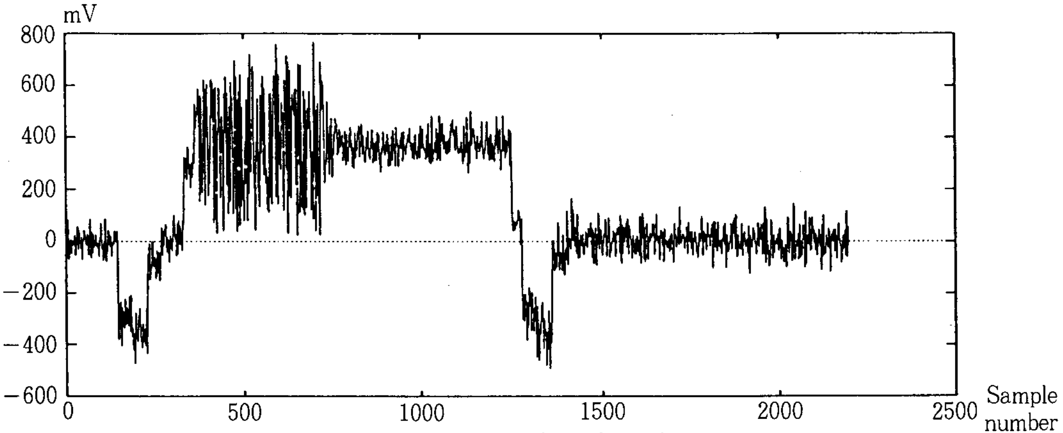
(a) Ghosted video waveform for noise free case



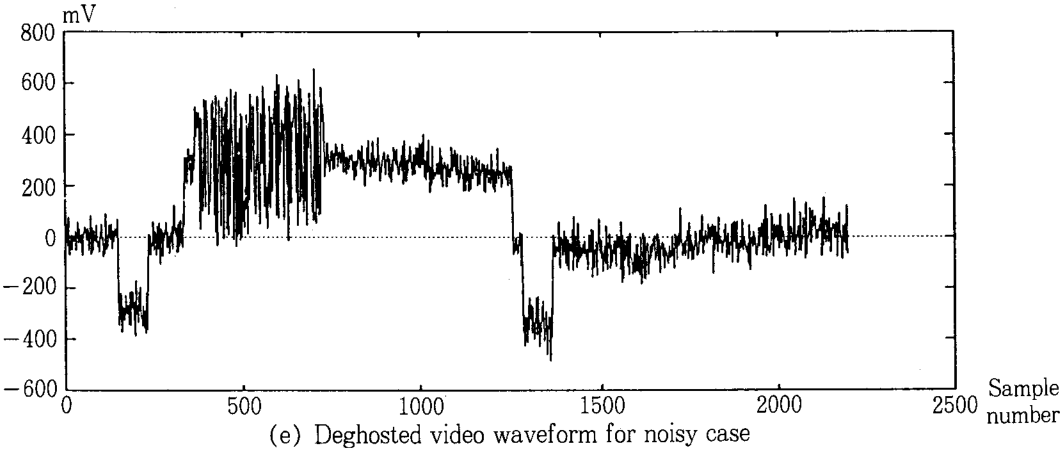
(b) Deghosted video waveform for noise free case



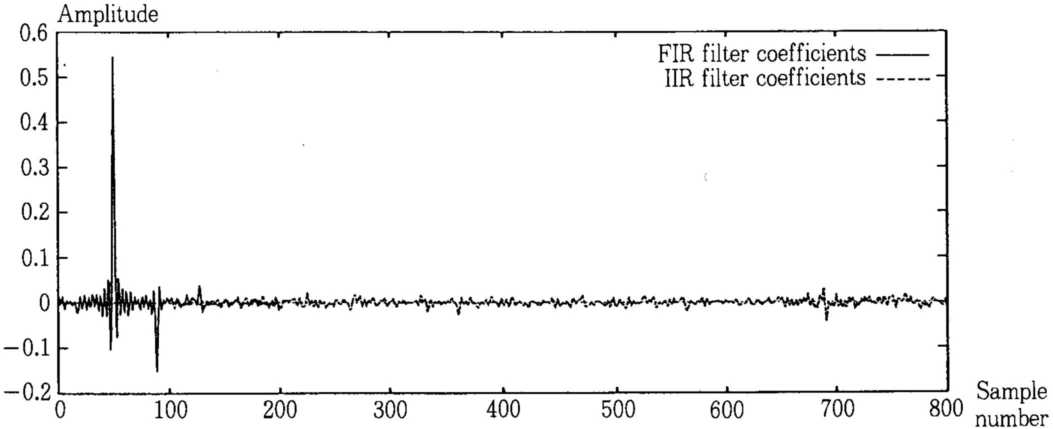
(c) Filter coefficients for noise free case



(d) Ghosted video waveform for noisy case



(e) Deghosted video waveform for noisy case



(f) Filter coefficients for noisy case