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Applications of a DPCM system with median predictors for image coding

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SUMMARY

Fig. 1 illustrates a DPCM system. While most DPCM systems employ linear predictors[1], in some applications such as image coding use of a nonlinear predictor has been suggested. In [2], a DPCM with a nonlinear median-type predictor was proposed and used to encode images. It has been shown that such a predictor can result in smaller prediction error variance than can some practical linear predictors.

In this paper, we investigate a DPCM system with median predictors, which is called the predictive median DPCM(PM-DPCM), and which may be considered to be a modification of the DPCM system in [2]. In contrast to the DPCM in [2], the prediction error variance associated with PM-DPCM is usually larger than that of a conventional DPCM with linear predictors(this is shown in the paper through statistical analysis). The PM-DPCM, however, outperforms other DPCM systems when transmission bit errors occur. Specifically, in PM-DPCM transmission errors are often isolated, while in most DPCM systems the errors are propagated over reconstructed signals. A simple example illustrating the noise isolation characterisic of the PM-DPCM is presented below.

Consider a 1-D PM-DPCM employing the median predictor of size three which is defined as

$$\hat{y}(n) = \text{median}[z(n-1),z(n-2),z(n-3)]$$

The PM-DPCM is used to encode the signal y(n) in Fig. 2 (a). As depicted in Fig. 2 (b) - (d), when the prediction error signal x(n) is noise free, the reconstructed signal $y_r(n)$ is equivalent to the original signal y(n). Fig.3 illustrates the case where transmission noise occurs. $x_r(n)$ in Fig. 3 (a) is the same as x(n) in Fig. 2 (c) except at n = 6 where an error occurs. Fig. 3 (b) depicts the reconstructed signal from $x_r(n)$. It is important to note that the orignal signal y(n) in Fig. 2 (a) is perfectly reconstructed except at n = 6: the error was isolated and not propagated.

In the paper, PM-DPCM is applied to 2-D images. It is observed that PM-DPCM performs like conventional DPCM with linear predictors under noise-free conditions, and that it acts like hybrid DPCM[3] when transmission errors occur.(Hybrid DPCM is a robust scheme which is resistive to tranmission errors.) Since PM-DPCM is considerably simpler to implement than hybrid DPCM, the former is a useful alternative to the latter.

Finally, statistical properties of PM-DPCM are analyzed by inputting the 1st order AR processes. The variance of the prediction error signal and the conditional expected values of the reconstructed signal given a transmission error value are evaluated. The

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result will be presented in the paper.

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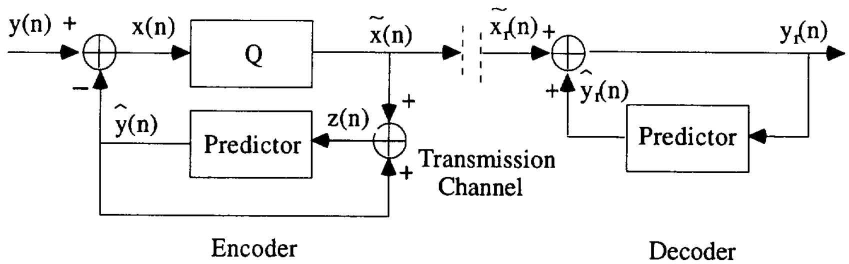

Figure 1. The DPCM System

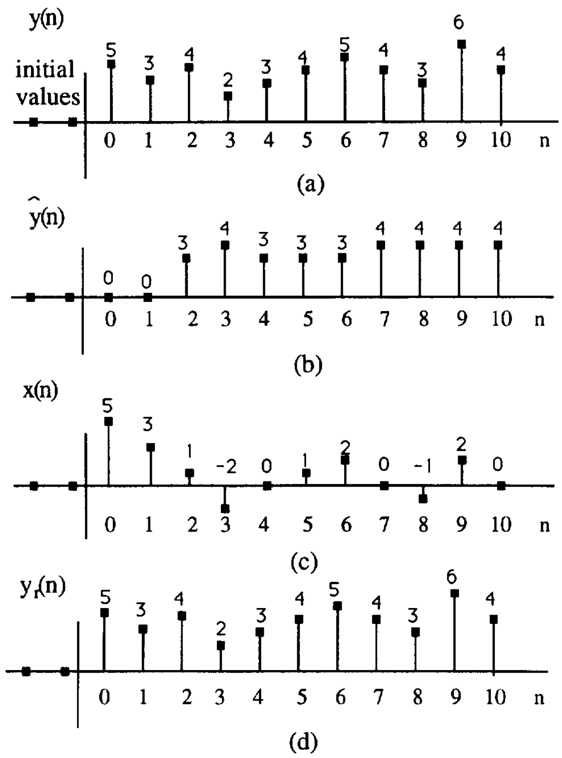

Figure 2. (a) The original signal, (b) ouputs of the median predictor of span 3, (c) outputs of the encoder, (d) the reconstructed signal
(Quantization effect is ignored.)

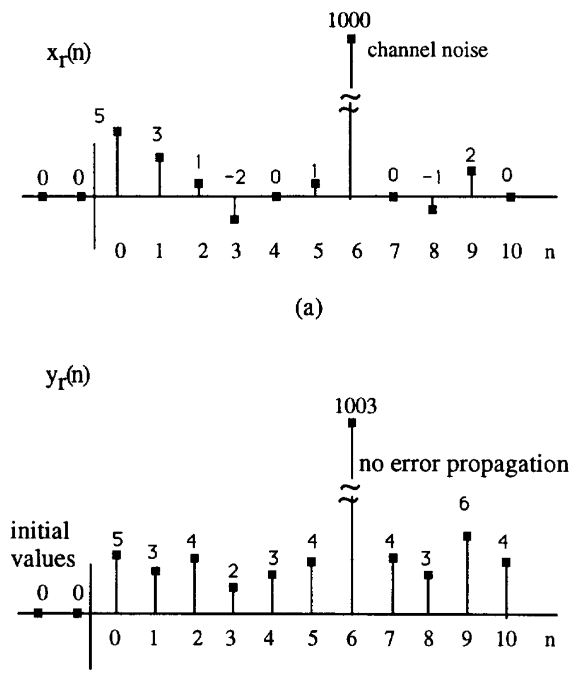

Figure 3. (a) x(n) corrupted by channel noise, (b) the reconstructed signal from corrupted x(n)