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Comments on comparison of the ECG by prediction or interpolation and entropy encoding

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important. The vapor phase deposition of parylene C produces a coating of uniform thickness, which is impossible to achieve in a dip coating operation. The variation of the coating thickness due to each technique is shown in Table II.

Good adhesion of the coating to the substrate is a must for an efficient conformal coating. Polyvinylidene chloride and fluorinated polymers have poor adhesion to most surfaces. The lack of adhesion prevents these coatings from expanding or shrinking with the substrate due to thermal fluctuations leading to the formation of microcracks in the coating surface.

The removal of the coating using appropriate solvents would be of great advantage if the electronic modules need to be reworked. Parylene C, due to its excellent adhesion and solvent resistance, literally has to be scraped away. This might be a serious disadvantage if delicate components are involved. Also, the reworked area will have to be repaired using epoxies or silicones which leave a weak spot in the encapsulation. The silicone coatings can be removed using a sharp blade and later patched up with a drop of the same silicone system. On curing, the repaired area once again forms a continuous envelope with the original coating. If complete removal is required, the coated module should be immersed in toluene or hexane. After a few hours, the silicone coating swells considerably and can be literally brushed away. The solution coated polymers can be removed using the same solvents that were used to dissolve the polymers initially. Entire removal of the epoxy coating is very difficult as most printed circuit boards are also made of epoxies and tend to be affected by the removing agent (methylene chloride). Localized repairs are performed by mechanical removal of the coating by scraping or peeling followed by recoating with the same epoxy system.

Based on this study, it can be concluded that parylene C is the obvious choice for conformal coating of high-reliability electronic circuits.

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Comments on "Compression of the ECG by Prediction or Interpolation and Entropy Encoding"

PER-OLA BÖRJESSON, GÖRAN EINARSSON, AND
OLLE PAHLM

Abstract—A recent paper¹ discusses prediction and interpolation for data compression of ECG. This communication points out that both methods can be viewed as linear filtering. They are therefore equivalent and give the same result in terms of the amount of data compression achieved.

In a recent paper,¹ Ruttimann and Pipberger seem to claim that predictive coding, where the residual is obtained by in-

terpolation, may have advantages over a data compression system using prediction.

Fig. 2 in the paper¹ shows their interpolator to be a linear filter producing the residual

$$e_n = (z^{-1} - a - bz^{-2})x_{n+1} \quad (1)$$

where z^{-1} stands for the shift operator (time delay T). The coefficients are selected as $a = b = 0.5$ in which case (1) can be written as

$$e_n = -\frac{1}{2}(1 - 2z^{-1} + z^{-2})x_{n+1}. \quad (2)$$

If a second-order predictor is used, the residual would be

$$e'_n = (1 - a_1z^{-1} - a_2z^{-2})x_n. \quad (3)$$

A second difference predictor performs linear extrapolation and has the coefficients $a_1 = 2$, $a_2 = -1$. Substitution into (3) gives

$$e'_n = (1 - 2z^{-1} + z^{-2})x_n. \quad (4)$$

Comparison of (2) with (4) shows that the interpolator and the predictor are identical, apart from an unimportant gain factor of $(-\frac{1}{2})$ and a difference in time delay of one unit between input and output.

Data compression of ECG's utilizing a second difference predictor has been studied previously in [1], [2], and [3].

The reconstructed signal for the interpolator (2) is

$$x_n = (1 - 2z^{-1} + z^{-2})^{-1}(-2e_{n-1}) \quad (5)$$

and for the predictor (4)

$$x_n = (1 - 2z^{-1} + z^{-2})^{-1}e'_n. \quad (6)$$

Since the residuals e_{n-1} and e'_n differ by a constant factor of $(-\frac{1}{2})$, the variance of e_n is 6 dB below that of e'_n . This, however, does not mean that fewer bits are required for its digital storage. From (5) and (6) it is evident that to produce the same x_n , the residual e_n must have a quantizing distortion which is 6 dB lower than the distortion of e'_n .

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Author's Reply²

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We agree with the comment made above [1] that both prediction and interpolation can be viewed as linear filtering oper-

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¹U. E. Ruttimann and H. V. Pipberger, *IEEE Trans. Biomed. Eng.*, vol. BME-26, pp. 613-623, Nov. 1979.