NASA TECH BRIEF
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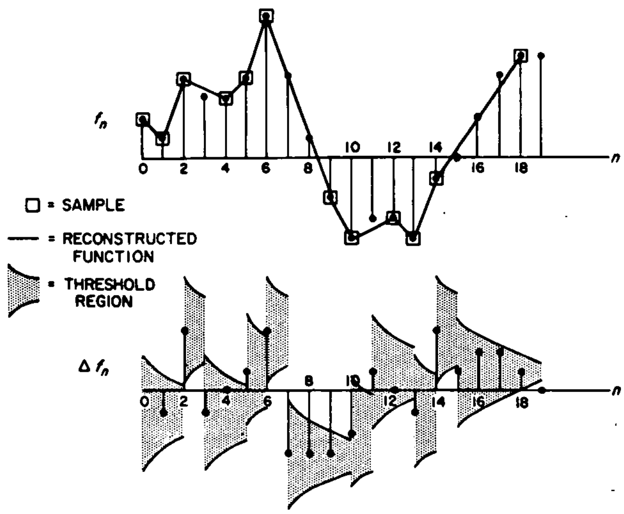
Data Compression by a Decreasing Slope-Threshold Test

Excellent resolution can be obtained at large compression ratios with a novel method for selecting data points for transmission by telemetry in a television (TV) compressed-data system. A net compression ratio of 3 or 4 to 1 is achievable with no visually detectable degradation in TV picture quality.



The scheme of the slope-threshold compression method is to test the slope (first difference) of a raw data stream and compare it to a symmetric pair of decreasing thresholds. When either threshold is exceeded, the data are sampled and transmitted; the thresholds are reset, and the test begins again, as follows:

Let f_n = raw data sequence
$\Delta f_n = f_n - f_{n-1}$
n_m = index of the m^{th} transmitted sample.

When the m^{th} sample has already been transmitted and the search for the m+1 sample is in progress, the upper and lower thresholds $T_U(n)$ and $T_L(n)$, are (for $a \geq 0, b \geq 0$)

$$T_U(n) = \Delta f_{n_m+1} + a \exp[-b(n-n_m-1)]$$

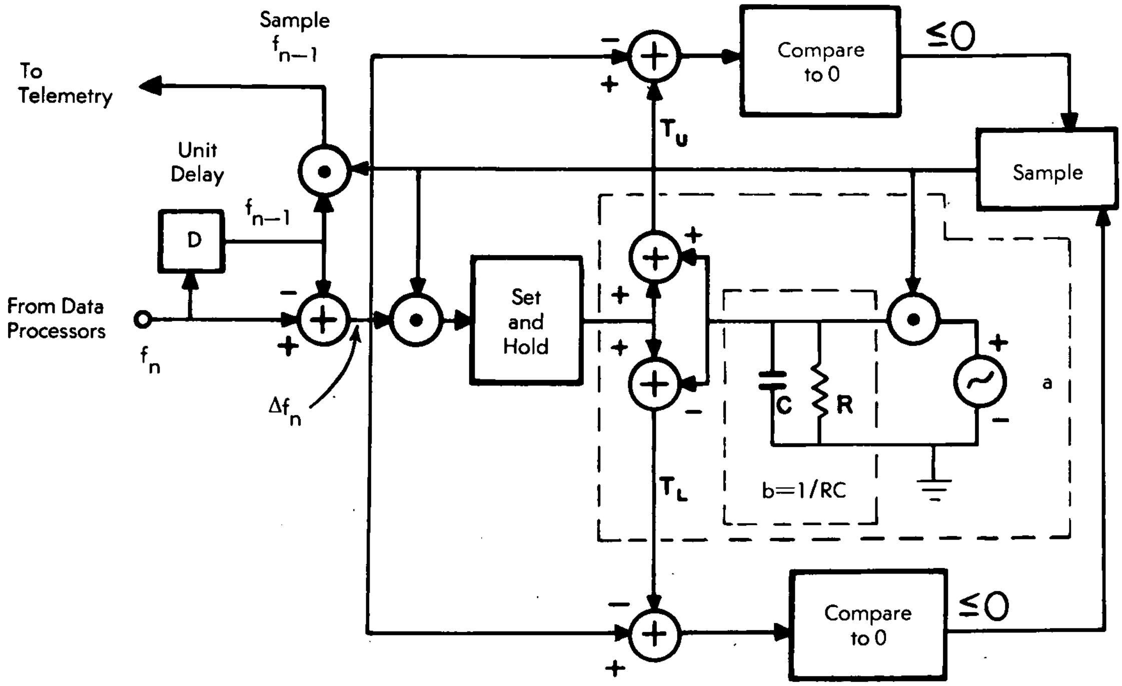
$$T_L(n) = \Delta f_{n_m+1} - a \exp[-b(n-n_m-1)].$$

Thus, when $\Delta f_n - T_U(n) \geq 0$, or when $\Delta f_n - T_L(n) \leq 0$, f_{n-1} is sampled and n_{m+1} is set equal to n−1. The reconstructed function is a linear interpolation of these samples. Referring to the diagram, point 6 is not within the threshold; therefore, point 5 would be sampled. Point 7 is not within the threshold; therefore, point 6 would be sampled. Point 8 *is* within; therefore, point 7 would not be sampled. Point 9 *is* within; therefore, point 8 would not be sampled. Point 10 is not within; therefore, point 9 would be sampled.

The decreasing slope-threshold method is easily implemented in analog form as shown in the circuit diagram. The raw data sequence f_n is applied to the input of the decaying slope-threshold sampling circuit and also to the adder (operational amplifier) and unit delay line. The output of the unit delay line is the raw data sequence f having an index n−1. To obtain the change, Δf_n, in the data, the raw data sequence f_n is algebraically summed with f_{n-1} in the adder. The unit delayed raw data sequence f_{n-1} is also applied to an AND gate which will gate f_{n-1} to the output when a coincident sampling command is received from the sample circuit (which is a one-shot multivibrator).

The difference voltage Δf_n is applied to adders in opposite polarities where it is algebraically summed

(continued overleaf)



with the upper and lower decaying thresholds emanating from the biased, decaying threshold-generating circuit. This circuit generates the decaying voltage

$$a \exp\left[-b(n-n_m-1)\right] + \Delta f_n$$

where a is the dc standard voltage source and a exp $[-b(n-n_m-1)]$ is the capacitor charge decay due to the time constant of the RC circuit. The start of the decaying threshold is coincident with the sampling pulse by the operation of an AND gate. A bias is derived from the fact that the voltage Δf_n is gated to adders by operation of an AND gate and the HOLD circuit (capacitor storage). The bias centers the decaying thresholds above and below the previous sampled point.

The results of the subtractions in the first adders determine if $\Delta f - T_U(n) \geq 0$, or if $\Delta f_n - T_L(n) \leq 0$. If the remainder is zero outside of the upper $T_U(n)$ and lower $T_L(n)$ thresholds, the delayed data point must be sampled. Therefore, an output from either of the adders would trigger the sample circuit by operation of Schmitt trigger circuits. The f_{n-1} data point would thereupon be gated to the output and would be one point that would be transmitted by telemetry in the compressed data channel.

Patent status:

This invention has been patented by NASA (U.S. Patent No. 3,598,921). Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to:

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