Unlimited Sampling with Local Averages
Recovery of High Dynamic Range Inputs from Average Samples

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Summary
- We address a fundamental bottleneck in physical sensors: dynamic range limitation.
- The limitation is mainly discussed in the traditional scenario of ideal point-wise sampling as part of the Unlimited Sensing Framework.
- In our hardware experiments, we noticed a deviation from the ideal sampling model, particularly for signals with jump discontinuities.
- The observations are better described by a sampling model with local averages.
- We introduce a new average sampling architecture based on a nonlinear operator called modulo-hysteresis.
- We give theoretical recovery guarantees and show the performance of our method using hardware and synthetic data.

The Unlimited Sensing Framework (USF)
- A conventional ADC saturates for inputs outside its dynamic range.

Theorem 1 (Estimation of Folding Times).

M_N = \{ k \in \mathbb{Z} \mid |\Delta^N y[k]| \geq \lambda \} is the set of samples displaced by modulo

< \frac{1}{2\nu} then

\bar{\tau}_1 = \bar{\tau}_1 T - 2\nu \bar{\tau}_1 + \nu and \bar{\tau}_1 = \text{sign} (|\Delta^N y[k_m]|)

be the estimates of the folding time with \bar{\tau}_1 = k_m N and \bar{\tau}_1, where

\begin{align*}
\bar{\tau}_1 &= \Delta^N y[k_m] \\
\bar{\tau}_1 &= 1 \quad \text{if } |\Delta^N y[k_m]| \leq 2\lambda - \frac{\lambda}{\nu} \\
\bar{\tau}_1 &= 1 \quad \text{if } |\Delta^N y[k_m]| > 2\lambda - \frac{\lambda}{\nu}
\end{align*}

References