Mitigating Non-linear DAC Glitches Using Dither in Closed-loop Nano-positioning Applications

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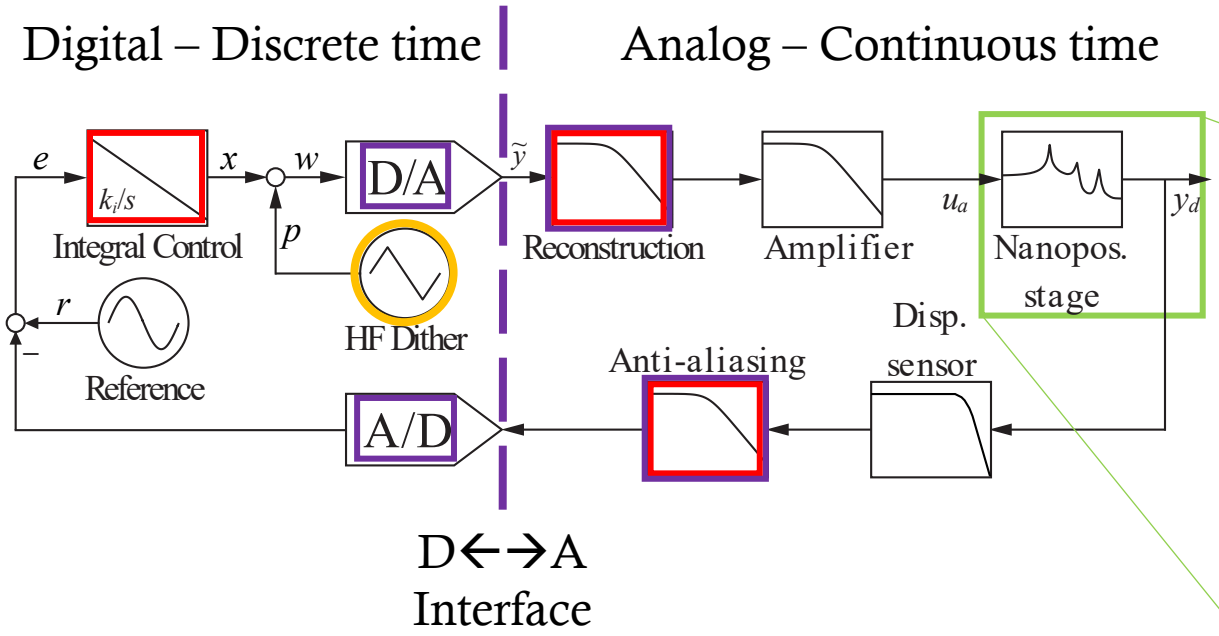
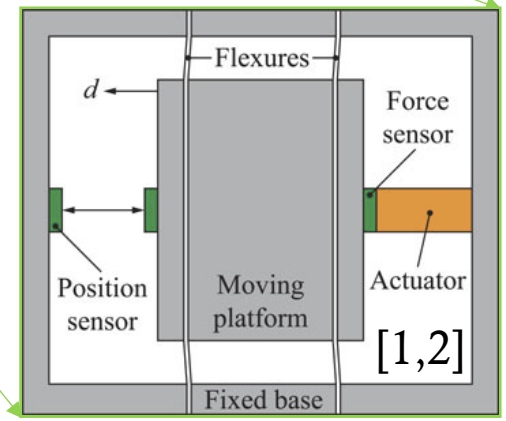
CLOSED-LOOP NANO-POSITIONING SYSTEM

Controller

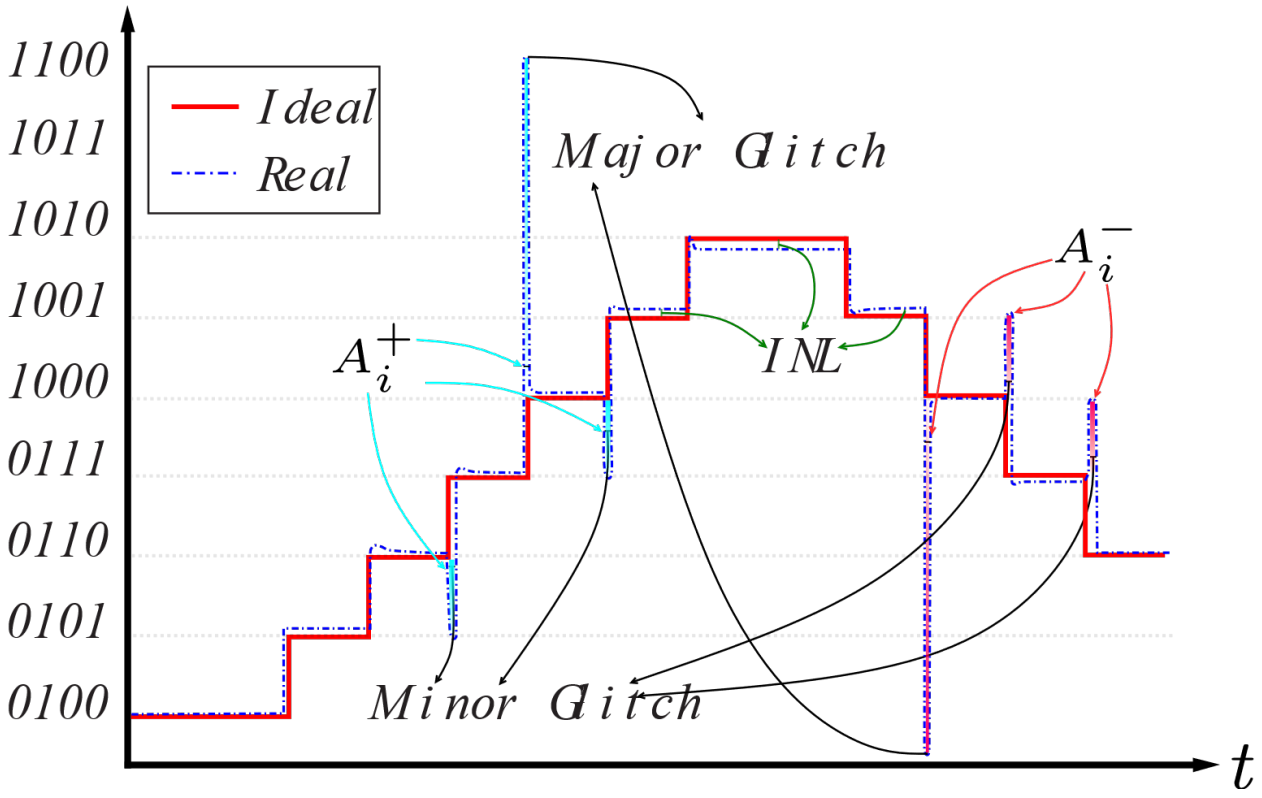


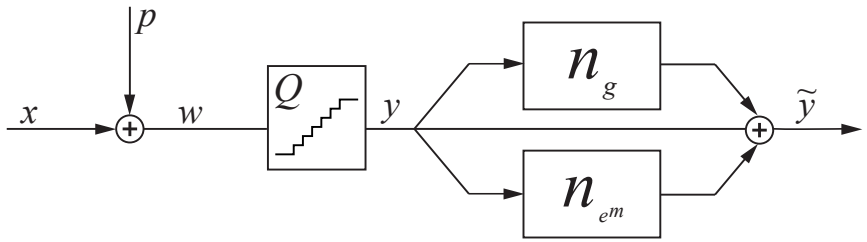


Nano-positioning mechatronic system

NON-LINEAR DAC MODEL

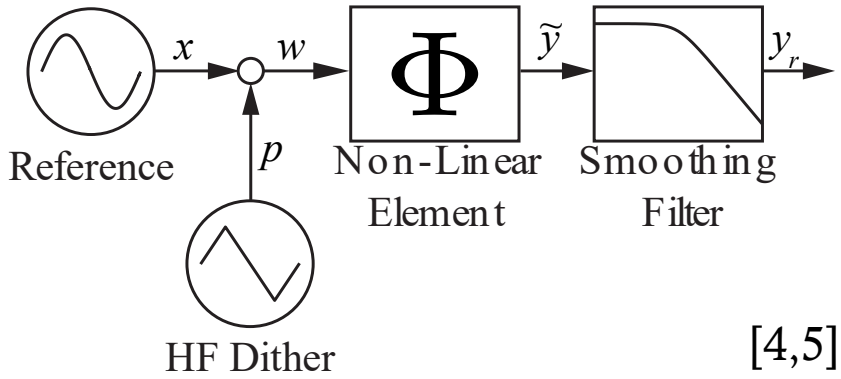
DAC model accounting for glitched and INL non-linearities for a 16-bit Texas Instruments DAC8544.



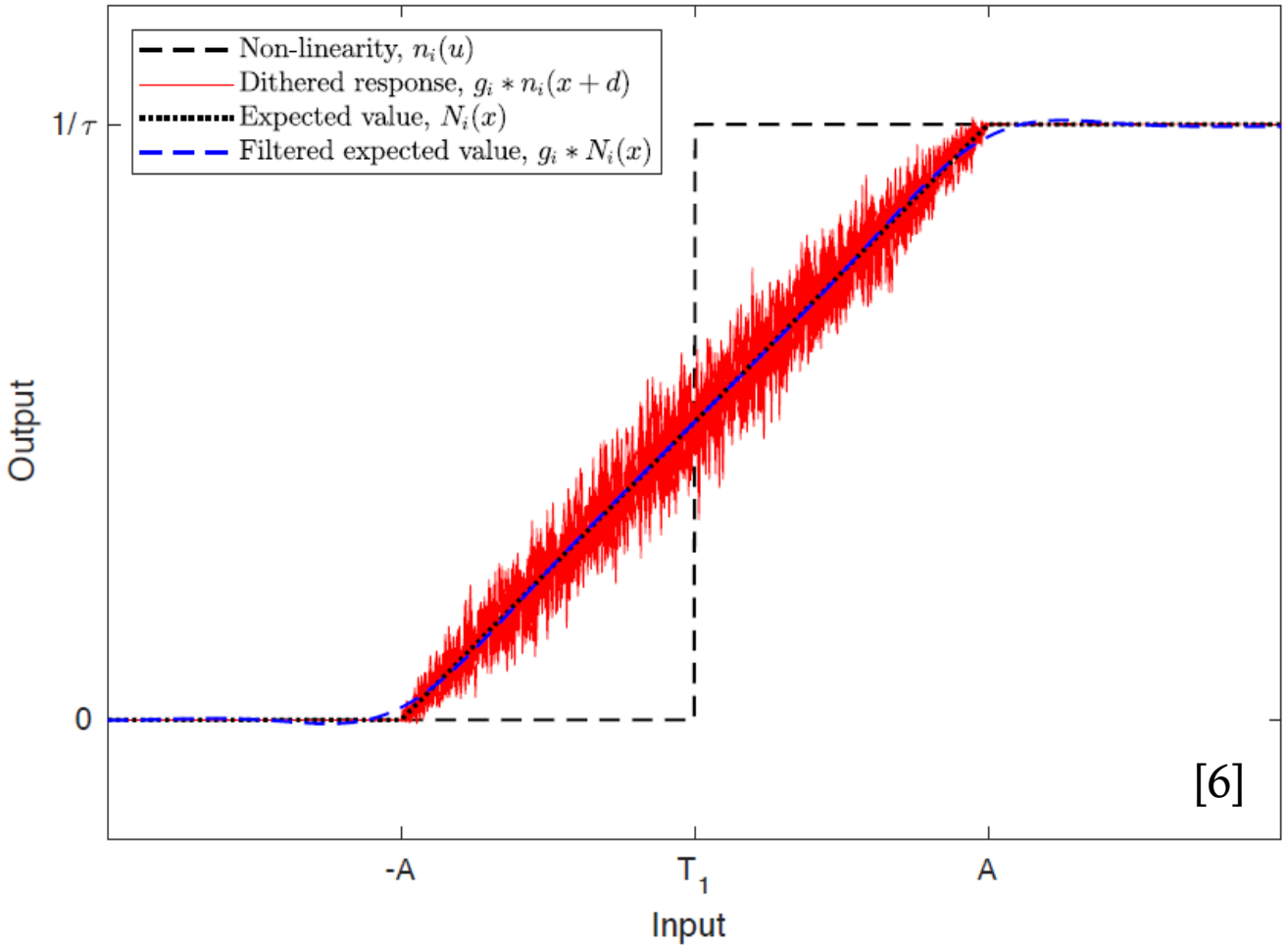


WHAT IS DITHERING?

- Dithering: is a process by which a form of noise is intentionally applied to a signal in order to randomize the quantization error (e.g. due to intended resolution reduction) [3].



[4,5]



[6]

GLITCH DISTURBANCE IN CLOSED-LOOP

Glitch mitigation performance:

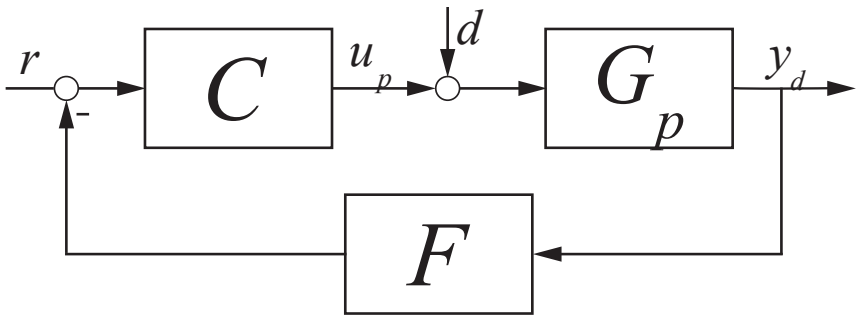
Nominal Design

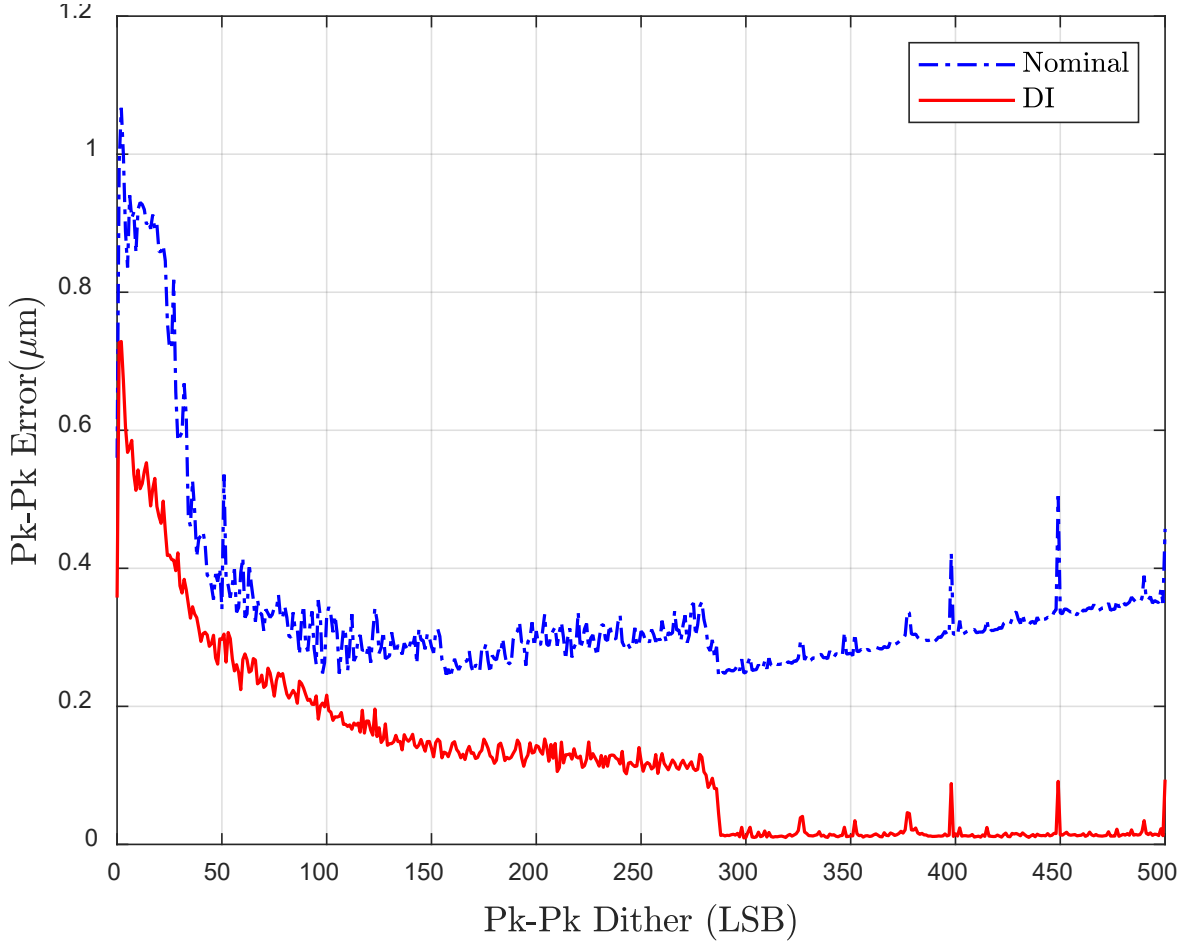
(Nyquist Criterion)

vs

Damping Integral

Incorporated Design





REFERENCES

- [1] Leang, K. K., & Fleming, A. J. (2008, June). High-speed serial-kinematic AFM scanner: design and drive considerations. In *2008 American control conference* (pp. 3188-3193). IEEE.
- [2] Eielsen, A. A., Vagia, M., Gravdahl, J. T., & Pettersen, K. Y. (2013). Damping and tracking control schemes for nanopositioning. *IEEE/ASME Transactions on Mechatronics*, 19(2), 432-444.
- [3] Wannamaker, R. A., Lipshitz, S. P., Vanderkooy, J., & Wright, J. N. (2000). A theory of nonsubtractive dither. *IEEE Transactions on Signal Processing, 48*(2), 499-516.
- [4] Zames, G., & Shneydor, N. (1976). Dither in nonlinear systems. *IEEE Transactions on Automatic Control*, *21*(5), 660-667.
- [5] Iannelli, L., Johansson, K. H., Jönsson, U. T., & Vasca, F. (2006). Averaging of nonsmooth systems using dither. *Automatica*, 42(4), 669-676.
- [6] Eielsen, A. A., Leth, J., Fleming, A. J., Wills, A. G., & Ninness, B. (2020). Large-amplitude Dithering Mitigates Glitches in Digital-to-analogue Converters. *IEEE Transactions on Signal Processing*, 68, 1950-1963.

THANK YOU