INF5350

Obligatory exercises following lecture #6 – SNR model

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1. Let H(f) be the transfer function of an ADC, and Nin(f) be the power spectral density at the ADC input. Write down an expression for the rms output noise of the ADC.
2. Explain why correlated double sampling reduces 1/f noise.
3. Briefly explain what Correlated Multi-sampling means.
4. A pixel has 24e- signal and 24e- dark current. What is the signal/noise ratio?
5. Ref above exercise, what happens to the SNR if the integration time is doubled?
6. Let the CCM coefficients for red pixels be as follows: (1.2; -0.9; -0.9). Assume 10e- signal in all three color channels. What is the crosstalk noise?
7. A CMOS sensor with 0.6% rms PRNU captures an image of a white wall. Each pixel has 20000e- signal. What is the prnu noise in e- rms? Compared to shot noise will prnu dominate if 100 image captures are averaged?
8. A pixel can store up to 17k electrons (ie full well capacity) and prnu is 1% rms. What is the maximum SNR the pixel can achieve?
9. Calculate the ***readnoise*** value (in e- rms) of a CMOS image sensor with below characteristics. By readnoise we mean noise at zero illumination referenced to the floating diffusion (FD) node. See below figure. Assumptions:
   1. Conversion gain, CG=90uV/e-
   2. Source follower gain, G=0.85
   3. Source follower noise, Nsf=200uV rms
   4. ADC is 12bit, Vref is 1V, and ADC noise is dominated by quantization noise



1. Calculate the noise (in LSB rms) at the ADC output (node D).