

Electronic Noise Properties of active-matrix flat-panel imagers

A detailed empirical and theoretical investigation of the fundamental limits affecting the dark noise level of active-matrix flat-panel imaging systems has been performed. Models of electronic noise have been developed based upon equivalent noise circuits of array pixels and acquisition electronics. At the level of the pixels, thermal noise associated with TFT-on resistance, shot noise, and $1/f$ noise associated with pixel leakage current was modeled. At the level of the system, intrinsic pixel noise, data line thermal noise, and readout charge-amplifier noise was modeled. The TFT noise and the data line thermal noise, generally expressed by $s = \sqrt{kTC}$ (where k is the Boltzmann constant, T the temperature, and C the capacitance), are found to be the dominant noise components at frame rates above ~ 1 frame-per-second. However, at lower frame rates, the shot noise and $1/f$ noise from the leakage current grow larger and eventually become the dominant noise components. Extensive measurements of the various noise components were carried out on a clinical prototype array whose acquisition system incorporated low noise, application specific integrated circuit preamplifiers. Good agreement was found between model predictions and the measurements. Such studies provide a quantitative understanding of the processes determining the minimum dark noise levels possible for active matrix imagers - which directly affects the lowest exposures for which images containing clinically useful information content can be obtained.

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