Compensating for the Impacts of Camera-induced Noise in Super-Resolution Localization Microscopy
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The impact of camera noise on localization precision and accuracy in super-resolution microscopy has been theoretically [1,2] and experimentally examined [3]. Generally, these investigations have focused on degradation in the precision of localization caused by electron multiplication noise (EMCCD cameras) and read noise with CCDs or CMOS cameras when maximum likelihood estimation reconstruction methods are employed. However, interactions between camera noise and measurement errors with actual reconstruction algorithms have received only limited attention. Computational imaging methods re-allocate measurement errors and noise in the reconstructed image, potentially increasing the noise in some areas of the image while reducing it in other areas [4]. Furthermore, computational imaging has the potential to create significant image artifacts. F. Huang et al [5] have shown that, when using current scientific CMOS cameras, proper modelling of the pixel read noise in the noise model in maximum likelihood reconstruction improves localization precision and avoids image artifacts.

We compare reconstructed images built from identical datasets for scientific CMOS and EMCCD cameras using different algorithms (both algebraic and statistical methods) to show the effects of technology-specific camera imperfections on the reconstructed images. “Raw” image datasets use highly realistic simulated data from “perfect” and real cameras, incorporating measured imperfections and experimental data obtained from biological samples. The reconstructed images are analyzed for qualitative artifacts as well as quantitative metrics of localization quality such as image resolution (Fourier Ring Correlation), the localization precision obtained by the Root-Mean Square Error and the fraction of molecules detected.

The results are experimentally confirmed with EMCCD and scientific CMOS cameras.


