NOISE EVALUATION OF SCMOS CAMERAS FOR SUPER-RESOLUTION MICROSCOPY

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Scientific Complementary Metal-Oxide Semiconductor (sCMOS) cameras are commonly used for high-throughput super-resolution imaging since they accelerate data acquisition and achieve large field of views while providing high quantum efficiency. However, they pose new challenges in image-processing and reconstruction since their electronic architecture results in pixel-dependent noise which is not trivial to model. The image quality is then greatly affected by the camera noise, which is a combination of deterministic and random contributions caused by several sources related to the internal structure of the camera chip. The degradation in image quality hampers the quantification of fine cellular structures and limits the achievable resolution of the microscope.

Due to the characteristics of Parallelized RESOLFT imaging scheme, where different illumination patterns are applied to the sample sequentially, we have observed a new type of noise, which we called the trapped-charge noise (TCN). We demonstrated that TCN is caused by fluorescence hitting the camera chip before exposure, resulting in trapped-charge stored in the camera, causing salt noise in the raw data. Additionally, we performed designed experiments with the Hamamatsu Orca Flash 4.0 v3 sCMOS camera, using a selected 640x640-pixel region of interest (ROI) to measure the TCN behaviour, which is then modelled. We observed that the magnitude of the noise depends on the camera pixel characteristics and the amount of fluorescence emitted from the biological sample, according to our model.

Based on this knowledge we developed an open source image processing algorithm for sCMOS noise modelling and reduction including the TCN. The algorithm also reduces the fixed-pattern noise (FPN), a pixel-dependent noise caused by differences in the gain and offset of each pixel in super resolution data.