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Super-resolution X-ray imaging with a hybrid pixel detector

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With increasing demand for high-resolution X-ray images, the super-resolution method allows to estimate a single high-resolution image from several low-resolution images. Hybrid pixel detectors provide high-quality and low-resolution images, which makes them particularly well suited for super-resolution. However, such detectors consist of a limited number of pixels at high cost.

Applying super-resolution with hybrid pixel detectors shows that it is a viable method to achieve high-resolution images. Since hybrid pixel detectors have a square point-spread function of 1 pixel, the estimated super-resolution image shows almost no blur making such detectors the ideal choice for the application of super-resolution X-ray imaging.

Utilising an X-ray source, which allows magnetic stepping of the X-ray spot, several slightly shifted images can be obtained without requiring mechanical movements. Registering the shifts between individual images with sub-pixel precision allows to estimate a high-resolution image. With repeatable and equally spaced X-ray spot position patterns, sufficient information can be obtained with only a few images. In this paper, we present the application of super-resolution for X-ray imaging and single-shot phase-contrast imaging using a Pilatus 100K hybrid pixel detector from Dectris Ltd. and a prototype microfocus X-ray Source from Excillum AB. Moreover, we analyse the image quality and discuss the required pre- and post-processing for applications in X-ray radiography and tomography.

Using a sufficient number of low-resolution images allows us to achieve an increase in resolution, without introducing significant blur or artefacts into the image. However, different methods of image interpolation and pre-processing of the low-resolution images will affect the super-resolution image. Further, the quality of the estimated high-resolution image and thus the required post-processing also depends on the relative image translation on the detector, the number of images.

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