

Reduction of Ring Artifacts in High Resolution X-Ray Microtomography Images

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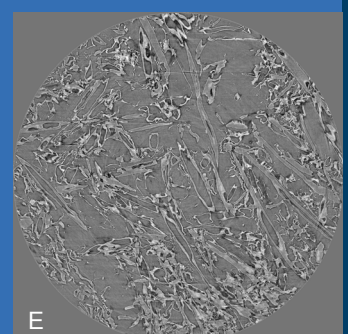
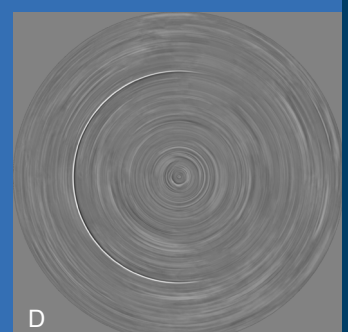
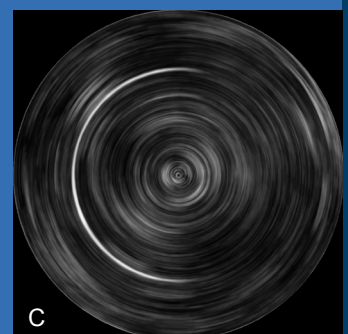
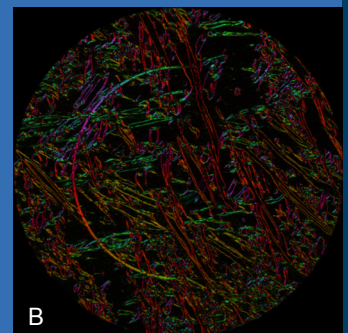
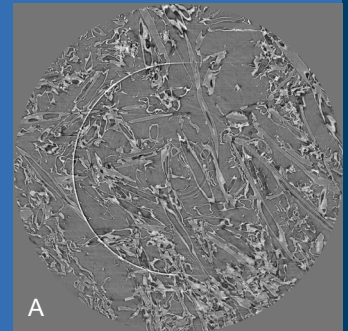
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Problem

Ring artifacts occur in reconstructed images from X-ray microtomography as full or partial circles centred on the rotation axis (see A). Variations in the intensity of the incoming beam and differences in detector element gain are two causes for the ring artifacts. The ring artifacts must be reduced before further processing of the images.

Method

- Estimate a local structure tensor in each pixel neighbourhood using quadrature filters. The eigenvectors and eigenvalues of the tensors give information about the local orientation (B) and the anisotropy.
- Find orientations in the tensor field that correspond to circular patterns around the known rotation axis by using the scalar product between the normalised first eigenvector of each tensor and a normalised vector from the centre of rotation. The absolute value of the scalar product is sharpened by an exponent and scaled by the anisotropy of the tensor. This is used to create a smoothed certainty map (C) with the probability of each pixel to contain a ring.
- Calculate an image of the artifacts from the certainty map and the original image using normalised convolution in the polar domain. The filter kernel is one pixel wide in the radial direction and has a fixed length in the angular direction. Close to the origin shorter filters are used. The mean value of the ring artifacts is also subtracted from the artifact image (D).
- Calculate the corrected image (E) by subtracting the artifact image (D) in all pixels proportional to the certainty map (C).



Experiments and Results

The images used for evaluation are 2D slices from a set of X-ray microtomography volume images of paper imaged at the European Synchrotron Radiation Facility (ESRF) in Grenoble. Both images with and without artifacts are present in the evaluation set. The results show that the method reduces both full and partial artifacts that are not completely saturated.

The main features of the method:

- The original image resolution is not altered by interpolations.
- Only pixels estimated to contain artifacts are changed in the correction step.
- The artifacts are estimated and corrected locally for reduction of both full and partial rings.

