Innovation with Integrity

# BRUKER MICRO-CT ACADEMY

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In this issue:



## Welcome

In this issue we will have a closer look at image filtering in CTAnalyzer. An inherent characteristic of X-ray microCT is the presence of image noise. Using filters, such as Gaussian blur, allows reducing it. The recognition of edges plays an important role in image analysis in which filters also can play a beneficial role. These techniques eventually allow us to better visualize and analyze samples.

## Image Filtering in CTAnalyzer

CTAnalyzer currently offers five options for the filtering of greyscale images. Their specifics are presented below and in depth in "*MN077 Image filtering in CTAn*". They are available as Plug-Ins in the Custom Processing menu of CTAn. Two user-defined parameters are common to all of them: the selection of application in 2D or 3D space and the definition of a Radius. The latter relates to the size of the region in which the filtering is performed, commonly referred as the kernel size.

- Gaussian blur:

  It is probably the most well-known and most commonly used filter of recent times. The application of a Gaussian blur is typically done with the aim of reducing noise. This in term may better allow us to segment phases in reconstructed images and generate quantitative information. The general form of the Gaussian filter in 2D is given by:

$$h(x,y) = \frac{1}{2\pi\sigma^2} e^{-\frac{x^2+y^2}{2\sigma^2}}$$

  where σ denotes the standard deviation. In CTAnalyzer this parameter is defined by the radius R. The kernel size reflects the truncation of the normalized Gaussian function, and is chosen empirically as a compromise between speed and accuracy. In CTAnalyzer this truncation value is set at 3R.

- Median:

  As could be suspected from its name, the median filter replaces the brightness value of a given pixel by the median value of the brightness within a given support. The radius R defines the size of the square kernel. Similar to the Gaussian blur it is mainly used for noise reduction, it however can be better at preserving edges.

- Uniform:

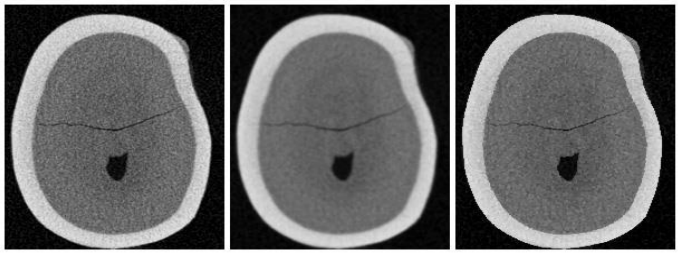
  The uniform filter outputs an image based on local averaging of the input where all the values of the square kernel have the same weight. It hence offers a cruder way of reducing noise than the two previous filters but is mathematically less complex than the latter.

- Kuwahara:

  The recognition and separation of edges plays a crucial role in image processing. The Kuwahara filter has an important attribute to preserve edges under smoothing, hence it being called an edge-preserving filter. It does this by considering both the mean brightness and variance in four sub-regions around the pixel in the kernel. By selecting the region with lowest variance the edges of phases can be preserved.

- Unsharp mask:
  Unlike its name would suggest, the unsharp mask is a tool intended to sharpen images. It achieves this by first applying a Gaussian blur, similar to as described previously in this document. Subsequently the difference between the filtered and original image pixels is made should their difference be larger than a user defined threshold. The user additionally has control over the magnitude of each overshoot (how much darker and how much lighter the edge borders become), a parameter referred to as the amount.

Finding the most suitable image filtering conditions for a given task commonly calls for a certain amount of iteration. The use of task and collections on a small volume of interest greatly facilitates this process.



*The left image shows a reconstructed slice of a tooth scanned using the SkyScan1172. In the middle is a Gaussian blur in 3D space with Radius 1. The right image illustrates the effect of a Kuwahara filter with same settings.*

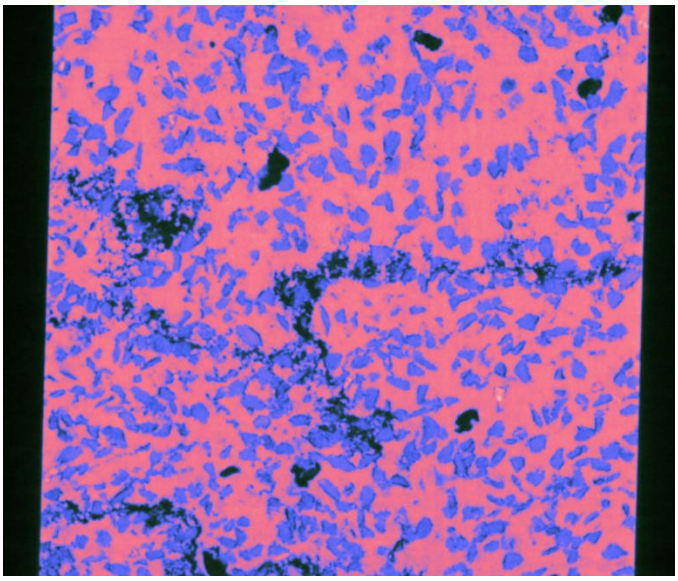
## Bruker microCT News

The micro-CT User Meeting is around the corner! With all of the presentations and poster/movie submitted, we thank all the authors for their contributions! The detailed program with an overview of all the user presentations can be found on the website. We look forward to welcome you all to Bruges!

On May 12 we will organize an educational webinar covering a wide range of preclinical applications. Click here for more information and registration.

## Image of the Month

Maximum Intensity Projection of five reconstructed slice, made using CTAnalyzer, of a K390 steel sample of ~14.5mm diameter. In this experimental steel sample different phases are clearly visible, along with corrosion related defects. The sample was scanned using the SkyScan 2211 at 190kVp with 0.5mm Mo, the resulting image pixel size is 12.5 micron.



## Upcoming Events

Bruker microCT will participate with an exhibit in the forthcoming conferences. Please click the link below for more information. We hope to see you there!

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| AACR | Apr. 18-22 | Philadelphia, USA |
| ECTS + IBMS | Apr. 25-28 | Rotterdam, the Netherlands |
| ISBM | Apr. 27-29 | Tokyo, Japan |
| ATS | May 15-20 | Denver, USA |
| INTERPORE | May 18-21 | Padova, Italy |
| ICEF12 | Jun. 14-18 | Québec, Canada |
| DIR | Jun. 22-25 | Ghent, Belgium |
| ICTMS | Jun.29 - Jul.03 | Québec, Canada |
| TCES | Jul. 17-21 | Southampton, UK |