

SETP10

## Quantification and standardization of resolution for X-ray computed tomography scanners

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Determining the resolution of X-ray computed tomography (CT) scans is of utmost importance for quantitative assessment of the scanned material. Without knowledge of the uncertainty associated with any given border between two substances, fundamental calculations like volume, porosity, and fracture widths are unreliable, especially when these features are small with respect to the CT data resolution. Yet, comparison of images produced by different scanners, without scanning the exact same item, has yet to be standardized. The Point Spread Function (PSF) tool proposed here fulfills this need - operating independently of what the scanned object is, and thus allowing any data set to be evaluated and characterized.

Due to the inherent blurriness of boundaries between materials in CT data, a step function is too idealistic to model a boundary. A PSF is a continuous function that more realistically describes the observed gradual transition from one material to another in CT data. The PSF radius is a measure of the length of the transition period, and it is this radius that can be employed to compare the image quality produced by different CT scanners. A longer radius corresponds to greater blur, and thus a less resolved scan.

After creating the PSF radius tool, it was tested on basic images convolved with known PSF radii. Images were tested with blur in both 2 and 3 dimensions to confirm the robustness of the underlying algorithms. The implications of this development are: a simple, reliable way to compare CT scanners that does not require them to image the exact same object, and better constrained boundaries for 3-D CT imagery. These constraints permit future developments in CT analysis, such as 3-D fracture tracing with uncertainty quantification and sub-voxel accuracy in aperture and position.

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