Scalable 3D X-ray Computed Tomography Measurement and Accuracy for Metal Additive Manufacturing

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In metal additive manufacturing (AM), component size variability presents distinct challenges for quality control and inspection, especially in X-ray Computed Tomography (XCT) measurement. Larger components typically require lower resolutions to cover their entire volume within a reasonable time frame, which can compromise the detection of smaller defects. To address this, a scalable 3D XCT measurement approach is developed in this work that maintains high resolution by stitching X-ray images in the projection domain. This proposed approach captures X-ray projection images while adjusting the component's position in an arranged grid, ensuring that the voxel size remains consistent across all projections. A linear blending strategy is then applied to smoothly manage the overlapping areas between the stitched images, resulting in an expanded coverage of the metal AM component without sacrificing detail. Finally, the Filtered Back-Projection (FBP) algorithm is used on these stitched and scaled X-ray images to generate 3D reconstructions. The performance and measurement accuracy of this scalable 3D XCT measurement are experimentally evaluated using laser-based powder bed fusion (LBPF) specimens, demonstrating its ability to handle size variability while maintaining precise and consistent quality control.