Visual Tools for Computed Tomography Volume Representation: Large Data Visualisation and Surface Extraction

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Diplôme : Master : ingénieur civil en informatique, à finalité spécialisée en "computer systems security"
Année académique : 2023-2024
URI/URL : http://hdl.handle.net/2268.2/20388

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Academic year 2023-2024

A very important technique in the field of Non-Destructive Testing (NDT) is X-Ray Computed Tomography (CT). This technique allows the reconstruction of an inspected part in a 3D voxel volume, which can be used to detect internal defects in industrial parts. One issue of this technique is the size of the data, which can be too large to fit into the memory of the graphics processing unit (GPU), making the rendering of this part impossible.

The scope of this thesis is to develop a real-time out-of-core rendering solution which allows the rendering of CT volumes larger than the available memory of the GPU (VRAM). On top of this solution, rendering techniques specific to X-Ray CT must be implemented. These rendering modes are the ones implemented by X-Ray Imaging Solutions (X-RIS), the industrial promoter of this thesis, in their Maestro software.

Our solution is based on the GigaVoxel library, which is itself based on the paper "GigaVoxels: ray-guided streaming for efficient and detailed voxel rendering". This library allows the rendering of large voxel volumes in real time by using a combination of level of detail techniques, occlusion culling and a page table system on the GPU. It was modified during this thesis in order to optimize the pre-processing step of voxel volumes, improve its rendering performance, and fix bugs. The rendering modes of the Maestro software were then implemented on top of it, and the initial goal of the thesis has thus been achieved. Based on our results, importation of the library into Maestro can be launched. A future work can focus on optimizing the memory usage of the library, as it works under the assumption that the whole volume always fits in the RAM.

In a second part of the thesis, different surface extraction techniques are studied. These techniques allow the extraction of a non-voxel representation of the surface of an object from a voxel representation of it, which is useful in the metrology field to measure the features of a scanned object. Unfortunately, the tested methods did not offer a good enough precision for what is required in the field of metrology, especially on the sharp edges of the tested volume. Future work shall focus on the use of a method that better deals with sharp edges and on a better way to filter out the noise in the volume caused by the reconstruction artifacts of CT scans. These changes can help reduce the error in the range of a tenth of a voxel, which is required for precise metrology applications.