SEGMENTATION APPROACH FOR 'FULL-CAR'-CT APPLICATIONS

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Summary: We performed a complete car-CT at our XXL-CT facility in Fuerth, using a Wendler oldtimer dated back to 1938. The resulting volume data amounts to 18 GB at a voxel size of 1.2 mm. In order to extract automatically different components from the car body, we implemented a block based segmentation approach. The performance of this approach is shown for the windshield and the wooden body structure of the car.

1. EXPERIMENT

The high energy X-ray facility at EZRT (Fraunhofer Development Center for X-ray Technology, Fuerth, Germany) incorporates a very large scale X-ray chamber with inner dimensions of 20x20x14 m^3 and up to 3 m thick walls allowing the scan of very large objects with respect to all safety requirements regarding the generation of high energy X-ray radiation [1,2]. A linear accelerator provides X-ray bremsstrahlung spectrum with a maximum energy up to 9 MeV (Siemens SILAC). The dominant effect at such high energy is the Compton scattering effect. Thus in order to reduce the strong influence of scattering on the image quality, the HE X-ray scanner is equipped with a 4 m long linear detector with 10000 pixels optimized for high energy photons. The scanner provides images for CT reconstruction based on a high precision manipulation system composed of a specimen rotation stage capturing a circular field of view of 3.2 m in diameter and a scanning height of up to 5 m.

Due to the touchiness of the BMW Wendler car, the acquisition geometry was chosen such that the car was placed with his wheels down on the turn table. Since the length of the car exceeded the 3.2 m field of view, this geometry led to some truncation artifacts at the back of the car. Less sensitive objects could be scanned in an upright positioning, leading to much better image quality. 2500 projections of size 3300 * 1250 pixels were taken during a 2-day scan. The reconstruction was done in stacked fan beam mode, resulting in a 5000*2048*1250 voxel volume of 1.2 mm voxel edge length and 25 GB data size.

2. DATA PROCESSING

The goal of our CT data analysis is the extraction of specific subcomponents of the car, in order to study its geometrical shape as well as its condition as far as it is possible (larger cracks, moisture). Most interesting subcomponent in this case is the wooden body structure of the car, which extents more or less over the whole car body. None of the available segmentation tools was able to directly extract the subcomponent. Within a student internship, we implemented a block based segmentation approach for the analysis of such large data. It is related to the Object Based Image Analysis approach from geographic remote sensing [3,4]. Starting from an initial oversegmentation of the data, sets of discrete objects with arbitrary properties and their network of relationships are computed. We implemented a 3D version of OBIA, resulting in a simple Object Based Volume Analysis (OBVA). The approach has been integrated to our VolumePlayer Plus software as a plugin.

3. RESULTS

For the extraction of the car subcomponents, we focussed mainly on the local density and the local object thickness properties for creating a figure-of-merit function, which was used to group together blocks containing similar objects. Currently, we are not yet using a resolution hierarchy, but only a fixed block size of 32^3. Figure 1 shows at left hand side the original car and its reconstruction, and at right hand side preliminary segmentation results of the wooden car body. Globally, the structure has been extracted correctly, but there are still limitations

due to a lacking local parameter adaptation. Computation time is about 5 min on a moderately equipped PC with 32 GB RAM. Future work will focus on a resolution hierarchy and a more powerful local adaptability of the figure-of merit functions.

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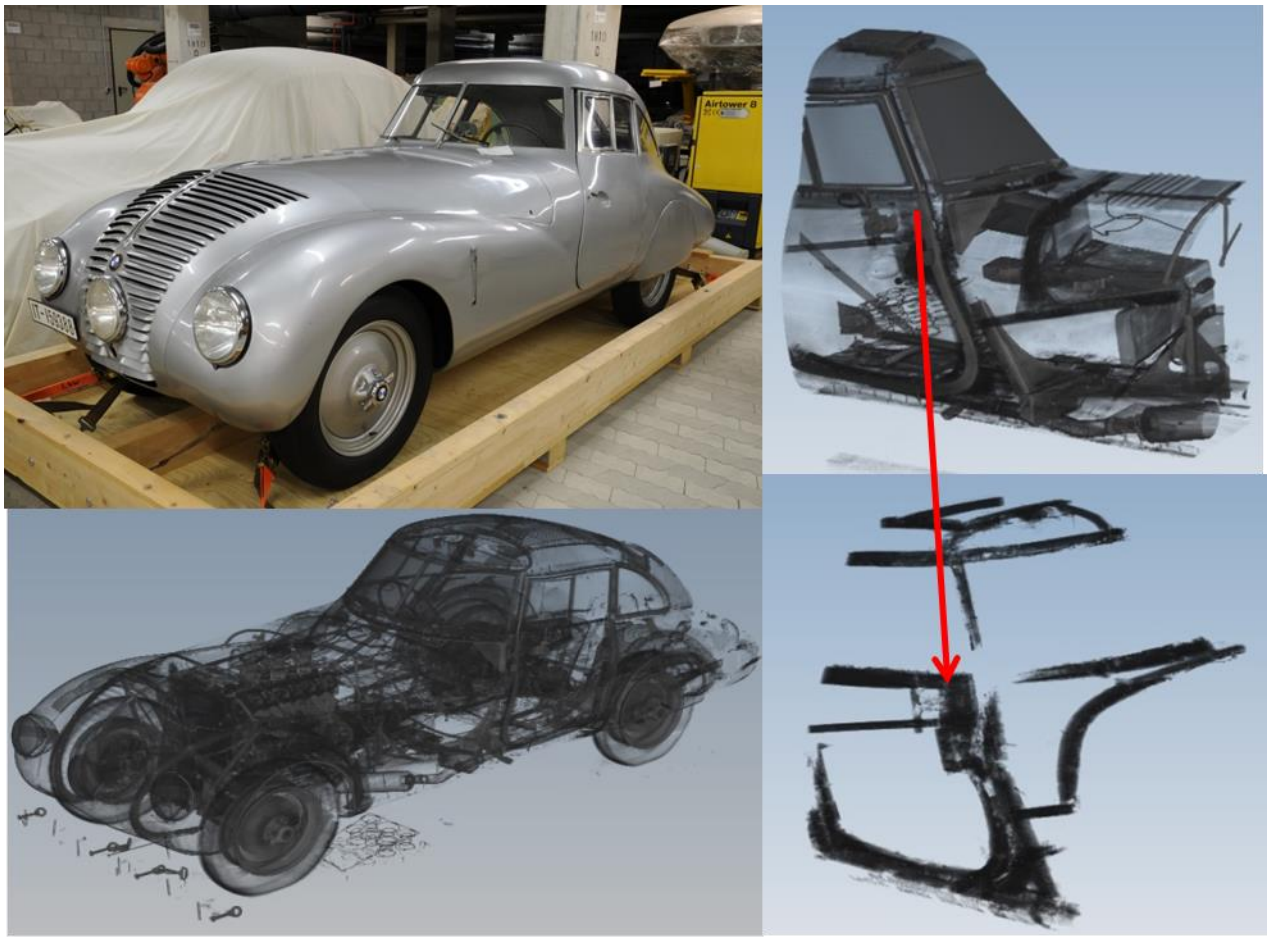

Figure 1: (left hand) The beautiful BMW Wendler car from 1938 (image source Annemie Danz) together with its 3D CT reconstruction. (right hand) Detail of the CT volume with the extracted wodden body structure, extracted with the block based segmentation approach.