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White paper

Simulation enabling technologies

Introducing Artificial Intelligence in generating 3D models from CT scans

Computed Tomography scans of multi-material items with segments of varying thickness and density, are often dominated by artifacts, noise, and suffer from extremely low contrast. RETOMO introduces AI to address even the most complex cases of generating 3D models from CT scans.

RETOMO Explained

Computed Tomography (CT) is continuously developed to offer improving image quality and resolution. High resolution images of large objects result in big amounts of data requiring considerable computational power to generate 3D models. RETOMO has been designed to process data sets of hundreds of gigabytes large, allowing the user to access and modify every single voxel using only modest computer hardware. Apart from the powerful image and mesh processing tools, the latest version of RETOMO introduces Artificial Intelligence to improve segmentation even in very complex cases.

Artifacts in CT scans

Scans of multi-material items with segments of varying thickness and density are often dominated by artifacts. Bright 'streaks of light', shiny regions, and fading ligaments are frequently seen in both industrial and medical scans (in the presence of implants). Some artifact reduction techniques may partially alleviate such issues, accompanied, however, with the risk of altering the artifact-free regions.

Occasionally, the image is dominated by noise, or the contrast among different materials is barely noticeable. Moreover, these issues may occur locally in some sub-regions of the image. In such cases, noise reduction filters employed in image processing remove noise along with the main signal, rendering segmentation virtually impossible.

Artificial Intelligence driven segmentation

RETOMO introduces Artificial Intelligence (AI) as a versatile tool that can improve segmentation in such situations. The AI engine may be invoked when traditional filters fail to produce the desired result, or when extensive manual corrections are required. A lean user interface is employed, making the complete process accessible even for occasional users. RETOMO, allows for the application of the AI engine in complete images or only in selected sub-regions of the image for local automated fixes.

The AI augmented process

The standard seed-grow procedure is used to perform an initial material segmentation of the image. In some cases, traditional tools (morphological filters, manual tools and other) may efficiently fix problematic regions. However, when these tools generate inadequate results, the AI engine is employed. This is a two-step process which requires, first, a training phase for the AI engine.

For the AI engine training, a mix of successfully and poorly segmented regions are marked on the image by the user. These regions may cover small portions of several slices, possibly oriented in different coordinate axes, or complete slices. Within those regions the user has to employ manual tools to fix any errors (see figures below). Subsequently these regions are used as training data for the AI engine.

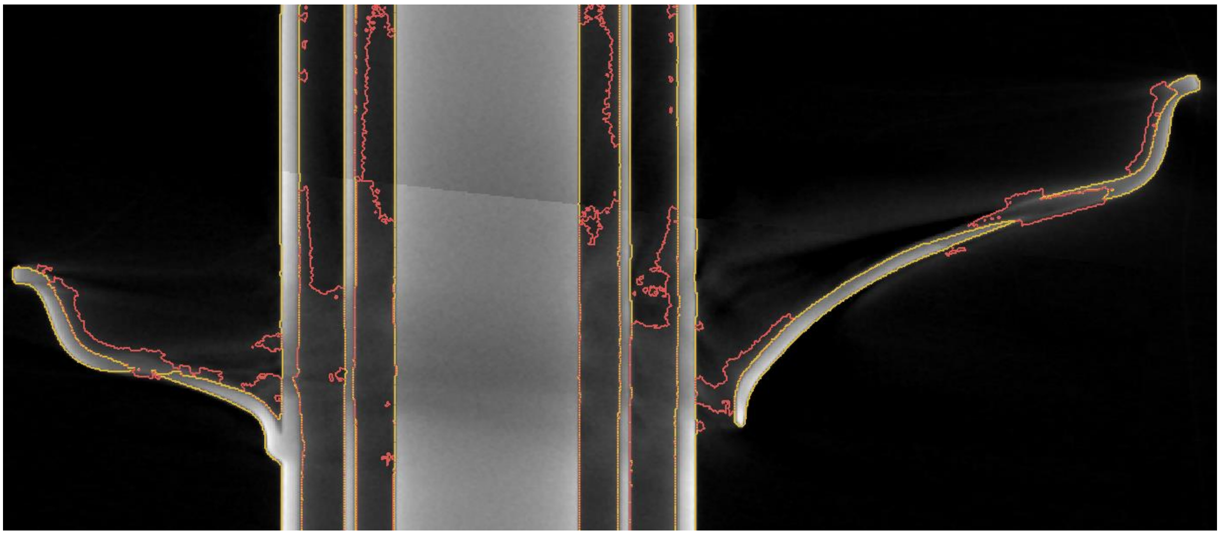

Figure 1: Result of automatic segmentation on a noisy scan (sample slice)

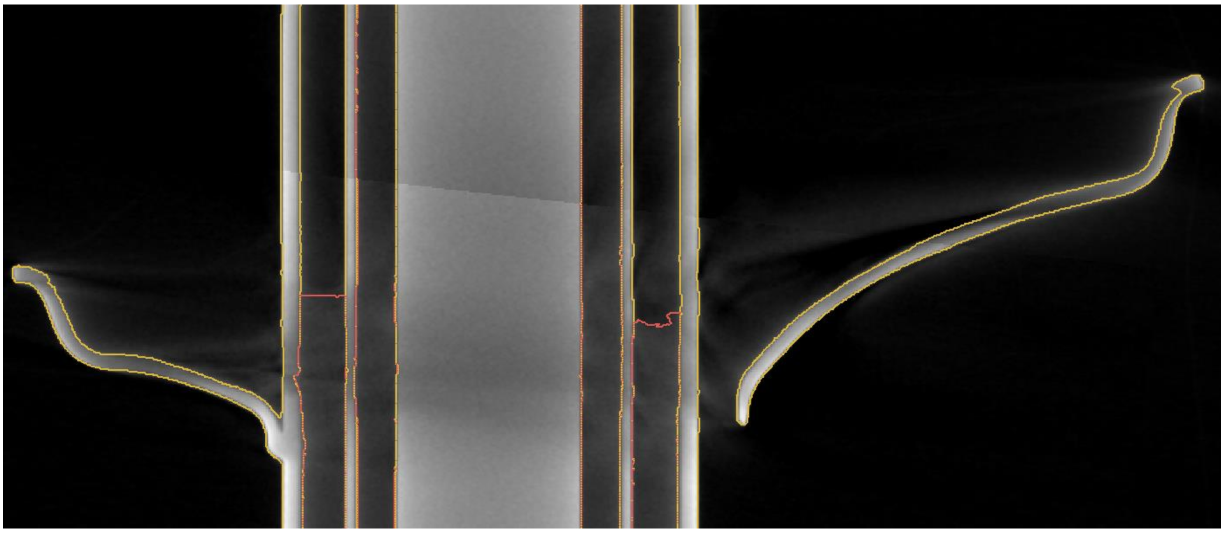

Figure 2: Same slice after manual fixes. Using manual tools, a single slice may be fixed within a minute.

In the application phase, the user selects a 3D region of the segmented image where corrections are deemed necessary, and simply applies the trained AI engine. Depending on the quality of the result, a second training phase may follow. Otherwise optional post processing

and meshing is performed. Different AI engines may be tuned to different type of image artifacts. In the following images the improvement on the resulting mesh is the result of AI driven segmentation alone (i.e. no other filters or mesh processing has been used).
Both the training and application phase are computationally demanding. RETOMO exploits all CPU power available to accelerate the process, while elaborate caching techniques keep memory requirements low. A single parameter is exposed to the user, allowing the selection of the desired quality-speed balance. Typically a couple of fast train/application cycles are performed in a low quality setting, guiding the selection of the appropriate training regions. Finally a medium or high quality setting will generate the optimum result, requiring minimal post treatment on the resulting segmentation.

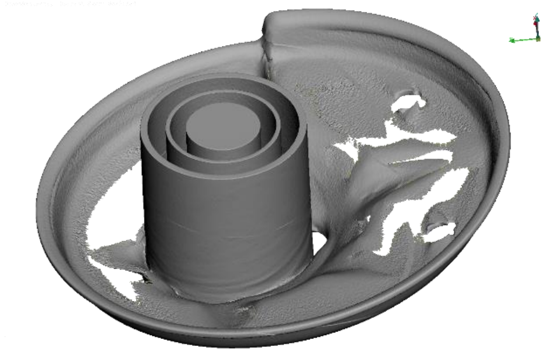

Figure 4: Mesh generated from uncorrected automatic segmentation. Extensive areas of structure are missing. (Central section of a strut shown).

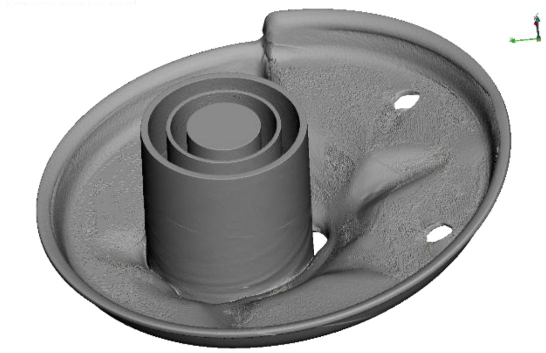

Figure 3: Mesh generated from AI driven segmentation. Correct topology of structure is achieved.

Apart from local fixing of automatically segmented images, RETOMO also allows the application of the trained AI engine directly on a greyscale image which has not been segmented yet. This becomes an invaluable feature for large datasets. A cropped representative region of the image may be swiftly segmented and used to perform the computationally expensive AI training and application trial cycles as described above. The resulting AI item can be subsequently applied directly to the original complete greyscale image, minimizing costly interaction with the full data set.

An expert ally

Introduced in v20, the AI-engine greatly leverages user effort towards segmenting challenging regions of a CT scan. The lean interface hides the sophisticated implementation which allows for processing extremely large data sets. The flexibility of the engine allows for the treatment of a great variety of situations, making it an invaluable ally in CT image treatment.

Benefits

- Great flexibility: AI will successfully handle a variety of image problems
- Required user interaction time is kept at minimum
- Low memory requirements; highly parallelized implementation
- Well integrated in RETOMO workflow
- High quality results obtained with minimal expertise

About BETA CAE Systems International AG

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Headquarters

D4 Business Village Luzern, Platz 4
CH-6039 Root D4,
Switzerland
+41 415453650

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