Avizo® - Visualizing and Understanding Scientific and Industrial Data

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Abstract. In these days where detector resolutions seem to grow faster than Moore’s Law, interactive 3D visualization and analysis of tomography datasets become an ambitious challenge.
Avizo®, by Visualization Sciences Group, is leading 3D visualization software for scientific and industrial data.
Wherever three-dimensional datasets need to be processed, in material sciences, geosciences, environmental or engineering applications, Avizo offers abundant state-of-the-art features within an intuitive workflow and easy-to-use graphical user interface.
Powerful, multifaceted and extensible, the Avizo software suite is organized to maximize flexibility and configurability, making it an ideal environment for a wide range of NDT application types.

Introduction

Avizo’s state-of-the-art features efficiently meet user’s specific requirements for 3D data visualization and analysis in scientific and industrial fields, such as material and physical sciences, geosciences, computer-aided engineering, environmental and generic scientific activities.

Avizo software suite is organized to maximize flexibility and configurability, making it an ideal visualization environment for a wide range of application types. Powered by Open Inventor® by VSG, Avizo is layered to optimize the environment for user’s specific needs.

1. History

Avizo has been originally developed at the Konrad-Zuse-Institute (ZIB), Berlin, GERMANY in the late 1990s. It was first intended to target biomedical applications, as the very first Avizo users were interested in visualizing and reconstructing bee brains in order to understand and compare normal and hydroxyurea-treated bees.

Over the years Avizo evolved more and more to a state-of-the-art general purpose visualization and reconstruction application.
2. NDT in aerospace

Radiology and computed tomography (CT) have been dedicated to medical applications for a very long time because it was a very time and processing power consuming task which was not seen worth enough or just not possible to be applied in industrial NDT in general nor NDT in aerospace in special. These techniques were only applied in single, rare situations, where standard technologies failed. It was also not applicable because of its long cycle time. E.g. to examine a 2D cross section of an airfoil requires approximately $1024^2$ pixels. To inspect a complete airfoil it would require $1024^3$ voxels. It simply took too long for a meaningful and reasonable application.

Since compute power, storage capacity and total cost of ownership (TCO) of such systems developed significantly in means of performance, capacity and reduced cost since last decades, more and more impact of such systems in this application area can be recognized. This also increased the need for NDT specialists which are able to bring in the necessary understanding of the nature of defects, the possible location of defects or even the way how to detect specific defects. These highly educated technicians usually apply analysis software providing the necessary tools to detect individual defects. Avizo is only one of the commonly used software packages, but it is one of the most dedicated packages; dedicated to NDT in many aspects starting from material testing, to rapid prototyping, to inclusion detection, to material quantification, material characterization, etc.

The already mentioned highly qualified defect detection engineers use common visualization tools like arbitrary slices, volume rendering or surface extraction tools:

![Figure 1: die casting visualization. Data: North Star Imaging](image-url)
Of course it is neither reasonable nor affordable to keep a department of specialists in order to do high volume inspection. This is a different approach: All the reasons where one had to ask a specialist have vanished:

- The nature of possible defects is known.
- The location of possible defects is known.
- The way to make such possible defects visible or detected is known.

Furthermore there are other aspects to be kept in mind in high volume defect detection:

In typical casting operations, an operator has limited time to review a part. It is not possible for him to load a dataset into dedicated analysis software, create more or less complicated visualization scenes and finally do the evaluation with different visualization techniques. To be able to meet the target cycle time, the solution must provide predefined ROIs (region of interest) with predefined visualization modules to the operator. If necessary the solution must also perform predefine filter operations to enhance the quality of the images or the visualization respectively and hence the quality of the final decision if a part is accepted or rejected.

Another aspect of such scenarios is the qualification of the operator. Nobody would hire highly educated engineers to do high volume inspection. Therefore the system should guide the (less qualified) operator through the whole inspection process. This will guarantee that the operator will bring in his review expertise and won’t have to concentrate on building review scenarios.

2.1 Avizo® Fire-based applications for high-volume inspection workflows

Avizo® Fire open framework enables the implementation of custom applications for the automation of specific tasks in the inspection process. Typical solutions provide users with dedicated assistants at all steps of the inspection process. In this example, each processing operation has been automated using the Avizo Fire framework in order to provide NDE operators with a straightforward workflow from image server to inspection scenarios and automated test report generation, for a highly efficient quality control cycle.

2.1.1 Inspection Data Service

The “Inspection Data Service” tool is a Windows® service. It retrieves stacks of images, registers them against a reference model, and stores them for further review.

The image retrieval procedure is realized by using the DICOM protocol. Each time the tomography reconstruction service produces a new image it is sent to a dedicated DICOM server taking care of the image management. When the last image of an image stack is received the service initiates the automatic registration against a predefined reference model:
2.1.2 Designer Tool

The “Designer” tool allows NDE specialists in charge of defining inspection procedures to create custom inspection scenario vs. a reference model. The NDE operator is guided through the steps to define test regions, views to be depicted and analyzed during the inspection, quality criteria for each test region, and quality tests for each view or region.

2.1.3 Inspector

The “Inspector” tool executes the appropriate workflow script showing each view, 3D region and associated test results to the NDE operator during the inspection process of a part. “Inspector” can be launched as a batch application so that tests are run automatically and results saved for later review.
2.1.4 Inspection reviewer

This tool allows the NDE operator to review detailed test results as ambiguous cases are detected.

2.1.5 Complete NDE workflow
3 Avizo Editions

3.1 Avizo Standard

The Avizo Standard Edition for scientific visualization enables users to gain valuable, detailed insight into their scientific 3D data. Any kind of scientific data can be imported. Dedicated readers enable the system to read a huge amount of data starting from simple 2D/3D images until complex result of numerical simulated data or even time series.

3.2 Avizo Earth Edition

Avizo® Earth Edition is a dedicated framework for integrating, manipulating, and visualizing seismic, geology, reservoir engineering, and petrography datasets. Geophysicists and geologists can use this solution to import, manage, interact with, and visualize multiple sources within a single environment.

![Figure 5: Visualization of seismic data](image)

3.3 Avizo Wind Edition

Avizo Wind Edition introduces techniques to easily and accurately visualize scalar, vector and tensor data using a large set of visualization tools including: iso-surfaces, cross sections, boundary views, colored vectors, animated particles, line integral convolution, illuminated stream lines, stream ribbons, and advanced volume rendering. This edition works with 2D or 3D regular and unstructured meshes. This solution can handle any combination of tetrahedron, hexahedron, wedge and pyramid cells.
3.4 Avizo Fire Edition

Avizo® Fire Edition software provides advanced 3D visualization and state-of-the-art quantification capabilities to researchers and engineers who require great insight into complex materials and objects structures. It allows the import and fusion of 2D and 3D data from multiple sources, enabling easy integration of Avizo® into data analysis workflows.

Avizo® Fire includes 2D and 3D image filtering modules, advanced slice alignment capability, automated or assisted segmentation with 3D surface reconstruction, allowing for phase separation, visualization, and measurement.