Automatic dental panoramic

From a simple approach to the advanced and precise solution provided by Thermo Scientific™ Open Inventor™ Toolkit

It is a common procedure for a dentist to use CBCT to acquire images for treatment planning. A panoramic view of the patient's jaw can also be acquired using another X-Ray technique which would put this person under another radiation exposure. Those radiations are dangerous and potentially harmful as they can cause cell mutation and accelerate the development of cancer. To avoid this extra acquisition, the panoramic view can be obtained by unfolding the 3D data. Different techniques exist from manual, semi-automatic to fully automatic.

Figure 1 3D CBCT volume & Panoramic view

The main concern with this approach is to find the correct surface which would accurately and precisely align with the curvature of the jaw.

For both workflows we expose in this article, the same input CBCT data has been used.

Simple approach: Unfolding using the dental arch

For this simple approach and to limit computation time, the developer can decide to use a dental arch. This line can be generated using a set of points defined manually by the user or automatically generated using a workflow placing points at the maximum intensity locations.

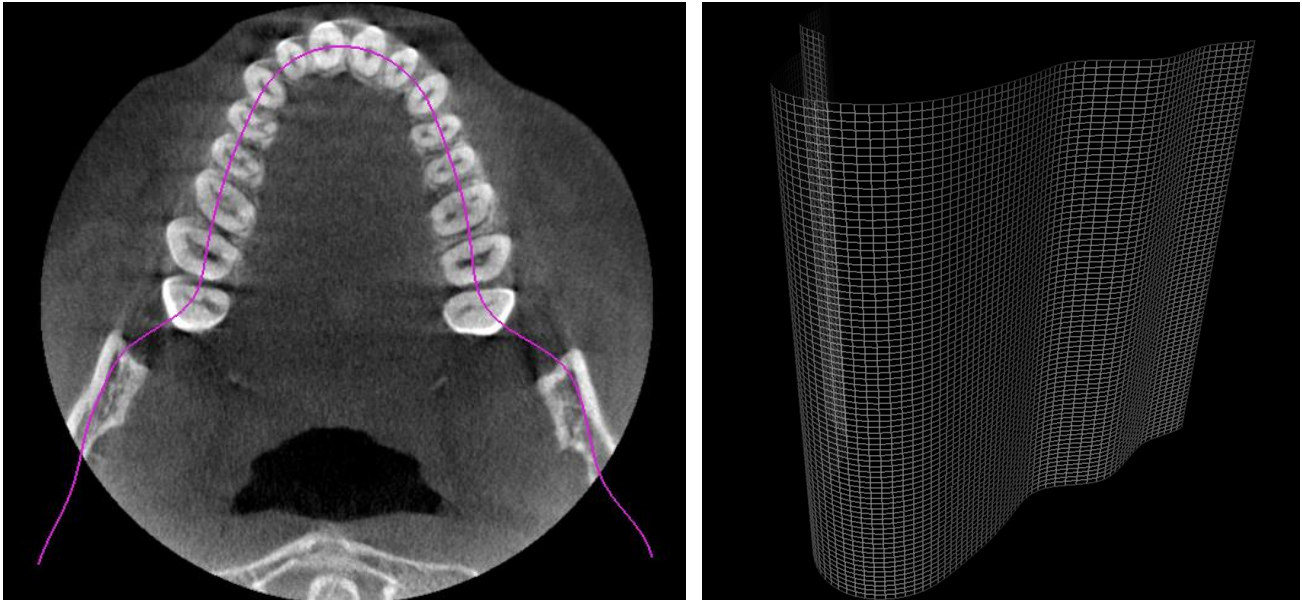Then, we simply extrude this line to build a simple regular surface mesh using the SoPolylineExtrusionApproximation3d

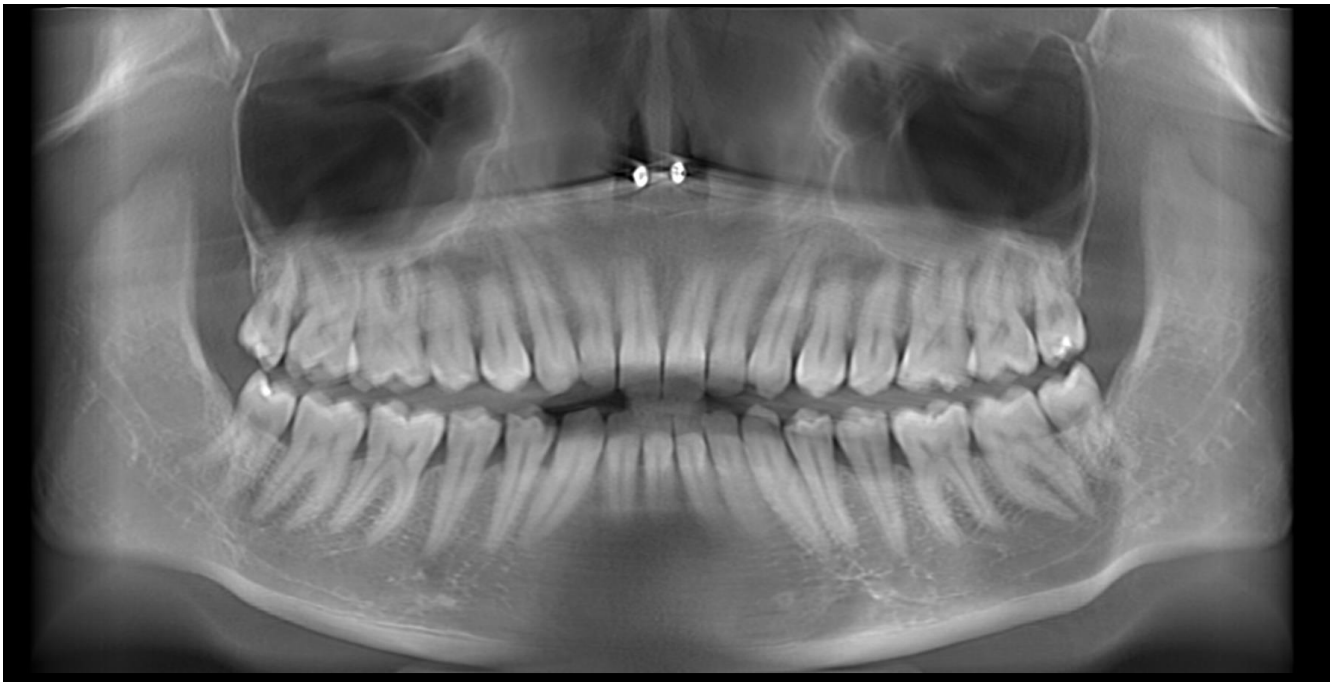*Figure 2 Mesh extruded from a dental arch*

Figure 3 Result of the automatic surface unfolding from dental arch

This approach has the advantage of being simple but can give very inaccurate results. Figure 5 is the result of the unfolding using the mesh in Figure 4 as an input. In the next part, we compute the panoramic view from a more complex automatically generated mesh before comparing the results.

Advanced approach provided in Open Inventor 9.9.2 & 10.1: Automatic dental panoramic workflow

This approach starts with the same dental arch but instead of directly using an extruded mesh, we use the ImageViz engine SoSurfaceFittingApproximation3D to adjust the position of each voxels so the mesh matches the entire curvature of the face.
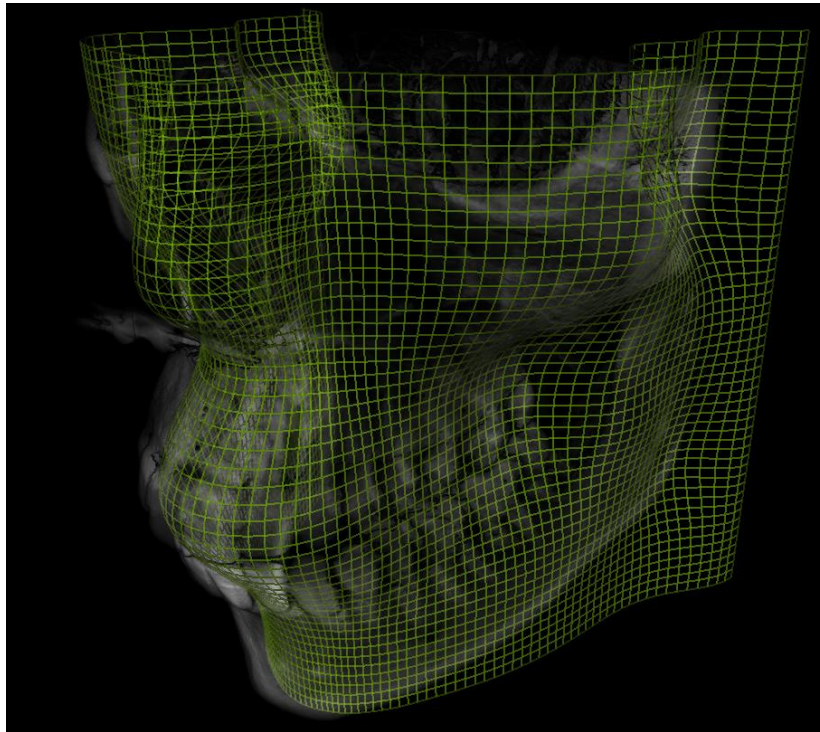

Figure 4 Automatic generation of fitting mesh

Then, this mesh is used in the engine SoSurfaceUnfoldingProcessing3D to unfold the volume and get the panoramic view.
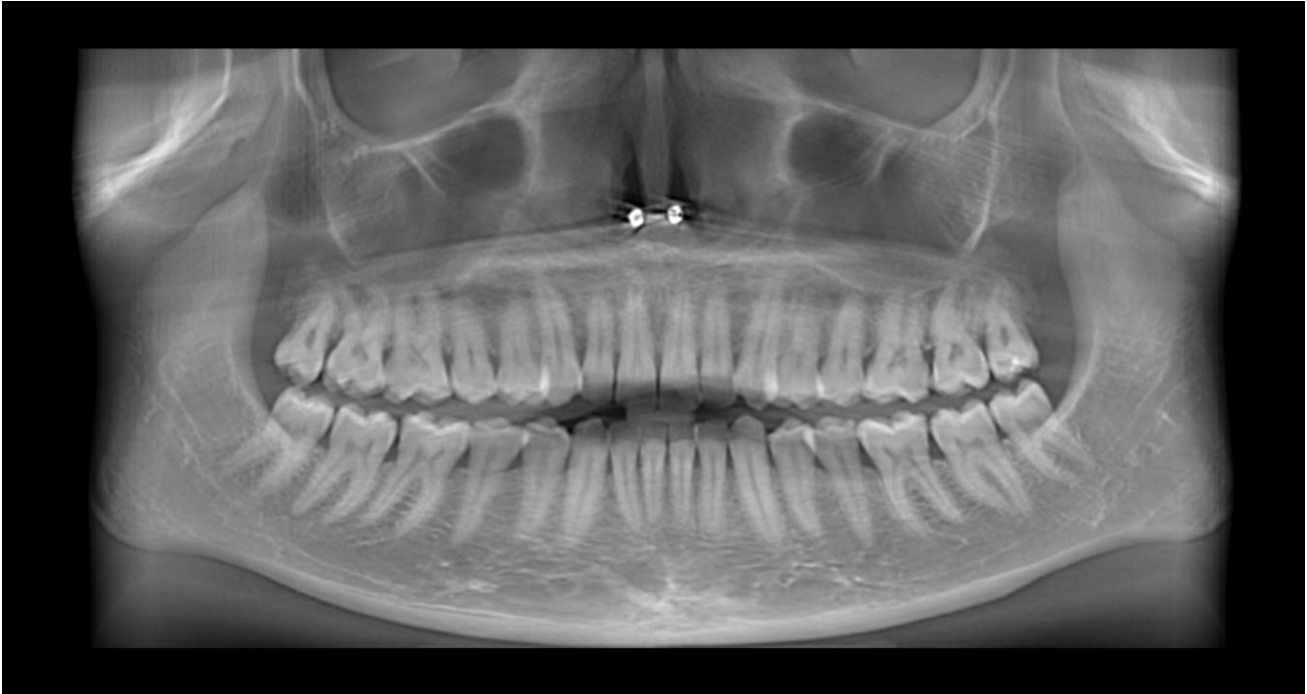
Figure 5 Result of the automatic surface unfolding from generated fitted mesh

This workflow demonstrated in the Open Inventor package is entirely and fully automatic.

This complete workflow provides a fully automatic generation of high-quality dental panoramic views directly from the patient's CBCT image data. Using the advanced algorithms provided in Open Inventor, this workflow can:

- Automatically detect the "dental arch" (curve containing the teeth)
- Compute a surface fitted to the teeth and facial bones,
- Extract a new volume from the neighborhood of this surface (unfolding)
- Project the resulting image stack with deblur and other techniques.

Comparison and conclusion

Figure 6 highlights the areas where high intensity values have not been considered by the simple approach to generate the final rendering. Obviously, the farther we get from the input fitted line, the less accurate the resulting rendering is. If we look at the nose area or the upper cheek, we completely missed important values.
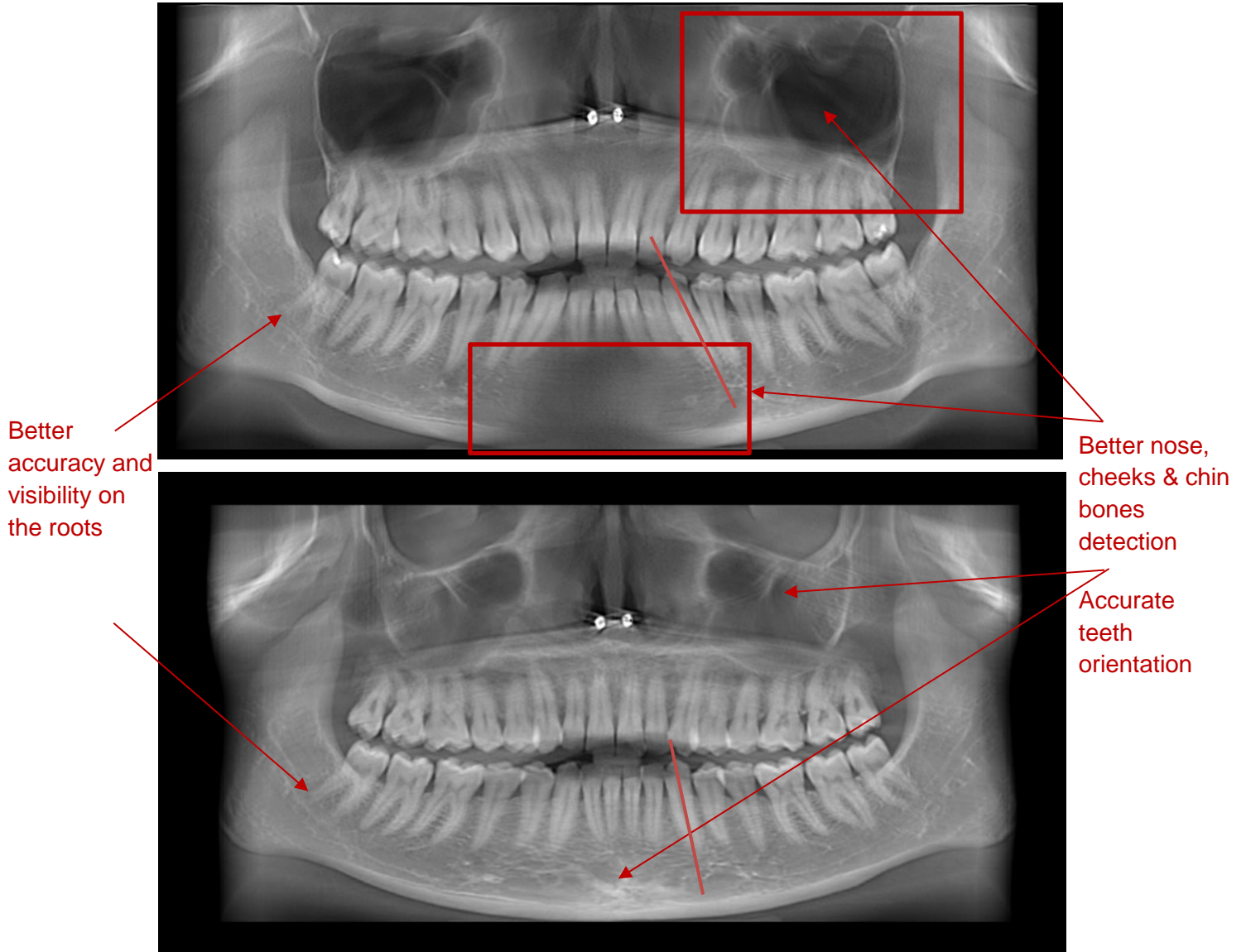
Figure 6 Highlight of the high-quality result from Open Inventor fully automatic workflow

A fully automatic workflow provides a convenient and productive solution for the end user. Most of the time, other panoramic-from-3D solutions require the dentist to manually select points to identify the dental arch. Our workflow uses a surface fitted to the teeth and facial bones, instead of a simple extrusion of the dental arch curve. This ensures the highest possible quality image because no important voxels are ignored.

The unfolding workflow can be tested with the new MedicalDentalSurfaceUnfolding demo added in folder $OIVHOME/examples/bin/arch-<xxx>-Release/Medical/Dental in the Open Inventor package.