The Complete Guide for the IAN Annotation Tool

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1 Introduction

This document will provide a complete guide to the use of the IAN Annotation Tool, provided by AImagelab-Zip. The tool aims to support medical experts in the manual segmentation of the Inferior Alveolar Canal (IAC) on CBCT scans, optionally annotated by a radiologist with a sparse label.
The source code is available at `https://github.com/AImageLab-zip/IAN_annotation_tool`. In the following sections, every view (i.e. all the different kinds of windows that can be encountered during the usage of the program) will be described in the order it should appear to the user. During the usage of such a tool, you will encounter many buttons and check-boxes with a text label in the form: *Description of the button (Key)*. This means that you can avoid pressing such checkbox/button/whatever with your mouse and press the given key instead.

2 Initial View

Initially, a quite blank window will appear. From there, the only option is to open a DICOMDIR by pressing *Ctrl+O* or by clicking in the menu *File ¿ Open (Ctrl+O)*. The File Explorer will appear and you can look for the DICOMDIR you wish to open. It might be possible that two windows boxes will appear:

- **Ground Truth Available:** This means that the DICOMDIR you have opened has already been annotated by the radiologist with a sparse annotation and this can be used as a starting point. This will avoid you from manually selecting the axial view, tuning the arch curve that will create the panoramic view, and sparsely annotating the canal over it. All these things will be automatically computed based on the annotation made by the radiologist. Even when "automatically" computed, you will be able to fine-tune them before moving to the Annotation Screen. If you press `Yes`, you will be redirected to the Panorex Spline Screen, `No` will redirect you to the Arch Spline Screen or Slice Selection Screen, based on the answer you will provide to the next question.

- **Load:** If this window appears, it means that you (or someone else) previously opened this volume with this tool, thus is possible to load the previously described configurations from file. Based on what you have answered previously, you might be redirected to the Arch Spline Screen, Slice Selection Screen, or Panorex Spline Screen.

For completeness, these are all the possible combinations:

- `No > No` → Slice Selection Screen
- `No > Yes` → Arch Spline Screen
- `Yes > Yes/No` → Panorex Spline Screen

3 Toolbar Menu

From now on, more sections will be available in the menu:

- *View > Volume:* An interactive 3D plot of the original volume will be opened.
- *Options > Edit HU thresholds:* It allows you to change the correspondence between HU values of the volume and black/white values. This option is intended to better visualize areas of images where foreground values are pretty close to each other.

4 Slice Selection Screen

You can select the best axial slice that shows the dental arch. When you change the slice an approximation of the dental arch is automatically computed. On the bottom-left corner you will find two checkboxes:

- **Arch:** When checked, the red line approximating the arch will be drawn over the image.
- **Generated Arch:** When checked, the dental arch will be approximated with a different technique, not based on the selected slice.

Confirm button terminates the procedure and redirects you to Arch Spline Screen window. An example of that windows is shown in Fig. 1

5 Arch Spline Screen

This screen, shown in Fig. 2, provides you different views. On the left side, the axial slice you have previously selected is shown and the arch curve drawn in red is now editable by moving the control points (small green squares). Control points can be added with right mouse click or moved with left mouse click. The

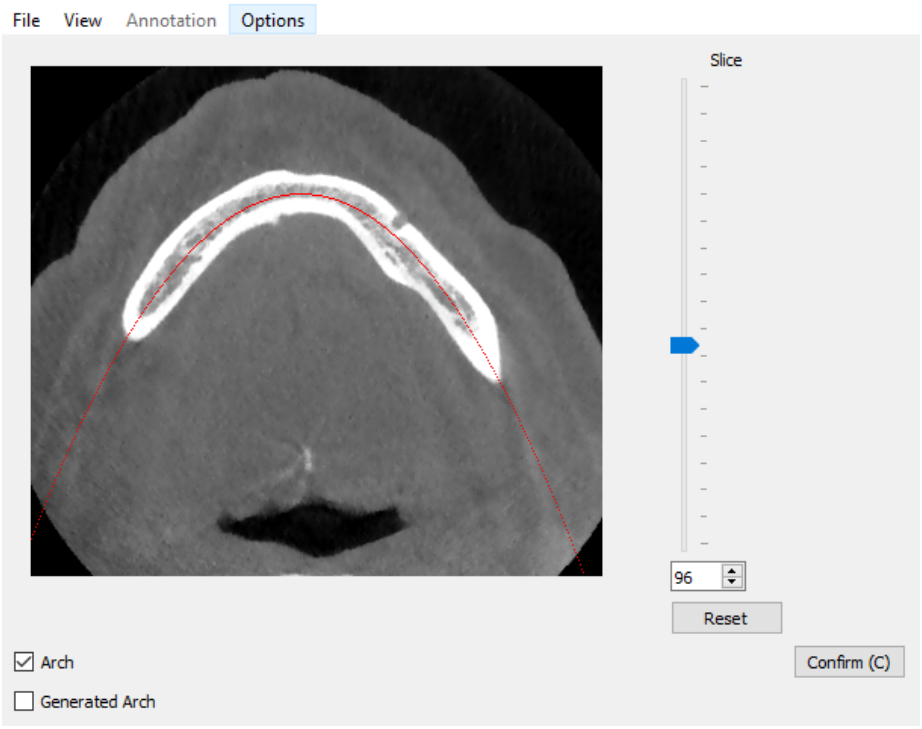

Figure 1: Slice selection screen.

cyan curve is an approximation of the red curve and it is the one that is used to compute the panoramic views shown in the center of the screen. Three different panoramic views are computed at the same time and they only differ by an offset. You can move the *Panorex Offset* slider below to change this offset. On the right side, the cross sectional view is displayed. On that view, you will see a slice of the panoramic view, and it will be the image where you will have to annotate the canal in the following steps, so make sure that:

- The canal in the central panoramic view is as visible as possible. This will be helpful afterward.
- The canal is visible in the cross sectional view(s).

Here you should fine-tune your arch spline to improve the canal position. Once you are satisfied, you can click on *Confirm (C)*. You will now lend into the Panorex Spline Screen.

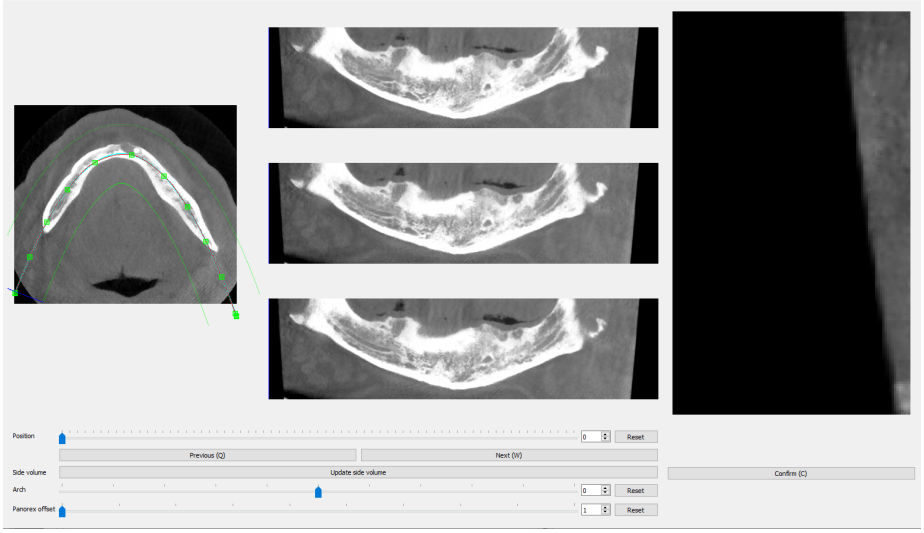

Figure 2: The arch spline screen.

6 Panorex Spline Screen

In this section, you will see the arch spline and the related panoramic view. If you are coming from the *Slice Selection Screen* → *Arch Spline Screen* path, in the panoramic view there will not be any annotations and you will have to add them. By using the *Right Mouse Button* you can add/remove a control point and with the *Left Mouse Button* you can move them around. Otherwise, if you are coming from the initial view, you will see the spline that has been automatically computer (or loaded if you have responded `Yes` to the second question) Note that these splines are *Catmull Rom Spline* (`https://en.wikipedia.org/wiki/Centripetal_Catmull%E2%80%93Rom_spline`) this means that the curve between the first/last and the second/second-last control points are not drawn (you can still place two control points close to each other to overcome this limitation) You are still able to edit if needed. Something that **you have to check** is:

- The arch **must take all the dental arch**, and not miss it in the lower part of the image (an example of a bad arch detection is shown in Figure 3).
- The spline drawn over the panoramic view **must be cover all the canal** (and possibly something more, just to be sure to not miss any relevant canal portion). An example of a bad spline is shown in Figure 4.

Once satisfied, you can press *Confirm (C)*. You will be prompted a question about orthogonal/tilted side views. If you press `Yes` (suggested), the side views where to annotate the IAC will be orthogonal to the spline you have drawn in

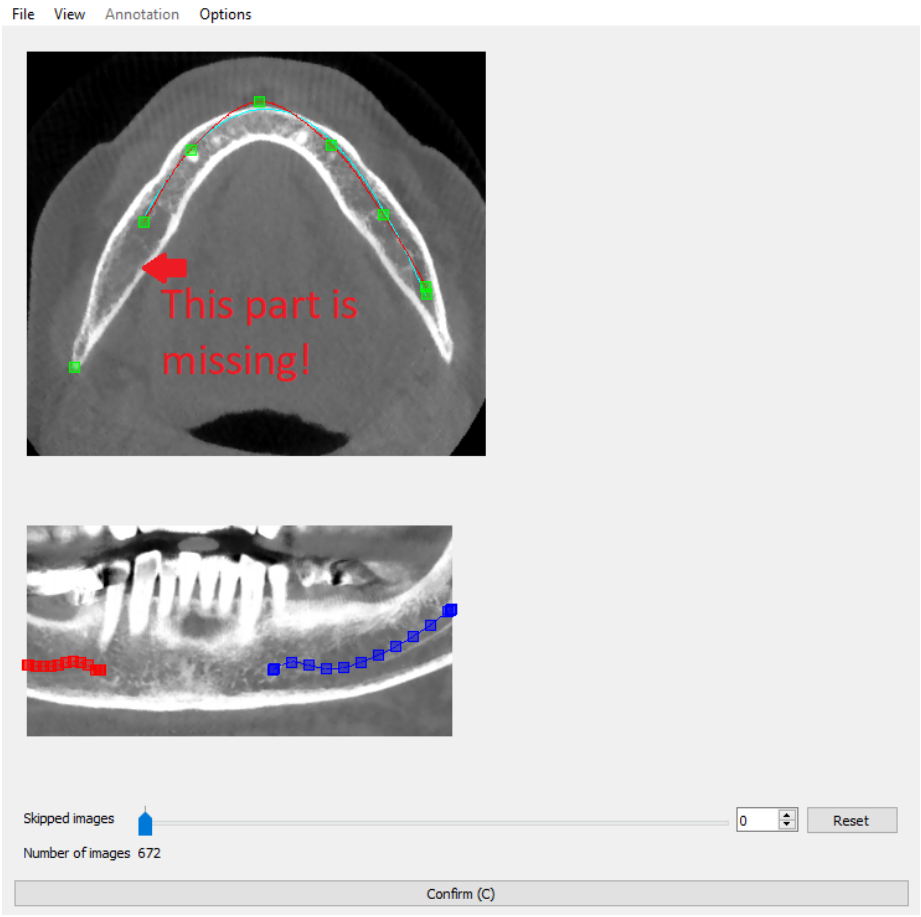

Figure 3: An example of bad arch spline that misses part of the dental arch.

the panoramic view. This should ensure that the IAC will always look like a circle and not as an ellipse. These views have already been computed by us for the already computed splines, but they will need to be re-computed if you changed the spline. This might take up to 1 minute.

7 Annotation Screen

This is the last screen you will encounter and where you will spend most of the time. On the left side you have multiple control buttons, on the right you can see two identical side views. All the configurations are detailed below. Please note that some of them can be only controlled using the keyboard and/or the mouse, no button is available.

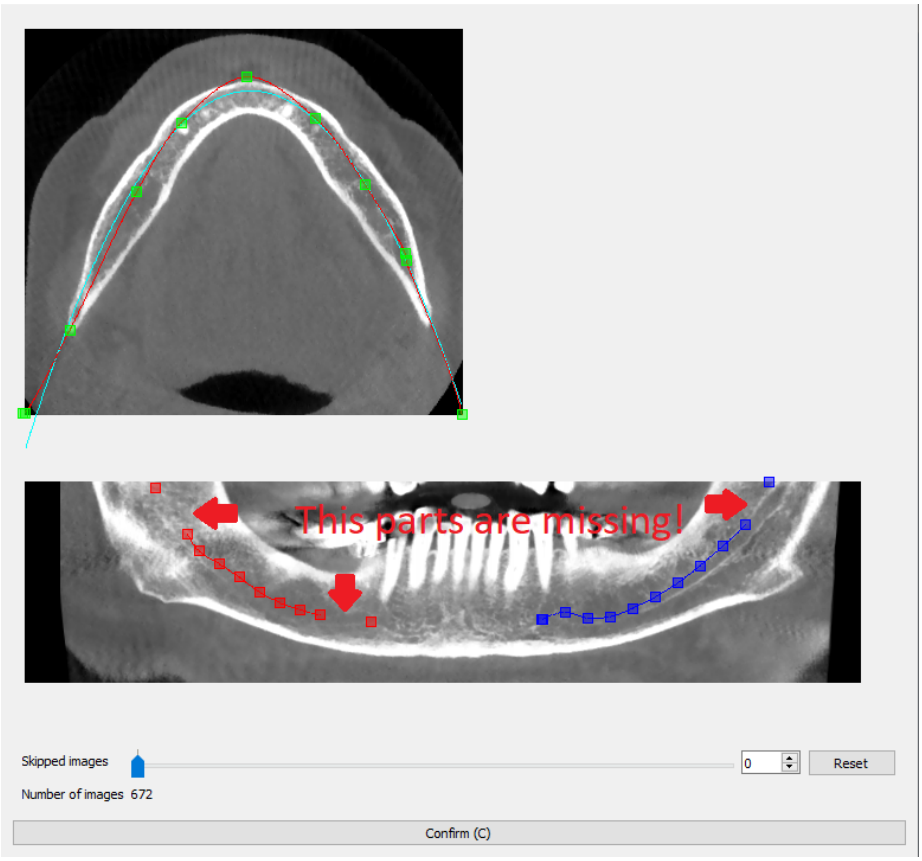

Figure 4: An example of bad panoramic spline, notice as it is missing part of the canal in multiple parts.

- With the *Position* slider, you can glide through all the side views, and by looking at the blue vertical line on the panoramic view, you can understand where a given view has been taken from.
- By pressing `Q` and `W` you can go to the previous/next slide while *Reset* set the slider to `0`.
- The checkbox *Show dot (D)* hides/shows the red/blue dot visible in Figure 5, which is a projection of the canal spline. The same is valid for *Show mask spline (S)* and *Show control points (C)*.
- By activating *Automatically acquire annotation from previous/succeeding (Ctrl+A)*, when you will go to the next/previous slice the software try to guess automatically where the IAC is, based on the previous/next annotation. This is just a guess and surely needs adjustments, but it speeds up a bit the whole process.

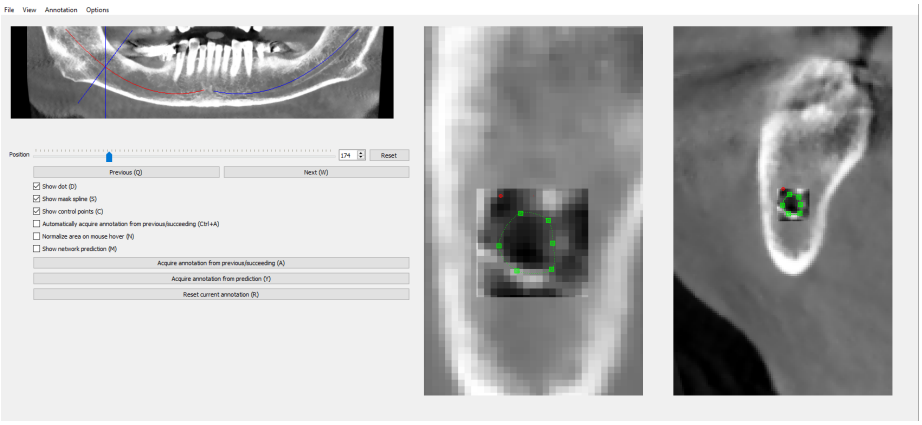

Figure 5: The annotation screen.

- When you are unsure of where the canal is, because the contrast of the image is good, the *Normalize area on mouse hover* will let you use the mouse to apply contrast stretch to a limited area of the image. The square is resizable by pressing *Ctrl + Mouse Wheel*, *Shift + Mouse Wheel*, and *Ctrl + Shift + Mouse Wheel*. Sometimes it will help to stick the square into the desired position, this is possible by positioning the mouse where you wish and pressing `N`. You can also stick the squares in both views by enabling the option (press `N`, place the mouse in the desired position on the first image, press `N` to stick it, move to the next image, press `N` again to select the new position then press `N` again.

- *Show network prediction (M)* will mark in red some pixel of the annotation based on a previously performed annotation, and, when that is not available, a prediction of the network. When such an area looks good, you can click on *Acquire annotation from the prediction (Y)* to compute a spline that covers that area.

- *Reset current annotation (R)* will remove all control points in the given slice.

- By pressing `+` and `-` you can zoom in/out in the first side view, and move with *Arrow keys up/right/down/left*

8 Exporting the annotation

When you are satisfied with the annotation carried out, you have to export the annotation, this can be done from *Menu > Annotation > Export ground truth volume*.