

User Manual

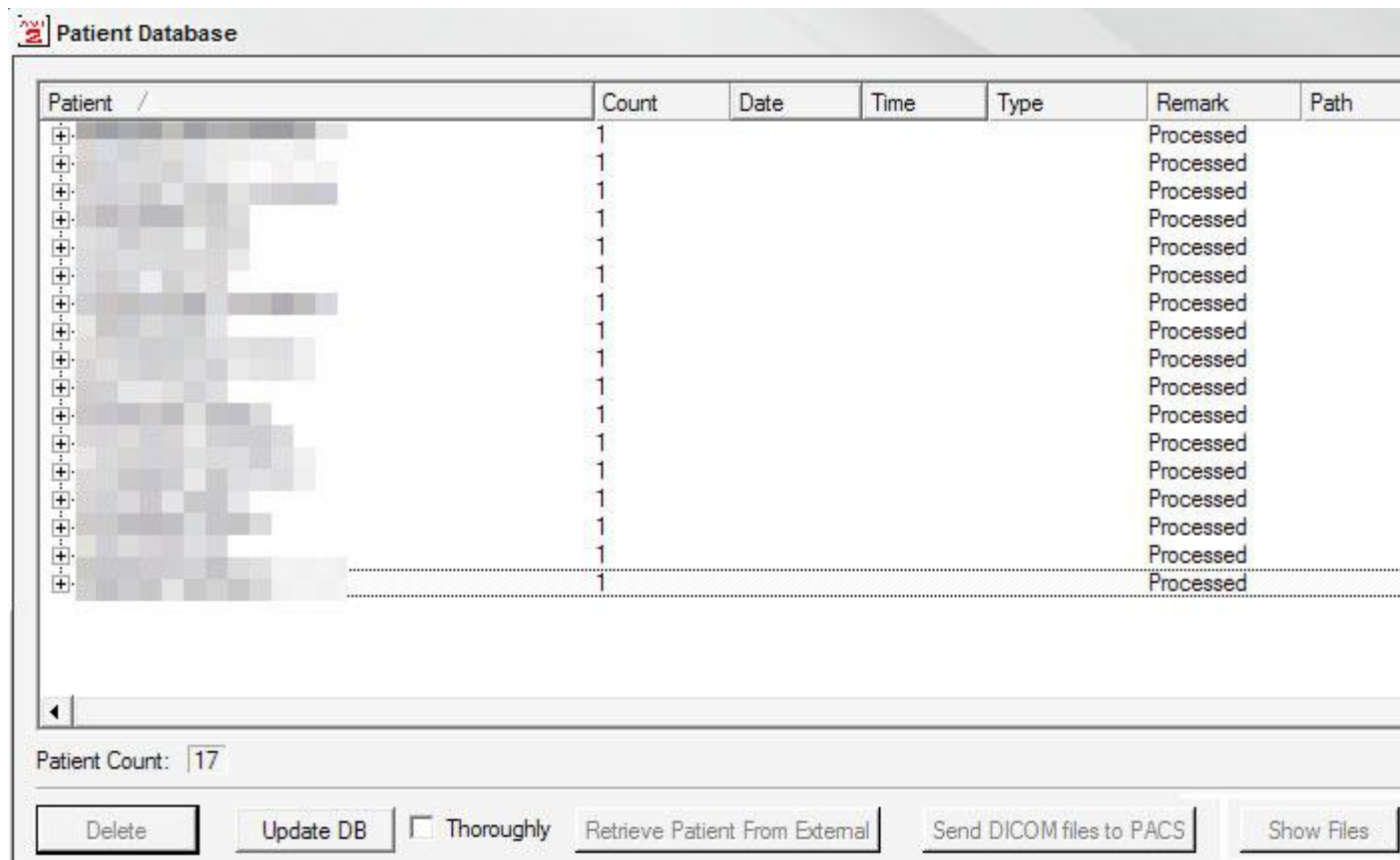


Right after program start, AngioVis Toolbox (AVT) presents with all necessary buttons arranged in the top left corner.

The first two buttons are for loading and saving a patient dataset (AWT file extension) from/to the harddisk, the third one opens the database of the program. The lower 4 buttons are the 4 steps of image processing: **I**dentify Background, **B**one Remover, Vessel **T**racker and finally Image **G**enerator.

DATABASE

The database can contain Dicom images received from the PACS system as well as the patient datasets created by AVT. Before you can start to process a patient, the Dicom files have to be converted to AngioVis' own dataset format (AWT). This is done in the database, so fire it up.



This is the database window. Some of the buttons on the bottom are non-functional at the moment.

The database cannot detect automatically if new dicom files were transmitted from the PACS, so first you have to select "Update DB" to let the program look for new files. The checkbox "Thoroughly" rebuilds the whole database from the scratch (Necessary when files were deleted outside of AVT).

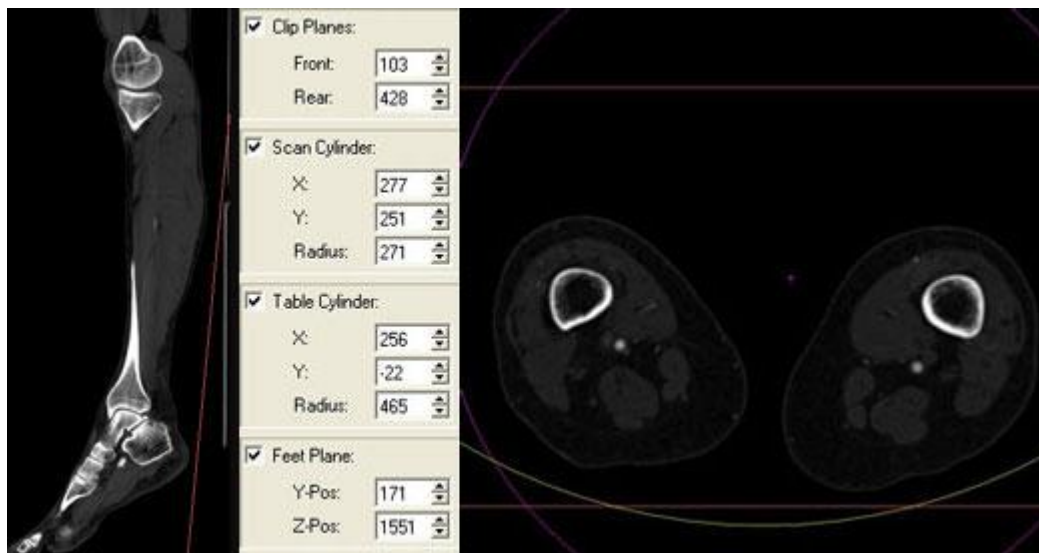
A Patient, whose dicom images were already converted to AWT-dataset are indicated with an "Processed" remark. A patient, where native dicom images are still available have an empty remark field.

To open a patient for processing select the name and click on open. If the files are still native dicom files they will be converted automatically first, might take up to five minutes.

When the loading is done, the patient name will show up in the top bar of the window.

IDENTIFY BACKGROUND

Dataset is presented in two views, sagittal to the left and axial to the right. In both views, the visible layer can be changed with the scrollbar at the bottom of the window.



The window width and center can be adjusted by moving the mouse in one of the windows while keeping "Alt", "Ctrl" and the left mouse button pressed. Zoom factor can be adjusted by moving the mouse while keeping the shift key and the left mouse button pressed. Moving the mouse while keeping "Ctrl" and left mouse button pressed will pan the window. (These functions work in the windows of Bone Remover and Vessel Tracker as well.)

To identify the background for removal from the dataset, it is necessary to highlight the relevant voxels. For that, the following options are available:

- Clip Planes (red, axial)
- Scan Cylinder (pink, axial)
- Table Cylinder (yellow, axial)
- Feet Plane (red, sagittal)

The settings for these features can be modified in the boxes shown at the right edge of the screen. Alternatively, you can simply click on one of the items and keep the left mouse button pressed while moving the mouse. That way you can adjust the position of

the planes and the radius of the cylinders. The position of the Scan cylinder can be adjusted with the small pink cross in axial view.

When you are set, click "Identify" and "Flush" to remove all background information and close the "Identify background" window.

BONE REMOVER

Next step is the separation of bones and arteries.

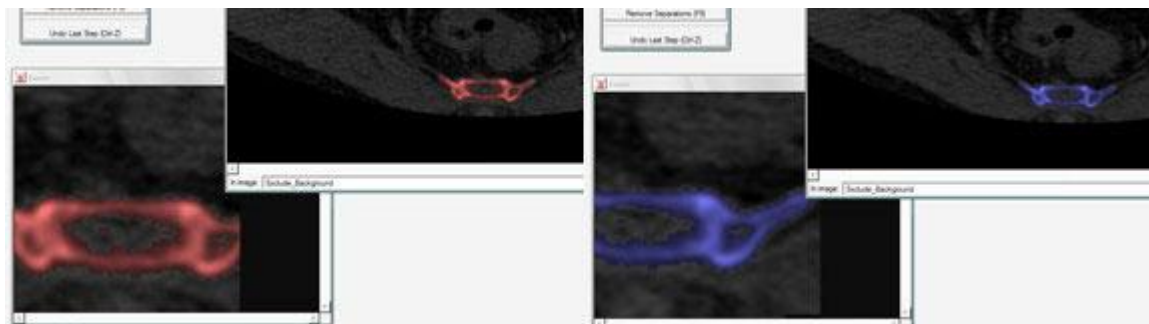
To the left is a window with a coronal MIP of the dataset, to the right an axial view.



First of all, it is important to know that the program divides the whole dataset into slabs to optimize the workflow. The slab, that contains the axial slice shown on the right, is highlighted in yellow on the MIP to the left.

To change the axial slice (z-axis), use the mouse wheel in one of the windows or move the horizontal red line in the coronal window with *Alt* + left mouse button pressed. (This both scrolling methods are available in the vessel tracker the same way.)

The program has an automated segmentation that should be started by clicking on "Auto Segment" (or press *F3* on the keyboard). After that, almost all bones should be removed from the MIP image to the left. Now the remaining bones have to be removed manually and arteries identified as bones by mistake have to be recovered. In the right axial window, structures detected as bones are colored blue, arteries red. This coloring can be disabled by unchecking the checkbox "Colors in axial" or pressing *F11* on your keyboard.

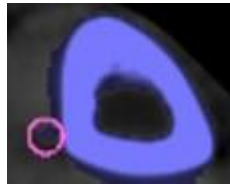
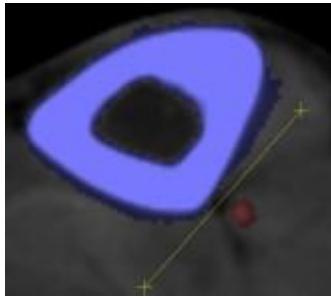


To change the identification of a structure, activate the "Toggle Tissue" (*F4* on the keyboard) and click with the left mouse button on the structure.

In some cases, arteries and bones are too close to each other, so the program cannot separate them from each other correctly automatically.

In this cases, user interaction is required to add division markers manually. There are two possible markers: planes and cylinders.

To create a separation, click on the appropriate button (or press the corresponding *F*-button on the keyboard) and go to the first slice of the slab where a division is necessary. Now place the top borders of the divider between bone und artery by clicking once with the mouse button to start the placing, then adjust the direction (plane) or the radius (cylinder) click the left mouse button a second time,when you are set.



Now scroll to the beginning of the next slab and place the bottom borders of the divider. During the scrolling, the top borders will remain visible as a yellow line or circle. After placing the bottom borders, the program will calculate the area between top and bottom borders automatically, the divider will become pink.

Sometimes, the separation in a slab cannot be done with a single divider. Thus, it is possible to create several dividers in one slab. Just make sure you don't leave any slices without a division marker. That mean, that a new divider must start at least at the same slice where the last divider ends, otherwise the separation is incomplete!

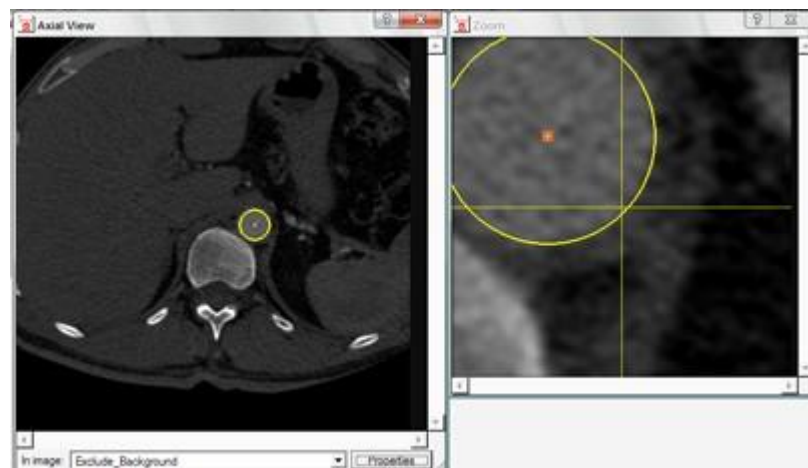
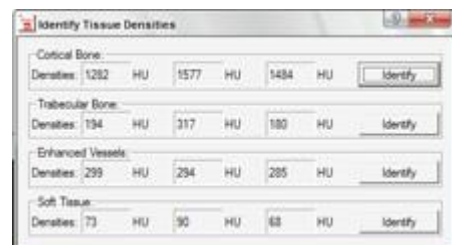
In some cases, the arteries are so close to the bones that it is really hard to separate them from each other with the divison planes and cylinders. In these cases, another feature called the Vessel Extractor is very useful. Activate it by clicking on "Extract vessel" (F8 on the keyboard), center the vessel you want to extract in the axial window (so it is visible in the zoomed window) and press L on the keyboard to lock the view of the zoomed window. Now move the mouse over the zoomed window and click on one border of the vessel with the left mouse button and a second time at the opposite border (to indicate the diameter of the vessel). The program will then try to extract the vessel, but just for a small part. Continue to mark the diameter in the course of the vessel.

To leave the bone remover, simply close on of it's windows, the others will close automatically.

VESSEL TRACKER

- Identify Densities
- Insert CP - F2
- Move CP - F3
- Intermediate CP- F4
- Track&Center Seg - F5
- Center Segs I - F6
- Center Segs II - F7
- Revert Segs - F8
- CPR Gauging Catheter
- Paths
- Viewing Properties
- General Properties
- Tracker Properties
- Centering Properties
- 3D Wire Model
- Volume Rendering

This step starts with the Identification of Tissue Densities for the shown tissues. To start the identification of a tissue, simply click on "Identify" to the right and select three different sample tissues in the axial view. When you are set, you can close the window, if you need to adjust these settings later, you can re-open the window with the



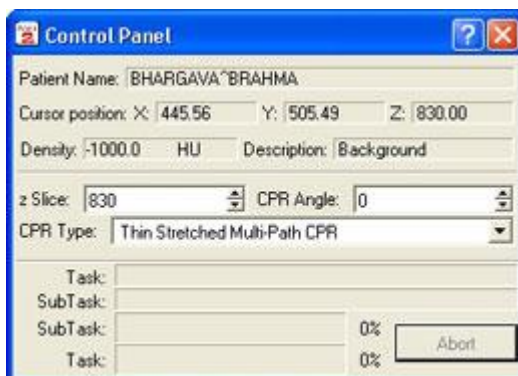
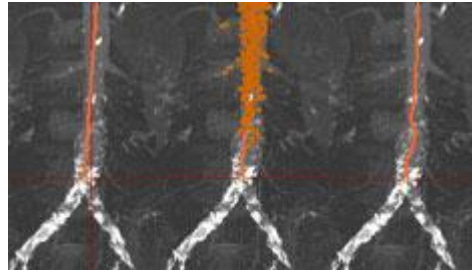
"Identify Densities" button in the action window (shown on the left).

Now start with the tracking! The program needs some control points entered by the user and will calculate the centerlines between these control points automatically.

As in the bone remover the view of the zoomed window can be locked by pressing *L* on the keyboard. It is highly recommended to use the zoomed window for control point placement to achieve higher accuracy!

To insert a control point, press *F2* on the keyboard (or click on "Insert CP") and click in the center of a vessel in axial view. After that a circle will appear around this center, that needs to be adjusted with the mouse to match with the vessel diameter. Click a second time with the left mouse button when the diameter is set correctly to fix it.

Now go ahead and create the next control point, right in front of the next vessel bifurcation. The active segment (between those last two created control points) is now shown in the overview window with an orange line. (All others segments of the current path are shown in green, segments of other paths are shown in blue, see below.) To track the vessel and detect the centerline in the active segment, click *F5* on the keyboard.

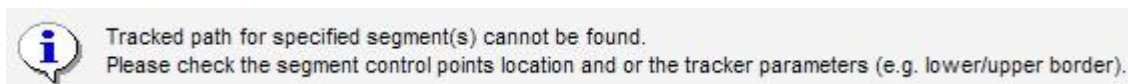


In the CPR window to the right, you can check the results of the tracking. You can choose between several CPR modes in the "Control panel" window. In the context menu of the CPR window, you can disable the yellow path line (to see the rendered vessel itself more clearly) and enable gauging ticks, if you want.

If the centering is not sufficient, you can try to use alternative centering with *F7*. If that is even worse, you can redo standard centering with *F6*.

Pressing *F3* on your keyboard, it is also possible to change the center of a control point to overcome pseudostenoses introduced sometimes at bifurcations. To do so, click and hold the left mouse button on the Control point that you want to move. If you need to make changes to the radius again, simply right click on the control point in axial view and choose "Change radius of control point" in the context menu. After moving the control-point, you have to re-run the tracking for the adjacent segments. The segment below is already active (shown in orange), so simply press *F5*. To select the segment above, make sure no control point action (*F2*, *F3*, *F4*) is enabled (e.g. to disable "Move CP" click on the button it or press *F3* again) and click with the left mouse button on the segment. It should turn from green to orange on activation, now go ahead and click *F5* to re-track this segment.

Pressing *F4* on your keyboard, you can add an intermediate control point. To do so, simply click at the position where you need an additional control point in your segment, you can then adjust the center of the control point with *F3* (see above).



Sometimes, tracking will fail to detect the vessel between two control points. In that case you can delete the second control point in its context menu (right click on that control point in axial view). You can then try to create a new control point.

In some occluded vessels, the tracker will not be able to track the centerline correctly at all, but you need to create a path anyway to continue with the vessels below that are perfused again. In such a case, place only control points close to each other and do NOT use F5, until the vessel shows good enhancement again, so the tracker can work again.

When you have finished one of the six vessel paths, you should assign it a name, the program starts every new path labeled as Unknown. Click on "Change Name" and select the right label for the path actually created.



To start with a new path, simply click on the control point above the bifurcation, where your next path should start from and add a new control point in the new path. The software will detect this as a new path. In the overview window, the currently selected path will be shown green, the active segment you can also switch back to another path created before to make some changes. To do so, use the drop-down-box shown in the image below.

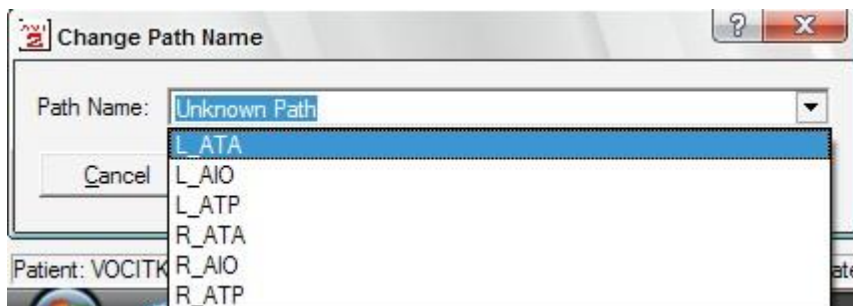
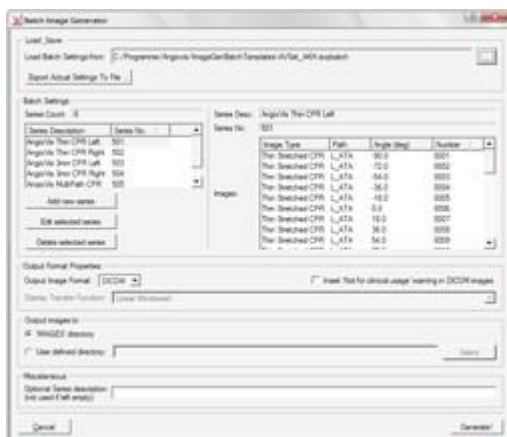


IMAGE GENERATOR



The last step is the creation of the images. If you created all six vessel paths, simply click on Generate in the bottom right corner to start the image creation.

If some paths could not be created in the vessel tracker, it is necessary to remove the instructions for the creation of their images in the presets. To do that, click on the image series you want to change (e.g. Thin CPR Left 501) and click on "Edit selected series". Then delete e.g. all lines that contain ATA if the ATA on the left side could not be created in the vessel tracker.