

Forensic Image Comparator3D

Tutor 3. Fingerprint images comparison. Latent Fingerprint Examination.

Introduction.

In general, 3D image enhancement is an easy procedure, but it requires some understanding of what 3D surface is all about. As a reward of spending time on basic concepts below, you will gain a very powerful tool. The idea of 3D enhancement and visualization is quite simple. We apply to human personal experience in the real world, i.e. the experience on how the real things look like. As we live in 3D rather than 2D photography world, we used to see various details of the objects that are inevitably lost in 2D pictures. For example, when you want to see a scratch on CD surface, you will try to look on the surface from different directions until you find the correct angle of view. This procedure seems to be very natural and simple, but in fact what happens is that you are using your powerful brain “computer” to find optimum lightning and viewing perspective at which you see the scratch. Or, more technically, you are looking for optimal illumination condition such that brings the scratch into nicely interpreted contrast and reflection into direction of your eye.

Now think of the “scratch” as a tiny feature of the surface under investigation. Think of 3D software as a tool that allows you to imitate real live case, i.e. simulate the way you would be looking for the scratch of a real object. You are close to understand why 3D software is useful for image enhancement. Simply because it is used in conjunction with your brain to interpret in the images what is hard to see otherwise.

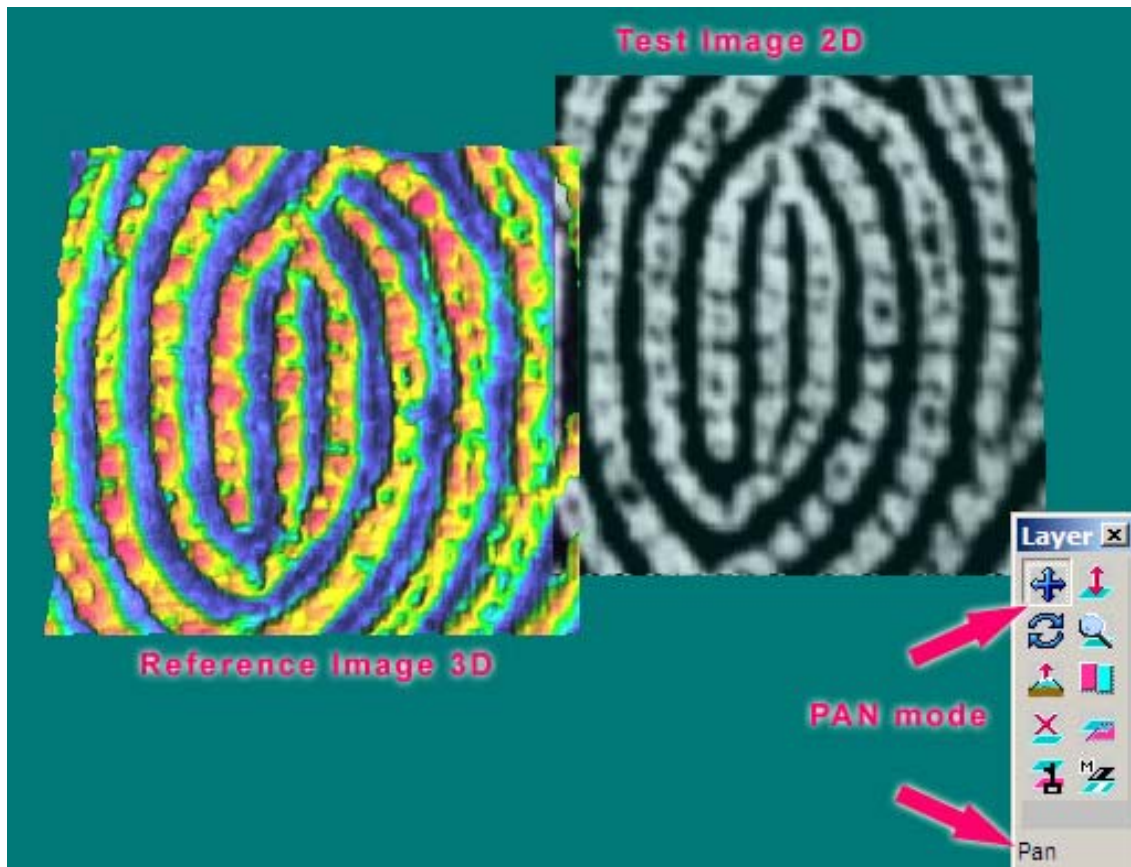
Until recently the 3D visualization was exclusively used by professionals (movie makers, web designers, etc.). We provide you with the scientific grade visualization software solution, that helps you to solve the practical problems. Our software will make you immediately productive. The examples of this tutor are designed to streamline your experience in 3D image enhancement and comparison.

Our software is most useful for latent fingerprint examination, analysis and comparison.

The 3rd Z dimension in the enhanced images is interpreted as the elevation height proportional to luminescent value (intensity level) of the input image.

1. Double Image 3D/2D Mode.

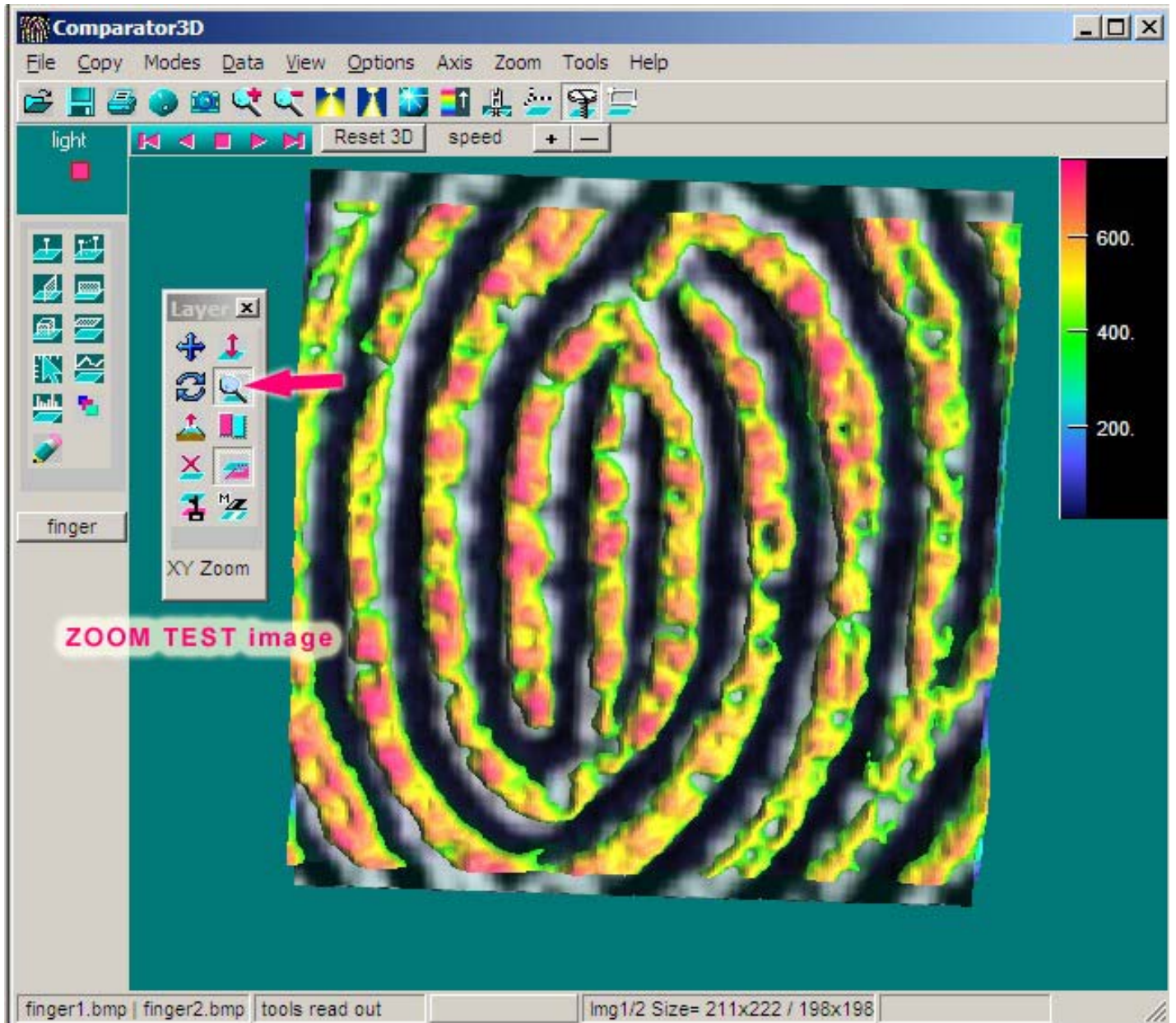
Load images with Fingers button on the left side. This will load 2 sample fingerprint images as shown in figure below.




Screen shot: Initial Double Image 3D/2D Mode. Floating toolbar is used to operate with test (2nd image) on the right side.

Image1 is the Reference image, image2 is the image under test that is referred as the Test Image. Images can be analyzed in 3 different modes as selected from Menu. The initial mode for this demo is Double Image 3D/2D. The floating toolbar appears to provide you with access to properties and options of the test image. Pan mode is used to move test image relative to reference with mouse.

You can move, rotate, zoom the test fingerprint image to achieve better matching as shown in figure below. While moving the test image over reference fingerprint you can use semi-transparency of test image as selected within floating toolbar.








Screen shot: Main Form. Double Image 3D/2D mode of fingerprint examination. Zoom mode is selected. Zoom is done with mouse operation within 3D screen. Note that semi-transparency is ON.

To make the best match the test image can be moved, zoomed and rotated. The operation is selected with floating layer toolbar as shown below. The floating layer toolbar is designed to provide you an fast access to the layer (test image) operation. The layer toolbar is called from Main toolbar by pressing  button. In figure below the buttons are numbered from 1 to 10 for description of the functionality of the test layer.



Screen shot: Layer Toolbar. PAN Mode selected.

The toolbar provides 6 modes of the mouse operation on test layer as numbered in figure above, in each mode the actual operation is achieved with mouse drag within 3D screen:

- | | | | |
|--|---|---------------|---|
| #1. Pan the layer with mouse, move test image in XY directions | – | Mouse pointer |  |
| #2. Move the test layer in Z direction | – | Mouse pointer |  |
| #3. Rotate test layer in horizontal plane | – | Mouse pointer |  |
| #4. Zoom Layer, all directional zoom | – | Mouse pointer |  |
| #5. Data Zoom, i.e. zoom elevation data of the test layer | – | Mouse pointer |  |

#9. Lock the test layer with the main surface, i.e. operate both layers together with mouse
While the Layers are locked to each other the left mouse will rotate both images, the right mouse will Pan both images.

#10. Make mask on the test image layer

The current selected operation is shown at the bottom of the toolbar. While Pan selected the mouse drag within 3D window will move layer. Similarly mouse operates in other modes such as Rotate or Zoom.

In addition from Layer toolbar you can reset layers to the side-by-side position (button #6), clear all translations to Zero values (button #7), construct masked layer with button #10.

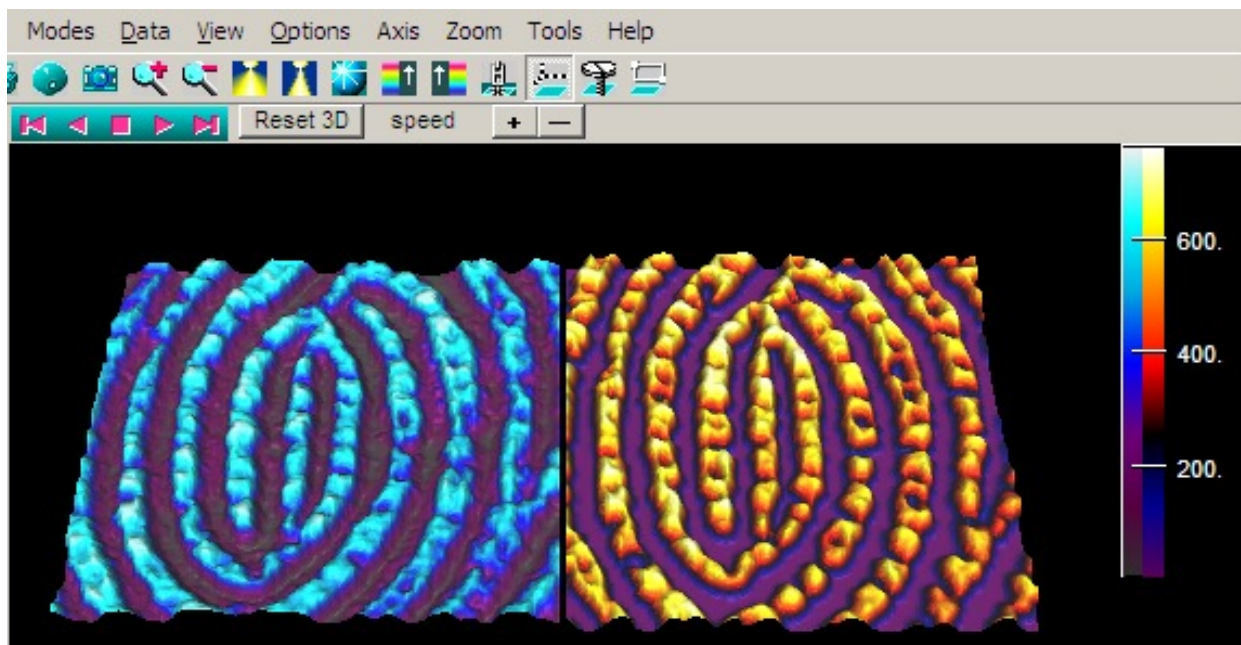
Press button #8  to make test layer image semitransparent.

Try to use functions 1 to 4 to see the effect of various mouse operation modes.

You can Press #9 button to lock reference and test images. While Layers are locked to each other the left mouse will rotate both images, the right mouse will Pan both images.

2. Double Image 3D Mode. Processing images.

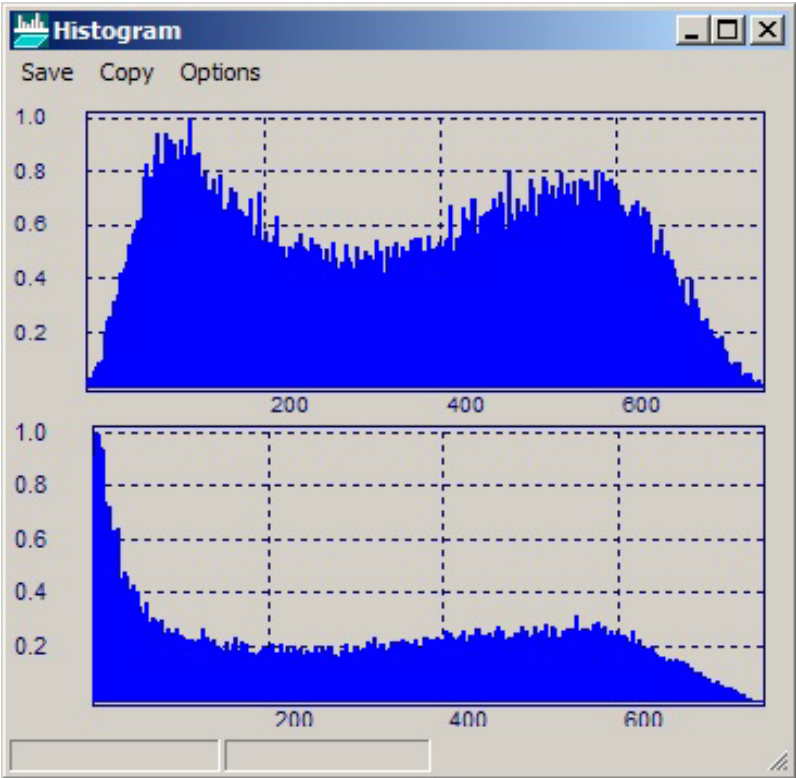
You can visualize and analyze both layers in 3D representation mode. From Menu>Modes select Double 3D mode.



Screen shot: Main Form. Double Image 3D Mode is selected. The same palette is used for both images. Mask OFF for test image.

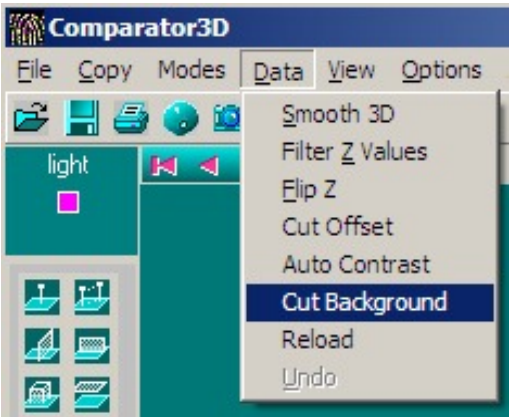
You can analyze the data under investigation with the histogram tool. The histogram tool is called from left toolbar by .

button. The tool shows distribution of the height in both images.



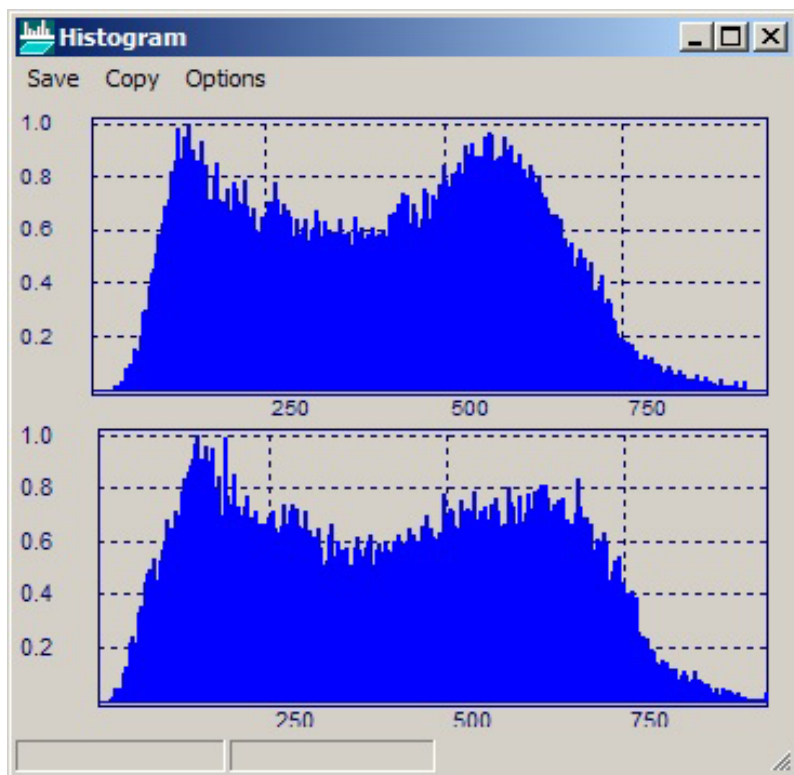
Screen shot: Histogram Form. Initial non-processed height distribution for both images.

The histogram represents the data distribution (number of hits) in vertical axis vs. elevation value (intensity of input images). For the raw images in this sample, the data distribution is presented in the figure above. The test image has some background offset, that is seen as an increased distribution at low elevation level. This background can be removed by our “Cut Background” filter called from the main menu. The background is removed by our 2D FFT filtering algorithm.



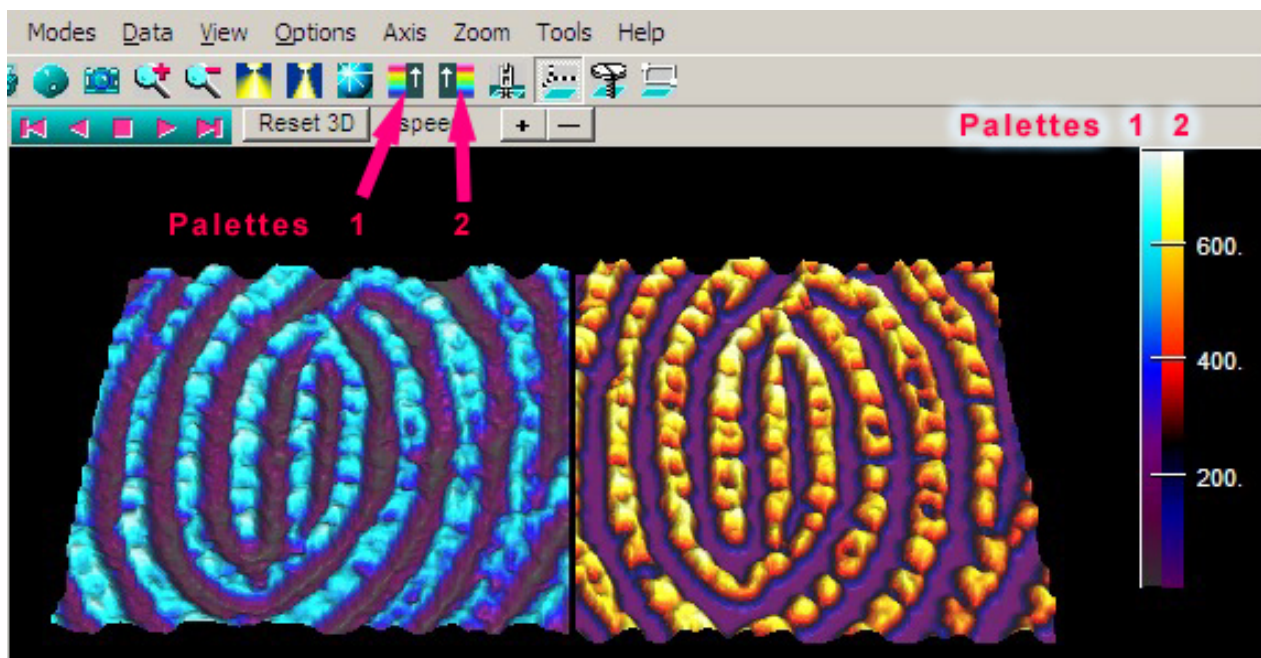
Screen shot: Background removal.

After the background is removed the histogram shows similar height distribution in both images.



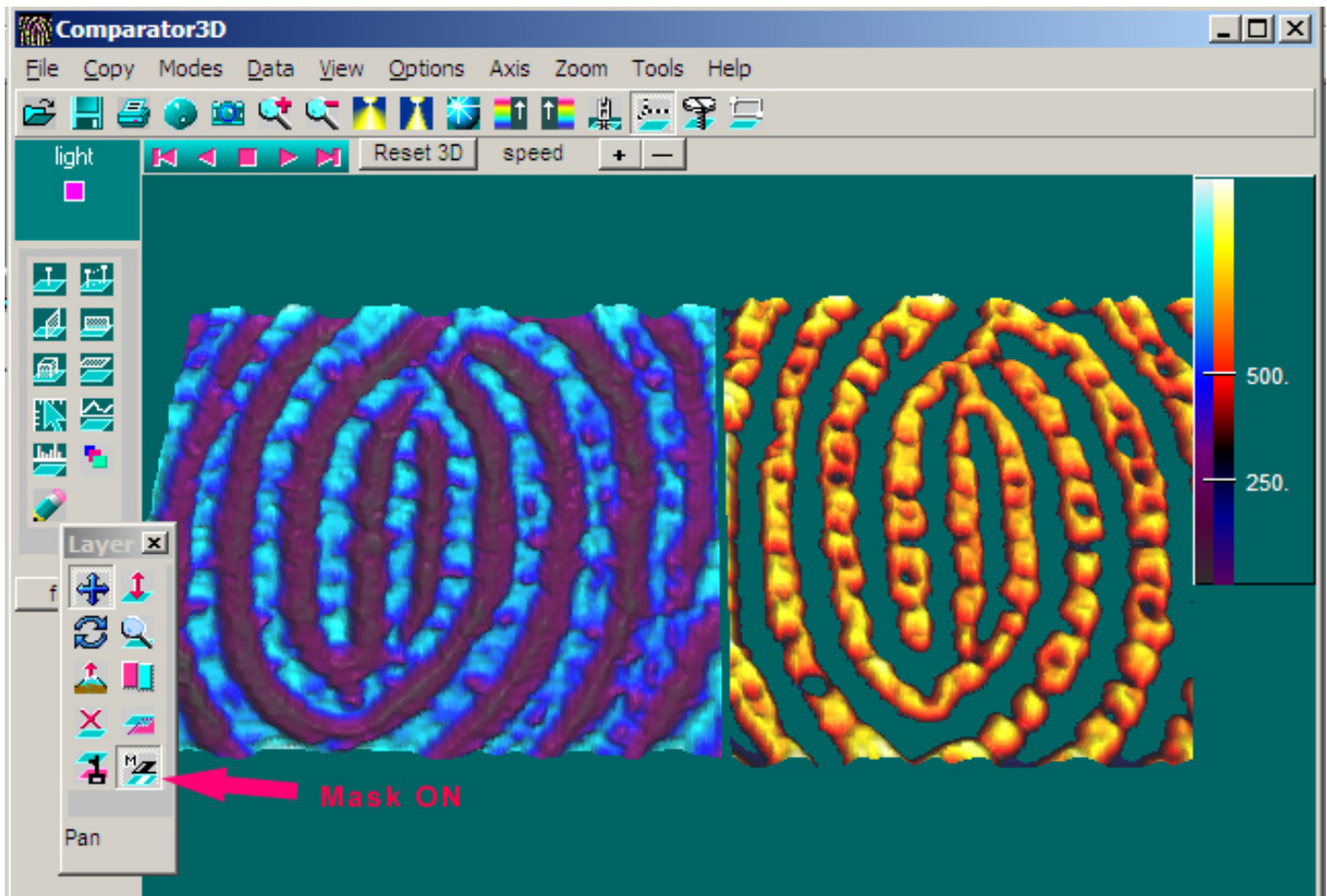
Screen shot: Histogram Form. Height distribution after background is removed.

We suggest that you change the palettes of the surfaces to achieve better visibility of the features of interest. Palettes are changed separately for both images from main toolbar as shown in the screenshot below.



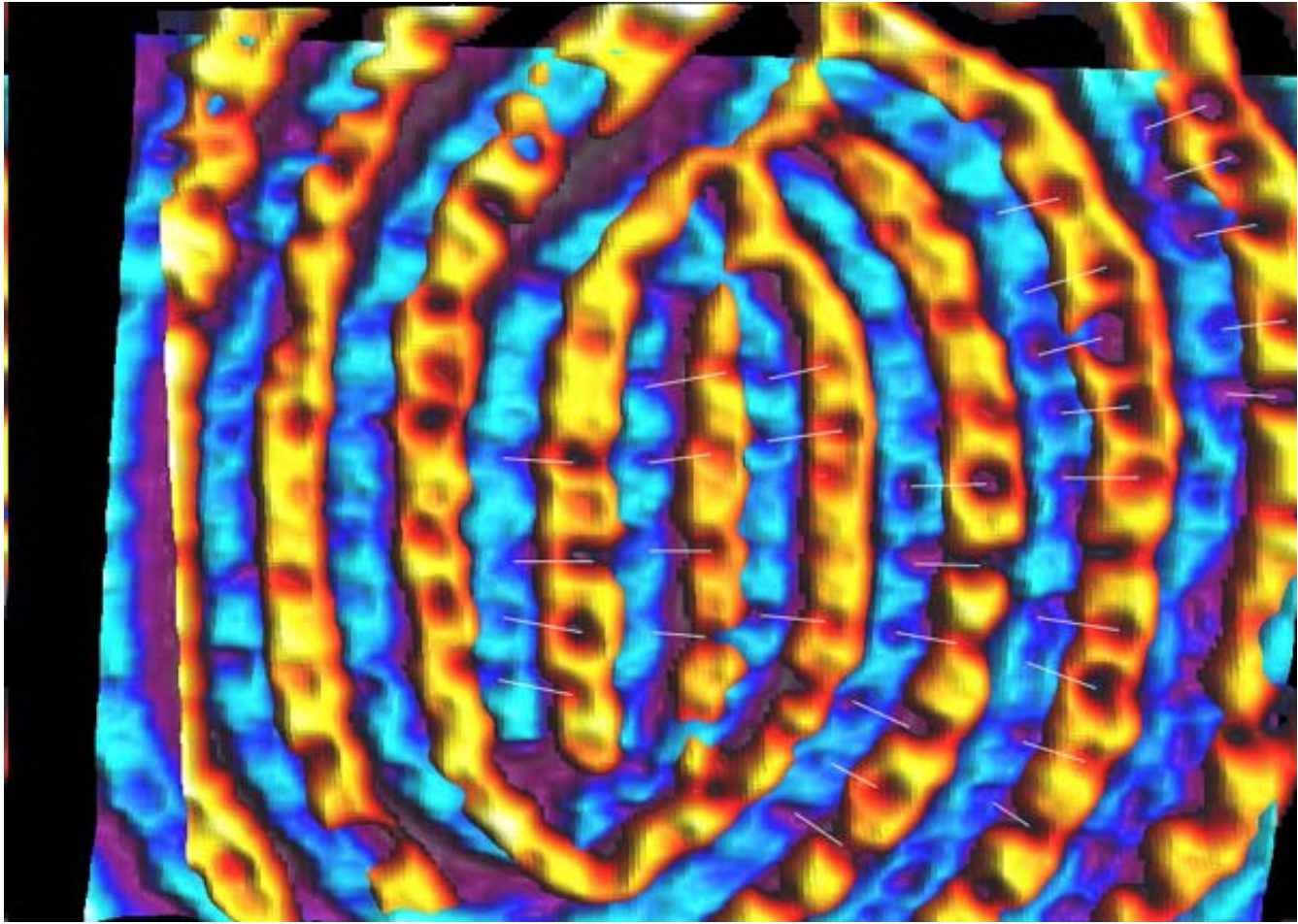
Screen shot: Main Form. Double Image 3D Mode. Different palettes selected from main toolbar. Mask is OFF in test image.

One of the most useful modes for image matching is 3D with test image masked. Mask ON/OFF is selected from floating toolbar as shown in figure below. The low elevation values (not informative in our example) are hidden by mask.



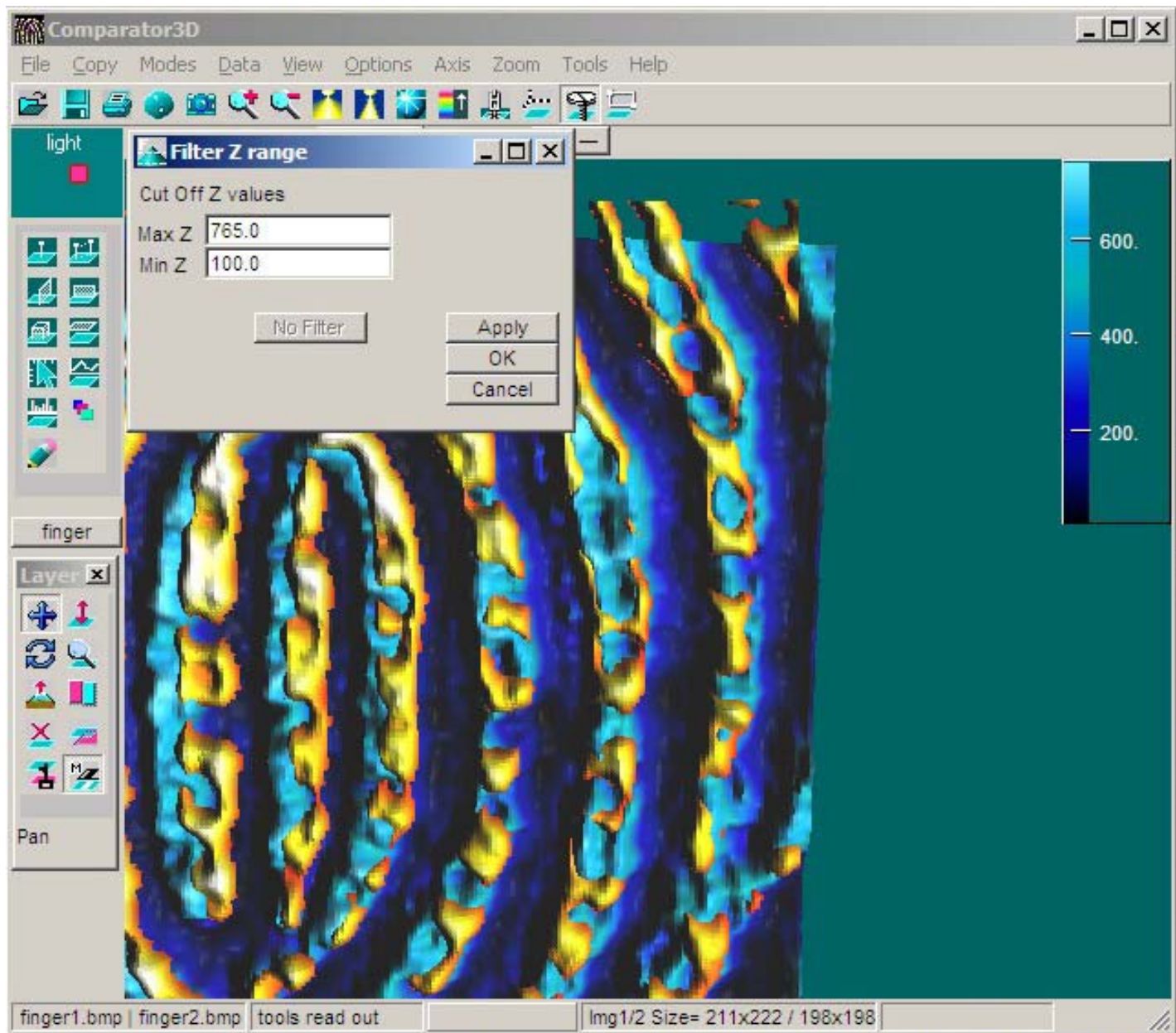
Screen shot: Main Form. Double Image 3D Mode. Different palettes selected from main toolbar. Mask is ON in test image.

Now you can move test image to compare features. Porous structure of the fingerprints can be compared as shown below. Use Pan, test layer image Zoom, and rotate.



Screen shot: Main Form. Double Image 3D Mode. Mask is ON in test image. Porous structure of matches is matching.

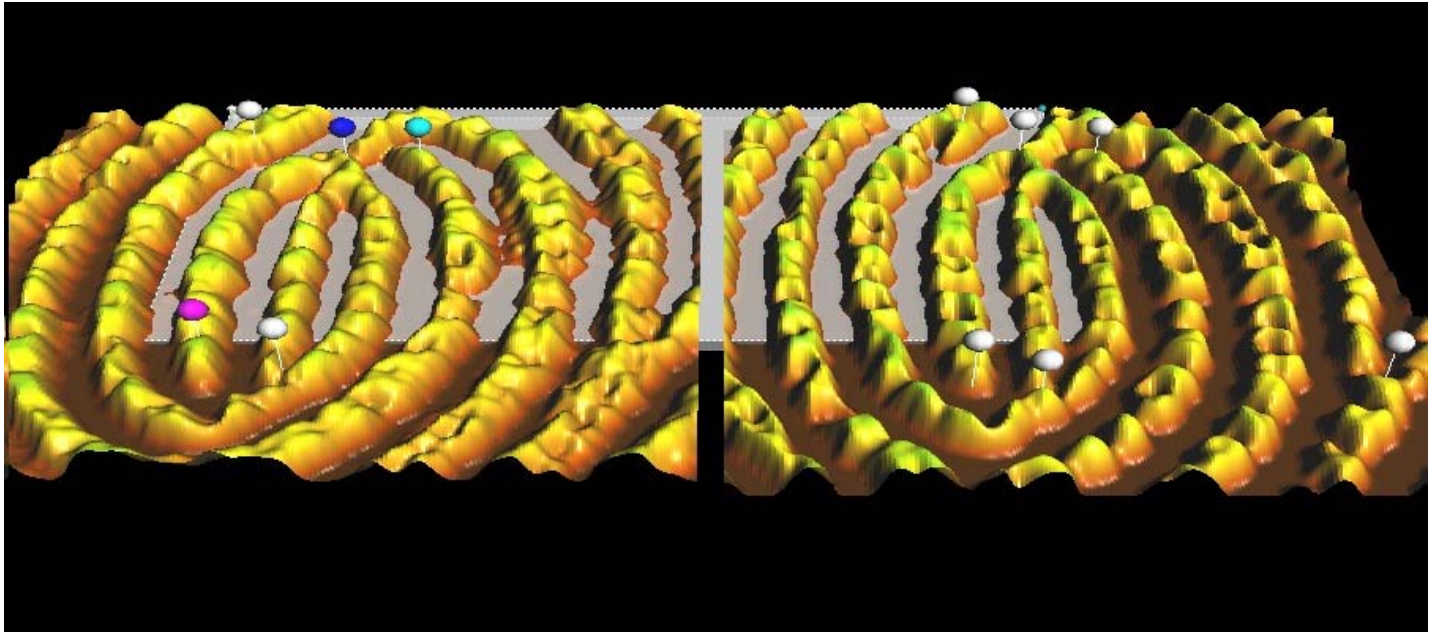
It is useful to cut low elevation portion of the image with Z filter tool.



Screen shot: Main Form. Double Image 3D Mode. Filter Z minimum set 100. Mask is ON in test image.

3. Multiple Pin Markers for Minutiae Marking.

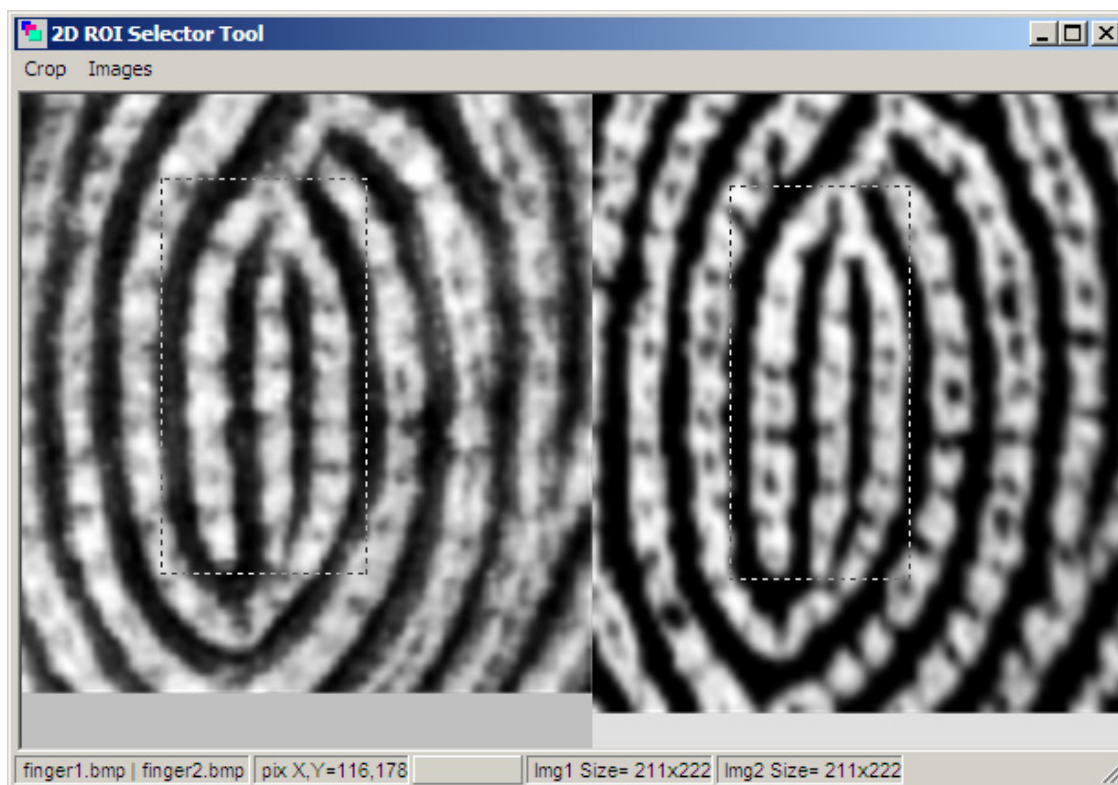
The markers are activated from left toolbar by button pins . The markers are moved within 3D by mouse operation.



Screen shot: Main Form. Double Image 3D Mode. Minutiae markers.

3. Working with ROI and interpolation for fine detail comparison.

In many cases you might find it useful to crop test image to Range of Interest. You can do it using ROI selector form called from left toolbar as shown below.



Screen shot: ROI selection Form. ROI selected for Test Image 2.

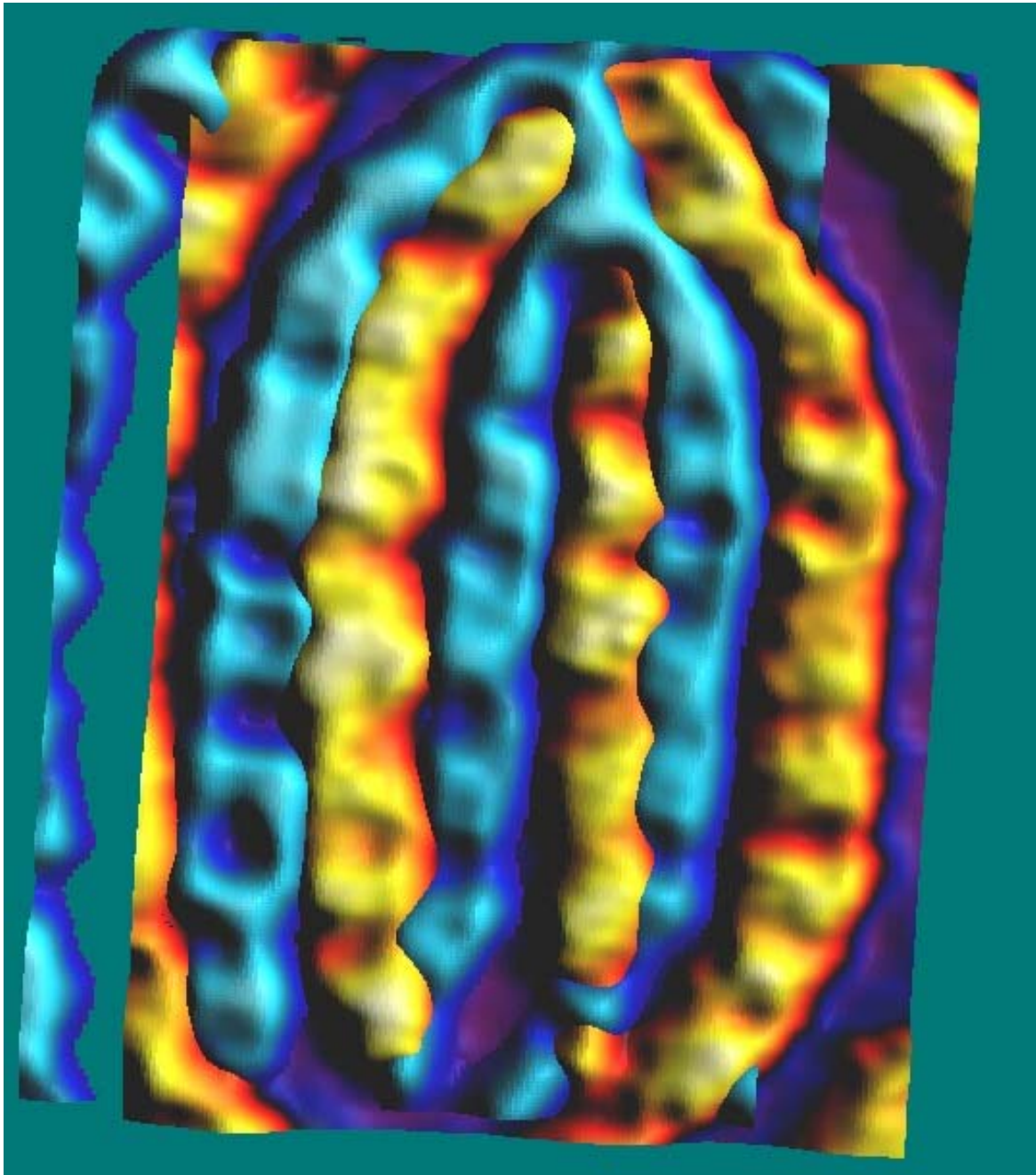
Select ROI in both images with mouse. Menu Crop>Crop both operation will cut portion of the test image as selected. Menu> Images> OK will pass ROI into main form.

When you need maximum quality in comparison you can use following enhancements:

1. Interpolate feature from main menu. This will effectively pass your image to better resolution in all XYZ directions.
2. Smooth 3D
3. Inclined illumination from Light Tool.



The result of all the enhancements is presented in figure below.



Screen shot: Main Form ROI selected. Test image is masked. Interpolation was performed. Light is adjusted.

Make the test image masked. Select different palettes. Use Layer toolbar to adjust images into some position that makes visible the features of interest in both images at the same time. In figure above the ROI usage is demonstrated for porous analysis of fingerprints.

For more information please contact www.sciencegl.com

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