Volume visualization

The Volume Visualization module is the file `volrend.dll`. If this DLL exists in the directory of EIKONA3D when the program starts, a sub-menu called *Volume Visualization* is added under the *Modules* menu. The menu options of this sub-menu provide several ways for 3D visualization derived directly from the volumetric data of a volume, including parallel projection (normal, average, maximum), sectioning and volume rendering.

For all the available options, the same procedure is followed; the user selects the input volume to visualize (optionally with modified VOI) through the *Select Volume to Visualize* dialog box and then he can control the visualization through the *Volume Visualization Control* dialog, which is common for all different visualizations that may be active simultaneously. For each active visualization, there is a separate display window.

The operations performed in the *Volume Visualization Control* dialog affect the display window that has the focus. This dialog contains a small display window that displays a preview of the visualization together with the axons *x*, *y*, *z* of the orthogonal co-ordinate system. The preview window works with a sub-sampled version of the input volume, thus achieving better interactivity. The user can interactively manipulate the preview window with the mouse to set the desired viewpoint, which is defined by two angles: (1) a rotation by *theta* degrees around *z* axis and (2) a rotation by *phi* degrees around *x* axis. The manipulation of the preview window is accomplished by clicking and dragging inside it with the mouse - left and right to change the *theta* angle, up and down to change the *phi* angle. Alternatively, the user can directly set these angles in the respective edit boxes of the dialog. Also, the user can change the threshold values that define the maximum value of the background points. For a gray-level volume the threshold defines that the useful information inside the volume is composed of the points with gray-level higher than it. For a color volume the thresholds define that the useful information inside the volume is composed of the points with at least one of the RGB values higher than the respective channel threshold.

The *Update* button of the *Volume Visualization Control* dialog can be used for updating the normal display window, which displays the visualization in real size, using the current settings. The displayed image in the normal display window can be saved in disk by selecting the *Save Image* menu option from its system menu.

The *Movie* button of the *Volume Visualization Control* dialog can be used for producing a series of frames (movie), each one representing a view of a volume calculated with successive increments of the *theta* angle (in order to complete a 360 degrees cycle) and the current *phi* angle. The more the frames that are produced, the smaller the difference between successive angles. The user is first prompted to specify the required number of frames through the *Number of Frames* dialog box and the volume where the movie is to be written in through the *Select Output Volume* dialog box. In the case of the *Section* menu option (see below), the movie is composed of frames with increasing depth percent.

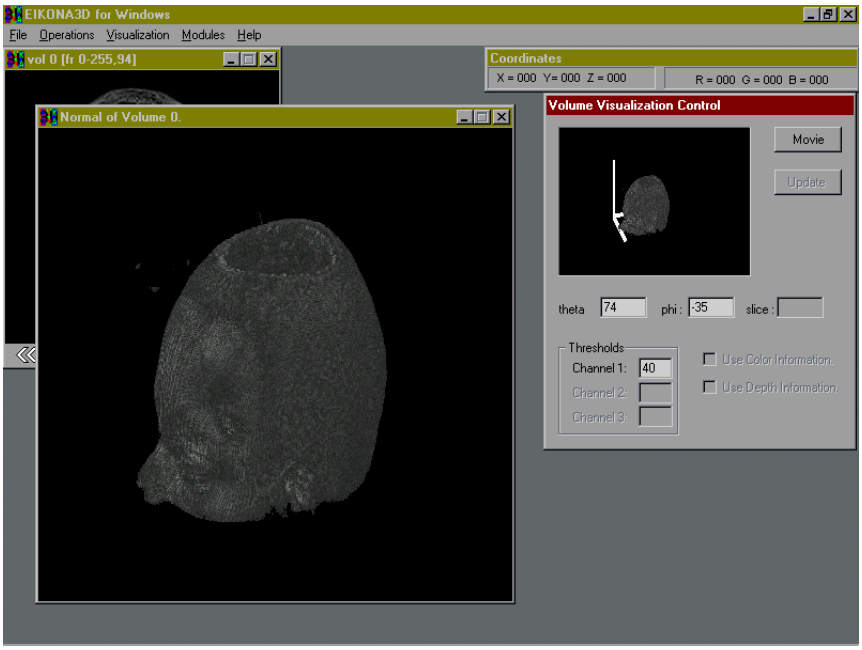

Figure 1: An example of normal projection of volume containing an image sequence of cross-sections of a human head.

The special characteristics of each of the available visualisation methods are described below [1].

Normal Projection: This menu option performs the parallel projection method. The projection is composed of the gray-level/RGB value of the first point each parallel ray hits. An example of normal projection of a volume is seen in Figure 1.

Average Projection: This menu option performs the parallel average projection method. The projection is computed by averaging the gray-1evels/RGB values of all the points that each parallel ray goes through. Here, the threshold values have no effect.

Maximum Projection: This menu option performs the parallel maximum projection method. The projection is composed of the maximum gray-level/RGB values of all the points each parallel ray goes through. Here, the threshold values have no effect.

Section: This menu option performs sectioning of the volume, which enables the exploration of the inner invisible structure. The result image is computed by cutting away a section of the volume with a plane defined by the selected *theta* and *phi* angles with respect to the volume (the cutting plane is always parallel to the screen) and the depth percent, which is chosen through the provided scroll-bar next to the preview window or the *slice* edit box. Here, the threshold values have no effect.

Volume Rendering: This menu option performs a three-dimensional volume rendering technique. The input volume can be binary, grayscale or color. Volume rendering differs from projection in the fact that it illustrates the 3D structure of the objects; it is not based on the intensity values but on the angle between the normal of the object surface and the viewing direction. An example can be seen in Figure 2.

There are two options that affect the rendering which are described below.

Use depth information: This is a toggle option in the *Volume Visualization Control* dialog. When it is enabled, the rendering considers the information of the depth of the rendered object surface. By this way, the surface points that are of more distance from the viewing plane appear darker. If this option is disabled (default), then the luminance of the rendered surface points is varied only with the angle of the surface normal with the viewing direction. An example is shown in Figure 3.

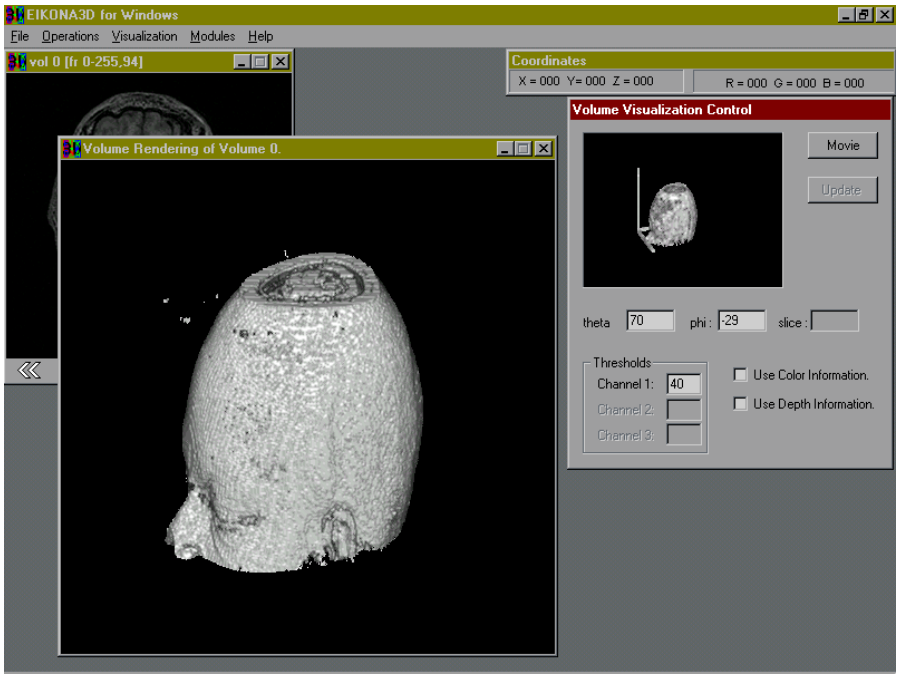

Figure 2: An example of interactive volume rendering of a volume containing an image sequence of cross-sections of a head.

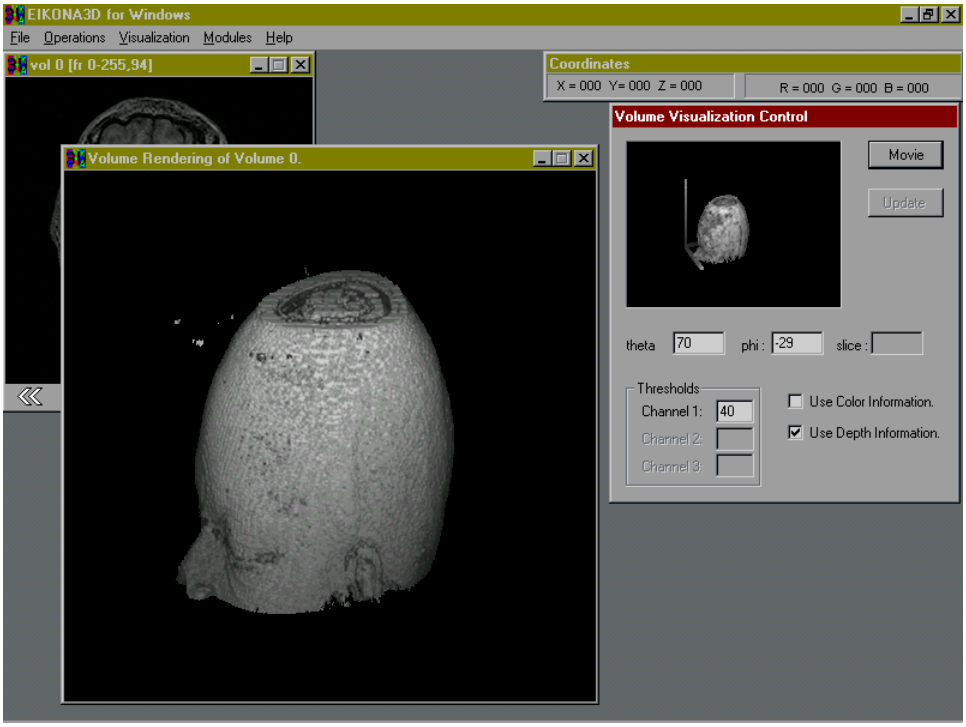

Figure 3: An example of interactive volume rendering of a volume containing an image sequence of cross-sections of a head. Here, depth information is used.

Use color information: This is a toggle option in the *Volume Visualization Control* dialog. When it is enabled, the rendering considers the information of the original

color of the rendered object surface. By this way, the rendering seems more like a projection. If this option is disabled (default), then the luminance of the rendered surface points is varied by scaling the whole range of color levels (256 different levels of the first channel – gray levels for binary or grayscale volumes and red component levels for color volumes). An example is shown in Figure 4.

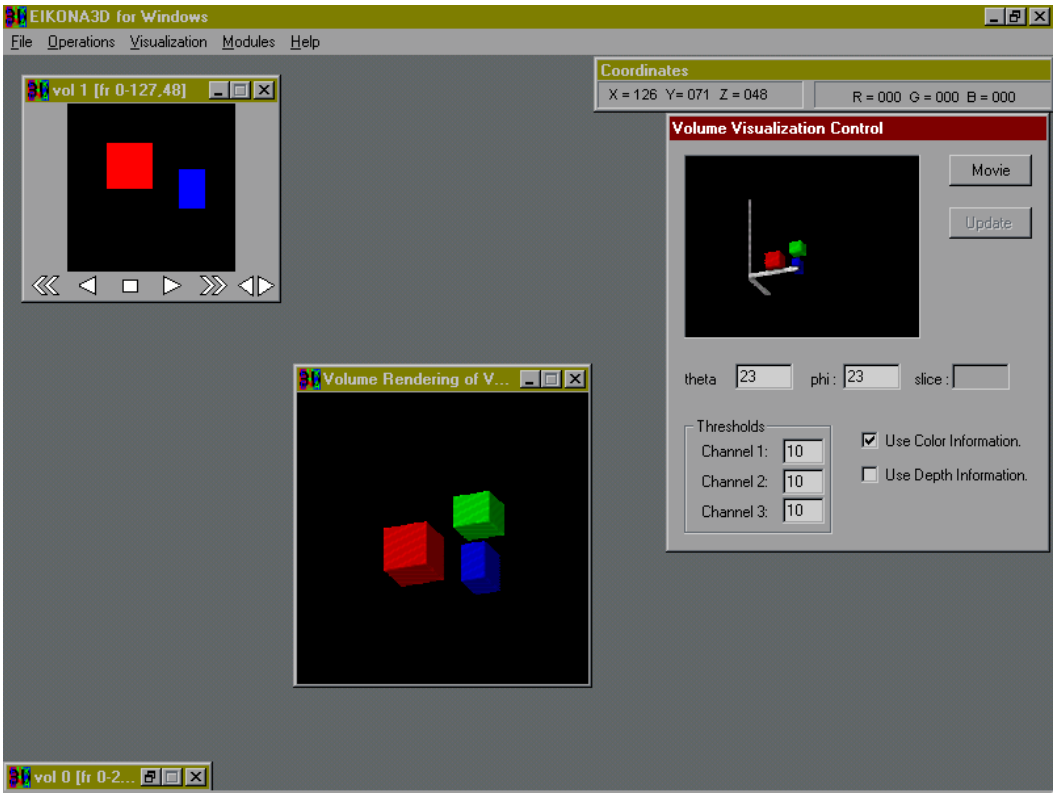

Figure 4: An example of interactive volume rendering of a volume containing three 3D objects (red green, blue). Here, color information is used.

References

[1] N.Nikolaidis, I.Pitas ‘3D image processing algorithms’, Wiley 2000.