

Powerful 3D–visualisation for demanding users

VirtualGIS is a 3D visualisation and GIS module that offers fast and beautiful viewing, smooth moving and 3D analysis for everyone and superb stereo viewing if you have the necessary hardware. Its many options offer powerful possibilities but can be confusing to new users.

Let's start with an important fact: VirtualGIS is not a stand-alone 3D GIS. It is an add-on module for the Erdas IMAGINE software. Erdas is well established world-wide as a powerful GIS package, mainly used for satellite image processing as it has its roots in specialised raster data handling. Over the past years, the system has grown to incorporate a much broader range of functionality's, of which VirtualGIS is the latest. Although the standard IMAGINE module already offered the possibility to view Digital Elevation Models (DEMs) in a basic perspective view, VirtualGIS opens up a wide range of 3D viewing possibilities that leave little to be desired, combined with some analysis tools.

Installation and documentation

Erdas IMAGINE, and thus VirtualGIS, is available for Windows as well as Unix platforms. We reviewed the Windows version, which comes on a CD and was installed without problems on the departmental WindowsNT server. We tested it on a 120 MHz Pentium II machine running Windows95 as well as on a 230 MHz Pentium II running Windows98. Only the latter was equipped with a hardware accelerator for OpenGL (the graphics language the 3D visualisation routines rely on for geometry and texture rendering) but the software ran quit happily, albeit somewhat slower, on the lighter machine.

After installation, a new icon is added to the IMAGINE toolbar, which offers access to the new VirtualGIS viewer window. This in turn holds a menu- and toolbar containing much of the VirtualGIS functionality (figure 1).



Figure 1: The VirtualGIS interface.

Besides a Installation Guide, the documentation consist of a "Tour Guide", which comes as a PDF file on the CD. This offers an overview of all the software's capabilities and there is also an extensive on-line help system. But when we started experimenting on other data than the provided sample sets, we soon found ourselves in need of something more structured and, generally, more helpful. The basic IMAGINE software comes with an excellent "Erdas Field Guide" and a similar document for VirtualGIS would certainly be very welcome. This is especially true because this is not a piece of software to take lightly: VirtualGIS is very powerful and inherently has a lot of options, parameters and settings, which for the first time user will be quite daunting. A minor annoyance is that the Unix look and feel (eg. the "Tour Guide" uses screen-views from the Unix application) can sometimes put the Windows users on the wrong foot. Some user interface defaults they've come to expect do not work yet, such as pressing Tab to select and cycle through input fields or pressing Return to confirm a dialog.

Viewing the world in beautiful 3D

As stated in the Tour Guide "VirtualGIS is a 3D visualization tool. It allows roaming of large databases with real time performance. Multiple layers of raster, annotation, and vector imagery can be viewed and queried within a virtual environment". And indeed VirtualGIS has much to offer as a 3D visualisation tool: Performance is smooth and responsive, even on our rather modest hardware and certainly compared to some other 3D visualisation software we use. Apparently, this smoothness is achieved through the clever use of *multi-resolution rendering*, by which objects farther away are rendered at a lower resolution than objects closer to the observer. Furthermore, VirtualGIS provides so-called fallback options that allow for faster display speeds when the observer is in motion. The result of this is that the overall appearance of the 3D views is excellent and the tools offered for customising and editing the view are impressive. One can influence the way the 3D world is displayed by changing a host of parameters. For example, one can set the elevation exaggeration, the background colour (just black or a realistically fading sky), the sun azimuth and angle by either typing them in, by clicking in a graphic or even by filling in the date and time to allow the software to determine the settings based on the geographic position of the viewer. The true GIS background of the

software is always clear: everything you do is georeferenced. Moving the cursor around the 3D image the coordinates and elevation are known and shown and the software takes care of projections and coordinate transformations quite well.

Normally the software displays your virtual world in *perspective view*. As this is of course actually shown on a two-dimensional computer screen it is therefore not really three dimensional, but something commonly called “pseudo-3D” or “2½ D”. VirtualGIS also offers possibilities to show 3D images in more realistic ways. The most readily useable of these is the *anaglyph* view. Anaglyph stereo requires no equipment other than a simple pair of coloured glasses. On the screen two images are shown from slightly shifted viewpoints in two different sets of colours. Because of the filters in the anaglyph glasses, each of the viewer’s eyes receives only one of the images and thus the image is interpreted as true 3D. Although VirtualGIS uses this technique reasonably well, anaglyph quality is always limited by the screen resolution. However, you can view the more advanced Stereo-in-a-Window or Full Screen Stereo modes if you have a graphics card capable of *frame-sequential* or *interlaced stereo*, as well as the required emitter and glasses. These hardware solutions are usually only found on specialised computers, such as digital photogrammetric workstations. With the prices of such hardware steadily falling, more people will have access to such equipment and for them VirtualGIS makes 3D models really become *virtual worlds*, worth visiting just for the fun of it.

Navigating the 3D world

In order to move through the 3D images, VirtualGIS offers several modes of navigation: *Position* mode, where you pivot the image around the current viewing position; *Target*, where you fix a target position in the terrain and then pivot the terrain around that; *Dashboard*, where two virtual joysticks are shown that you can use to fly through the world (see figure 2); *Terrain*, where the viewing position is placed on ground level and you navigate through the terrain as if you are in a vehicle; and finally *Selection*, where the viewing position is moved automatically to an object selected in the attribute table.

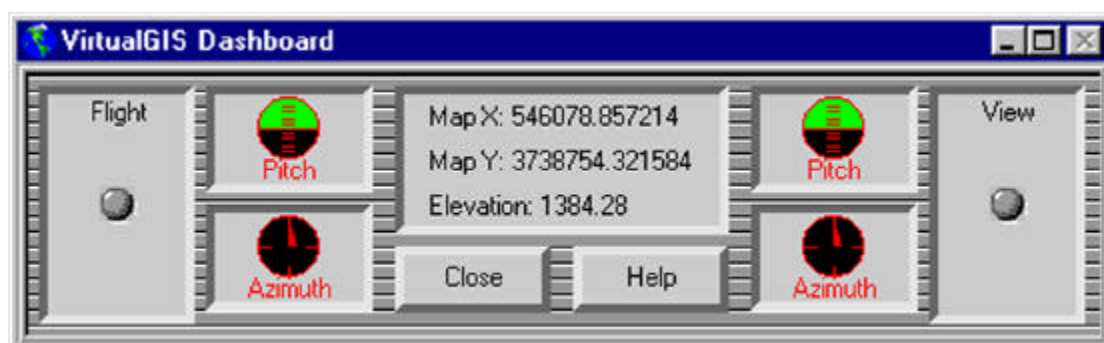


Figure 2: The dashboard navigation window.

Working with the navigation modes requires quite a lot of getting used to and for accurately navigating to a desired viewpoint it is necessary to switch often between the different modes. We found this one of the few parts where the software could use some work, to get a truly intuitive way of moving around.

A further option to navigate is the creation of a pre-determined flight path (either by digitising a polyline or by inputting the necessary coordinates) and subsequent “automatic flying” along this path by the system.

Data for the 3D world

All 3D worlds have to start with some 3D data. The basis for all VirtualGIS worlds and thus the first file to be opened is always a Digital Elevation Model (DEM). Apart from Erdas' proprietary file format many other GIS and CAD data can be used for this. Stacked on top of the DEM can be a multitude of other layers used for various purposes. Firstly, raster layers, such as satellite images, scanned photographs or maps can be draped over the terrain. This works very smoothly and a strong point is the possibility of linking the 3D world with standard IMAGINE views of the same raster files. This so-called Geo-link shows the observer's current position and viewing direction in the standard 2D view as well as the outlines of the area of the image being viewed in VirtualGIS. Secondly, vector layers can be used, either draped over the DEM or as elevated fences or blocks. This way, a file containing building shapes can be viewed in the 3D model as solid building blocks, where the building heights can be calculated from attribute data in the vector file. Similarly, existing 3D models such as DXF or VRML objects can be imported and placed somewhere in the virtual terrain. Raster images can also be displayed vertically, as *billboards*, containing for example the scanned photograph of an object of special interest. The same technique is used for annotations, so that placenames always face the viewer and can thus be easily read. All in all, the data import and display options are broad-ranging and well implemented.

VirtualGIS's way to manage and integrate these multiple data sets is the *Virtual World Editor*. This tool is used to prepare data sets for the multi-resolution display that is necessary to get the smooth 3D performance. Although in most cases the default settings used by the system when importing and integrating various data sets will suffice, you are able to set very precisely all kinds of parameters, providing you have the relevant know-how.

3D analysis

Besides visualising your data in 3D, VirtualGIS also allows for 3D analysis, by way of the so-called Intervisibility Layers and Viewshed Analysis. The former allows you to position several objects (called *observers*) in the three-dimensional view of the landscape and set various attributes of their field-of-view, such as the viewing angle, the range, the azimuth, etcetera. The fields-of-view are shown as domes, intersecting the terrain and each other, whose attributes can be queried and visualised. After this you can determine which of the observers can see any object or location in the landscape you select. Viewsheds are similar constructions in a 2D viewer window, which can be used to for instance to calculate the areas that can be reached from mobile phone transmitters. A possible output from this is a colour-coded map of the areas not visible from the observers, and data indicating how many meters higher the transmitter should be to reach those areas.

Output

The intended use of VirtualGIS is the query, analysis and real-time visualisation of three-dimensional data. For this purpose it uses the computer screen as its main output medium and as described before, it does that very efficiently. Furthermore, a series of 3D views, based on the *flight path* method mentioned earlier, can be saved to several digital movie formats. Unfortunately QuickTime, one of the widely accepted standard formats currently very popular on the Internet, is not among them. A third and important output possibility is export to VRML, the much used Virtual Reality Modelling Language.

Unfortunately, as a result of the focus on on–screen viewing, VirtualGIS (like almost all GIS software) does not offer the output possibilities required for professional quality printed output (eg. good resolution control, CMYK–colour management, spot colours and overprinting).

Barend Köbben (kobben@itc.nl), lecturer Electronic Visualisation, Division of Geomatics, Cartography and Visualisation, International Institute for Aerospace Survey and Earth Sciences (ITC), Enschede, The Netherlands.

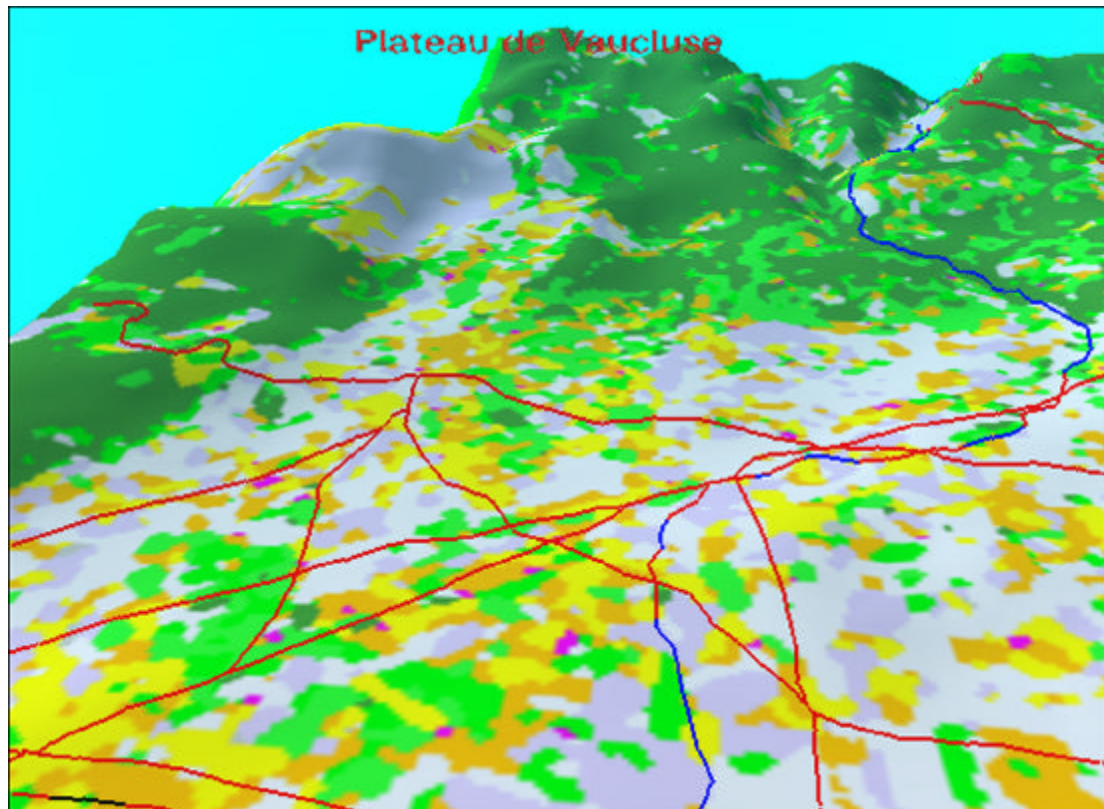


Figure 3: A landcover visualisation (a classified SPOT XS image combined with vector data for roads and rivers), draped over a Digital Elevation Model of the Luberon Valley, France