



IDL Tutorial

Contours and Surfaces

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The IDL Intelligent Tools (iTools)

The IDL Intelligent Tools (**iTools**) are a set of interactive utilities that combine data analysis and visualization with the ability to produce presentation quality graphics. The iTools allow users to continue to benefit from the control of a programming language, while enjoying the convenience of a point-and-click environment. There are 7 primary iTool utilities built into the IDL software package. Each of these seven tools is designed around a specific data or visualization type :

- Two and three dimensional plots (line, scatter, polar, and histogram style)
- Surface representations
- Contours
- Image displays
- Mapping
- Two dimensional vector flow fields
- Volume visualizations

The iTools system is built upon an **object-oriented** component framework architecture that is actually comprised of only a single tool, which adapts to handle the data that the user passes to it. The pre-built *iPlot*, *iSurface*, *iContour*, *iMap*, *iImage*, *iVector* and *iVolume* procedures are simply shortcut configurations that facilitate ad hoc data analysis and visualization. Each pre-built tool encapsulates the functionality (data operations, display manipulations, visualization types, etc.) required to handle its specific data type. However, users are not constrained to work with a single data or visualization type within any given tool. Instead, using the iTools system a user can combine multiple dataset visualization types into a single tool creating a hybrid that can provide complex, composite visualizations.

Contouring a 2-Dimensional Dataset

IDL has the ability to create **contour** plots of data stored in a rectangular 2-D array or a set of irregular unstructured points (X, Y, Z). One of the most appropriate datasets that can be visualized with contours is a digital elevation model, or "DEM", which is a gridded 2-D matrix of elevation values that define the topography for a region. In the following exercise, DEM data for the Grand Canyon in Arizona will be displayed within the *iContour* utility. This example data is stored in a file named "*Grand_Canyon_DEM.tif*" that is located in the "*data*" subfolder.

Although the file "*Grand_Canyon_DEM.tif*" is in TIFF image format, the pixels of this dataset contain actual elevation data values in units of meters. Use the following steps to load this dataset into the *iContour* utility :

1. IDL> *iContour*
2. Select "*File > Open...*" from the IDL *iContour* window.
3. Select the "*Grand_Canyon_DEM.tif*" file and hit "*Open*".
4. A contour graphical object with the default properties will be automatically inserted into the IDL *iContour* window.

5. It may help to maximize the iTool window in order to see the graphic, so select "*Window > Zoom on Resize*" from the menu system and maximize the *IDL iContour* window.
6. Select the contour plot object, right-click, and select "*Properties...*".
7. Within the *Visualization Browser* window, click on the box to the right of the "Levels color table" property and select "*Edit...*" [Fig. 1].
8. A separate dialog entitled *Palette Editor* will be displayed. In the "*Load Predefined...*" droplist, select the "*RAINBOW*" color table.
9. Press "*OK*" to dismiss the *Palette Editor* window.
10. At this point the *IDL iContour* window will be brought to the foreground. Relocate the *Visualization Browser* window, which may be behind the *IDL iContour* window. Change the "Number of levels" property to a value of "10", hit *Enter* on the keyboard to complete the change, and close the *Visualization Browser* window [Fig. 1].

The DEM data for the Grand Canyon should now be displayed with a sequence of color contours that resembles a topographic map. The elevation at which the contours are drawn are automatically computed by dividing the data value range (minimum to maximum) into 10 evenly sized levels. The exact elevation for any given contour, and all other relevant properties, can also be modified by the user if necessary.

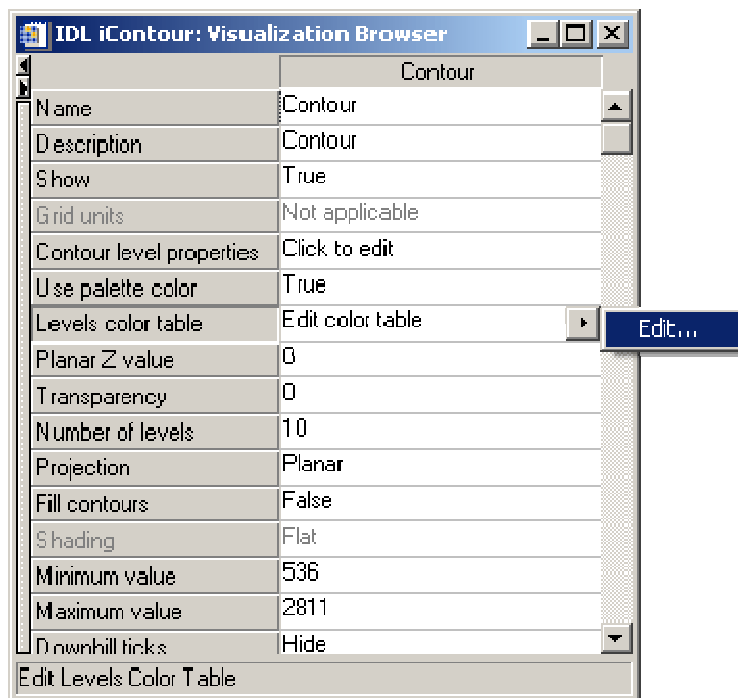


Figure 1: Modifying the properties of the contour plot

The iTools system also have built-in tools for inserting a colorbar and legend for a contour plot graphic :

11. Make sure the contour plot is selected.
12. Select "*Insert > Colorbar*". A colorbar showing the color table and range of elevations is automatically inserted below the graphics area.

13. Reselect the contour plot.
14. Select "Insert > New Legend". Re-position the legend that is inserted in the upper-right hand corner.

The final *IDL iContour* window should appear like Fig. 2.

15. Once finished viewing the contour plot visualization, close the *IDL iContour* window.

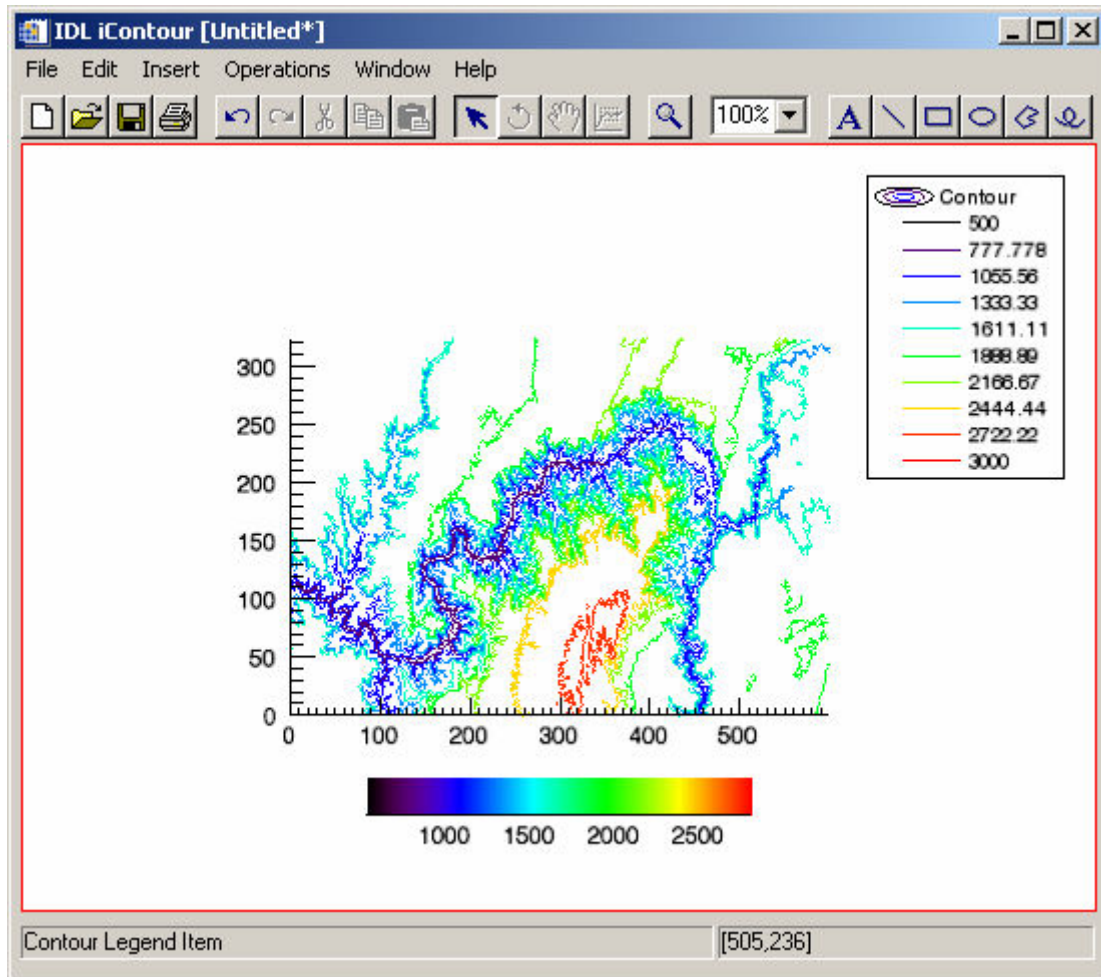


Figure 2: Contour plot visualization of DEM data for the Grand Canyon

Creating a Surface from a 2-Dimensional Dataset

A **surface** representation provides a way to visualize a gridded 2-Dimensional array of data values as a 3-Dimensional object. The height of the surface at any given X-Y location is defined by the data value (Z). In some cases, the 2-Dimensional data may be in the form of 3 unstructured (X, Y, Z) vectors instead of a gridded matrix. For example, elevation data is quite often measured and stored in irregular X-Y-Z format. In order to visualize this type of data as a surface graphical object, the data



must first be **gridded** using an interpolation algorithm that converts the scattered data values into a 2-Dimensional array. Fortunately, the iTools system has a built-in *Gridding Wizard* to help walk the user through the process of gridding irregular X-Y-Z data.

In the following exercise, the X-Y-Z data from the example data file "*elevation.txt*" will be input into the *iSurface* utility. This example data file is located in the "*data*" subfolder.

The file "*elevation.txt*" contains standard ASCII text consisting of 3 columns of data separated by commas. The first column contains the longitude position, the second column contains latitude, and the third stores the elevation data values. Here are the first 2 lines of this ASCII text file :

```
Longitude, Latitude, Elevation
-136.049, 59.3303, 3537
```

Use the following steps in order to load the data from the file "*elevation.txt*" into the *iSurface* utility :

1. IDL> *iSurface*
2. Select "*File > Open...*" from the menu system.
3. Select the "*elevation.txt*" file and hit "*Open*".
4. In Step 1 of 3 for the *ASCII Template wizard*, make sure to change the "Data Starts at Line:" field to "2".
5. In the remaining steps of the *ASCII Template wizard*, all settings can be left as their defaults. Simply hit "*Next >>*", followed by "*Finish*". There may be a short delay while IDL ingests the data from this ASCII text file.
6. In the *IDL iTools Create Visualization* dialog, select "*Launch the gridding wizard*" and press "*OK*".
7. The *IDL Gridding Wizard* window will appear. In Step 1 of 3, the wizard describes the data that was input and displays a preview of the resulting 2-Dimensional grid. Confirm that this dialog appears as it does in Fig. 3 and hit "*Next >>*".
8. In Step 2 of 3, change the "Dimension:" parameter for both the "X coordinates:" and "Y coordinates:" from the default setting of "25" to "500" [Fig. 4] and hit "*Next >>*".
9. In Step 3 of 3, change the "Please choose a gridding method:" droplist setting to "*Linear*" [Fig. 5] and hit "*Finish*".

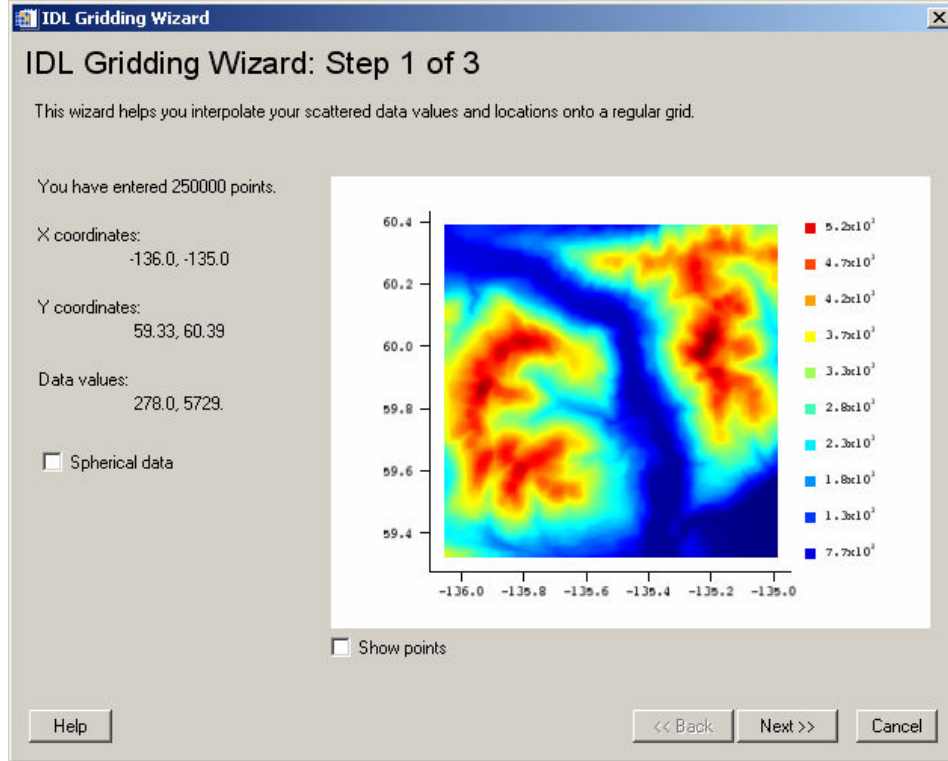


Figure 3: Step 1 of 3 for the IDL Gridding Wizard

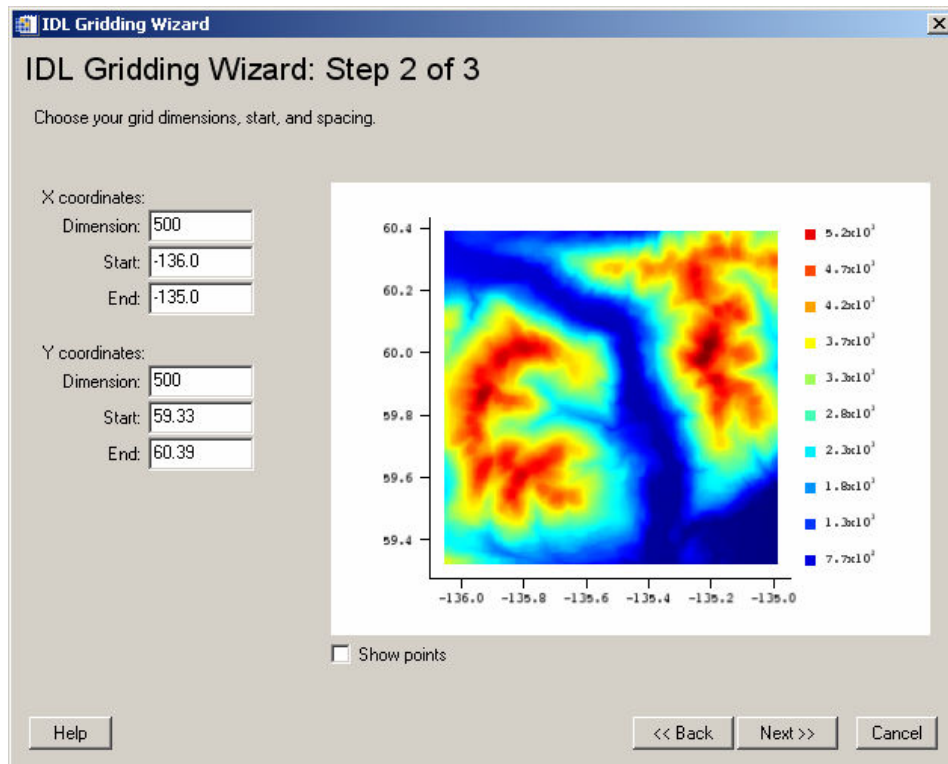


Figure 4: Step 2 of 3 for the IDL Gridding Wizard

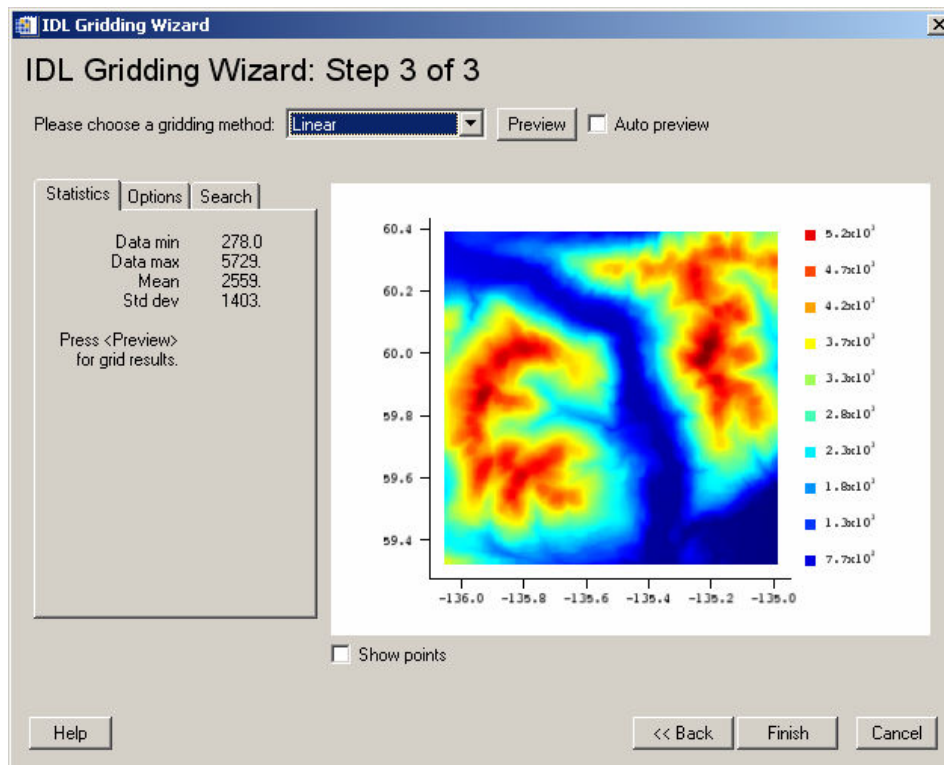


Figure 5: Step 3 of 3 for the IDL Gridding Wizard

After the *IDL Gridding Wizard* is completed, the selected gridding and interpolation algorithm is used to convert the unstructured X-Y-Z data into a 2-Dimensional grid. Once this processing is finished, a surface object for the elevation data will be displayed within the *IDL iSurface* window [Fig. 6]. At this point, it may be beneficial to maximize the *iSurface* utility :

10. From the *IDL iSurface* window menu system, select "Window > Zoom on Resize".
11. Maximize the *IDL iSurface* window.

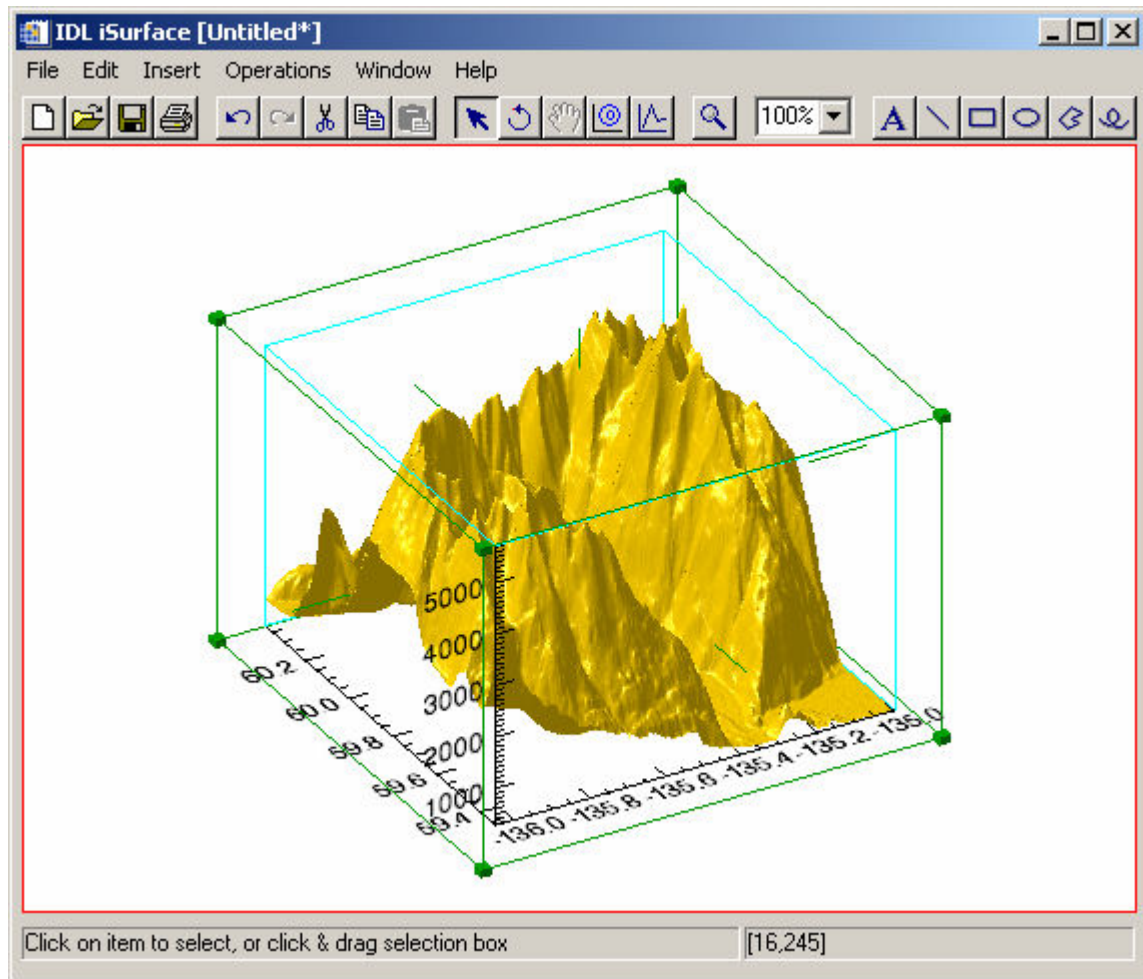


Figure 6: Surface visualization of the X-Y-Z format elevation data

Manipulating 3-Dimensional Graphical Objects

The object selection, translation, view zoom, undo/redo, and annotation tools all behave in the same exact manner as they do in 2-Dimensional graphics mode. However, when an iTool is displaying a 3-Dimensional graphical object, the scaling and rotate manipulators behave in a slightly different fashion.



There are 3 types of scaling available for 3-D objects :

- Constrained Scaling
 - Multiple-Axis Scaling (↕ mouse pointer)
 - Single-Axis Scaling (↔ mouse pointer)
- Unconstrained Scaling (✕ mouse pointer)

The **multiple-axis scaling** mouse pointer for 3-D objects is obtained when the mouse pointer is positioned over a corner of a 3-D object's data space. Dragging the constrained scaling pointer scales the object a fixed distance along all axes in the

direction of the drag. In contrast, the **single-axis scaling** is accessed when the mouse pointer is positioned over an axis “whisker”, which are small linear hash marks on the edges of the data space in the direction of the three orthogonal axes. Dragging along an axis whisker scales the object only in the direction of the axis (and the arrows of the mouse pointer). Finally, unconstrained scaling of 3-D objects can be performed when a single side of the data space bounding box is dragged, scaling the object along the dimensions of the selected side.


1. Experiment with the 3 different styles of scaling with the 3-D surface object within the *IDL iSurface* window.
2. Use the single-axis constrained scaling along the Z-dimension whisker to adjust the vertical exaggeration of the surface object. It may be appropriate to reduce the vertical exaggeration in order to make a more realistic visualization of the terrain.
3. If at any time an undesirable scaling operation is performed, remember that the Undo tool can be used to reverse the operation.

The rotation of 3-D objects in the iTools system can be done in a freehand (unconstrained) fashion or constrained along each of the three orthogonal axes. When a 3-D object is selected within rotation mode, a **rotation sphere** consisting of circular X, Y, and Z dimension axes is displayed around the object. To rotate an object in a constrained fashion, position the mouse cursor over one of the three axis circles in the rotation sphere until the cursor changes to a constrained rotation  pointer and drag in the desired direction. To rotate an object in a freehand fashion simply position the mouse pointer anywhere on the object until the cursor changes to an unconstrained rotation  pointer and drag in any arbitrary direction.

4. Experiment with both constrained and freehand rotation of the 3-D surface object.

Adding Contours and a Texture Map

One of the benefits of the object-oriented design of the iTools system is the ability to make composite visualizations that include more than one graphic. The data that is currently being used to define the surface graphical object is digital elevation data, and as the previous exercise demonstrated it is quite appropriate to visualize DEM data using a contour plot. Fortunately, the iTools has a built-in operation that allows the user to automatically add contours to the current visualization utility.

1. Using the Select/Translate  arrow, select the surface object within the *IDL iSurface* window.
2. While the surface object is highlighted, select “Operations > Contour” from the menu system. The *Contour* dialog will appear [Fig. 7].
3. Within the *Contour* dialog, change the “Number of levels” parameter to “20” [Fig. 7].
4. Click in the box to the right of “Projection” parameter and change its setting to “Three-D” [Fig. 7].
5. Once these changes have been made, press the “OK” button. This will insert the contour graphical object within the same *iSurface* utility as the existing surface object.

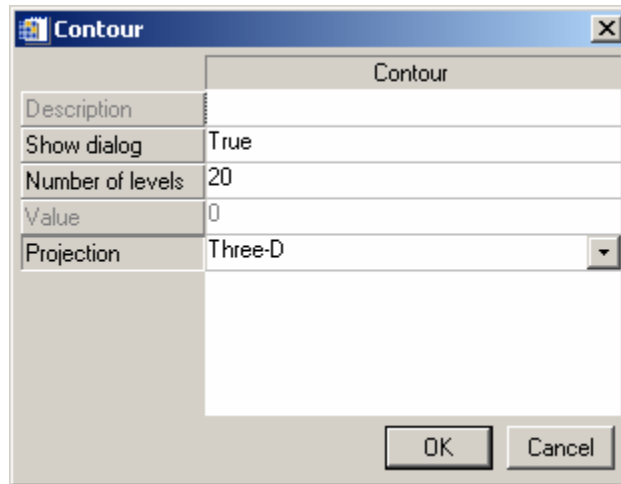


Figure 7: Options when inserting a contour visualization

In order to get a better view of these contours, it may be beneficial to change their color so it contrasts with the surface.

6. Select "*Window > Visualization Browser...*" from the menu system.
7. Make sure the Contour object is selected. Within the property sheet along the right-hand side, click on the box to the right of the "Contour level properties" item and select "*Edit...*".
8. A separate window entitled "*Contour Levels*" will appear. The first column of this dialog can be used to adjust the properties of all of the contours. Change the "Color" property for "All Levels" to bright blue and hit "OK" to dismiss this dialog.
9. Close the *Visualization Browser* window.

The resulting visualization should look similar to Fig. 8.

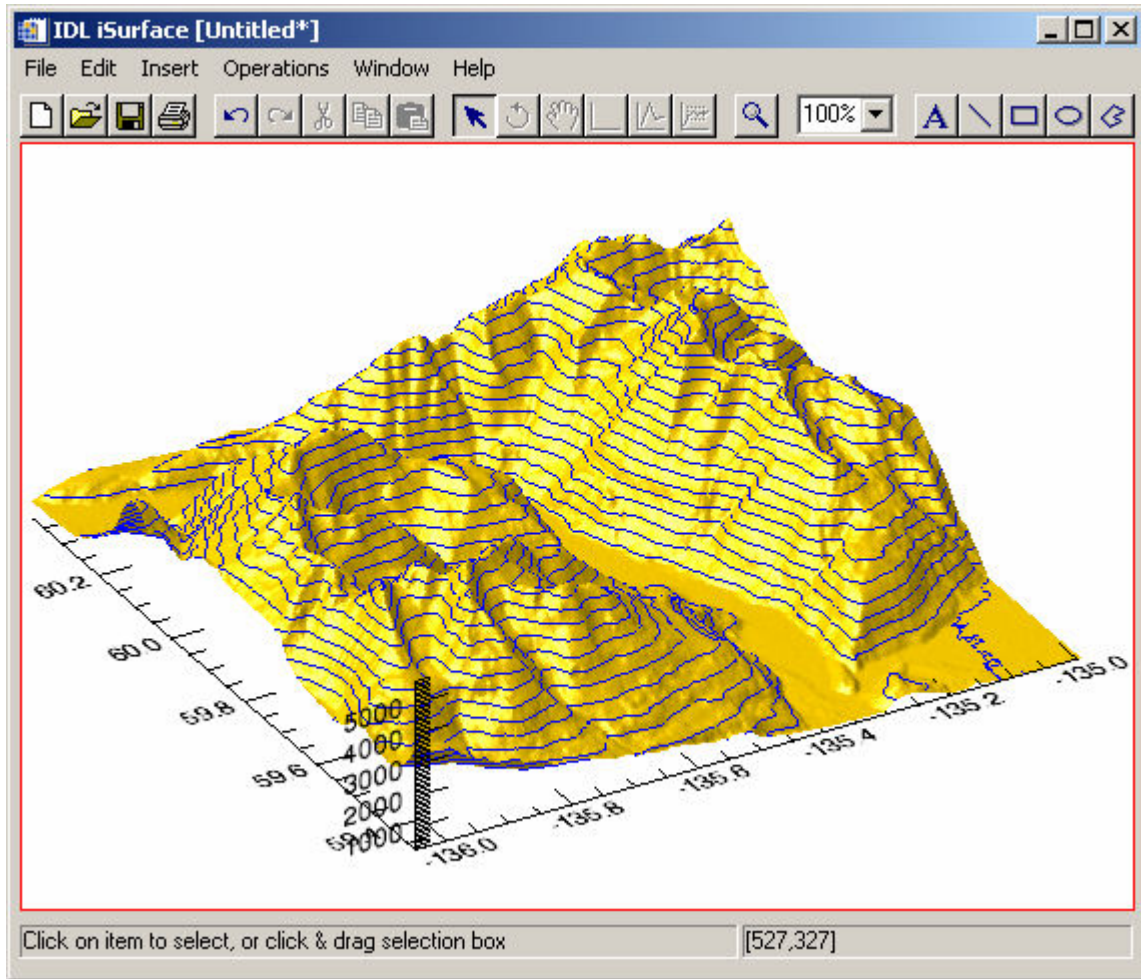


Figure 8: Surface with contours draped on top


In addition to the ability to drape contours on top of a surface, IDL also has the capability to drape images on top of 3-Dimensional graphical objects. This visualization technique involves the use of what's known as a **texture map**.

The example "data" subfolder for this tutorial contains a PNG image file of a satellite image that covers the same exact area as the elevation data. This image can be draped on top of the surface as a texture map using the following steps :

10. First, remove the contours so they will not hinder the display of the texture map image. This can be accomplished by opening the *Visualization Browser*, right-click on the Contour object, and select "Delete".
11. Close the *Visualization Browser* window.
12. Within the *IDL iSurface* window select the surface object, right-click, and select "Parameters...".

The *Parameter Editor* dialog will appear. In the lower-left hand corner the parameters that define the current surface object are listed. Currently, only the "Z", "X", and "Y" parameters has been defined using the elevation data. Notice that there is also a parameter called "TEXTURE", and it is this parameter that can be used to

specify a texture map image to drape on top of the surface. However, the "satellite.png" file must first be opened and input into the iTools system.

13. From the *Parameter Editor* window, press the "Import File..." button. This will launch the *File Import* dialog.
14. Within the *File Import* dialog, press the file selection  button, navigate to the appropriate location, select the file "satellite.png" and hit "Open".
15. Once this file is selected, the *File Import* wizard should recognize the format as being "Portable Network Graphics".
16. Hit "OK" to dismiss the *File Import* dialog.
17. Back within the *Parameter Editor*, expand the new "satellite.png" image item so the "Image Planes" contained within are visible. This image is in 24-bit RGB true color mode, so it has 3 image planes.
18. Select the "Texture" row located in the lower-left table, and then double-click the "Image Planes" from the Data Manager in the upper-left corner of the window in order to load this image as the surface's texture map [Fig. 9].
19. Once this is accomplished, press "Apply" followed by "Dismiss" to complete the changes.

The resulting visualization should look similar to Fig. 10.

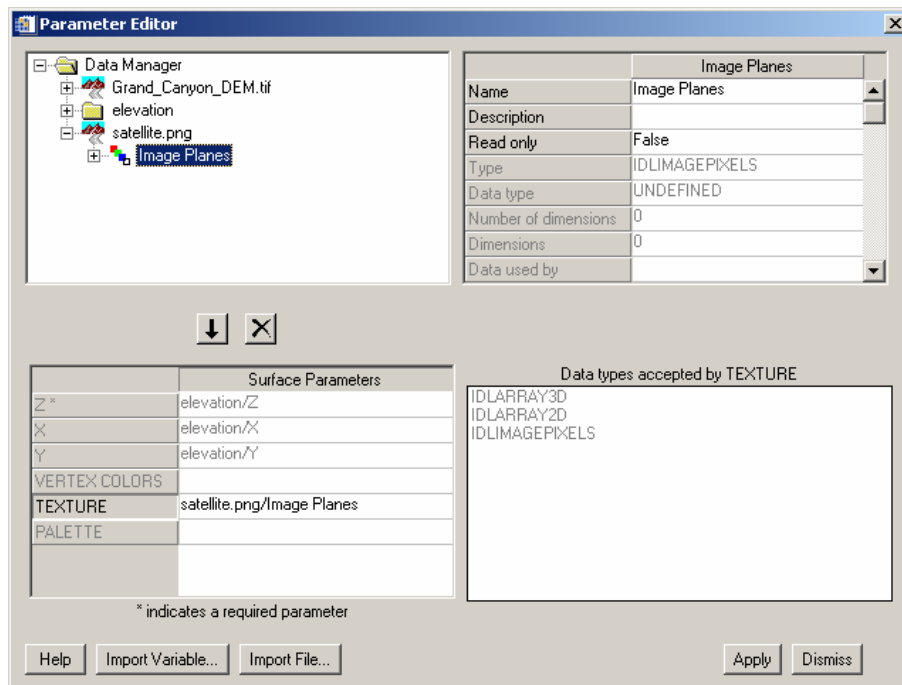


Figure 9: Using the satellite image to define a texture map

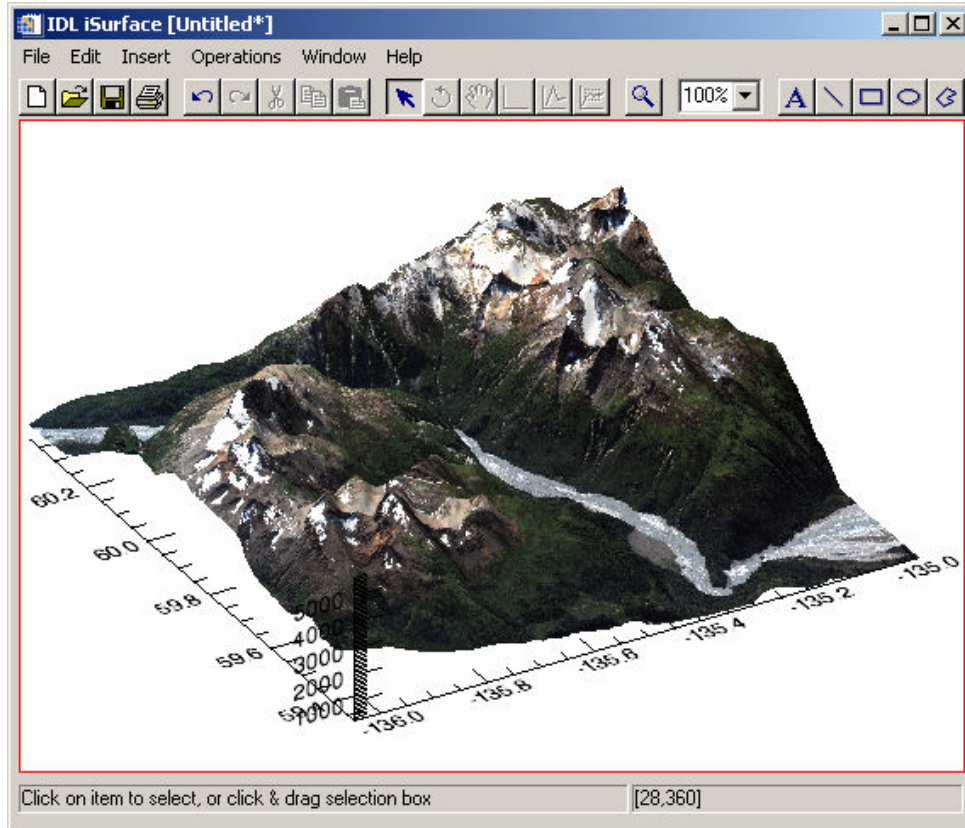


Figure 10: Surface with texture map draped on top

20. Once finished viewing the surface visualization, close the *IDL iSurface* utility.

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