Stanford Exploration Project, Report 110, September 18, 2001, pages 1–172

Short Note

Ricksep: Interactive display of multi-dimensional data

Robert G. Clapp[1]

INTRODUCTION

SEP has always been interested in displaying and interacting with multi-dimensional datasets (Claerbout, 1981; Sword, 1981; Ottolini, 1983; Ottolini and Rocca, 1986; Ottolini, 1988, 1990; Biondi and van Trier, 1993; Clapp and Biondi, 1994; Clapp, 1995; Mora et al., 1995, 1996; Clapp et al., 1994) In 1997 Rick Ottolini provided SEP with an extension of his old X11movie program written while at Unocal. In the last two years I have added several additional features to the code. These changes include:

picking Expansion of the picking ability including some degree of auto-picking.

annotating The ability to annotate figures and then output the same view using SEPlib programs.

velocity The ability to do velocity analysis.

multiple depth The ability to work on X environments that do not have support pseudo-color.

multiple views The ability to have multiple views of the same-dataset or two equivalent datasets.

This paper explains how to use each of these new features.

PICKING

The ability to pick points in a multi-dimensional cube was part of the original `Rickmovie` program. The original design was limited in the respect that picks could not be differentiated. Therefore picking multiple surfaces required either erasing each individual pick or restarting. To allow multiple objects to picked I added a marker component to the stored picking information. The marker is a single text character that can be changed by bringing up the picking

[1]**email:** bob@sep.stanford.edu

menu (hold down ‘c’ and press the right mouse button). The `TEXT` field of the picking menu is used to set the active marker. Once the `Change` button on the picking menu is hit each new pick will be displayed with the new marker. Figure 1 demonstrates the concept. One object is marked with ‘b’ the other with ‘a’. When the picks are written out, the mark character will also be written.

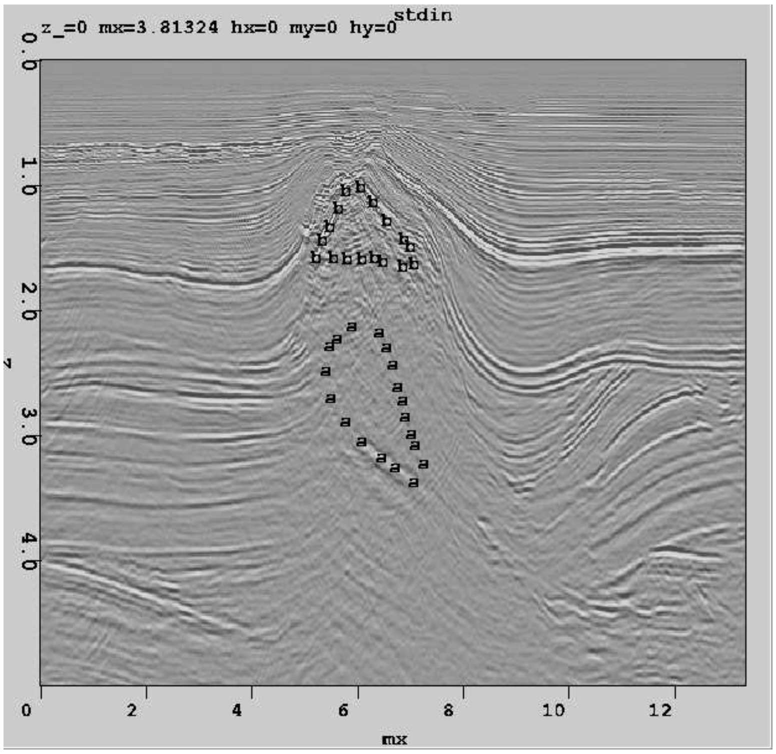

Figure 1: An example picking multiple surfaces. bob2-picking [NR]

Another limitation of the original design was the inability to do auto picking. I added a couple rudimentary auto-picking features. The first is the ability to ‘snap’ picks to similar locations (activated by holding down ‘b’ and the right mouse button). To figure out the ‘snapped’ location all the points within the currently viewed cube, with the active marker are sellected. A super trace is built by taking a region (arround a user-specified dependent axis) the selected point and summing. Cross correlation is then run to find the shift at each location that produces the highest correlation with the super-trace. A new super trace is then constructed from the new point locations. The process is repeated five times. The dependant axis and the search radius are both changeable through the picking menu.

In addition to the ability to snap points a simple auto picker is included. The auto-picker uses a basic region growing algorithm. It uses the simple dip and coherency calculation method of Claerbout (1992). Figure 2 demonstrates its use. In this case three points were seeded for the algorithm.

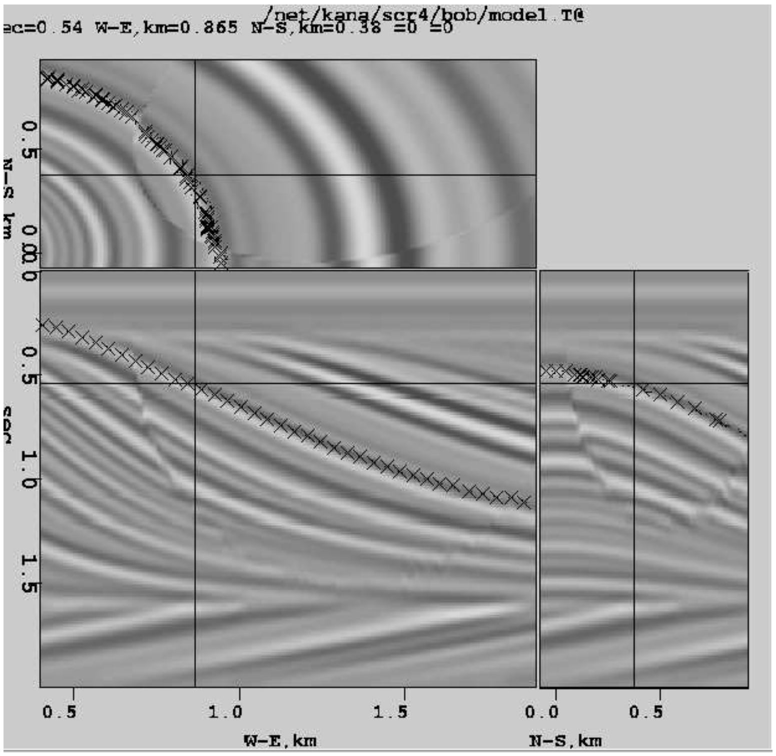

Figure 2: The auto-picker in Ricksep. The ‘x’ were seeded with 3 points. bob2-auto [NR]

ANNOTATION

Figure annotation is often necessary to direct a reader/viewer’s eye, especially in static media such as paper. SEP’s main graphics package, vplot (Cole and Dellinger, 1989; Dellinger, 1989), lacks all but rudimentary interactive ability. Rather than invest the time required to rewrite what is generally a bug-free, effective package, I decided to add some basic annotative ability to Ricksep. Figure 3 shows an example of the different types of objects that can be used for annotation. To do annotation the `Annotate` button must be selected from the menu. Many of the zoom and picking functions are then replaced with annotation functions. The table below shows the various options.

Keystroke/Mouse	Function
Left-button, drag	Draw an oval
Center-button,drag	Draw a rectangle
Center-button, click	Add text
a+Right click	Add point for polyline
f+Right click	Finish polyline object

Ricksep is designed to be an interactive viewer. It generally can’t compete with vplot for static displays. In order to take advantage of the abilities of both packages I added the ability to output the SEPlib commands to make an equivalent vplot figure. Figure 4 shows the result

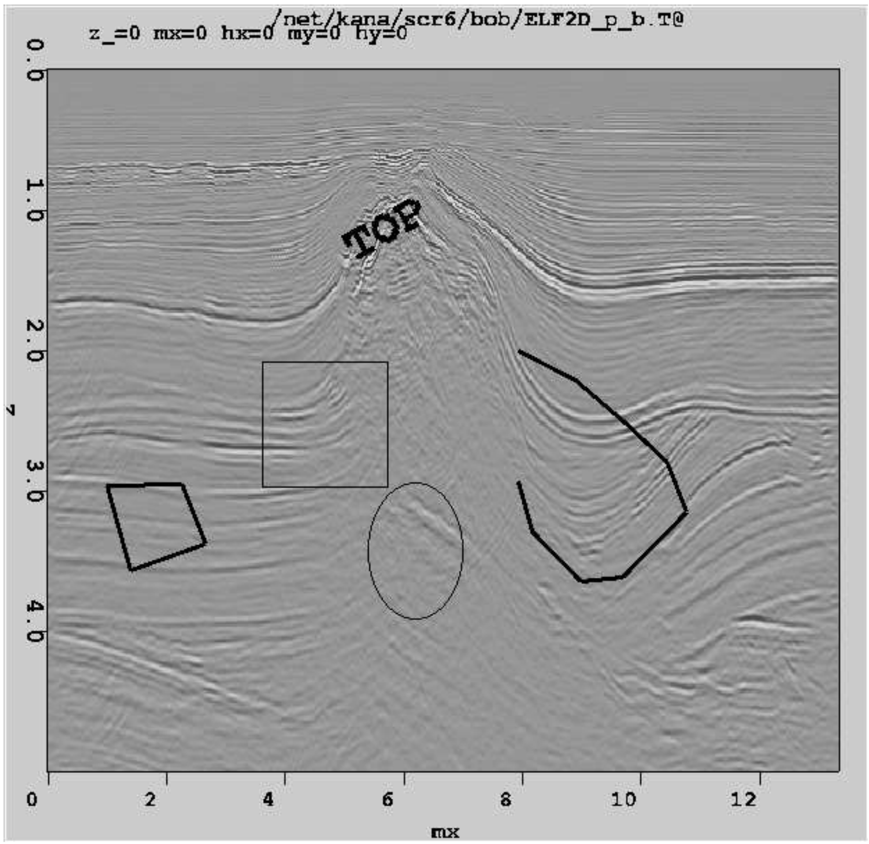

Figure 3: A view of Ricksep of a 2-D slice annotated with a box, text, an oval, and two polylines. $\boxed{\text{bob2-annotate}}$ [NR]

of running the commands outputed with the `section->display->output commands` menu option.

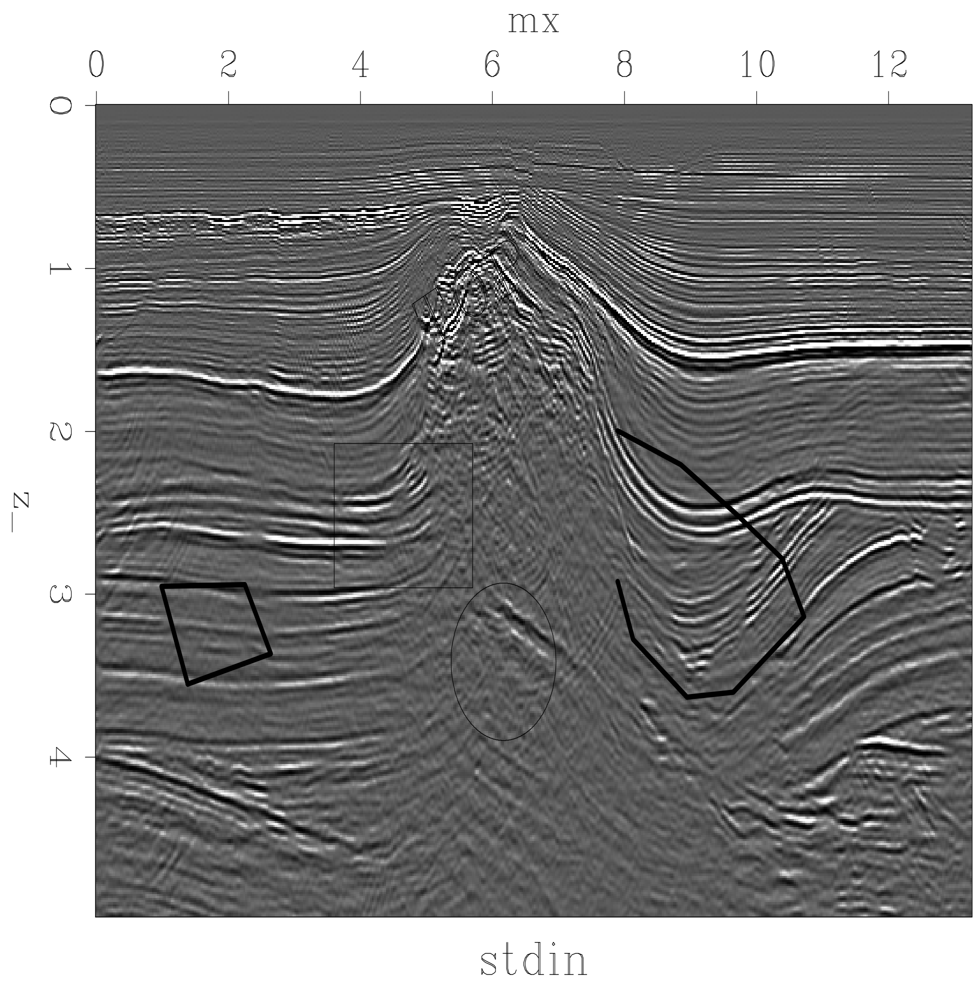

Figure 4: A 2-D slice annotated with a box, text, an oval, and two polylines, produced using the `output commands` option of Ricksep. bob2-ano-v [NR]

MULTIPLE VIEWS

The original Rickmovie was very effective in displaying 3-D cubes, but it wasn't good at handling four and five dimensional datasets. Viewing dimensions larger than three is generally a challenging problem. Rather than create a set viewing method I instead added the ability to have multiple, linked, views within one Ricksep session. Each view can contain the same or a different, equivalent sized dataset, and can correspond to any possible combination of up to five axes. As expected adding this level of flexibility quickly causes an explosion in the number of parameters to the program, and leads to what amounts to the development of a scripting language. To allow easy uses of these features I created three simple perl scripts for some of the most common display possibilities.

Displaying 4 and 5-D datasets

The first of these scripts shows one way of displaying four and five dimensional datasets. In this case the script 'Rick4d' is called. The resulting view, Figure 5 shows the first, third, and fourth axes in the left display and the first, and second axis in the right display. So in this case we are looking at CRP gathers in the right display at the location specified in the left display. For five dimensional data the right display becomes axes 1, 2, and 5.

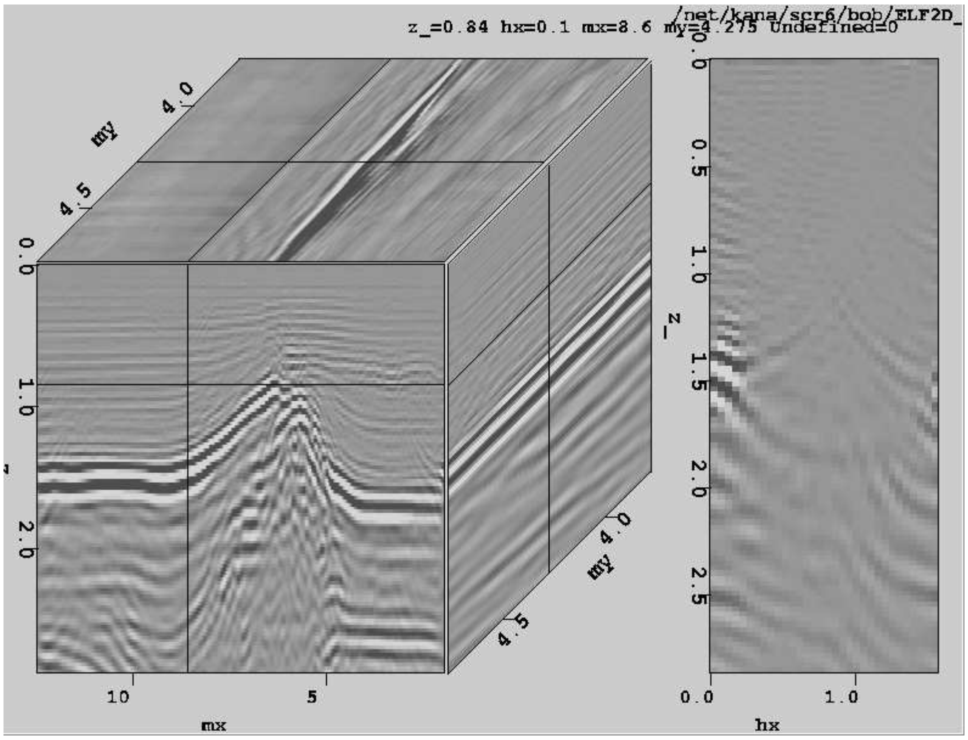

Figure 5: Viewing of a 4-D dataset in Ricksep. The left panel shows CMP locations, the right panel is a migrated CRP gather. The two panels are linked so that the CRP gather corresponds to to the midpoint specified by the cross-hairs in the left panel. bob2-multid [NR]

Comparing datasets

As long as the datasets are consistent the different views can contain different data. Figure 6 shows two different datasets using the `Rick_multi` script. The views are again linked, but each dataset has its own pickset, display format option, etc.

Velocity Analysis

The third variation is accessed through the `Rickvel` script. It displays CMP gathers in the left display, a semblance panel at the given CMP location, and the NMO corrected gather

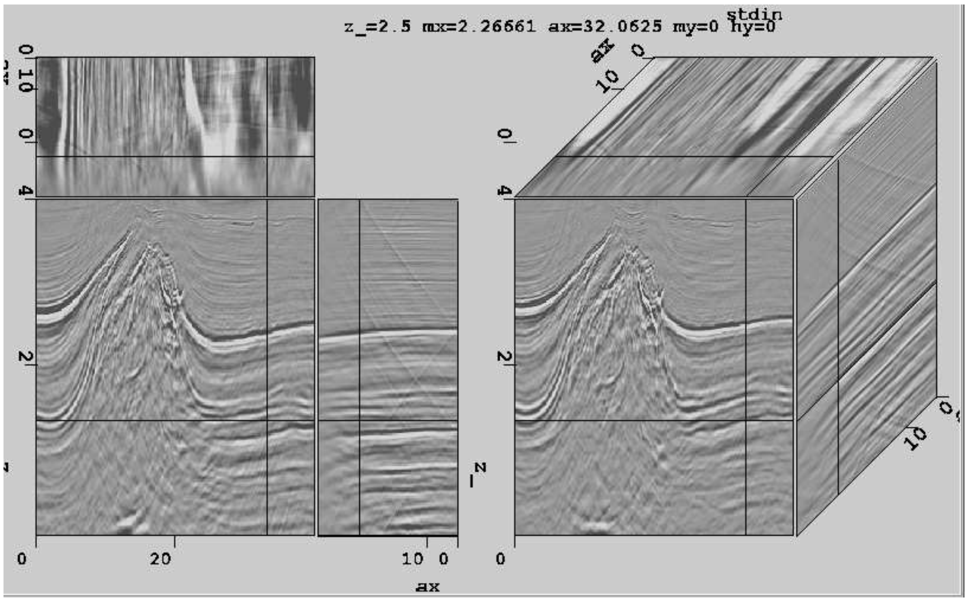

Figure 6: Comparing multiple datasets. The two panels are two different migration results. Moving locations in one gather causes the same position to come up in the second gather. bob2-multiple [NR]

(Figure 7). It lets you pick the velocity function on the semblance panel and automatically updates the NMO panel. When you quit Rickvel, it outputs the RMS velocity function.

MULTIPLE DEPTHS

`Rickmovie` relies on the pseudo-color X11 Visual. This visual is the default on most Unix systems. On most current Unix platforms several visuals are supported. Unfortunately, Linux is only beginning to support multiple visuals. As a result you have to make a choice when you configure your Linux workstation. You must decide if you want to be able to run pseudo-color applications, and continuously run out of your colormap, or to run 16,24, or 32-bit systems, which provide plenty of colors, but are unable to pseudo-color applications. Hopefully, in a year or two, Linux's multi-visual ability will be mature. For now I have added rudimentary support for 16, 24, and 32 bit depths. Because the overlay functionality (only available with pseudo-color) is fundamental to the operation of Ricksep, the hacks I introduced degrade performance.

CONCLUSIONS

Several new features have been added to the old `Rickmovie` program, the new Ricksep. Among these are expanded picking ability, annotation ability, multiple views, and support for multiple X11 visuals.

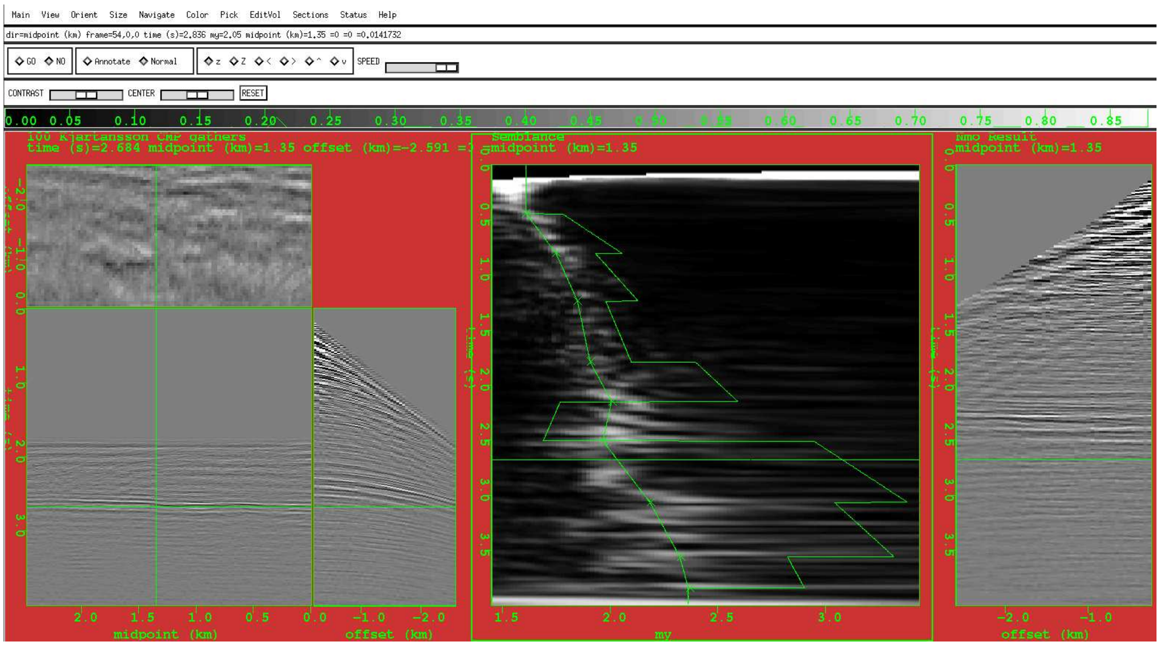

Figure 7: The Ricksep view when doing velocity analysis. The left panel is the input CMP sorted data. The center panel is the semblance, with the two curves representing RMS and interval velocity. The right panel shows the correct CMP gather. bob2-rickvel [NR]

REFERENCES

Biondi, B., and van Trier, J., 1993, Visualization of multi-dimensional seismic datasets with CM-AVS: SEP–**79**, 1–12.

Claerbout, J. F., 1981, On-line movies: SEP–**28**, 1–4.

Claerbout, J. F., 1992, Earth Soundings Analysis: Processing versus Inversion: Blackwell Scientific Publications.

Clapp, R. G., and Biondi, B., 1994, Iterative velocity model building for 3-D depth migration by integrating GOCAD and AVS: SEP–**80**, 635–644.

Clapp, R. G., Biondi, B., and Karrenbach, M., 1994, AVS as a 3-D seismic data visualizing platform: SEP–**82**, 97–106.

Clapp, R. G., 1995, SEP AVS User Guide: SEP–**84**, 395–408.

Cole, S., and Dellinger, J., 1989, Vplot: SEP's plot language: SEP–**60**, 349–390.

Dellinger, J., 1989, Why does SEP still use vplot: SEP–**61**, 327–336.

Mora, C. B., Clapp, R. G., and Biondi, B., 1995, Velocity model building in avs: SEP–**89**, 133–144.

Mora, C. B., Clapp, R. G., and Biondi, B., 1996, Visualization of irregularly sampled seismic data with AVS: SEP–**93**, 75–86.

Ottolini, R., and Rocca, F., 1986, Movies of data lag histograms with application to deconvolution research: SEP–**50**, 35–42.

Ottolini, R., 1983, Movie cubes: SEP–**35**, 235–240.

Ottolini, R., 1988, Movies on the Macintosh II: SEP–**59**, 255–268.

Ottolini, R., 1990, Seismic movies on the XView graphics system: SEP–**65**, 315.

Sword, C. H., 1981, SEP goes to the movies: SEP–**28**, 11–20.