Integrated Open-Source Geophysical Processing and Visualization

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SIA is an open-source software package which addresses the needs of both researchers and commercial users. The use of open-source software has become common place in many institutions, and companies both small and large. Beyond the immediate cost savings are the fundamental advantages that come with access to the source code. The software is both adaptable to new purposes and readily maintainable even if the authors cease to support it. Though a number of open-source geophysical packages exist they lack the scope and integration most users expect and as a result most processing is still done by commercial software.

SIA attempts to respond to this problem by offering a general open-source code framework to meet the needs of both academic and commercial researchers in a number of geophysical areas. Here we present an update on the processing system, interpretation components, collaboration model, and new real-time data acquisition features.

Integrating Processing and Interpretation via 3D Visualization

SIA contains over 200 tools and unlike other systems, this seismic monitor supports structured multi-component seismic data streams, multidimensional data traces, and employs a unique backpropagation processing logic. This results in an unusual flexibility in the types of processing, and the system is able to handle potential field and travel time data in addition to seismic.

Traditionally, geophysical software packages developed, for example, in the reflection seismic industry have been differentiated into “processing” and “interpretation” systems. Processing systems emphasize flow-based design, with numerous operations applied to the data in complex processing sequences, and only limited interactive functionality offered by the individual tools. Special emphasis is made on reproducibility of the results and batch (unattended) execution, often using multi-processor (up to several thousand nodes) computer networks. In the open-source community, several seismic processing systems were developed, such as the Seismic Un*x (Stockwell, 1999). However, these systems still offer only basic user interfaces (essentially, UNIX and Perl shells) and most importantly, are restrictive in their data formats (typically SEGY-like formatted UNIX pipes or files), limited scopes and integration of the tools.

By contrast, interpretation systems are visualization-centred and based on data viewers (for a 3D seismic open-source example see OpendTect, http://www2.opendtect.org/). In such a system, data organization follows spatial patterns, and system operation is mostly driven by data displays and user commands. Application of various “plug-in” tools is typically determined interactively by the user, and only a limited number of fast operations can be performed in real time.

In our visualization approach, we endeavour to erase the above differentiation between processing and interpretation workflows and perform them on a common software base and user interface. As described below, complex images and user interfaces can be defined by the user as parts of SIA data processing flows. These images can then be rendered either in publication-quality PostScript (based on the interfaced GMT programs; Wessel and Smith, 1995) or using the new interactive OpenGL-based display server described here. Because the content of the display is entirely determined by the underlying processing, the display server can implement any functionality, such as displaying seismic data and performing gravity modeling and seismic ray tracing in the same session. Through direct access to GMT databases, the server is also able to include 3D coastline base maps in its displays. In addition, full seismic and other data processing capability is also available to the interpreter through the underlying batch flow capability.

Flows are saved in a scripting language resembling that of the DISCO processing system (Morozov and Smithson, 1997). In this example new buttons are added to the display tool (Figure 1) and linked to functions within the disk reading tool (dskrd). This functionality is determined and implemented entirely by the user without the need for code development. The process is further simplified by the user interface which creates the flows by selecting items from toolboxes (Chubak and Morozov, 2006).

```
###### graphics settings and custom elements
*call   graphic
# buttons talking to tool “dskrd” below
button  button1            Next trace
dskrd.1             exec   next 1
button  button2            Restart input
dskrd.1
*call   dskrd   outfile
hold
```

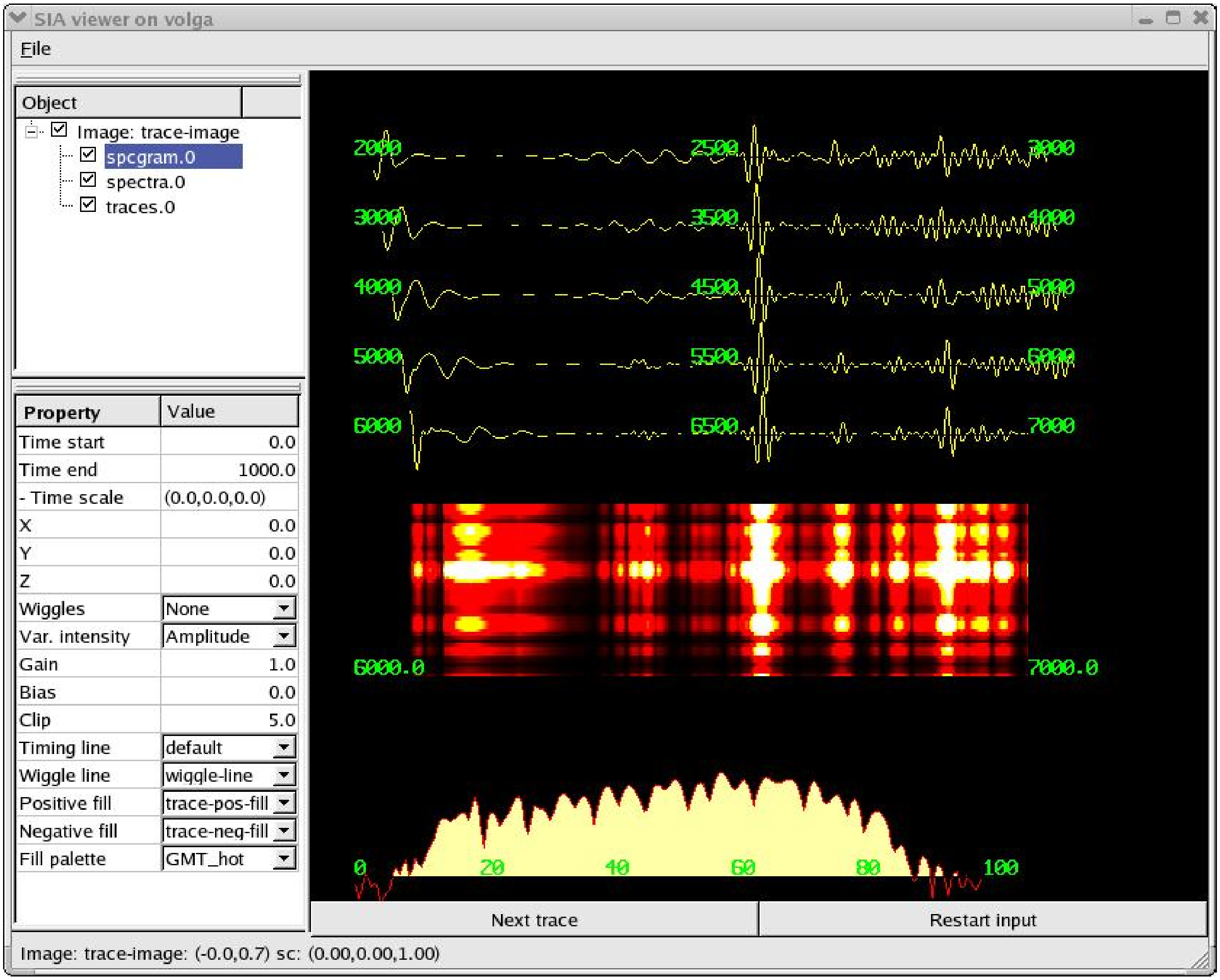

Figure 1. Trace display with a time variant spectrogram (middle) and amplitude spectrum (bottom). Buttons along the bottom edge are used to control the input.

Real-Time Data Acquisition

We have built a seismograph which relays data to the University of Saskatchewan over an internet connection. For the data collection to be most useful, it should be continuously analyzed including filtering and detecting seismic events. The data is made available in real-time to a SIA processing flow. An event detection module called "pickfb" has been written for SIA which uses the LTA/STA (Long Term Average / Short Term Average) method. LTA/STA is an effective method of event detection that uses minimal CPU and memory requirements so that a reasonable computer should be able to monitor many data streams and detect events in near real-time. "pickfb" will allow the computer to automatically determine if a seismic event such as an earthquake has occurred and respond immediately. The tool has been written with a number of parameters which allow it to perform noise suppression and false event rejection.

Conclusion

SIA is currently a full-featured seismic processing system which could be of interest to researchers in both academia and industry. Its strengths are in its unique processing concept, broad scope, modern interface, robust core, very general visualization system, and parallelization capabilities. Since new ideas in seismic processing constantly require new software, SIA is optimized to serve as a concurrent development framework allowing new processing tools to be rapidly developed while leveraging the existing code and graphical utilities to dramatically reduce the time and effort required. The display system seamlessly handles both 2D and 3D data while offering some unique features and allowing extensive customization by the user without the need for programming. Also, GIS (GMT) information can easily be incorporated into the display to aid in interpretation tasks. A new code update and distribution which is modelled after open-source solutions such as yum or apt-get, provides easy and automated access to software updates and allows developers to share their work without the need for installation or maintenance utilities. The system now also has the ability to monitor and retrieve data from remote sites while performing event detection and a client is provided to view the data stream.

References

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