Industry-grade seismic processing system for controlled- (and passive-) source academic research

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Open-source seismic processing provides flexibility, functionality and value that are not found in commercial packages. A seismic processing system called SIA (http://w3.uwyo.edu/~seismic/sia), initially developed at the University of Wyoming (Morozov and Smithson 1997) and continued at the University of Saskatchewan, represents one of the most extensive efforts to integrate academic-style seismic data analysis with polish and performance of a commercial seismic processor. At present, SIA offers capabilities for nearly complete reflection processing, combined with built-in support for multicomponent, variable-format seismic data, extensive database capabilities, I/O in several formats (e.g., SEG-2, PASSCAL-SEGY, GSE3.0, SAC), original inversion codes (e.g., 2-D and 3-D reflection and receiver function migration, genetic algorithms and artificial neural networks), maintenance utilities, and interfaces to popular packages such as Datascope, GMT, *rayinvr*, *reflectivity*, and Seismic UNIX. SIA is the only system (of which we are aware) allowing creation of processing sub-flows embedded in the main processing stream (e.g., to implement plotting of the Common Image Gathers during migration). However, like in other similar projects (ITA, SEP, Seismic UNIX, SIOSEIS), these advantages have historically come at the expense of an intuitive and consistent graphical user interface. Processing jobs had to be described using either UNIX shell or specialized scripts, which always resulted in a significant learning curve.

Recently, a modern graphical user interface (GUI) was designed for SIA (Fig. 1). It was based on the open-source, platform-independent QT technology that is used most extensively under Linux but is also available for nearly any other platform. The interface was designed to provide non-technical users access to the SIA processing capabilities, without the need to learn the scripting language. The interface generally resembles that of ProMAX, the industry-leading reflection seismic processing system by Landmark Graphics. SIA GUI, however, is not a script builder but rather an integrated software package which allows interaction with the tools while building the flow. Along with its GUI-based functionality, the system also retains its batch operation mode allowing execution of complex processing meta-tasks via UNIX shells.

The interface organizes project data while hiding the system structure from the user (Fig. 1). Multiple processing flows may be opened simultaneously allowing the user to edit and execute multiple jobs. Over 130 tools are arranged into packages (e.g., CMP, travel-time, earthquake data processing, or graphics). Context-sensitive help can be accessed through the interface, in addition to the full HTML documentation automatically generated by the system. Processing flows are constructed by simply dragging tools from the packages and dropping them at the appropriate place in the flow. The tool can then be configured by modifying its parameters. Both tools and parameters can be rearranged by the drag and drop process, making it easy to correct mistakes. Defaults and drop-down selections are provided and are customizable by the user. Context-dependent color highlighting is used to improve readability of the parameters. Multiple monitors can be used effectively by allowing parameters to be displayed in a separate window from the flow construction.

Processing jobs are submitted through the Parallel Virtual Machine (PVM) which allows multiple processes to be initiated and controlled from a single interface. Jobs may be submitted either for parameter checks or for full processing, and executed either locally or on a single or multiple remote systems in a heterogeneous computing environment. Management of both local and remote processes is handled through the interface which reports errors and allows user interaction with the processes. The GUI also includes provisions for cluster scheduling, allowing processes to be executed on entire Beowulf

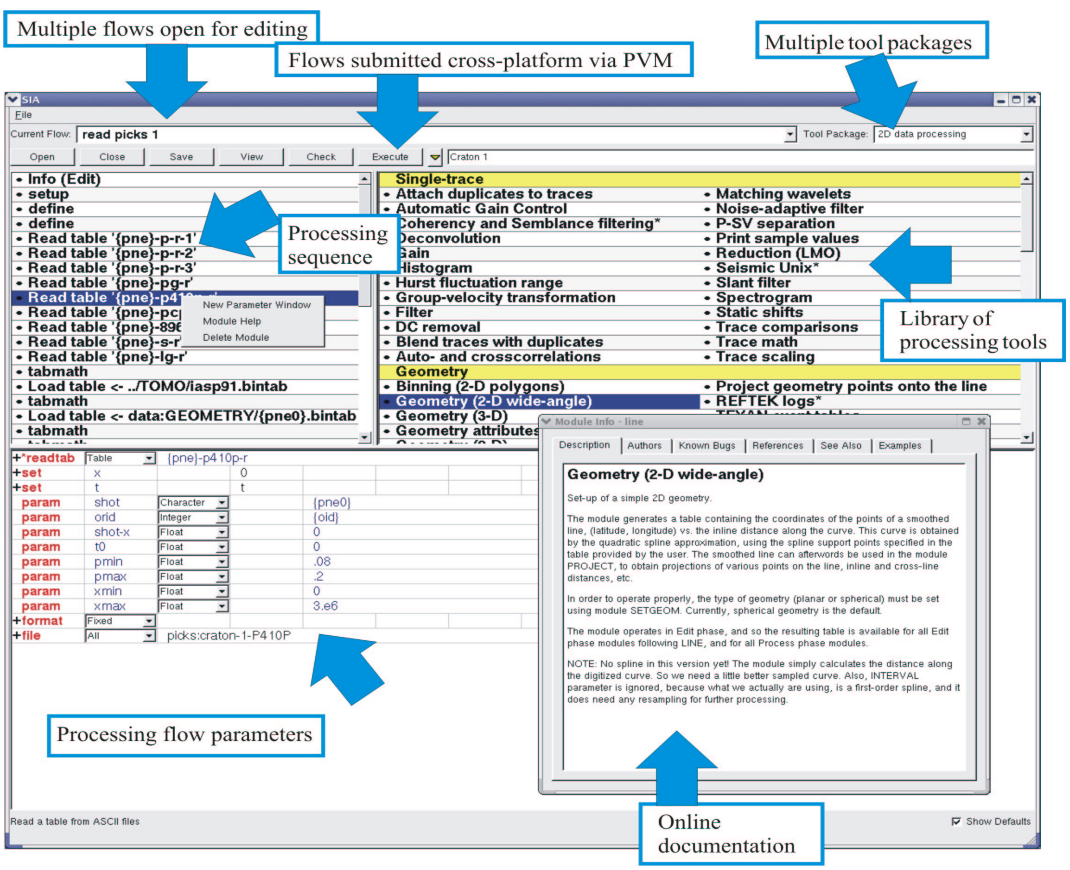

Figure 1. Main SIA GUI frame.

clusters or on subsets of their nodes. Depending on the design of the tools and cluster configuration, either PVM or MPI (Message Passing Interface) could be used to provide massively parallel processing capabilities.

Due to special efforts for package maintenance, code development for SIA is relatively easy. In our experience, a reasonably complex tool can be developed in 1-2 days. Addition of new tools does not require any modification to the monitoring program and can be done by the users. The tools are dynamically linked at run time from shared libraries, and thus there is no limit neither on the number of the tools nor on the types of operations they perform. SIA includes utilities for compilation and maintenance of the codes, resolving library dependencies, and for documentation support. Libraries of C and Fortran subroutines and C++ classes are provided to facilitate development. Finally, the configuration of the system allows maintaining multiple versions for different computer architectures[1] from a single set of source codes.

With the addition of the GUI and PVM capabilities and improved ease of operation surpassing that of ProMAX, the utility of SIA for the controlled-source community could broaden significantly. This package has been used successfully in several PASSCAL experiments, from initial pre-processing[2] to final migration and preparation of publication-quality illustrations. With its shared UNIX libraries and PVM installed on multiple machines, grid computing and seamless data exchange could become a reality without any effort from the users. In passive-source work, which is quickly adopting reflection processing techniques, this industry-style processing using PVM could provide sophisticated, inexpensive, and high performance approaches[3] to data retrieval and access to hundreds of signal enhancement tools developed in reflection seismics.

Reference

Morozov, I. B., and Smithson, S. B., 1997. A new system for multicomponent seismic processing, *Computers & Geosciences*, 23, 689-696.

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1 Thus, at the University of Wyoming, there are four such concurrent configurations.

2 For example, during the 2000 Rice University Hill AFB 3-D experiment, using SIA jobs instead of PASSCAL programs allowed I. Morozov to perform on-site, real-time quality control, geometry set-up, clock correction, gathering, and plotting of the data from ~600 shots offloaded ***daily*** from more than 600 RT-125 (“Texan”) data loggers.

3 Particularly compared to the currently preferred Java-based technology.