Integrated open-source geophysical code framework: I. Data processing, modelling and visualization

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Open-source software is rapidly gaining acceptance for use in both academic and industry geophysics due to its versatility, large body of code developed, and low cost. In the recent years, the open-source model has received another boost from spreading of Linux operating system. However, most open-source software systems are still limited in their scopes or lack the integration and quality of user interfaces attained by commercial software suites.

The SIA package (http://seisweb.usask.ca/SIA) has been developed as a major effort to provide an open-source code framework to meet the needs of both academic and commercial researchers in several areas of geophysics. SIA includes over 200 dynamically-linked plug-in tools which are closely integrated with a content-agnostic processing monitor and serve a wide range of processing tasks. The current system scope includes reflection, refraction, and to a certain degree earthquake seismology, 2- and 3-D potential field processing and inversion, and graphics. The package consists of three main components operating in parallel and communicating via an object protocol based on the Parallel Virtual Machine (PVM): 1) the user interface, 2) multiple and optionally distributed processing flows, and 3) 3D/2D interactive visualization server.

The graphical interface (Figure 1) is key to making the various features of SIA accessible to users. The interface is an integrated component of SIA and (in principle) allows interaction with running flows. To achieve good performance, portability and modern design it is written in C++ using the Qt libraries from Trolltech. All of the major functions of SIA are available from the GUI, including project management, flow construction, cluster configuration, and software updates. Projects are arranged with the typical Line-Processing flow hierarchy found in commercial seismic processing packages. Flows are constructed by arranging the available tools in a sequence and configuring their parameters.

When a flow is executed, one or several PVM process are spawned and displayed in the monitor window where they can be controlled by the user. The processes can run on a single system and in parallel on peer systems or on a dedicated Beowulf cluster. Each process communicates with the interface through the PVM connection to transfer data, report results or errors, or request input from the user. In addition, various programs, such as the Seismic Un*x, Generic Mapping Tools, or PostScript viewers on multiple compute hosts can be invoked by the jobs.

Recent efforts have focused on integration of seismic interpretation tools through introduction of parallel 2D/3D visualization based on OpenGL. Flows may present their data on any system available through PVM, and multiple displays can operate concurrently on several compute hosts. In this model, processing may occur on a

dedicated cluster but the visualization process can be created on a system with specialized capabilities, such as a stereoscopic GeoWall display. The visualization tool is entirely configurable in the processing flow and allows the end users to create custom applications without any programming. For example, multiple images and buttons could be added to the viewer to create an interactive 2D travel-time picking, ray tracing, and gravity modeling application.

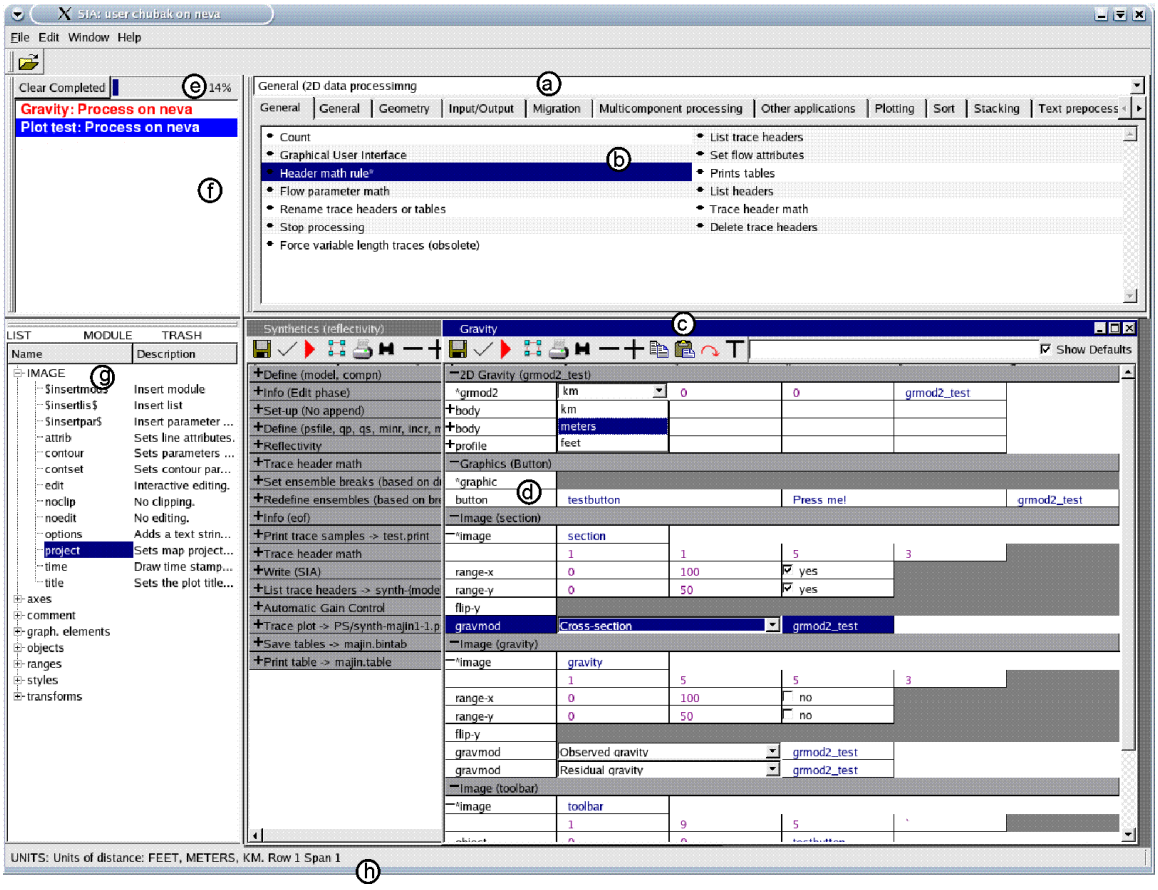

Figure 1. SIA Graphical Interface window including: a) selectable tool packages, b) tool library, c) multiple-job flow editor; d) parameterization of the selected tool; e) job progress bar, f) PVM job monitor, g) tool parameter lists, and h) status bar.