The Scientist's Expert Assistant Demonstration

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Abstract

One of the manually intensive efforts of Hubble Space Telescope (HST) observing is the specification and validation of the detailed proposals for scientists observing with the telescope. In order to meet the operational cost objectives for the Next Generation Space Telescope (NGST), this process needs to be dramatically less time consuming and less costly. The Scientist's Expert Assistant (SEA) is a prototype effort that uses a combination of artificial intelligence and user interface techniques to determine if we can reduce the time and effort involved for both scientists and the telescope operations staff. The Advanced Architectures and Automation Branch of NASA's Goddard Space Flight Center has been working with the Space Telescope Science Institute (STScI) to explore SEA alternatives. We are testing the usefulness of rule-based expert systems to painlessly guide a scientist to his or her desired observation specification. We are also examining several potential user interface paradigms and exploring data visualization schemes to see which techniques are more intuitive. Our ADASS demonstration will include the latest version of the SEA software. This will include prototypes of early pre-release concepts in the hope of generating feedback on the usefulness of these concepts.

Background

The Scientist's Expert Assistant (SEA) is currently completing its final phase of prototype development. During the course of this project we have developed both a central proposal browser and several visual components that allow users to develop their observing programs in a more visual and intuitive manner. We have focus**ed** on visual components that can either be executed within an integrated environment or run independently, with no change in set up or installation. In addition to exploring new visual tools, we have also been exploring the effectiveness of applying expert systems technology to guide users.

At ADASS '98 we demonstrated an earlier release of SEA. At the time, SEA supported single observations, but did not yet have support for multiple exposures or visits. SEA had the basics of a graphical exposure calculator and a visual target tuner. We had a very

limited expert system, providing basic support for choosing detectors and filters. Even then, we had found significant user enthusiasm for visual approaches.
Over the last year, we have added features to the target tuner and exposure calculator, improved the overall proposal browser, added two new tools: an orbit planner and a visit planner, a context-sensitive help system, and more complex expert systems applications. Our purpose in demonstrating SEA at ADASS '99 was to present these new features, gather additional feedback on their potential value, and to further explore collborative possibilities.

New features in the SEA

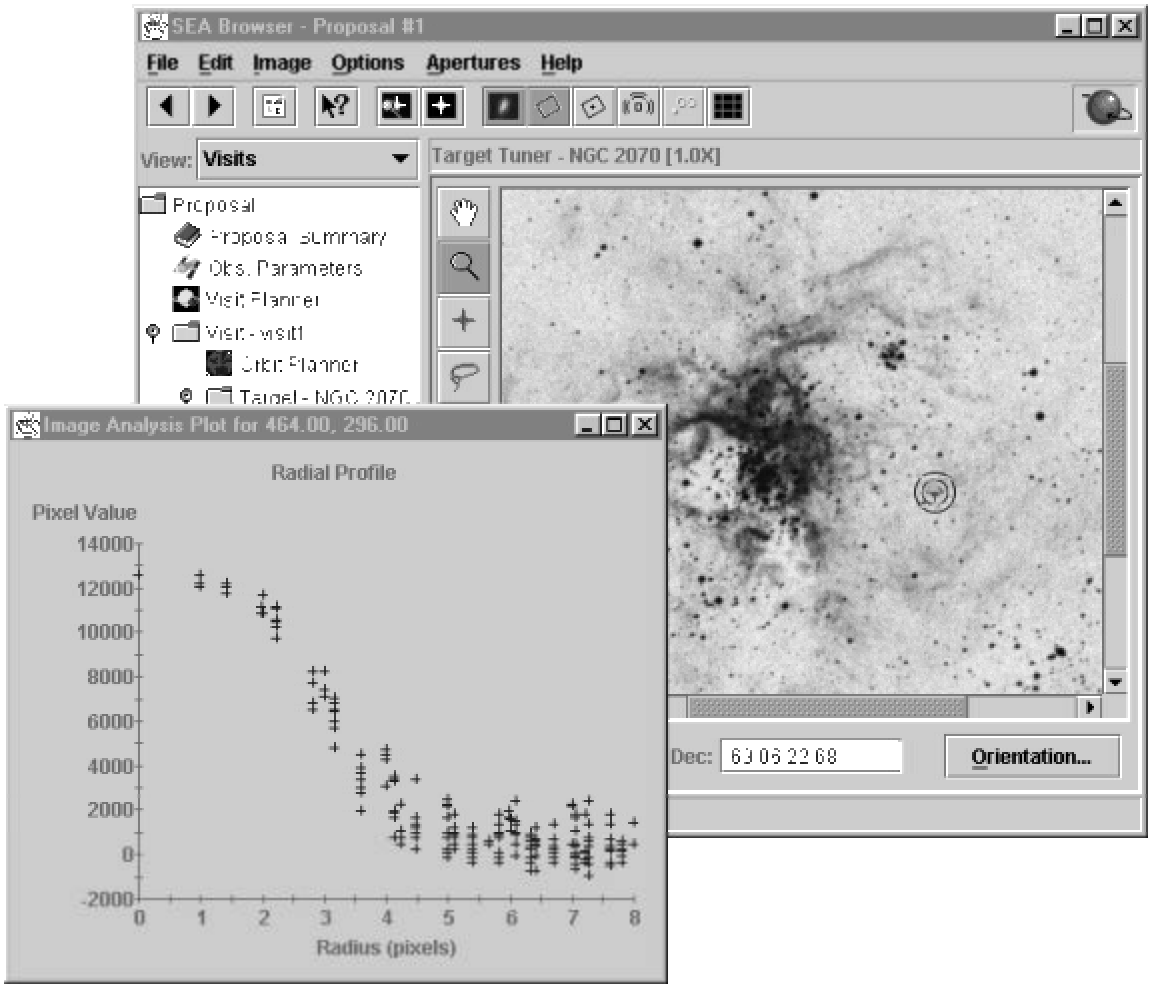
Several of these features are shown in the sample images at the end of this article.

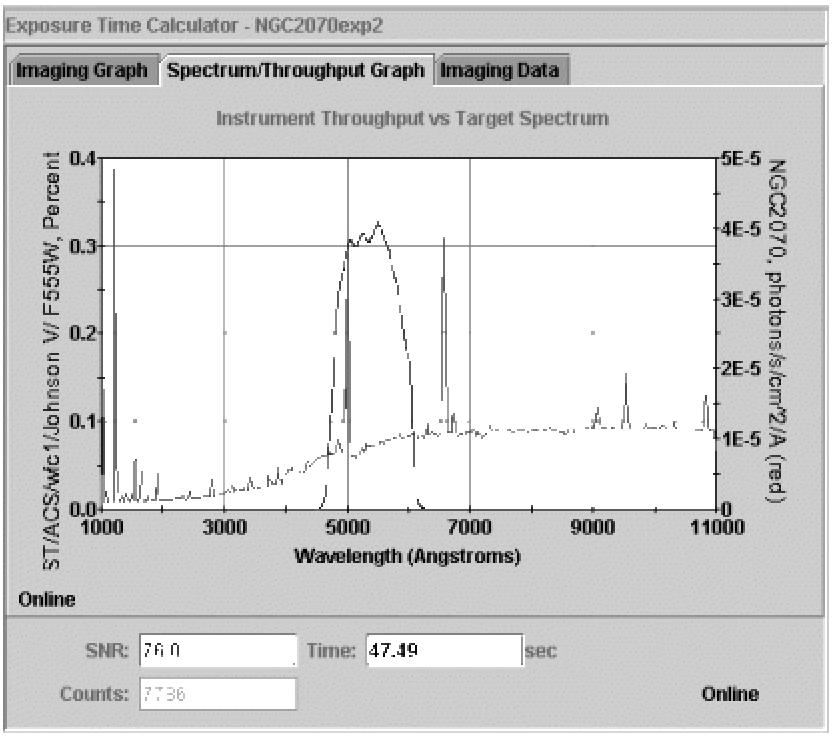
- The overall proposal browser has been enhanced to add table oriented text views of a proposal by several different groupings: exposures, visits, instruments, or targets. This allows an experience user to quickly edit and enter properties of their proposal rather than use the more intuitive but lengthier process of filling out forms.
- Context-sensitive help has been added throughout the system to allow users to click on any button or field and display help information directly related to the selected item. The help text itself is evolving and contains a blend of more interface-oriented help and scientific assistance including references for one-click access to the appropriate location within detailed online handbooks.
- The Visual Target Tuner nows supports display multiple apertures, and has a variety of 2 and 3 dimensional tools for analysis. Additional online image databases such as the Digitized Sky Survey have been added.
- A new component, the Orbit Planner, graphically assists users in laying out their exposures within a single HST orbit. It has the ability to establish links between exposures, and shows predicted overheads. With a simple "click-and-drag" users can re-arrange exposures, or change the duration of exposures. While this features is nicknamed "Orbit Planner" because the group has been working in the context of space-based observing, it can be easily adapted to earth-based observing during a single night.
- The second new components, the Visit Planner, provides visual support for organizing all the exposures and visits in the entire proposal. Similar to the Orbit Planner, the Visit Planner allows the user to use "click-and-drag" technology to organize visits, exposures within a visit, and establish links or constraints between visits and exposures.
- The Exposure Time Calculator now encorporates more information about an exposure's target and instrument. For example, it now contains a graph comparing the target's spectral energy distrubtion to the throughput of the instrument configuration. It also now supports spectroscopic exposures.
- A new Dither Planning Module represents the team's recent efforts to blend a visual tool and an expert assistant. This expert assistant in the Dither Module runs in the background, monitoring the data input and options selected by the user and provides suggestions and recommendations as needed. Greater details on the Dither Module can be found in these proceedings at: < link to KARL's article >

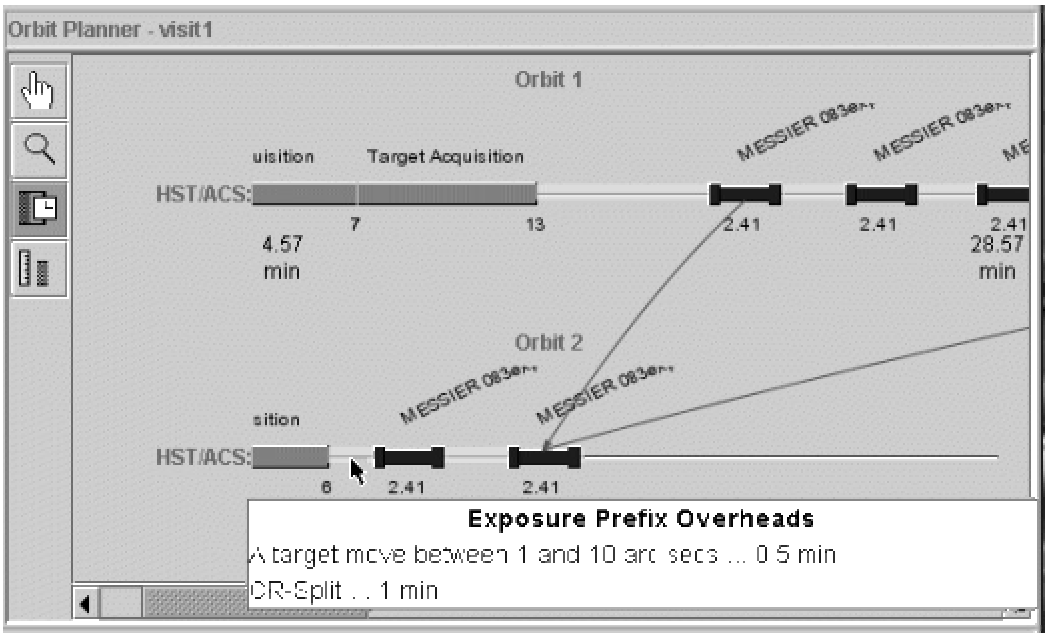
Lessons Learned

A major goal of the SEA project has been not simply to implement new features, but to evaluate and understand better the effectiveness of these new features. The team is preparing for the final phase: evaluation. Even before we do our formal evaluation, we have already learned a great deal:

- Expert Systems technology is still improving, but it's still difficult to make it work effectively. Java-based rules engines exist, as do nice visual rules development environments. But the actual development and testing of rules is still primarily a "programming" task, and is difficult when subject matter such as astronomical observing science drivers require advanced astronomical understanding.
- Visual approaches have strong immediate favorable impact. This impact is more than just a "whiz bang" effect, it provides a significant jump in intuitive feel of the tools. The actual productivity boost remains to be measured.
- Collaboration involving reuse of tool components, and driving towards common observing software suites could have a revolutionary overall affect on software costs.


SEA Browser - Proposal #1
File Edit Image Options Apertures Help
View: Visits
Proposal
Obs. Parameters
Visit Planner
Visit - visit1
Orbit Planner
Target - NGC 2070
Target Tuner - NGC 2070 [1.0X]
Dec: 60 06 22 68
Orientation...
Image Analysis Plot for 464.00, 296.00
Radial Profile
Pixel Value
14000
12000
10000
8000
6000
4000
2000
0
-2000
0 1 2 3 4 5 6 7 8
Radius (pixels)


Exposure Time Calculator - NGC2070exp2
Imaging Graph
Spectrum/Throughput Graph
Imaging Data
Instrument Throughput vs Target Spectrum
ST/ACS/wfc1/Johnson V/ F555W, Percent
NGC2070, photons/s/cm^2/A (red)
Wavelength (Angstroms)
Online
SNR:
Time:
sec
Counts:
Online


Orbit Planner - visit1
Orbit 1
Target Acquisition
HST/ACS:
4.57 min
28.57 min
Orbit 2
Exposure Prefix Overheads