

On the Use of IDL for Instrument Control

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On the Use of IDL for Instrument Control

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Abstract. The Aerospace Corporation has developed a near-infrared and visible spectrograph that is used for astronomical observations at Lick observatory's 3 meter telescope. This paper describes the instrument control and data handling system, which employs the Interactive Data Language (IDL) for both the user interface and instrument control. The system employs IDL in a client-server design to control all aspects of data acquisition, and has been operational for several years. The use of IDL has simplified the system design and allowed for extensive modifications.

1. Introduction

The Aerospace Near-Infrared Imaging Spectrograph (NIRIS) is a long-slit spectrograph that covers the wavelength range from 0.38-2.5 micrometers. It uses two 1024x512 HcCdTe focal-plane arrays (FPAs) for the Near-IR (NIR), and one 1024x256 deep depleted Si FPA for the visible channel. Each FPA is fed by a separate camera, collimator and grating. A common slit and field lens ensures that all three channels of the spectrograph view the same field simultaneously, with beam splitters to separate the wavelengths to each array. The slit jaws are reflective, allowing a CCD camera to image the light not passing into the spectrograph for guiding, and provides an exact view of what is observed by the spectrograph. Figure 1 shows an image of Saturn on the slit, while Figure 2 shows the associated near infra-red spectra obtained. Figure 3 shows the spectra converted to reflectance units.

2. System Design

The control system for the instrument had several requirements. The system is planned to be used for several years, spanning multiple operating system and computer upgrades. The system was to be hardware independent, e.g. requiring no plug-in boards. The instrument design allowed for upgrades to the hardware, so the software architecture needed to be extensible as well. And the software was to be accessible and modifiable by the instrument Principal Investigator (PI).

A previous version of the control software was written for the Microsoft Windows 3.1 operating system using the C language. This required expertise in using both the C language and the Windows Software Development Kit (SDK). With support for that OS ending there was a need to move to the Windows NT/2000 environment, which required a complete rewrite of the control software.

Saturn on Spectrograph Entrance Slit

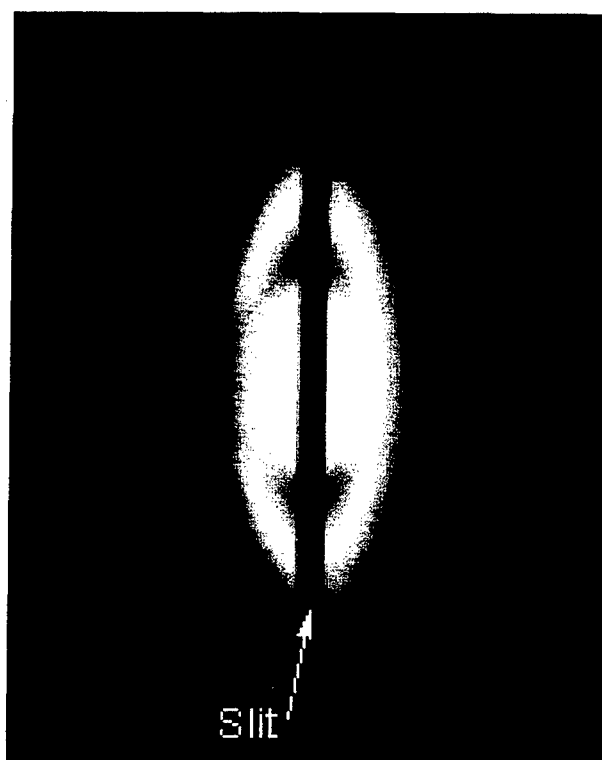


Figure 1. NIRIS entrance slit image showing the planet Saturn, taken using the Shane 3 meter telescope at Lick observatory.

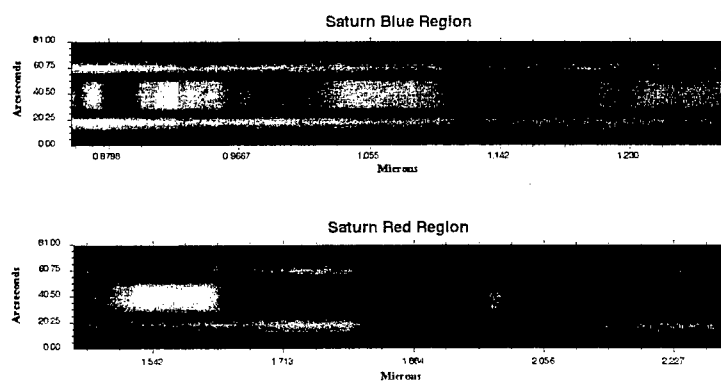


Figure 2. The near infrared spectra obtained from the regions of Saturn in the slit.

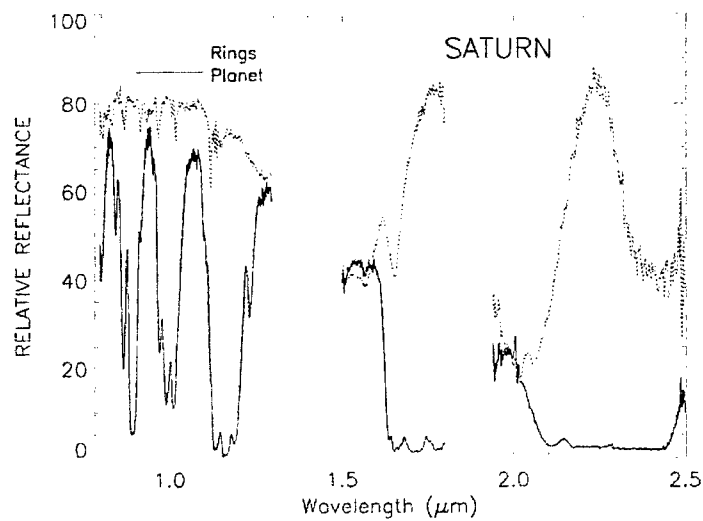


Figure 3. The spectra of Saturn reduced and converted to reflectance units.

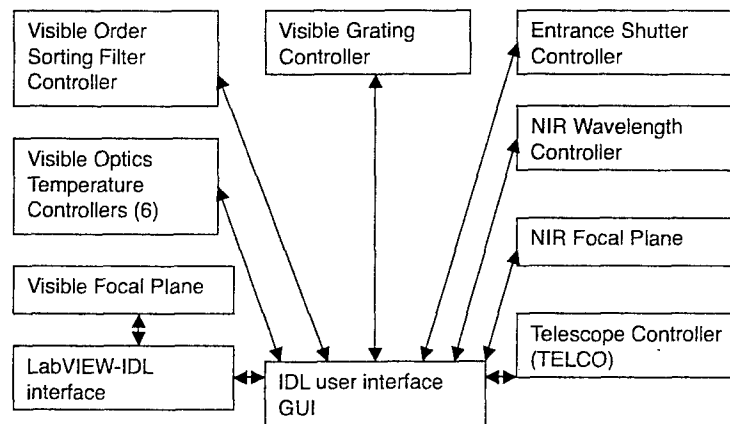


Figure 4. Functional block diagram of the NIRIS control system.

Since the data analysis software for the instrument was entirely written in IDL, and all the team members were facile with the language, we decided to use IDL to implement the control system as well. IDL implements the Unix socket communications protocol, which enables network communications with no additional hardware. This is a lossless bi-directional protocol, required for a control application, with IDL implementing client-side connections only. Since IDL is running as an application environment on top of the operating system, this insulates us somewhat from changes in the underlying OS.

The system design implication of going to a socket communication architecture is that all devices must connect to the local area network (LAN). Devices can be direct connected or can use interface conversion boxes, e.g. Ethernet-to-serial. The communications protocols must be clearly documented as well, since the socket standard only defines the interface and not the protocol. The protocols can be defined by the manufacturer for commercial off the shelf (COTS) products, or developed internally for lab-fabricated controllers.

The control system functions shown schematically in Figure 4 is implemented as an IDL widget graphical user interface (GUI). The visible and near infra-red focal planes are separate systems, and the focal planes are operated independently and asynchronously. Timing events generated by the GUI drive the system timing during both acquisition and idle times, using a state machine internal organization. During idle times the system monitors the temperatures of lenses in the visible channel. These temperatures are actively controlled to compensate for changes in the refractive index of the lenses and differential expansion of materials in the optical chain.

The commercial CCD camera used as the visible focal plane did not have a public communications protocol available, however a driver for the LabVIEW environment was available. We developed a socket communication protocol to communicate between IDL and LabVIEW to deal with this problem. The LabVIEW application handles all the camera control functions, and communicates

with the IDL-based control program via the socket connection. One advantage of this approach was that we were able to tailor the communications protocol to meet our specific operational needs. Both the LabVIEW and IDL applications run on the same computer system at present, but they could be readily moved to separate machines as performance needs change.

3. Summary

This paper has described the control system used for the Aerospace NIRIS instrument. The control system is implemented in IDL to allow for rapid development and ease of modification. The use of socket communications simplifies system design so no plug-in cards are required in the controlling PCs. This results in an all-software system that can be easily transferred to another machine, eliminating a single point of failure. An IDL-LabVIEW socket communication application has been developed for control of a visible CCD focal plane. Implementing an IDL-LabVIEW interface allows control of equipment that may not have a public communications protocol available.

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