IRAF NEWSLETTER

October 1988 Number 5

Central Computer Services National Optical Astronomy Observatories* P. O. Box 26732 Tucson, AZ 85726

Table of Contents

* Operated by the Association of Universities for Research in Astronomy, Inc. (AURA) under contract with the National Science Foundation

System News

Over the past year we have had over a dozen inquiries from sites considering an Apollo workstation for use as an IRAF host. Due to the continuing level of interest the community has shown in having IRAF run on their systems, Apollo Computer Inc. has agreed to a donation of an Apollo DN3500 workstation to the IRAF group for the purposes of porting and supporting IRAF on the Apollo. We still have some concerns over the cost to NOAO to maintain this system (current estimates exceed $4K/yr.) but assuming that this can be resolved we expect to have the machine in-house before the end of the year and the port will progress as time allows.

We would like to thank Apollo Computer for donating this system. It should be emphasized, however, that at this point all we are committed to doing (assuming we decide to accept the machine) is bringing basic IRAF up and evaluating the Apollo as an IRAF host. There is no guarantee that we will continue to support this system indefinitely, and the level of support we can afford to provide for this system is not yet clear. Sites interested in Apollo should contact us for more up to date information.

Other IRAF ports currently in progress are for the Convex and the Sun386i. The basic Convex port has been completed for some time, but release of the system remains on hold until we have time to bring up the latest version of IRAF and thoroughly test the system. A group from NOAO plans to visit the NRAO in Socorro for the final checkout later this year. We currently have about half a dozen sites waiting to get Convex/IRAF.

The IRAF Sun386i has arrived and IRAF is now up and running on this machine (see related article in this newsletter). Basic testing has been completed and no serious problems were discovered. Some further testing and optimization remains to be done, but early releases of the test system are already being made to local sites.

Our local Sun network was recently upgraded to SunOS 4.0, hence future Sun/IRAF releases will be for 4.0 or later releases of SunOS. We will continue to support IRAF under SunOS 3.X at least until next year, however, to gives sites additional time to complete this major upgrade.

Although VMS 5.0 has been out for several months now we, like many VMS sites, are not planning to upgrade to this new operating system for some time, so the next general release of IRAF will support VMS 4.X (we are currently at V4.7), with full support for 5.X to follow sometime next year. We were able to bring VMS 5.0 up on one of our local systems briefly, and preliminary tests indicate that the VMS 4.7 release of VMS/IRAF will run as is on VMS 5.0, however further testing is needed.

Despite all this porting activity good progress continues to be made on the new IRAF systems software projects, with most of the effort thus far having gone into the new image structures, particularly the photon image kernel (the first version of which has just recently been completed), the image mask facility, and the datafile file manager. Four major interface designs and about 25,000 lines of new systems code have been added to the system since the first of the year, but much work remains to be done before the work planned for the current phase of systems development is completed.

In related developments, a first version of the "image calculator" task IMCALC has been implemented in collaboration with Eric Mandel of CFA, who did most of the work. This task permits evaluation of arbitrary arithmetic expressions involving images as expression operands; expression evaluation is performed without writing the intermediate products out to disk. We plan to include this task in the IMAGES package in the next major release of IRAF.

Good progress has been made on the port of DAOPHOT to IRAF. Dennis Crabtree visited the IRAF group in Tucson for a week recently, bringing with him an early working version of the IRAF DAOPHOT. Further work is planned for the next several months, after which we plan to combine DAOPHOT, APPHOT, and some related tasks to produce the first version of the IRAF DIGIPHOT package. A period of systems integration and testing will follow, followed by a release of the package (probably as an add-on) sometime next year. We are very pleased to see software of the caliber of IMCALC and DAOPHOT starting to be contributed to IRAF by sites outside NOAO.

Work is well along within the IRAF group on a general image registration and mosaicing package (Lindsey Davis), a radial velocity analysis package (Mike Fitzpatrick), a general spectral analysis program called DECOMP (Dyer Lytle), and some software for volume visualization and movies (Steve Rooke). Frank Valdes, although currently on a year's leave, has completed a port of FOCAS to the Sun (using the Sun/IRAF IMTOOL image display server), which can be obtained by contacting the IRAF group. See related articles in this newsletter for further information regarding all these projects.

The IRAF group is planning another demo for the AAS meeting in Boston in January. We are currently planning to have IRAF running on a Sun386i, with poster session displays and live demos of much of the new software discussed above. We are looking forward to this opportunity to meet with the many people we have corresponded with over the past year who are now using IRAF, and to hear your concerns and suggestions.

Doug Tody

Invitation to Work with the IRAF Programming Group

We are pleased to offer full or partial salary support to one or more persons who wish to visit NOAO and work in collaboration with the IRAF programming group. Ideally, we would like to arrange visits which result both in concentrated IRAF experience for the visitor, and development of a generally useful piece of software for IRAF. Visits of at least two months would be most useful, and stays up to a year could be considered. Depending on the length of the visit, we could offer some combination of full or partial salary, travel, and partial living expenses. Starting dates are flexible, and at this time we are planning visits through early 1989.

We will be happy to consider either software professionals or astronomers for this opening. In either case the opportunity would be best suited for a person with extensive astronomical software experience.

If interested, please prepare a summary of the reasons for your interest, relevant experience, proposed dates, and funding requirements. Also, feel free to contact me for any further information.

Stephen Ridgway
Manager, CCS

Note to Potential Sun386i/IRAF Users

An IRAF port to the Sun386i (Roadrunner) is in progress at NOAO. For those considering purchasing a Sun386i, be advised that the Fortran compiler has to be purchased separately. If you plan on doing any software development in the IRAF SPP/VOS environment or with IMFORT, you will need a Fortran compiler. Also note that the Sun386i integer and floating point data formats are byte swapped relative to the Sun-3 and Sun-4, so certain binary files will not be directly shareable among a network of Suns - this includes IRAF images. In a future release of IRAF, images will be stored in a machine independent format, lessening this problem.

Many people that are purchasing a Sun386i are not purchasing a standard 9 track tape drive. This is not a problem if the 386i will be networked with other machines that do have a 9 track drive, but IRAF users should note that IRAF i/o does not currently support the 1/4inch cartridge tape drive. Until support is available for the cartridge drive users must read and write FITS files by using a system utility such as *dd* to copy the files between tape and disk, and accessing only the disk copies of the FITS files with the IRAF DATAIO tasks. This restriction applies as well to IRAF running on all other workstations equipped with cartridge tape drives which cannot backspace over a record.

Doug Tody

An Integrated Data Acquisition/Reduction Environment for CFHT

The CFHT data acquisition system, like any such system at a national observatory, must be designed for ease of use by visitors. The computing environment must provide versatility for the experienced user and an excellent development environment for the programmer. At CFHT the available facilities include imaging and spectroscopic instrumentation (such as Coude, longslit spectroscopy and multi-object spectroscopy) and a full complement of detector heads, including several CCD’s of differing sizes, characteristics and operational parameters. The computers that had been in use until recently at CFHT had become seriously outdated, difficult to maintain and lacked critical capabilities and power that are fundamental to modern observing. A detailed account of the problem that existed, the system design constraints and the solution implemented was reported in the *CFHT Information Bulletin, No. 19, 1988 Second Semester* by J. Brewster. Basically hardware constraints such as CAMAC, IEE488, HPIB, etc., compatibility with existing facilities, and the desire to use standard state-of-the-art computing equipment and software led to a decision to purchase HP9000 Series 800 machines running HPUX (Hewlett Packard Unix) for data acquisition. A SUN Microsystems 3/180 workstation is networked to these machines for image pre-processing at the summit.

The user interface for the acquisition environment uses X-windows. Users may select functions (technically referred to as *boinking*) from a series of icons that are displayed in an area referred to as the ‘‘Session Manager’’. Once the selected user input form appears, one positions the mouse cursor over a ‘‘button’’ or a box for text input and selects the function or enters the required text. For example, to take a CCD exposure one boinks the *CCD* icon and when the form appears, selects a *bias*, *dark*, *flat*, or *object* exposure via the buttons and then enters the observer name and exposure time, etc. via text boxes. Other top level icons available allow the user to startup the IRAF *cl* or perhaps the image display tool *XIMAGE*. Users may run IRAF on the HP9000 to examine images, perform image arithmetic and display images on XIMAGE.

One of the design specifications for the system is that the instrument control sequences (taking a CCD exposure, configuring the spectrograph, moving filters, etc.) that are normally done through the X-forms described above are also available through *UNIX shell* commands and are accessible from IRAF commands. In addition to being an invaluable resource for the programming and astronomical staff, this development will allow the experienced IRAF or UNIX user to set up macro sequences tailored to their observing program. One envisions image mosaicing, multiple filter observations and the like being pre-programmed. In the long run it may be possible to export the package to prospective users to enable them to prepare more adequately for specific observing sequences and to become familiar with the instrument operations *well before* their arrival at the observatory.

The X-forms, shell commands and IRAF commands communicate through files similar to IRAF *par* files. Therefore entry of parameters through any of these modes will be retained and useable from any other mode if the parameter has been programmed to be ‘‘sticky’’. In this way IRAF fits naturally into the observing environment which can be as simple (using only X-forms) or as deep (using shell, *cl*, or program scripts) as the user prefers. IRAF provides routines to the observer for analyzing incoming data and provides tools for the developer to streamline observing procedures (eg., checks on focusing procedures, wavelength identification). Graphics are displayed by issuing commands from the IRAF command window, the *gxterm*, and are displayed in a separate Tek window that may be moved and resized at the user's convenience. Depending on preference, the user may simply have one window displayed at a time or have the observing command X-forms, XIMAGE, the IRAF *gxterm*, and the graphics all displayed on the 1280x1024 monitor simultaneously.

The SUN workstation is networked to the data acquisition computers at the observatory on Manua Kea. FITS images may be transferred via tape, or preferably across the network to the SUN after being acquired by the HP. IRAF networking has greatly augmented the speed at which this facility was implemented, making access of images from the SUN simple. IRAF scripts can be built to acquire and process images quickly. These procedures are done by experienced users to streamline particularly demanding observing sequences.

For example, for engineering purposes, CCD transfer curves are run at the telescope to verify that device characteristics in the (noisy) observing environment are identical to those obtained in the laboratory. This was easily accomplished by building scripts on the SUN which had HP acquisition commands embedded in them. A set of images at a given signal level were obtained using exposure commands sent to the HP, and the images were medianed, statistics were calculated and written to a file and the procedure was repeated until exposures at all the correct levels had been obtained. The CCD characteristics were found from the stored statistics and the transfer curve was plotted using the SUN IRAF *gterm*. Obviously experienced staff can tailor these sequences for test purposes to automate what would normally be tedious and somewhat cryptic procedures in other systems.

The philosophy for image pre-processing is that although tools are available on the HP, the use of IRAF there should be restricted to quick-look work. The pre-processing is off-loaded to the SUN workstation so as to have minimal impact on the observing, both from the standpoint of the computing load and to avoid distracting the observer with reduction procedures when they should be observing (!). IRAF currently is better supported under SUNTOOLS than under X-windows, so this interface is the nominal one used. However one can run X on the SUN (in fact simultaneously with SUNTOOLS if one wants), so that the screens look the same as for the acquisition system. In the long run, the second summit HP 9000 computer which is now slated for development, instrument preparation and instrument testing may be used for preprocessing once the IRAF X interface is more robust. In that event the SUN may migrate elsewhere and the entire environment at the telescope will have network access to all our computers, including those off-summit, via a T1 link. The preprocessing package used for imaging data is CCDRED and a layer of procedures has been built above CCDRED so as to reduce the amount of user activity (read thinking) required at 14,000 ft in order to pre-process the data.

The entire system described above is duplicated at the base facility in Waimea, which includes a network of SUN's, a μVAX and HP9000 computers. Soon the computers at the summit and Waimea will be networked together over the high speed link, providing an invaluable resource for troubleshooting and development work. In fact right now several of us can run SUNTOOLS and X windows simultaneously and take CCD exposures across the network if we would choose to do so. (This is generally forbidden but is *technically* available). This means that support personnel may better assist observers by taking a few test frames (usually through X or shell commands) and analyze the images (through IRAF) while sitting in their offices in Waimea. Likewise the existence of similar equipment at the observatory and the base facility allows full testing of observing sequences before they are transferred to the summit systems. Our productivity is thereby increasing and our troubleshooting turn around time will greatly shorten through the use of these resources.

The integrated environment was created by the CFHT staff in a portable fashion and may find general use elsewhere (software -- J. Brewster, R. McGonegal, J. Kerr, S. Smith, R. Link, B. Grundseth; CCD interface -- P. Waddell, C. Clark; scientist responsible -- CC).

Carol Christian
CFHT

IRAF Image Display on the VMS VAXstation

At the moment there is no supported IRAF image display interface for the DEC VAXstation, and we have therefore been providing on request two pieces of user-written software. The Ultrix display program [XIMAGE], written at the Center for Astrophysics, runs under X-windows and provides considerable interactive capability. However, for the VMS VAXstation we have only had available a small program provided by Simon Morris of Mount Wilson and Las Campanas Observatories, of quite limited ability.

The ‘proper’ image display interface is intended to run under the ‘proper’ DEC-supported implementation of X-windows, called DECwindows, and will probably use at least part of the anticipated "DECtools" kit of interface routines. The introduction of DECwindows keeps getting pushed back, and even after its appearance, some substantial extra time will be needed for the IRAF interface.

We are pleased, therefore, to announce an enhanced version of the UISDISP.FOR program, comprising a complete re-write of Simon’s original effort (it wouldn’t exist without him, but it’s very different, so he should be thanked but not blamed). This imaginatively titled NEWUISDISP.FOR program can be run on its own, or in a subprocess. It accepts no terminal input, although it does occasionally issue terminal output, and can therefore be left running in the background, spawned either from inside IRAF or before starting IRAF. Almost all interaction with the user is via specially created windows, informative or interrogative, and through the mouse buttons. Where the different mouse buttons do different things, an explanatory window will appear with the left, middle and right actions listed. The routine provides interactive look-up table modification, cursor read-back, zoom and non-interactive pan, as well as the "usual" housekeeping touches (such as remembering if the window was moved, and shrinking to a user-definable Icon). All of the extra features are accessed from the "Additional Options" item of the main window Menu.

The program requires VAX Workstation software version 3.0 or later, although it has only been fully tested under VWS 3.2 running with VMS 4.7 on a VAXstation II/GPX (the only one we have at NOAO). We anticipate no problems with VWS 3.3, or even VWS 4.0 (for VMS 5.0), without, of course, guaranteeing anything. It needs an eight-bit display, and we run in color. The manuals suggest that it will work with a greyscale display, and we would be interested to see if it does, if anyone has such a beast (they seem to be rare).

The program has some limitations, in particular that all file names must be given in their VMS format, and it can only read IRAF images of type real or short integer (this is an IMFORT restriction). Images can, however, be read across DECnet from a VAX endowed with more disk space, provided that the image header and pixel files are in the same VMS directory (this is an IMFORT feature). The program allocates space with VMS-specific virtual memory calls (so don’t look for an Ultrix version !), and, due to some problems with the hardware window scaling and moving, the zoom and pan are done in software by keeping two copies of the display. Therefore, the larger the images you need to display, the more space you will need in the system pagefile, and it will need distinctly more room than you might have thought just from the array size needed to hold the displayed image section. Symptoms of inadequate space include very sluggish response, or perhaps a system hang, or the "page file badly fragmented" error message much beloved of VMS system managers. Images larger than the workstation screen will be rejected, and you'll be asked to pick again. There is no facility for sub-sampling an image. Note also that the zoom and pan features do not always center the indicated pixel on the exact center of the window (although it will always touch the exact center), and that if you zoom far enough for a single pixel to fill the window, zooming back out again sometimes picks an incorrect (although nearby !) center. These minor anomalies are not considered serious enough to warrant the absolutely gigantic effort apparently needed to fix them.

The program as supplied will run without any extras. However, we also have a program for creating the IRAF 'star' logo, to be used as an Icon. This program, and some study of the Workstation programming manual, should enable you to make customized Icons should you so desire. In addition, several problems with menu creation and virtual keyboard activation had to be solved, so that the program serves as a fairly complex example of a UIS application.

This is a 'stop-gap' program provided until such time as the proper IRAF image display interface becomes available, and as such carries no warranties or guarantees. Strange usage may give strange results (why would anyone want to zoom to a single pixel, and thereby trigger the error mentioned above ?). Bug reports, requests for enhancements (which will be filed under "blue moon"), comments, gratuities and insults should all be directed at the now-crazed author, Nigel Sharp (noao::sharp or 5355::sharp, sharp@noao.edu).

Requests for this software should be sent to Jeannette Barnes (email: jbarnes) or to the generic IRAF mail - see accompanying article in this newsletter for current e-mail addresses.

Nigel Sharp

APPHOT News

The APPHOT package has been installed in the DIGIPHOT package under the NOAO suite of packages in our current in-house version of IRAF and is now undergoing further user testing. Users running IRAF versions 2.6 and later should be aware that APPHOT will disappear from the local package directory tree in future releases. The news items listed below pertain to the version of APPHOT now running under IRAF version 2.7.

Cursor readback is now available from within IRAF on the SUN IMTOOL window and the IIS model 70 display. All interactive APPHOT tasks will accept cursor input directly from these two display devices. For example, users of PHOT can now point the display cursor directly at the star, center, fit the sky and measure magnitudes, etc. Users should be aware however, that IRAF tasks cannot yet write to the image display. The APPHOT options to mark centers, annuli, and apertures are not functional on a display device although they are functional on a graphics device, for example, a contour plot on a graphics terminal.

Several new tasks have been added to the APPHOT package. A new quick look photometer QPHOT is now available. QPHOT accepts as input the centering box width, the radius of the inner sky annulus, and the aperture list, in units of pixels. Centers are computed using the default APPHOT centering algorithm "centroid" and the sky values are computed using the default APPHOT sky fitting algorithm "mode" with three sigma rejection. No choices of algorithms are available. QPHOT is best used as a quick look photometer for use, for example, on the mountain during an observing run. A new task POLYMARK which will interactively create the polygon and accompanying coordinate files in the format expected by POLYPHOT has been added to the package as well. The LISTS package task LINTRAN for linearly transforming a list of coordinates is now callable from the APPHOT package.

APPHOT users will notice several changes to the APPHOT parameter sets (psets) in the new version. All those parameters which are data dependent have been moved into the datapars pset. These include *pfeature*, formerly in the centerpars pset, and *exposure* and *itime*, formerly in the photpars pset. The *threshold* parameter has been changed to *cthreshold* for centering threshold and a new parameter *threshold* for detection threshold has been added. Two new parameters *datamin* and *datamax* have also been added to datapars. These are currently inactive in the APPHOT package but will eventually be used to permit photometry in selected intensity ranges as well as being required for future integration with the DAOPHOT/IRAF package. Users will have to unlearn their APPHOT parameter sets when they acquire the new version.

Several minor changes have also been made to the package task parameters. APPHOT now supports a maximum of 100 apertures instead of the original 15. Users may read their apertures in from a file or a string instead of from only a string as previously. The aperture decoding routine now supports a simple ranges notation so that apertures can be specified as "apstart:apend:apstep". All the APPHOT tasks have been modified so that the current image name, coordinate file name and output file name may be changed interactively. An interactive mode has been added to the DAOFIND task wherein users can plot the radial profile of a sample star and mark the fwhmpsf and threshold interactively instead of being required to know their values ahead of time.

A new document "A User's Guide to the IRAF APPHOT Package" has been written which describes the general philosophy of the package, how to set up the IRAF environment to run APPHOT, and how to edit and store pset parameter files. Detailed examples for several typical astronomical applications are also included. The online help pages have been rewritten and include many more examples than the previous version.

Lindsey Davis

New Image Registration and Mosaic Package

Considerable progress has been made on the new image registration and mosaic package IMREGISTER which will become a subpackage under the images package. The new package will contain tasks to create feature lists (either interactively using the image cursor and image display, or noninteractively using an automatic feature finding algorithm), to linearly transform the coordinates of a list of features, to compute accurate centers for a list of features, and to match lists of features. Working versions of these tasks currently exist in the development version of IMREGISTER. Given a list of features in a reference and input image tasks will exist to compute the transformation between the input and reference frame and to do the transformation. Versions of these two tasks already exist (GEOMAP, REGISTER and GEOTRAN). These tasks have been streamlined to make their input more flexible and facilitate the processing of large groups of images.

A development version of a 2D registration program CROSSCOR has been written and is undergoing user testing. The task computes the shifts between selected regions, currently image sections, in a reference and an input image using crosscorrelation techniques. This registration technique is most suitable for data with features which do not have well defined centers. The crosscorrelation function can be computed using either discrete convolution or Fourier techniques. Various options exist to subtract zero points and slopes, Laplacian filter, boxcar smooth, or apodize the data before computing the crosscorrelation function. The fractional pixel shift in x and y is computed by finding the peak of the crosscorrelation function. CROSSCOR has been successfully used to generate movies from solar 10830 He line images (see also the article "Volume Visualization in IRAF" by Steve Rooke in this newsletter). By selecting small regions scattered over the image to correlate on, CROSSCOR can be used to generate position dependent shifts which can be input into GEOMAP.

A development version of a point spread function (PSF) matching task PSFMATCH was written by Drew Phillips while he was at NOAO under the IRAF visitors program. This program uses Fourier techniques to compute the convolution kernel required to smooth the resolution of one image to that of another (see the article "Image Matching in IRAF" by Drew Phillips in this issue). PSFMATCH will be integrated into the IMREGISTER package.

The IRALIGN program for creating mosaics of NOAO infrared camera data has been expanded to include intensity matching as well as position matching. This expanded version has been written and tested extensively on user data. These programs will be available as IRMATCH1D and IRMATCH2D under the PROTO package in the next IRAF release.

Lindsey Davis

Image Matching in IRAF

A common observational problem is to compare two images looking for small changes -- for example, variable stars. The more the two images look like each other, the easier it will be to find small changes. With digital images, we can perform operations on one image to make it look like another.

The problem of image "matching" can be divided into three operations: image registration, seeing "matching" and intensity "matching". The first step is geometrical and straightforward (at least in theory!), the second is messy and the third is almost trivial provided the first two operations have been successfully carried out. A new task called PSFMATCH addresses the second step.

"Seeing" in this case actually includes any image degradation caused by atmospheric turbulence, poor guiding, poor focus or telescope optics. Each of these effects can be described as a convolution of some unknown function with the image to produce the observed image. Ideally, the original image (before any degradation took place) can be reconstructed once the Point Spread Function of the image is known; in practice, image reconstruction is very heavy on computing resources and never entirely successful. For many applications it is also unnecessary, since we only need to make the PSFs agree in order to compare two images. Clearly, this operation is simply a convolution performed on the less-degraded image to make its PSF match that of the poorer image. The key is to discover the correct kernel for the convolution.

PSFMATCH derives the kernel by comparing the Fourier Transforms of the two input images. In practice, the images are usually too large to transform the entire image, so a section or sections are selected by the user. The ratio of the FTs of the two sections is simply the FT of the kernel. In practice, high frequency components in the ratio are dominated by noise and must be filtered. Similarly, the user must decide how much of the output kernel is relevant to the seeing problem and how much is due to noise, and trim the kernel to the appropriate size before using the task CONVOLVE to perform the actual convolution.

The algorithm is reasonably robust, but a few comments are in order. Ideal input image sections would contain bright (but unsaturated!) stars, but any section containing well-defined structure is usable. They must be of reasonable signal-to-noise for good results. Any instrumental signature must be removed, including hot pixels or cosmetic defects from the input sections, or else the algorithm will try to match those features as well. Similarly, CRs must be cleaned out of the input sections to avoid confusion -- remember, the kernel will try to make one section look just like the other!

Finally, as a bonus, any small registration shifts can be removed during the convolution (by the appropriate sinc function which is buried in the kernel) and image intensity will be approximately matched.

(See also the accompanying article about image registration by Lindsey Davis in this newsletter.)

Drew Phillips
University of Washington

Volume Visualization in IRAF

Early last summer some of the NOAO scientists participated in a joint project with Pixar Corporation to determine the feasibility of using Pixar's volume visualization techniques on three dimensional astronomical image data. Three and higher dimensional images may be thought of as stacks of 2D images packed together, with "voxels" (volume elements) rather than pixels. The project was successful, particularly for datacubes derived from the DensePak fiber optic array spectrometer. Since one cannot perceive depth in a single 2D projection from a datacube, one idea is to make a series of projections in a great circle around the datacube, and play them back as a movie. Pixar uses various projection algorithms, including opacity, intensity, and "refractive index" information in the interior voxels. What you see is a rotating volume that you can see into. The "orbits" of interior regions around the rotation axis, combined with obscuration, provide depth information. Another technique is to render the whole datacube, and cut away at any of its faces interactively ("cubetool").

As an outgrowth of this work, we decided to see how well volume rotations could be done in software. Early indications are that it will work, although not as fast as on a Pixar Image Computer. Currently three tasks are needed: PVOL for computing the projection images, I2SUN for generating a series of Sun rasterfiles, and MOVIE (a Sun, not IRAF, task) for playing back the rotation frames as a filmloop. In the future, filmloops will be supported in standard IRAF image display software, I2SUN will go away, and MOVIE will no longer be required. It should be noted that video movies could be made on any device that can display IRAF images, loading and recording the frames one at a time. We may add someday tools to help automate video movie production.

We are still experimenting with projection algorithms, and have yet to add features like image rotation about an arbitrarily oriented axis in 3D. At present, using largely unoptimized code, it takes about 11 minutes to compute 35 projections (one every 10 degrees) around a 50*50*50 datacube on a diskless Sun3/60. In practice, one first makes short runs with 2 or 3 different projection angles, to get the opacity and/or intensity transformation parameters right. Different types of data will require different projection techniques; some volumes will probably require a limited form of ray-tracing to really reveal the interior detail (ray-tracing a voxel database is much simpler and faster than ray-tracing an arbitrary geometric object database).

Volume visualization will be useful for a variety of purposes, not all requiring data representing three spatial dimensions. For example, a series of 2D speckle interferometry images, taken at successive rapid time intervals, may be packed into a datacube where the depth dimension represents time, then turned sideways and volume-rotated to look for persistent features. Fabry-Perot datacubes are also candidates, though in the limited work we have done with them, a "cubetool" type technique would seem to be more promising than translucent volume rotations. Having three dimensions in which to plot things, rather than projections compressed onto a plane should also prove useful.

I2SUN may be used to generate Sun rasterfiles from any IRAF images -- lists of 2D images or slices from 3D and higher-dimensional images. This is handy for people wanting to preview filmloops on a Sun before committing to the more lengthy process of generating full video movies.

This software is still in a development stage. Interested parties should contact Steve Rooke for further information.

Steve Rooke

Announcing a New Version of FOCAS

A number of improvements to the NOAO/FOCAS system have been made. The primary goal of these changes was to provide a complete FOCAS for SUN workstations. A secondary goal was to allow FOCAS to interface nicely with IRAF. In brief, FOCAS now provides interactive image and catalog review using the IMTOOL image display server on the SUN, new file formats for exchange of data between different computers (mainly VAXes and workstations), and access to the IRAF disk image format. The new features are described in more detail below.

The new FOCAS may be obtained by request through NOAO by contacting Jeannette Barnes (e-mail: jbarnes - see possible addresses in accompanying newsletter article). It is largely written in C and requires UNIX csh capabilities. There is on-line documentation which is out of date in some cases and the new tasks and features are not documented. There is also no user's guide. Additional documentation may become available in the future.

IMAGE DISPLAY:

Most of FOCAS can be used without an image display. However, FOCAS is much nicer to use with an image display to visually and interactively examine the objects detected and cataloged. In the previous version of FOCAS there was support only for the IIS model 70 and a separately maintained version (at AT&T Bell Laboratories) modified for the IIS model 75. In the new version the driver source for these two displays has been merged and a number of bugs fixed and enhancements made.

The most important change, however, is the added support for the IMTOOL display server for SUN workstations. Sites with SUN workstations are much more common than those with IIS devices so this development makes FOCAS more widely useful. IMTOOL is a display task which emulates a subset of the IIS model 70 command interface written and supported by the IRAF group at NOAO (author Doug Tody). In addition it has many other nice features. IMTOOL is not supplied with the FOCAS tape and must be obtained separately; it is automatically supplied with Sun/IRAF. FOCAS requires some recently added features of IMTOOL (namely cursor readback) so the IRAF group should be contacted about obtaining a recent version of IMTOOL for use with the new FOCAS.

Because IMTOOL is a prototype display server which either does not emulate some of the IIS functions or is incapable of efficiently emulating some functions provided by the IIS hardware some of the functions used in FOCAS with the IIS will not work. However, all the important ones have been included either by software emulation in FOCAS or by IMTOOL. A summary of the functions is given below.

Limitations:

- No zoom
- No trackball windowing (provided by IMTOOL directly)
- No color isophotes
- No selective erasing or toggling of isophotes
- Though IMTOOL is not limited to 512x512 the FOCAS code is fixed at this size, therefore this capability of IMTOOL is not supported

Additional capabilities:

- All the IMTOOL setup options
- Pseudocolor
- Screen hard copies

DISK IMAGE FORMAT AND IRAF INTERFACE:

There are two types of disk image file formats which may be used. One of these is the IRAF format. The advantages of this format are that FOCAS can be used in conjunction with IRAF without image file conversions. There are many useful routines in IRAF which are much better or not available in FOCAS. An IRAF package declaration file is also included to allow FOCAS to be called directly from the IRAF command language as a foreign package. The disadvantage is that it requires some libraries from the IRAF system not supplied with the FOCAS tape. The alternative choice is a simple self-contained file format.

CATALOG AND AREA FILES:

FOCAS is a system which detects objects in images and catalogs them. The object data is stored in a binary catalog file and the isophote or area descriptions are stored in a binary area file. Most of the tools in the package interact with this cataloged data. The catalog contains a general header keeping various parameters and a processing history and a, possibly large, number of records, one for each cataloged object. In earlier versions of FOCAS there was just one catalog and area file format which were machine dependent. The catalogs contain complex structures and it was not possible to move these files to a different type of machine even with FOCAS existing on both machines. To solve this problem the new FOCAS supports three catalog formats; the original machine dependent format, a short, packed, machine dependent format (used to save space when there are many large catalogs at the cost of losing some information), and a machine adaptable format. A machine adaptable format is one in which the computer reading the file can determine the structure of the file and correctly read it; basically, it determines whether byte swapping is required. The area files have also been made machine adaptable.

The FOCAS routines recognize all three catalog formats and there is a new tool, "catformat", for converting between these formats. However, if one selects the machine adaptable format as the default for the creation of new catalogs then conversion is not necessary and catalogs may be moved between VAXes and SUNs via network or tapes.

GRAPHICS:

FOCAS uses the simple UNIX graphics tools which produce Tektronix output. On SUN workstations the GTERM graphics terminal shell (also developed and supported by the NOAO IRAF group) is completely compatible with this type of graphics and so all the FOCAS graphics commands are available. A nice feature of GTERM over other graphics terminals is the separate graphics window and the Postscript hardcopy capability.

Frank Valdes

Summary of IRAF User Questionnaire #1

We mailed out over 500 questionnaires to IRAF users early last summer to ask for input to be used for planning future systems and science application projects as well as to establish interest in IRAF workshops and other types of IRAF support and to survey the extent and nature of IRAF use in the community. A total of 159 questionnaires were returned. A brief summary of these responses is presented below. The reader is assumed to be familiar with the format and content of the original questionnaire.

1. Software Development Priorities

1.1. System Software

Current system software projects were listed and the participants were asked to rank them numerically in order of importance (1=highest priority and 5=lowest priority). The results are tabulated in the following table.

Project	Ranking and # of votes				
	1	2	3	4	5
Image display interfaces	95	25	10	6	5
New image structures	34	39	31	17	12
User interfaces for image processing	49	40	26	5	11
Graphics enhancements	19	22	34	23	30
Better on-line help	16	32	36	21	24
Ongoing support for various systems	20	38	25	23	18
Improved prog. doc. at SPP level	14	24	25	22	24
Database management facilities	8	20	18	23	43

About all we can conclude from these responses is that the community agrees that what we have planned for systems software development is more or less what is required. The display interfaces and image structures projects, user interfaces capitalizing on both, and ongoing support for workstations and networking are most important, although the other enhancements are all badly needed too. The importance of these projects cannot be overemphasized; they are critical before IRAF can be a really good image processing system, and the lack of some of these facilities is holding up the development of some badly needed analysis software, and completion of important system packages like IMAGES. Precisely because these new system facilities are so critical, however, we feel that it is important to take the time to do it right; these projects cannot be rushed.

In a related systems question, the system or systems that received the most interest for a new IRAF port within the next year were the Macintosh II, the Sun386i, Convex, and Apollo (recall that we already have Alliant, DG, Sun, Vax, and HP ports). Just about every other system actively in use today has been mentioned at one time or another, and a number of (non-IRAF project supported) ports are always "in progress".

As indicated elsewhere in this newsletter, the Convex and Sun386i ports are already complete or nearly so, and an Apollo port is likely. No Macintosh port is currently planned due to limited manpower, lack of access to a development system, and to some extent because we are not convinced that this system is mature enough yet to make the effort worthwhile for a system as large and resource-hungry as IRAF. Nonetheless we recognize and share the great interest the community has in low end (inexpensive) workstations, and our interest in the Macintosh and other PC class machines as IRAF hosts continues to be high.

1.2. Applications Software

Currently planned application software projects were listed and the responses to these are presented in the table below. Again, the participants were asked to rank these numerically in order of importance (1=highest priority, 5=lowest priority).

Project	Ranking and # of votes				
	1	2	3	4	5
Improved Echelle reductions	31	22	8	16	19
Radial velocity analysis package	37	28	19	12	7
General image registration and mosaicing	47	30	27	7	6
Improved ONEDSPEC package	50	25	10	9	9
Digital surface brightness analysis	29	27	7	14	12
FOCAS port to IRAF	16	26	24	10	19
Fourier image analysis	28	24	17	20	14
Fourier spectral analysis	23	25	17	19	13
Standard photometry reductions	29	29	22	11	18
Astrometry	10	17	24	16	24
Artificial data generation, modeling	3	19	25	17	20

A brief update about some of the projects in this list is in order. There is already a new ECHELLE package that has been undergoing user testing and which will be made available in the next general release of IRAF. This package was discussed in a prior newsletter (IRAF Newsletter #3). Some improvements to the ONEDSPEC package have been made in support of the new ECHELLE package. These improvements have also been discussed in a prior newsletter (IRAF Newsletter #4).

Work on a general radial velocity package is currently in progress and a prototype cross correlation task has already been implemented. Although this package will not be available by the next release it should be available as an add-on not too long thereafter. A general image registration and mosaic package is also currently under development (see accompanying article in this newsletter). The FOCAS port to IRAF has not yet been implemented although the availability of FOCAS is now more widespread (see article in this newsletter).

There were many individual comments about these packages and projects in general. One of the more repeated comments was a request for DAOPHOT/IRAF (DAOPHOT was not mentioned in the questionnaire because it was already an approved project at the time). As we have mentioned elsewhere in the newsletter, the implementation of the IRAF version of DAOPHOT is well under way and we expect to be user testing this software in a few months.

Hence, we are already doing something about the most highly rated projects in this list. Of the remaining highly rated projects, additional work to improve and generalize ONEDSPEC is planned, but this cannot really go forward until the new image structures systems project is completed (more efficient management of large numbers of 1D spectra, generalized world coordinates, header keyword mapping, a more rational image template syntax, and support for the complex ONEDSPEC data structures requires the new image structures). Similarly, the digital surface brightness analysis package requires system facilities from both the image structures project (region masks, bad pixel list, noise function package), and display interfaces project (interactive use of the image display for region specification, overplotting isophotes, etc.).

Of the remaining high priority projects, work on fourier spectral analysis facilities is already underway in the DECOMP and to some extent the radial velocity analysis packages. Development of the fourier cross correlation facilities for the image registration and mosaicing package will lead naturally into development of general fourier image analysis tools. Discussion of some standard photometry reductions software is just getting underway and it is likely that something appear in this area within the next year.

In response to another set of questions, there was some general interest in the emerging high-end graphics technologies such as 3D graphics, 3D image display, movies and animation. The results from this part of the questionnaire are given below.

Interest in high-end graphics technologies	Very interested = 42 Mildly interested = 49 Not sure = 46 Not interested = 13
High-end graphics facilities in use at user's site?	Yes = 27 No = 64

Some work on new graphics and image display technologies is already in progress (see the accompanying article in this newsletter on volume rendering). We also feel that a "movie" or film loop capability is vital for visualizing certains types of image data sets, and support for such capabilities is planned as part of the display interfaces project. A prototype movie display program is already in use within NOAO, but this capability is currently only available for Sun workstations.

2. Seminars, Workshops, User Meetings, and Electronic Mail

There were quite a few questions about seminars, workshops, user meetings and electronic mail service. The responses to the questions concerning user seminars are tabulated below.

Informal seminars at user institutions?	Yes = 71 No = 30 Possibly = 2
Would host institution pay local expenses?	Yes = 35 No = 14 Unknown = 19 Maybe = 12
Would you attend seminars held at NOAO?	Yes = 72 No = 22 Maybe = 5
Best time of year?	Summer = 26 Any = 14 Winter = 8 Spring = 3 Bright time = 1
Worst time of year?	Academic year = 18 Summer = 8 Christmas = 4 Dark time = 1 Winter = 1

We listed a selection of possible topics for user seminars. The interest noted for these is tabulated in the next table.

Topics	#Votes	Topics	#Votes
Installation	23	Plotting	37
Graphics terminals	28	Using DATAIO and MTLOCAL	26
Hard copy graphics devices (SGI)	24	Reducing longslit data	36
Networking	33	Reducing echelle data	28
Basics of the CL	42	The APEXTRACT package	27
Programming with IMFORT	63	The ONEDSPEC package	40
Programming with SPP	59	The APPHOT package	33
Script writing	68	Image reductions within IRAF	68

We also had a few other questions about other types of workshops and means to inform our users.

Would you attend technical workshops?	Yes = 52 No = 55
Would you like to visit Tucson to work with IRAF?	Yes = 26 No = 48
Would you attend User's Group meetings?	Yes = 76 No = 32
Would you use an electronic bulletin board?	Yes = 114 No = 7 Possibly = 2

3. Your Experience with IRAF

We were interested in seeing what applications were most used by the community. A list of packages and reduction facilities were listed. These results are tabulated below.

Facility	#Votes	Facility	#Votes
General image processing	99	IIDS/IRS reductions	17
Graphics	100	Longslit reductions	51
CCDRED	51	Wavelength calibrations	64
APPHOT	31	Flux calibrations	42
DTOI	6	General use of ONEDSPEC	64
Echelle reductions	26	Non-NOAO data reductions	36

We were also interested in what type of software development others were doing within IRAF. Those results follow.

Have you done software development with scripts?	Yes = 53 No = 79
Using the IMFORT interface?	Yes = 47 No = 73
Using the SPP language?	Yes = 15 No = 96
Considering using IRAF for occasional software development?	Yes = 96 No = 15
For more extensive software development?	Yes = 45 No = 47 Possibly = 9

We would like to thank everyone who responded to the questionnaire. We found the comments and suggestions very useful.

Doug Tody
Jeannette Barnes

Interesting IRAF Statistics

The tables below summarize some interesting statistics about IRAF, IRAF site support, and the distribution of IRAF. The table below gives distribution and site information for IRAF versions 2.5 and later and does not include any information about prior releases.

Total # of IRAF sites	218	# of foreign sites	53
VAX/VMS sites	117	Sun sites, in general	59
VAX/UNIX	9	Sun3 sites	53
VAX/Ultrix	15	Sun4 sites	11
AOSVS Data General	6	Masscomp	3
Alliant	3	HP	1
Source-only distributions (for new ports)	12		

Other interesting bits of information are contained in the second table.

# of lines of text in the current IRAF system	850K
# of directories in the current IRAF system	289
# of files in the current IRAF system	8364
# of incoming messages to IRAFmail (1988 - does not include messages sent to individuals in the group)	405
# of outgoing e-mail messages (1988 - only includes selected logged messages and excludes many individual messages)	1657
HOTLINE CALLS (1988 - not including calls to individual group members)	273
remote login sessions (1988)	118
# of people on IRAF mailing list	552

Doug Tody
Suzanne Jacoby
Steve Rooke
Jeannette Barnes

IRAF Acknowledgment

We have been asked by several users of IRAF for a best way to acknowledge the use of the IRAF system for data reduction and analysis when preparing a paper for publication. We suggest the following footnote for use when the name "IRAF" is mentioned in a paper:

[1]IRAF is distributed by the National Optical Astronomy Observatories, which is operated by the Association of Universities for Research in Astronomy, Inc., under contract to the National Science Foundation.

In the case where a more extensive discussion merits listing a published reference paper, the following paper may be listed:

Tody, D., "The IRAF Data Reduction and Analysis System", *Instrumentation in Astronomy VI*, David L. Crawford, Editor, Proc. SPIE 627, 733 (1986).

Stephen Ridgway
Manager, CCS

Current IRAF E-mail Addresses

The current electronic mail addresses for sending mail to IRAF are listed below.

UUCP: {arizona,decvax,ncar}!noao!iraf uunet!noao.edu!iraf

Internet: iraf@noao.edu

SPAN/HEPNET: 5355::IRAF or NOAO::IRAF

BITnet: iraf@noao.edu (through a gateway)

If you have any problems communicating with us electronically, our local in-house consultant is Steve Grandi, (602)-325-9228.

For those of you who like "voice" contact, the IRAF HOTLINE is still going strong - (602)-323-4160.

Jeannette Barnes

The IRAF NEWSLETTER is published three times a year (February, June, and October) by the Central Computer Services, National Optical Astronomy Observatories, P. O. Box 26732, Tucson, AZ 85726. Editors: Jeannette Barnes, Doug Tody