IRAF NEWSLETTER

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System News

Beginning with this issue of the newsletter, we will publish the IRAF Newsletter on a fixed schedule for distribution in February, June, and October. It is our hope that by going to a fixed and more frequent schedule that we will be able to keep our users better informed about the progress of IRAF. New software developments will be announced as they are completed internally, but such software may not become available to the general community until the next major release of the system following the announcement date. Often, however, such software is available as an add-on to the current released version of IRAF and we will mention this in the newsletter when it applies. New projects planned or in progress will also be discussed and comments are certainly welcome.

IRAF was successfully ported to the new NOAO Sun-4 computer (10 Mips RISC architecture) upon its arrival at the Tucson headquarters in October. Despite a completely new architecture and set of compilers, the system came up without serious problems, and we are pleased with the current and projected future performance of this system. The Sun-4 (Gamma-2 release) is currently running an early release of the operating system, SunOS 3.2L. An upgraded version of the operating system, 3.2FCS, is expected sometime in early February. The Sun-4 version of IRAF is available to sites upon request, with the understanding that the system is not yet well tested and some minor bugs may be present (in the Sun software as well as in IRAF).

IRAF was also ported to a Convex C-1 vector minisupercomputer in late November, in collaboration with the Convex office in Greenbelt, MD. Although the basic port has been completed, further testing, optimization, and bug fixing (mostly to work around host Fortran compiler bugs, a common problem with new ports) remain to be done before the system can be made available to user sites. A number of other ports are currently in progress or are planned, with ports to the Apollo and Hewlett-Packard workstations being furthest along. These ports are being carried out by the manufacturers with some help from the IRAF group and prospective user sites.

Networking support was added to the system to allow for access to remote magnetic tape drives. Remote devices are accessed merely by prefixing the device name with the node name, e.g., "orion!mta" to access mta on the node "orion". The dev$devices file on the remote node is used to obtain the device information, hence no network information is required in the device files and device names do not need to be unique on the different nodes. Enough of IRAF to at least run the IRAF kernel server process must be present on a remote node if it is to be accessed in this manner. Note however that we do not yet have a TCP/IP IRAF kernel server for VAX/VMS nor DECNET support for UNIX/IRAF or Sun/IRAF, so this capability is not yet available between a UNIX client and a VMS server (although the reverse is supported, as is any UNIX to UNIX or VMS to VMS connection).

The image display software for the Sun, the *imtool* virtual display server, went through some major upgrades during December. The display window may now be resized and moved independently of the internal image frame buffer, allowing an arbitrarily large image to be viewed through a smaller window, panning the window about to view portions of the larger image. The frame buffer size is user configurable, with a variety of default sizes currently supported including buffers sized for the various NOAO CCD chips, e.g., 512 square, 800 square, 384 x 576 (GEC), 3040 x 976 (KPCA), and so on. Multiple frame buffers may be loaded and independently windowed and panned; a frame blink capability is provided. The image pixel intensity is now output in constant cursor readout mode. Network support has been added, allowing use of the display server with IRAF running on a remote node, e.g., a central file server, or a large VMS VAX or other powerful compute server. We plan to make this new image display software available to our Sun/IRAF user sites as soon as possible.

As a final note, the AURA display at the January AAS meeting in Austin was a joint demo of IRAF and STSDAS, an all new version of the Space Telescope Science Data Analysis System, being rewritten within the IRAF environment for improved efficiency, so that it will port with IRAF to any IRAF host, and to improve compatibility with the NOAO and other science applications also developed under IRAF. We would like to thank Sun Microsystems (Austin office)

for supplying us with a Sun workstation at the meeting for the purpose of demonstrating our software.

Doug Tody

Update on the APPHOT Package

The APPHOT package was made available as an add-on package to IRAF version 2.5 in November 1987. Approximately 20 sites have received the alpha test version of the package. At NOAO the package has proved most popular on the Sun workstation where it is used in conjunction with the IRAF *imtool* facility.

Users of the the alpha test version of APPHOT should be aware of the following changes in succeeding versions. A full list of revisions will be sent out with subsequent APPHOT requests.

[1] The format of the APPHOT output file headers has been changed. This change is transparent to the apselect task program and was made at users' request for greater clarity in reading the output format.

[2] An interactive setup keystroke command has been added to the polyphot task.

[3] The plotfiles in the APPHOT tasks are now opened in append mode so that the user does not have to specify a new plot file name on every execution of an APPHOT task.

[4] Minor changes to various keywords were made for the sake of internal consistency.

Users of the current alpha test version should be aware of the following bugs. An updated version of the package can be requested from the IRAF group.

[1] A memory allocation problem in the apselect task sometimes causes the task to fail with a segmentation violation after a few executions. The exact way apselect fails depends on what task produced the output file it was trying to read, how long the output file records were, and various other factors.

[2] Formatting errors in the output of polyphot and wphot can prevent the use of apselect altogether in some cases.

[3] The exposure time image header keyword is not being fetched correctly from the image header in the polyphot task. The photometry is being done correctly but the normalization (zeropoint correction) is in error.

All APPHOT users should be aware that two significant changes are planned for the APPHOT package in the future.

[1] Plans are underway to make the output file format and the input parameters of the APPHOT package compatible with those required by the DAOPHOT/IRAF package being developed at the Dominion Astrophysical Observatory/Canadian Space Astronomy Data Center by Dennis Crabtree. These two packages must be able to communicate with each other and present a uniform face to the user. Minor changes to the APPHOT psets are to be expected. The current text file output format will be replaced with a binary database file format. Binary file access is more efficient when the database file contains a large number of records as will certainly be the case for DAOPHOT/IRAF output.

[2] APPHOT will be interfaced to the image displays when the Image Display Interface becomes available. The package has been designed with that eventuality in mind so the conversion will be straightforward.

Lindsey Davis

Update on the CCDRED Package

Version 2 of the IRAF CCD reduction package CCDRED has been completed. A paper describing the package was presented at an instrumentation meeting. The CCDRED package was not part of the last IRAF release (V2.5) but it (version 1) was made available upon request as an add-on package. The new version and the paper describing the package are now also available upon request. The new version is similar to the previous one with the following improvements.

1) The detector and image coordinates are now maintained. This allows applying full frame calibrations to subsection readouts (a capability being developed for the CCDs at NOAO) with the correct calibration regions automatically applied. This has the added benefits that errors due to incompatible trimming are detected and it is possible to relate reduced image pixels to the original CCD detector pixels.
2) The SETINSTRUMENT task has been made more flexible.
3) A test/demo package has been added. The demo is very instructive and is recommended for people when they first use CCDRED.
4) A cosmic ray detection and replacement task has been added. This task is still open to comments and suggestions from users.
5) The combining algorithm will be exported as a general task in the IMAGES package in V2.6 and later (see related article in this newsletter). This task gets around problems and goes beyond the IMSUM task.
6) A number of minor bugs were fixed.

Frank Valdes

A User's Guide to Script Writing Now Available

A user's guide is now available for IRAF users writing scripts in the IRAF environment. While this functionality of IRAF is not yet fully developed, this user's guide will help those users that need to write IRAF scripts to make their data processing more efficient.

A copy of this new document has been sent to all site managers and is also available upon request. The paper is *An Introductory User's Guide to IRAF Scripts*, by Ed Anderson.

Jeannette Barnes

Understanding the NULL string

The "null" string is used by many IRAF tasks as a valid parameter value and its use is discussed in the on-line help for these tasks. It is important that this parameter value be entered properly in order for the task or subsequent tasks to execute properly. The "null" string is entered as "" - two quotes (or double quotes) with NO space between them. Examples where the "null" string is used are in the tasks `fitcoords` and `dispcor`.

A common user problem is entering the "null" string as a parameter value with a blank between the quotes. This can cause unexpected results. The blank can be interpreted as an image name, such as for the "reference" parameter in `dispcor`. Or the blank can be prepended to an

already existing name and then entered in the database as with the "fitname" parameter in `fitcoords`. In the latter case problems can be encountered later when the task `transform` attempts to access this entry in the database.

We are currently taking steps to make a blank string (two quotes with spaces between them) acceptable as the "null" string in the future, where possible.

Please also note that when the user types `lpar` *taskname*, the "null" string will appear visible as a parameter value, if it is being used. However, the "null" string is not a visible parameter in the `epar` mode.

Jeannette Barnes

New Task IMCOMBINE Added to IMAGES Package

A new task called IMCOMBINE has been added to the IMAGES package. It provides the following features.

- Any number of images of any dimension and pixel datatype with the same size may be combined. This task uses special features of the IRAF image interface and dynamic memory allocation when combining large numbers of images. This is in contrast with IMSUM which only works well with a small number of images.
- There are 9 different combining options (more might also be added) including summing, averaging, median, and algorithms for rejecting deviant pixels.
- The images may be scaled to the same exposure time or mode either multiplicatively or additively.
- When averaging, the combined images may be statistically weighted based on the number of previously combined images, the exposure time, and mode.
- An optional sigma image from the deviations of the combined images about the output image may be produced.

This task largely replaces the functions of IMSUM particularly when dealing with a large number of images. IMSUM is still available for those using it in scripts but notice is given that it may disappear at some point.

Frank Valdes

Prototype Code for IR Images

Two new tasks IRMOSAIC and IRALIGN have been added to the PROTO package. IRMOSAIC takes an ordered list of input images and places them on a grid in an output image. Options exist to order the input list by row or column or in a raster pattern starting at any of the four corners of the output image. Adjacent subrasters may be overlapped or separated by a specified number of columns and rows. Positions of objects which occur in adjacent subrasters can be marked using, for example, the Sun *imtool* facility, and then centered using the APPHOT center routine. IRALIGN takes this mosaic and the coordinate list and produces an output image where all the individual subrasters have been aligned with respect to some reference subraster. These two tasks are most useful for images which already lie approximately on a grid such as those generated by the Kitt Peak infrared CCD camera.

Work is already in progress on a task to generate a mosaic from an arbitrary list of images using information stored in the image headers. These tasks are prototypes for a more general image registration and mosaic package.

Lindsey Davis

Modifications and Additions to the ASTUTIL Package

1. Announcing Two New Tasks in the ASTUTIL Package

The task ASTTIMES computes and prints astronomical dates and times given a local date and time. Specifically it computes the universal time, epoch, Julian day, and local mean sidereal time given a date, local time and time zone, and longitude. The input may be from files or task parameters. In the latter case the output is also placed in task parameters for use in scripts. The output is formated to produce a table.

The task RVCORRECT computes and prints radial velocity corrections for an observation. It computes corrections for the motion of the observer due to the rotation of the Earth, motion about the Earth-Moon barycenter, orbital motion around the Sun, and the motion of the Sun relative to a standard of rest. If an observed radial velocity is given then it is corrected and if it is not given then the correction to be added is printed. The components of the motion are also printed. The input may be from text files, images (provided the appropriate keywords are used), or task parameters. In the latter case the output is also placed in task parameters for use in scripts. The input requires the date, time, place, and coordinates of the observation as well as the definition of the standard of rest; if zero then the correction is helocentric. This task is derived from a radio astronomy program and is accurate to fractions of a km/s.

2. ASTUTIL Package Reorganization

The ASTUTIL package has been reorganized by creating a subdirectory called ASTTOOLS. This directory contains various astronomical related algorithms. Currently there are tools for precession, radial velocity, astronomical time calculations and conversions, and coordinate conversions. These types of tools tend to be rather obscure, use complex interpolation and spherical coordinate formulae, and vary in accuracy. People are welcome to make copies of these procedures when needed and to submit routines to be added to the collection. Also information about sources of such routines would be welcome.

3. Modification to tasks PRECESS and GALACTIC

A more modern (accurate?) precession routine has been substituted in the ASTUTIL task PRECESS. It is based on the IAU system described in the supplement to the 1984 Astronomical Almanac. It differs from the earlier version at a level of a few tenths of a second of arc. The galactic coordinate conversion was replaced by an SPP routine with a slightly different algorithm. The answers are the same to hundredths of a degree.

Frank Valdes

Shifting of Dispersion Solutions Now Available

Changes have been made to the ONEDSPEC tasks IDENTIFY, REIDENTIFY, and DISPCOR for a more flexible dispersion solution (or coordinate function) definition. The change is to allow a dispersion solution to be shifted without changing the form of the coordinate function. Another way to think of this is that the wavelength zero point of the dispersion solution can be changed independently of the shape of the dispersion function. Three particular applications were considered.

1. Adjusting a well determined dispersion solution from a high signal arc spectrum for a flexure shift using a short exposure, low signal arc spectrum. The high order shape of the dispersion solution requires more and better information than a simple wavelength shift.

2. Adjusting an object exposure for flexure with even just one known feature, such as a night sky line, using an arc dispersion solution. This is particularly useful in multifiber spectroscopy where the individual spectra are expected to be aligned except for small alignment and flexure shifts in the zero points.

3. Arbitrarily shifting spectra for display or measurement purposes. This can be done with SPLOT on dispersion corrected data but with IDENTIFY this can be done without rebinning the data.

The change is implemented by a shift parameter to be added to the coordinate function. This shift is recorded in the IDENTIFY database by the entry labeled "shift". If this entry is missing then a zero shift is assumed. This makes the change backwards compatible. The shifts can be printed out for record keeping purposes.

In IDENTIFY the behavior of the 's'hift key has been changed. It no longer uses a feature position for specifying an initial shift, instead the user is asked for a wavelength at the position of the cursor. This has the advantage that the shift may be applied even with no features to shift the wavelength coordinates (application 3). If features are present then they are recentered after shifting and the initial shift is adjusted to make the mean difference between the fitted and user coordinates zero. A new dispersion function is not fit after recentering (a change from the previous behavior). Information about the shift is now printed on the status line (previously this was written to the text window causing some annoying jumping back and forth). The automatic fitting was also removed from 'c' and 'x' as being inappropriate to do so much automatically.

A new key 'g' (follows 'f') was added to determine a shift between the fitted and user coordinates. This is used by marking some features with a dispersion solution which may be slightly offset. The features will have the true wavelengths specified by the user and the offset fitted coordinates from the dispersion solution. After marking the lines 'g' will apply a shift to the dispersion solution to bring the fitted coordinates to a mean of zero about the user coordinates.

The only change in task parameters is a new parameter called "refit" in REIDENTIFY. In the past after reidentifying lines the task determined a new dispersion function. Now the user may specify that this not be done and instead only a shift to the reference dispersion solution be determined. As an aid to the user some better log information is now printed including the pixel shift, user shift, z shift (delta lambda / lambda), and the RMS after reidentification. The RMS can be used as a diagnostic for mistakes in the reidentifications.

DISPCOR was simply modified to use the shift term in the IDENTIFY database records if present. There was no outward change to this task.

Frank Valdes

Modifications to the APEXTRACT Package

There have been a number of suggestions, comments, criticisms, and performance reports concerning the effects of cosmic rays and the behavior of optimal extraction in the IRAF APEXTRACT package. Some recent changes have been made in the package to address these comments and improve the performance. The questions of cosmic ray removal, optimal extraction, and model extraction (2D strip version of optimal extraction) are basically the same since they all involve determining the shape of the spectral profiles across the dispersion and fitting the profile to the data being extracted. In the paragraphs below the changes are summarized. A brief paper will also be written discussing cosmic ray removal and optimal extraction with suggestions as to different techniques and when they are appropriate.

The earlier versions of the package determined the spectral profile directly from the data being extracted by using a trailing moving average corrected for shifts in the profile center. Except at the beginning the moving average is formed from data profiles cleaned of cosmic rays. This method is still available. Two problems with this method are that for very weak spectra, where the benefits are greatest, you must average many profiles and may still not have as clean a profile as you would like and, since these tend to be long exposures, there are many cosmic rays which may contaminate the moving average. In the previous version you could specify the entire image for making the profiles but it was wasteful of memory. Now if the profile shape is not expected to change with position (wavelength) you may specify an average greater than the size of the image and the profile will be a simple average without the overhead of saving profiles for the moving average.

There is now a new parameter to specify a different image from which to form the profile to be used for cleaning and optimal extraction. The profiles in the second image are assumed to be nearly the same as the image being extracted but they need not be centered identically (to allow for flexure). For some data this assumption is not valid though it may still be better than using the weak profile. However, many new spectrographs are being designed using fiber optics which, if done properly, will always produce the same profile. In this case one might use a strong quartz exposure to define the spectral profiles (which might even be the same over long periods of time). These profiles will not suffer perturbations due to cosmic rays and will have very good SNR. You still have the option to average profiles (though in this case it will be a centered moving average or the entire image) but you might even be able to use an average of 1; i.e. the profiles at each point in the dispersion are independent and given by the calibration frame. Thus these changes are most beneficial to sites with fiber-fed spectrographs.

Another way to use this new feature is to smooth the object profiles to be extracted and use this smoothed image as the profile reference. In other words you can have a detailed interaction with the data to define the profiles using any image processing tools you like. This allows almost duplicating the method described by Keith Horne in his paper on optimal extraction in which the profiles are smoothed at each point in the profile along the dispersion direction. This was tried using FIT1D and using iterative rejection to eliminate spectral features. This is the same technique use to define the continuum with the task ONEDSPEC.CONTINUUM and for some flat field applications. The result of this line-by-line continuum smoothing along the dispersion was quite good and eliminated cosmic rays and provided a good profile image. Since the object image is used the profiles are correct for each object image being extracted.

Another important change is that once the profile is determined by any of the above methods the high quality profile is shifted to the object profile position at the dispersion point being extracted. In the past it was the object profile which was interpolated to the center of the model profile. This had the effect of widening cosmic rays during interpolation and making detecting cosmic rays, particularly in weak spectra, much more difficult. Now the cosmic rays are not broadened and the deviant pixel rejection will work better. Another subtle change was that after a pixel was rejected and a new fit made to the profile the estimated sigma was not updated. Thus, with a strong cosmic ray the sigma would be large and a second point (cosmic rays are often more than one pixel) would not be found to be deviant enough to reject. The sigma is

now also updated after rejecting a point.

These changes are fairly major (though the rewrite simplified the code considerably and makes it less likely to be buggy) and so we will have a local user testing period before the revised package will be made available to outside sites.

Frank Valdes

New Echelle Package (in Progress)

Historically, we first tackled the problem of multispectral reductions for data such as aperture plates, slit masks, and multiobject fiber-fed spectrographs. This has allowed reductions of echelle format images with the current version of IRAF. However, this is done by treating each order as a separate spectrum which is cumbersome when there are many orders. This is particularly a problem when determining the dispersion relations.

A new echelle package is currently under development. This involves some modifications to existing software and the development of new tasks specifically for echelle format data. This note outlines what is planned. The basic reduction process remains the same: extract the data from the two dimensional format into one dimensional spectra by integrating across the dispersion, determine a dispersion relation between the (1D) pixel coordinates and wavelength, interpolate the spectra to linear wavelength coordinates, flux calibrate the spectra using standard observations, and perform any desired analysis. (Some of these steps may not be required for particular applications). The difference for echelle data will be that the echelle spectra will be treated as a single entity with its own data formats rather than processing each order as an independent spectrum.

The first steps of finding the orders and extracting them into one dimensional spectra will be done using the APEXTRACT package. This package will be slightly modified to provide a choice of output formats. Currently each spectrum extracted is a separate entity (a one dimensional image with a numeric extension based on the aperture number). However, an echelle spectrum is logically a single entity and there will be an echelle output format. This format is a two dimensional image with each line consisting of one extracted order. (Note that in the future there will be significant changes in the IRAF image and data formats but the concept of treating all the extracted orders of an echelle image as a single logical entity will still be valid). Thus, the APEXTRACT package and its use with echelle format images will be the same as before but there will be only one output image per original echelle observation rather than a large number of individual spectra.

Currently dispersion relations are determined by the task IDENTIFY for each order independently. This task is complex and provides many useful features. For echelle spectra a new task modeled on IDENTIFY will operate on the echelle format described above. It will have most of the same features and command syntax for consistency. The primary difference is that it will determine a single dispersion relation for all the orders using the echelle relationship between the orders. For example, one need only mark a few lines in a few orders and then a line list will identify the remaining lines. This is particularly important with high resolution data where there may be very few arc lines in a single order making it impractical to determine an independent dispersion relation for each order. Also there will be an echelle version of the task REIDENTIFY to automatically determine dispersion relations for spectra which are nearly the same as a reference spectrum except for small instrumental shifts.

The output of the dispersion determination will be used by a new task to interpolate the extracted echelle order format to a linear (or log linear) wavelength scale and possibly change format to a single one dimensional spectrum by combining the orders. This is comparable to

the current DISPCOR and COMBINE tasks in the ONEDSPEC package.

The last stages of flux calibration and analysis will use the existing ONEDSPEC package.

In summary, the new echelle package will allow reducing echelle format data as easily as is now the case with a single spectrum from a two dimensional multispectral image rather than multiplying the process and data files by the number of orders. Comments and suggestions are welcome, particularly from people who have used IRAF to reduce echelle data or those contemplating ever more data dense echelles.

Frank Valdes

Current Plotter Devices Supported by IRAF

Batch plotter devices can be interfaced to the IRAF graphics system through the IRAF Simple Graphics Interface (SGI). A device interface is implemented as a user written host FORTRAN or C program taking as input an SGI format metacode file or raster plot file written by the IRAF graphics system. These interface programs or *SGI translators* are relatively easy to implement. Already existing translators can be used as templates. The SGI is discussed in detail in the paper *The IRAF Simple Graphics Interface (SGI)* by Doug Tody, which is included as part of the installation packet with all IRAF distributions.

The following devices are presently supported as SGI graphics devices within IRAF.

UNIX/IRAF:

- Versatec
- Postscript language (Apple LaserWriter)
- Impress language (Imagens)
- QMS vector graphics mode (Talaris Lasergrafix, QUIC command mode)
- DEC LA-100 series line printers (DEC writer IV protocol) [†]

VMS/IRAF:

- Calcomp pen plotters
- Impress language (Imagens)
- QMS vector graphics mode (Talaris Lasergrafix, QUIC command mode)
- Printronix plotter
- Trilog plotter
- Versatec
- Postscript language (Apple LaserWriter) [†]
- HP LaserJet II [∗†]
- HP 7550A Pen Plotter [∗†]
- DEC LN03+ (in TEK mode) [∗†]

† Not supplied with IRAF V2.5; contact the IRAF HOTLINE for distribution

∗ Indicates a translator that was not written at NOAO.

Suzanne Jacoby

Overseas IRAF Shipments

We have received some reports from our overseas sites that unexpected costs have been incurred by them for various charges such as customs clearance and inland freight from the Port of Entry to the recipient site. While we understood that our contract with the carrier was from Tucson to the nearest Port of Entry, we were not aware that these extra costs could be so excessive in certain instances.

We are currently working more closely with our carrier to determine the differences between a door-to-door shipment and one to the nearest Port of Entry. If the site is more than a reasonable distance from the port of entry and if the additional door-to-door cost is not prohibitive, we will have the IRAF distribution delivered directly to the recipient site. However, overseas sites should be forewarned that they may encounter some shipping charges at their end if we either miscalculate the distances or if we feel that the additional charges for the door-to-door delivery are unreasonable.

Jeannette Barnes

A Request to Site Managers

IRAF newsletters are generally sent to everyone on our mailing list. However, in some cases the site manager or contact person is the only one on our mailing list from a particular site. Since the newsletter can contain information of interest to all IRAF users we ask the site manager to please be sure to make the newsletter available to everyone using IRAF at that site.

Bug reports are currently only being sent to the site managers. So it is very important that this information be made available to all IRAF users as well.

Jeannette Barnes

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