Software Tools for NICMOS

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1. Introduction

The NICMOS Software Group (NSG) at the University of Arizona has built a number of software tools in IDL[1] for processing NICMOS data. These tools are described below according to their category.

2. Planning

2.1. HSTField

`HSTField` is based on a program originally written at Goddard by Eliot Malumuth and heavily modified to our purposes at the University of Arizona. The program displays an image of the sky, often a digitized sky survey image, then overlays the Space Telescope apertures allowing the user to pick a prime aperture, orient the telescope, mark guide stars, get coordinates in RA and DEC as well as Ecliptic and Galactic coordinates, and determine the positions of other Space Telescope instruments. This program is designed for planning observations both single and parallel. The `HSTField` display is shown in Figure 1.

2.2. Simimage

`Simimage` is an IDL widget layered on top of the STSDAS task `simimg`. The STSDAS task computes a simulated image for the HST instruments FOC, NICMOS, and WFPC2 given the observing configuration and table of objects. `Simimage` allows a convenient mechanism for determining the necessary parameters plus the additional features of displaying the final result both as an image and shaded surface plot, computing statistics on the result, and generating a group of dithered images across the object field.

3. Editing

3.1. Cal_Edit

`Cal_Edit` is used to edit FITS header keywords in preparation for re-calibrating NICMOS data with CALNICA. The display consists of a set of action buttons at the top of the screen. The various calibration flags can be set using the radio buttons next to each flag. The calibration reference files can be changed by typing directly into the appropriate text fields or the `Pick` button can be pressed to bring up a file selection widget.

3.2. FHE

`FHE` is an IDL program for editing headers of groups of FITS files. It is particulary well suited to editing FITS files with multiple image extensions. One of its primary uses is to

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[1]IDL (Interactive Data Language) is an interactive analysis and visualization program written by Research Systems, Inc..
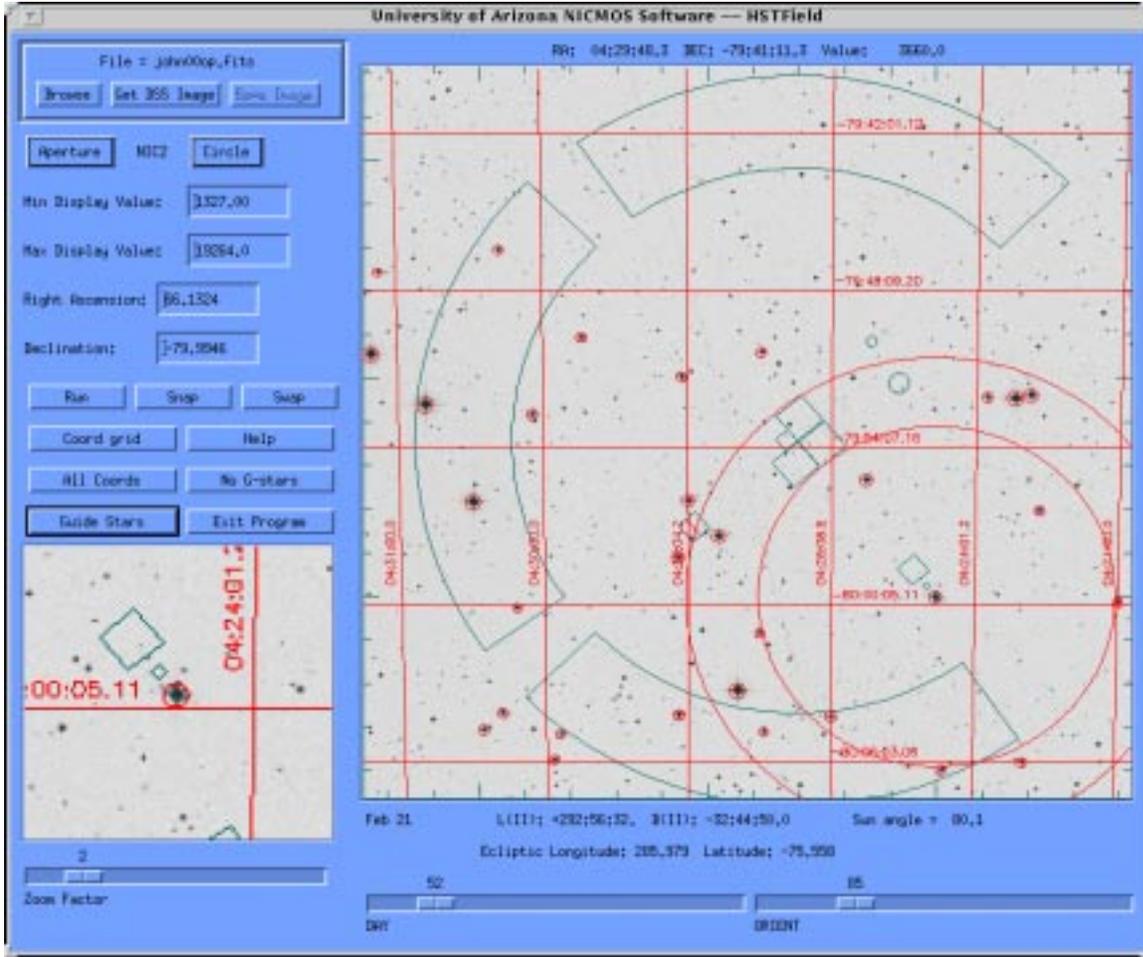
Figure 1.   Example of `HSTField` display with HST apertures and guide stars marked.

edit the calibration switches and reference file keywords in the headers of the NICMOS raw data files. Any keyword in the primary header or any extension header (excluding reserved FITS keywords) may be edited. Keywords may be modified, added, or deleted.

3.3. Maskedit

`Maskedit` is used to edit bad pixel masks. The inputs are the FITS data image and the FITS mask image. There are various keywords that can be used on input to scale the image and to set the "good pixel" value for the mask. The program displays the data image and marks the "bad" pixels based on values in the mask image (bad pixels are circled). The user may then set or unset masked pixels using the mouse buttons. Finally, the new, edited, mask can be saved to a file.

4. Calibration

4.1. Buildref

`Buildref` is an IDL program for building reference files from single FITS images. `Buildref` stitches together single-image FITS files into multi-extension FITS files. The user provides a command file that specifies the input images to be combined, the method of combination,

and any keyword additions or changes that should be made to the standard NICMOS header template files that are used. The outputs of this program are NICMOS standard multi-extension FITS files. `Buildref` also includes support for nonlinearity reference files.

4.2. CALNICA

`CALNICA` is an IDL replication of the `calnica` task in IRAF/STSDAS. Its single argument is the list of files to process. The outputs are a calibrated image with associated extensions and, in the case of MULTIACCUM data, an intermediate file with each readout fully calibrated excluding cosmic ray rejection.

5. Data Analysis

5.1. FITS List Calculator

`FITS List Calculator` (FLC) is a program to process large groups of FITS files together by creating data lists. The program parser supports a simple command syntax including the ability to process pre-defined scripts, do-loops, and if-then-else constructs as well as arithmetic operators, native IDL commands, and UNIX system commands. The program has an image scanner feature to view a list of images in a movie-like format, a more detailed graphics display which includes the image header, full image, single quadrant or zoomed region of the image, and the image histogram. There are also windows for editing pixels in an image and for building lists. The program supports four data types: lists, images, arrays, and scalars. The user may customize the number of each data type by editing the user definitions file. Several mathematical functions for lists are pre-defined for convenience including the computation of image statistics, pixel statistics, medians, means, and first differences.

5.2. Lucy

`Lucy` is a program that generates a deconvolved image from an input image and point spread function (PSF) using the algorithm developed independently by Richardson (1972) and Lucy (1974). The widget is based on the original and accelerated algorithms with optional damping developed by Rick White at STScI. The IDL program displays the original data as well as the result at the end of each iteration.

5.3. NICLook

`NICLook` is a quick look analysis tool for NICMOS data. The widget contains three display windows: full window, zoom window, and graphics window. Statistics may be computed for the full or zoom window. World coordinates may be overlaid on the full window and coordinates may be printed for any pixel in either the full or zoom window. Image arithmetic may be done on any of the five loaded images using arithmetic operators or IDL functions. Two images may be blinked. All commands are logged in a journal file.

5.4. NICMosaic

`NICMosaic` is a tool for mosaicing NICMOS images. The inputs are a list of images to mosaic and, optionally, a table of position data previously output from `NICMosaic`. If no table is given, the program attempts to line up the input images as best it can based on the world coordinate information in the image headers. Image rotation and fractional pixel shifts are used to accomplish this alignment. Once the data are loaded, the user may select two of the images (called the primary and the secondary images) and blink these two images. The user may then shift and rotate the selected primary image to improve the alignment using the buttons and value fields provided. On exiting, a table of positions is written that can

be used by the program `NICMerge` to create a final, mosaic, image. The `NICMosaic` display is shown in Figure 2.
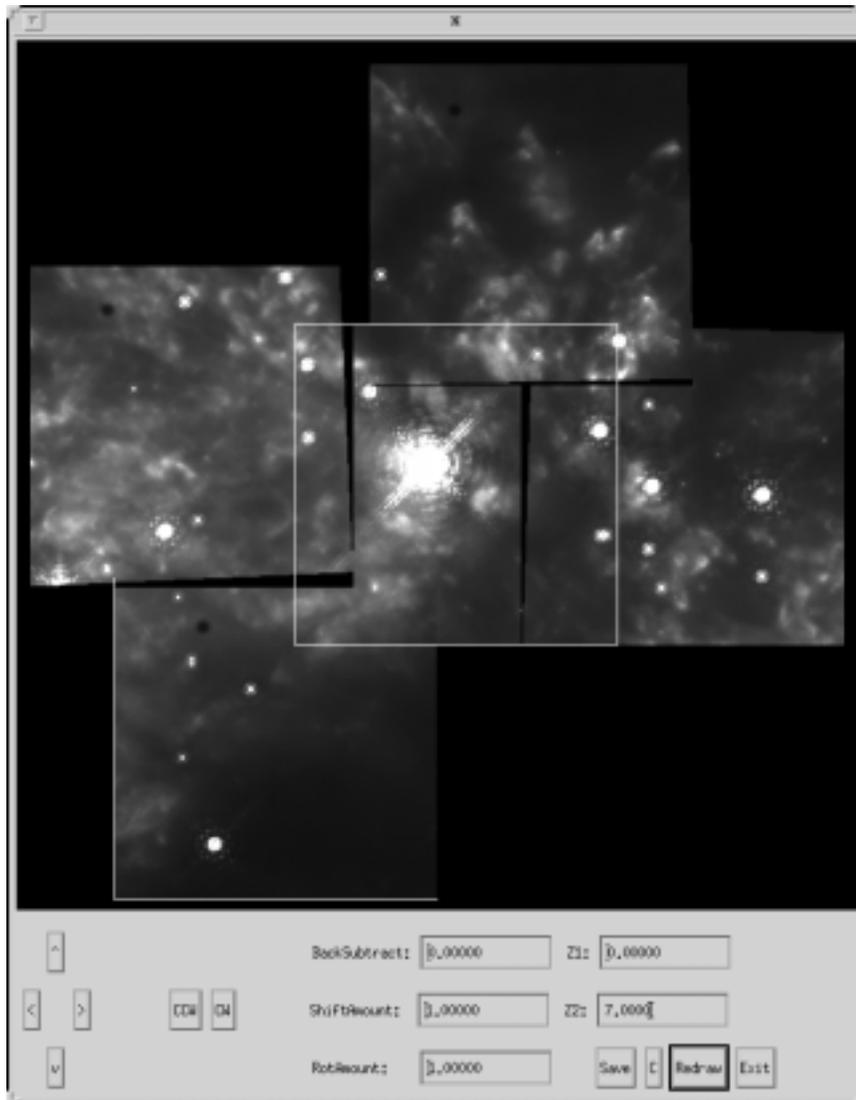

Figure 2.   Example of `NICMosaic` display with sample data.

5.5.   Polar and Polarplot

`Polar` and `Polarplot` are two programs that have been written for the analysis of NICMOS polarization data. `Polar` is a program that takes three images (one from each polarizer) as input, solves the linear equations, and produces as output the "I", "Q", "U", "P", and "Theta" images. `Polarplot`, shown in Figure 3, allows the user to overlay the polarization vectors on the intensity image. This program has many user adjustable parameters to customize the plot such as intensity image color table manipulation, axis, contour map, and polarization vector color manipulation, contour overlay, and thresholds for polarization intensity.
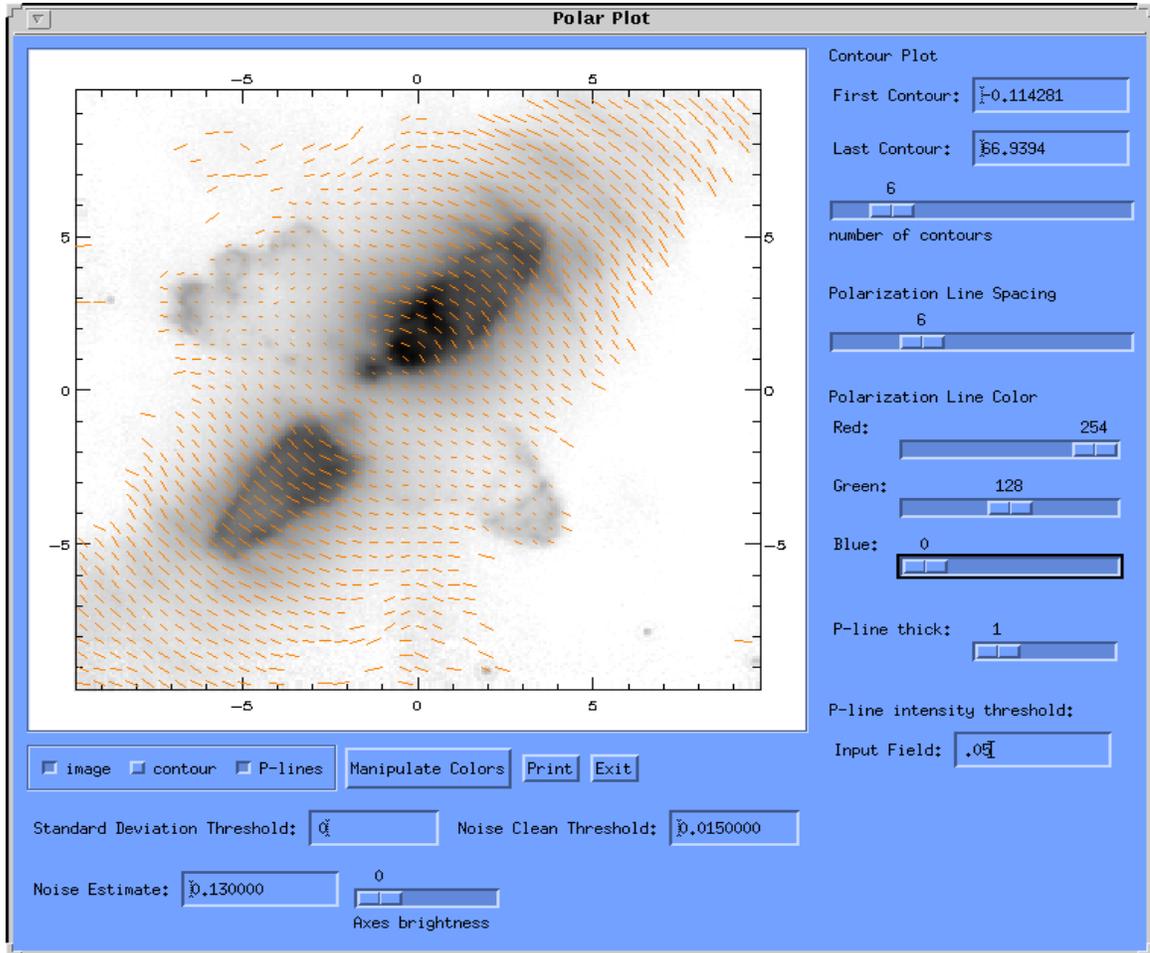
Figure 3. Example of `Polarplot` display: an intensity image is shown overplotted with polarization vectors.

6. Display

6.1. FITSTOOL

`FITSTOOL` is used to examine multiextension FITS files and allows the user to edit the primary and extension headers. The display consists of a file structure window down the left side, a header display window in the upper right, a full image display window in the lower center, and a zoom window in the lower right. There are three header editing buttons above the header display window that are used for adding, deleting, or editing header keywords. Certain header keywords are protected and can't be edited; the keyword "SIMPLE" is an example of a protected keyword. Clicking on any displayed extension in the file structure window will load that extension, image and header, into the appropriate windows. Clicking the left mouse button in the full image display window loads a subsection of the image centered on the cursor into the zoom window. Successive clicks without moving the cursor will increase the zoom factor. The `File` pull down menu at the top of the widget allows the user to load FITS files and save edited files.

6.2. MultiM

`MultiM` is an IDL widget for displaying many images simultaneously. The maximum number of images displayed is 144 by compressing from 256x256 pixels to 64x64 pixels, by either averaging or subsampling. Statistics for each image and each quadrant in the image are generated as data are loaded. Plots may be generated of a row or column in a single image, or of a single pixel across all images. A mean and a standard deviation image can be computed over all images and a median background may be calculated over a group of dithered images. This background may be subtracted and images then registered by world coordinates and averaged together. Bad pixels may be located according to the specific thresholds across all images with a sorted table as the output.

6.3. Super Display Widget

The `Super Display Widget` (SDW) is designed to be a general purpose FITS image viewer. It is very much a program in that is evolving day by day as time allows. In its current state, it allows general image display of multi-extension FITS files, zooming, bad pixel masking, log scaling, rudimentary pixel editing, min/max scaling, general IDL colormap adjustment, and cursor readback.

6.4. Trucolor

`Trucolor` is a program for displaying and printing true color images by loading the three display color tables, red, green, and blue with separate images and overlaying the result. Each color table can be scaled individually to obtain the desired "look". The images may also be log scaled to bring up background detail. This program works on systems with 8-bit or 24-bit color display and produces appropriate output postscript files when the print button is pressed.

7. Utilities

7.1. Delread

`Delread` is a batch program to delete one or more readouts (imsets) from a raw or ima MULTIACCUM file.

7.2. Kwlist

`Kwlist` is a batch program to print a table of keyword values for the specified list of files. The desired keywords are defined in a string array and the files to be read are defined in an ascii text file. The information is printed to the user's screen and to the specified output file.

7.3. Unstitch

`Unstitch` is a batch process to separate the readouts (imsets) of MULTIACCUM files into different files. Output files are named by replacing the last character of the IPPPSSOOT designation with the readout number. Readouts count from one to a maximum of 26 in forward time order (normal NICMOS files are in reverse time order). The inputs are an ascii text file of filenames and an optional path parameter.

References

Richardson, W. H., 1972, J. Opt. Soc. Am. 62, 55
Lucy, L. B., 1974, AJ 79, 745