

EMIMG.DOC

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A. INTRODUCTION

EMIMG is a multi-purpose program for examining and/or manipulating IMAGE data.

B. PROGRAM OPTIONS

This program provides several options driven by a TOUCH-KEY MENU as shown below.

TOUCH-KEY OPTIONS:

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-----  
A   ADD/SUBTRACT two images           N   Add random NOISE  
B   Compute S/N between 2 images      P   CARTESIAN --> POLAR  
C   Compute 1D CIRCULAR average       R   ROTATE image  
D   DISPLAY on graphics device        S   Get STATISTICS  
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                                       program
```

The first option the user must choose is "O", to OPEN a new IMAGE file and read in the array of intensity values. Whenever option "W" is chosen to WRITE an IMAGE array to a disk file, the user must EXIT the program ("E") or choose "O", to OPEN another IMAGE file. You may string together several operations before writing the result to a disk file. Realize that operations are performed sequentially, thus the only way to fully recover an "untouched" IMAGE is to reuse option "O". Also, some operations, such as INTERPOLATION ("I") or ROTATE ("R") result in an IMAGE array with dimensions (NCOL x NROW) different from the original array read in with the "O" option.

OPTION A: ADD/SUBTRACT two IMAGES

This option allows two IMAGE arrays to be added or subtracted. A second IMAGE file is opened after the user enters the appropriate filename, and the intensity data are read into a temporary INTEGER*2 array called TEMP. This routine fails if the second IMAGE array has different dimensions (NCOL x NROW) from the first array (IMGS(FLAG)) read in with the "O" option. The user has the choice to ADD<CR> or SUBTRACT(1) the two IMAGE arrays with the result stored in the array IMGS(FLAG). New statistics for IMGS(FLAG) are then computed and listed at the terminal. Automatic rescaling takes place if the range of data intensities (IMG_MIN to IMG_MAX) falls outside the window allowed for displays on the raster graphics device (usually 0-255).

OPTION C: Compute 1D CIRCULAR average

This option circularly averages the data in IMGS(FLAG). The user specifies the x,y position for the rotation center (XCEN,YCEN) about which the circular average is computed and an interpolation factor (INTERP) which determines how finely the one-dimensional average is sampled. The one-dimensional average is listed at the terminal and, if the user chooses, is stored in an ASCII file (EMIMG.TMP). To EXIT this option, enter a negative value for INTERP.

This option does not alter the values in the array IMGS(FLAG).

OPTION D: DISPLAY the current IMAGE on the graphics screen

This option displays the current IMAGE on the raster graphics screen. The user may erase the screen prior to displaying the IMAGE. The IMAGE may be centered anywhere on the screen by entering values for ICENX, ICENY (Default = 640,512 for the Purdue LEXIDATA). The IMAGE may be displayed on the screen with either the x- and/or y-axes inverted. The user also has the option to surround the IMAGE with an intensity = IMG_BKG (to "float" the IMAGE). There is no provision in this program to "bleed" IMAGES as can be done with EMIMGDSP.

OPTION E: EXIT program

This option terminates the EMIMG program.

OPTION F: FLIP IMAGE about X and/or Y axis

This option flips the values in the IMAGE array in the horizontal (X) and/or vertical (Y) directions. The user chooses from the following option menu:

- (1) INVERT X [X,Y = -X, Y]
 - (2) INVERT Y [X,Y = X,-Y]
 - (3) INVERT X AND Y [X,Y = -X,-Y]
- <CR> No change

After choosing an option the IMAGE data are flipped and replaced in IMGS(FLAG). New statistics for IMGS(FLAG) are then computed and listed at the terminal.

OPTION G: RESCALE IMAGE values INT1_OLD-INT2_OLD to INT1_NEW-INT2_NEW

This option is used to rescale intensity data in IMGS(FLAG) from INT1_OLD-INT2_OLD to INT1_NEW-INT2_NEW. Statistics on the current IMAGE array, IMGS(FLAG), are displayed at the terminal. The user then specifies the range of values ("window") within IMGS(FLAG) which are to be rescaled (Defaults: INT1_OLD = IMG_MIN and INT2_OLD = IMG_MAX) and the new range (INT1_NEW,INT2_NEW) to which they will be scaled. After the data values from INT1_OLD to INT2_OLD are rescaled from INT1_NEW to INT2_NEW, new statistics are computed for the IMGS(FLAG) array and listed at the terminal.

OPTION H: Plot histogram of image array intensities

This option displays a histogram plot of IMAGE intensities on the raster graphics screen. The X-axis plots the intensity value (0-255) and the Y-axis plots the number of pixels in the IMAGE array at each intensity value. Currently the screen is completely cleared before the plot is displayed. The user has the option to plot the data (Y-axis) on either a linear or logarithmic scale. The logarithmic scale is especially useful for large IMAGE arrays (eg. 512x512) where there may be several thousand pixels with a given intensity value.

For the plots on a linear scale the user must specify the range (IXMIN,IXMAX) of intensities to plot, a scale factor for the overall length of the X-axis (SCALEX = integer value), the range (IYMIN,IYMAX) of the Y-axis data, a scale factor for the overall height of the Y-axis (SCALEY = integer value), and the distance between tic marks on the Y-axis (YTIC_STEP).

For plots on a logarithmic scale the user must specify the range (IXMIN,IXMAX) of intensities to plot, a scale factor for the

overall length of the X-axis (SCALEX = integer value), the minimum and maximum extent of the plot in the Y-direction on the screen (IYMIN,IYMAX), and the number of orders of magnitude (NLOG) of the data.

The user has adequate flexibility in replotting the data as desired.

OPTION I: Interpolate the IMAGE array

This option generates a new IMAGE array of dimensions NCOL_NEW x NROW_NEW by interpolating the current NCOLxNROW array in IMGS(FLAG). The user can independently scale the two array dimensions using the following option menu:

```
INTERPOLATION TOUCH-KEY SUB-MENU
-----
A  Set NCOL_NEW x NROW_NEW
B  Set X-scale,Y-scale
I  Perform interpolation
X  X-scale toggle switch: OFF
Y  Y-scale toggle switch: OFF
.  UP/DOWN Toggle for X-scale/Yscale
E  Return to EMIMG main menu
```

Sub-options "A" and "B" are used to enter values for NCOL_NEW and NROW_NEW or X-scale and Y-scale by hand (within reasonable limits: all values must be positive and NCOL_NEW and NROW_NEW are generally restricted to lie between 1 and 1024). Use the "X" and "Y" keys to activate/deactivate the use of the "0-9" and "." keys to interactively change the X-scale and Y-scale factors. The "." key is used to switch the direction (XDIR,YDIR = +/- 1) of changes made to either X-scale or Y-scale. When X-scale or Y-scale are activated, the magnitude of change is given by:

$$X\text{-scale} = X\text{-scale} + XDIR * 0.001 * 10.0^{(N-1)},$$

where N = the number key ("0-9") pressed. Thus, pressing a "1" will change the scale factor by + or -0.001 depending on the value of XDIR or YDIR. Each time data is entered via sub-options "A" or "B" or the scale factors are changed using the "X", "Y", "0-9" and "." keys, the current values for NCOL_NEW, NROW_NEW, X-scale and Y-scale are listed at the bottom of the terminal screen as shown in the following example:

```
NCOL_NEW  NROW_NEW  X-SCALE  Y-SCALE
-----
      64      256      0.500      2.000
```

Option "I" is selected to proceed with the interpolation computation, where the interpolated data are stored in another IMAGE array which becomes the primary IMAGE for further manipulations of the EMIMG program. New statistics are computed for this array and listed at the terminal. At this point, press the "<CR>" to return to the main EMIMG program MENU. If you wish to exit from the interpolation routine without performing the interpolation, press "E" and return directly to the main program MENU.

OPTION J: Apply a rotational symmetry to the image data

This option applies an n-fold rotational symmetry to the IMAGE array. The user identifies a center of rotation (XCEN,YCEN) with the convention that the origin point (1,1) is at the lower left corner of the IMAGE array and also sets the value for NROT (the rotational symmetry order). If NROT is set > 100, a circularly averaged IMAGE is computed. The averaged IMAGE is stored in the original IMGS(FLAG) array. New statistics are computed for this array and listed at the terminal.

OPTION K: Manipulate image data

This routine currently has three sub-options:

- (A) Replace values inside/outside circle with IDENS
- (B) Replace values outside "window" with IMG_AVG.
- (C) Reduce the number of grey-levels

In sub-option "A" a circular boundary is set up with the center at IX,IY and a radius = IR (IX,IY,IR are all INTEGER numbers). Pixel values either inside or outside this boundary are replaced with a new intensity value (IDENS) specified by the user. The "fixed" image is rewritten in IMGS(FLAG), and new statistics are computed and listed at the terminal.

In sub-option "B", density values outside a user specified window (LOI,HII) are replaced with IDENS (Default = IMG_AVG). The "fixed" image is rewritten in IMGS(FLAG), and new statistics are computed and listed at the terminal.

In sub-option "C" the image is divided into a finite number of grey-levels (NLEVELS) set by the user (Limits: 2-256). Please note that once NLEVELS is reduced below 256, the original image intensities can not be correctly restored by resetting NLEVELS = 256 (i.e. this operation is not reversible).

OPTION L: Check/change header parameters

In this option the user may change the value of IMG_BKG and the information in the header record (IMG_TITLE). At present, only values in the range 0-255 may be entered for IMG_BKG. This routine also lists the values for NCOL, NROW, IMG_MIN, IMG_MAX, IMG_AVG and IMG_STD. Please note that, if IMG_BKG or IMG_TITLE are changed, option "W" must be used to save these in a new disk file.

OPTION M: Convert IMAGE data to MAP data

This option converts IMAGE data (INTEGER*2) to MAP data (REAL*4) which are written to a disk file in the standard MAP file format. The user enters a name for the output MAP file. This file can then be examined using the EMMAP* type programs.

OPTION N: Add random noise to image data

This option adds random noise to the IMAGE array. The amount of noise added (NOISE) is specified by the user (Default = IMG_STD). At each pixel in the IMAGE array the amount of NOISE added is computed using a random number generator which generates values in the range from -NOISE to +NOISE. New statistics are computed for the array and the data may be automatically rescaled if the range of densities exceeds predetermined bounds (usually 0-255 as set by the range of intensities that can be displayed on the raster graphics device).

OPTION O: OPEN new image file

This option OPENS a new IMAGE file and reads the intensity values into an NCOL x NROW INTEGER*2 array, called IMGS(1), for further manipulations. Enter the name of the file containing the IMAGE you wish to read in. A switch called IMGFLG(1) is set = 2 to signify that IMGS(1) contains the array to be manipulated by the next operation. Since the program can not manipulate arrays larger than 1024x1024, if NCOL is greater than 1024, a warning is given and the user must read another IMAGE file with option "O" or EXIT the program ("E").

Option "O" must also be used immediately following a WRITE operation ("W"), otherwise the user must EXIT ("E") the program.

OPTION P: Convert image from CARTESIAN --> POLAR

This option converts IMAGE data from Cartesian to polar. The Cartesian IMAGE is subdivided into NRADII annuli with each annulus

sampled NROT times. Enter the number of points/annulus, NROT, (DEFAULT = 128) and the number of annuli, NRADII, (DEFAULT = the smaller of (NCOL/2)-1 and (NROW/2)-1, where NCOL and NROW are the number of columns and rows in the IMAGE). Specify the radius limit, RADIUS, (DEFAULT = NANNULI), and the x,y position (DEFAULT XCEN,YCEN = (NCOL-1)/2,(NROW-1)/2)) defining the center (in the Cartesian system) for computing the polar IMAGE. The user must specify values for NROT and NRADII within defined limits (NROT 1-1024; NRADII 1-256). The default for NRADII is the minimum between (NCOL/2)-1 and (NROW/2)-1.

For example, if you start with a 100 x 50 pixel IMAGE, then, if default values are used for NRADII, NROT, RADIUS, XCEN and YCEN, the polar IMAGE will contain 24 annuli, each sampled 128 times. This polar IMAGE will be computed from the center (49.5,24.5) of the Cartesian IMAGE out to a radius of 24. You may, of course, change any or all of these parameters within defined limits. It's up to the user to be sure not to compute something ridiculous.

OPTION R: Rotate an image

This option rotates the existing IMG array and stores the answer in a new IMG array. Enter the angle (ROT_ANG) by which you wish to rotate the IMAGE (positive value corresponds to a counter-clockwise rotation). The user specifies the background value (Default = IMG_BKG) which fills in the array values outside the boundary imposed by the rotation operation. Please note that the "ENTER" key on the numeric keypad and NOT a "<CR>" must be pressed to enter the default value. If you press <CR>, a value of IMG_BKG = 0 is used.

The size of the rotated array can be restricted to be the same size as the unrotated array (NCOL x NROW) or it can be allowed to expand (NCOL2 x NROW2) as necessary to accommodate the rotated array (unrestricted). If the array size is unrestricted, then NCOL2 and NROW2 are calculated as follows:

$$\text{NCOL2} = \text{IFIX}\{ |\text{NCOL} * \text{COSD}(\text{ROT_ANG})| + |\text{NROW} * \text{SIND}(\text{ROT_ANG})| \}$$

$$\text{NROW2} = \text{IFIX}\{ |\text{NCOL} * \text{SIND}(\text{ROT_ANG})| + |\text{NROW} * \text{COSD}(\text{ROT_ANG})| \}$$

OPTION S: Compute statistics on image array

This determines the minimum (IMG_MIN), maximum (IMG_MAX), average (IMG_AVG), and standard deviation (IMG_STD) of the intensities in the IMAGE array and lists them at the terminal.

OPTION T: TRUNCATE/ADD rows or columns

This option allows rows or columns to be truncated from or added to an IMAGE array. Enter the first and last column and row numbers (i.e. COL1, COL2, ROW1, ROW2) from the initial array to be written to the new array. To add columns or rows to the existing image, the user may specify a range of values (eg. COL1 = -1, COL2 = NCOL+2) such that the original image array is "floated" inside a larger array. In this example, the new array would be the same as the old array with a two pixel border with intensities = IMG_BKG. Note that the user can position all, or a part of the original image within a new array using appropriate values for COL1,COL2,ROW1,ROW2. When the new IMG array is larger than the old IMG array, the user must specify a value for IMG_BKG used to fill in the extra pixels. New statistics are computed for the new array and listed at the terminal.

OPTION W: WRITE current image to a disk file

This option stores the current IMAGE array in a new disk file (name supplied by the user). You may enter a new header if desired or keep the current one. Any arrays currently open are deallocated, and the switches IMGFLG(1) and IMGFLG(2) are both set = 0 to signify the arrays are closed. The user must choose either option "O" to open a new IMAGE file or "E" to EXIT the program.

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FORTRAN code:  DEXTRO3:[TSB.FOR]EMIMG.FOR
Documentation:  DEXTRO3:[TSB.FOR.DOC]EMIMG.DOC                27-Nov-89
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