

**CCDSharp
Lucy-Richardson
Deconvolution Software

Operating Manual**

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Image Processing with SBIG's CCDSharp Software Package

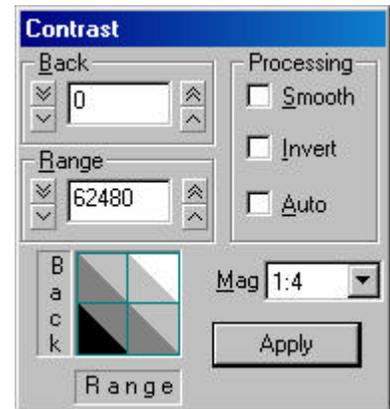
SBIG's CCDSharp processing package will sharpen well exposed CCD images with little noise increase or objectionable artifacts, such as bright rings around stars. The software works with all SBIG images except those captured with the ST-4 and with most 16-bit FITS format images. The program implements the well known Lucy-Richardson algorithm used on Hubble Space Telescope images. It is designed to run on a PC compatible computer using the 32 bit Windows 95 or later Operating Systems. It is also very calculation intensive – a high speed Pentium class machine is strongly recommended. An ST-7 image will process in about 20 minutes on a 133 MHz Pentium.

Installing the Software

CCDSharp is installed by inserting the CCDSharp floppy disk into the A drive, and then from the Start menu selecting RUN, and then entering A:\SETUP.EXE. The installation wizard will guide you through the process just like every other Windows program

Using the Software

1.) Displaying an image: Start the program as you would any Windows program, and load up an image using the File menu's Open command. You can open SBIG compressed and uncompressed images and most 16-bit FITS images. Once the image is on the screen a CONTRAST dialog box appears that allows you to adjust the brightness and contrast to best show the image, as well as invert the image, smooth it, or pick a contrast automatically. You can modify the image display using the little BACK and RANGE box by positioning the mouse over the center of the box, depressing the left mouse button, moving the mouse to select a contrast setting, and then releasing the button. Motion up and down affects the brightness of the image whereas motion left and right affects the contrast of the image. When you release the button the computer then redraws the image. BACK stands for the background pixel signal value in the image, and RANGE refers to the range of pixel signal counts that you wish to be mapped from black to white. The magnification (or zoom level) of the image on the screen can also be adjusted within this dialog box.



Under the VIEW menu you can turn the toolbars on and off. The TOOLBAR is under the menu bar and contains the image processing tools that you can use.



The STATUS BAR is the line at the bottom of the screen that reports Deconvolution status during the process.

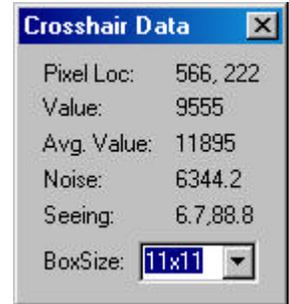


Under the DISPLAY menu you can select either PARAMETERS, which shows the information recorded with the image during acquisition¹, MODIFICATIONS, which shows the alterations that were performed on the image, such as dark subtraction, and CROSSHAIRS, which brings up a crosshairs dialog box.

Under the UTILITIES menu, you have a choice of flipping the image either vertically or horizontally to produce a view matching the object's orientation in the sky.

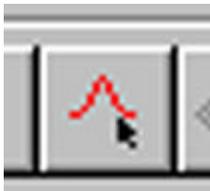
The WINDOWS menu gives you control over the display of multiple images on the screen. When multiple images are shown on the screen, the CONTRAST and CROSSHAIRS dialog boxes give information corresponding to the top, or highlighted image (the bar at the top of the image is colored).

The CROSSHAIRS dialog box displays the pixel location in the image in pixels from the upper left corner, the value of the pixel, the average value of the square region centered on that pixel, the rms variation in the signal counts over the selected region, and a coarse measure of the stellar full width at the half maximum points. The last value is useful when evaluating seeing, or Deconvolution improvement. One can also select the box size to define the region used in the calculations. One word of warning – do not use too small a box size when measuring halfwidths or the reported value will be erroneous, smaller than they actually are. Use a box size that nicely encompasses a bright, but not saturated star. Too big a box will cause little harm!

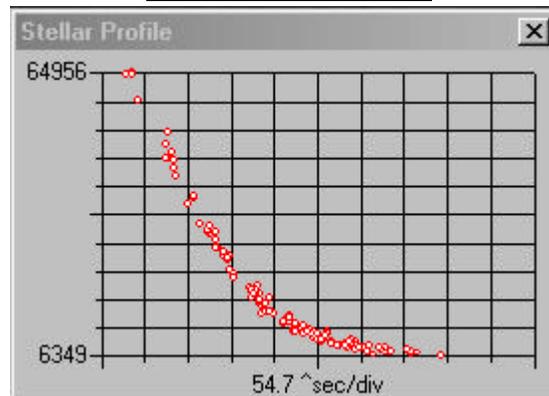


Clicking on a star with the left mouse button while the Gaussian Profile Tool is selected (in the toolbar) will bring up a stellar profile graph, which shows the radial energy distribution of the light in a star.

Gaussian Profile Tool



Stellar Profile Graph

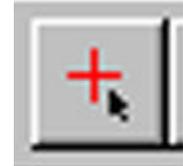


The computer first calculates the centroid of the image, and then displays each pixel in the box (box size selected in the CROSSHAIRS dialog) according to its brightness and distance from the centroid. The horizontal axis is in the units of arcseconds, based upon the focal length shown under PARAMETERS. The telescope parameters cannot be modified within this program, so take care to set them correctly when running CCDOPS. The stellar profile is useful for viewing the quality of the stellar images, and selecting unsaturated stars for use by the Deconvolution algorithm. Saturated stars are obvious since the stellar profile is clearly flat-topped.

¹ Some of the PARAMETERS and MODIFICATIONS information shown for FITS format images may not be 100% accurate as "all FITS images are not created equal". SBIG writes this information to FITS files but not all third party software packages do.

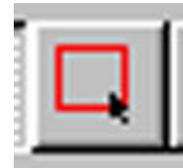
2) Deconvolving the image: When a celestial field is imaged the CCD records the field blurred by the telescope optics, atmospheric turbulence, and tracking errors. Usually the blur is constant across the field. Mathematically the final image is described as the scene convolved with the system point spread function. Deconvolution is the process of removing the blur and recovering the original scene. In practice the blur can only be partially removed due to the finite signal to noise of the recorded image, and the fact that the recorded image is sampled. However even a modest improvement can produce striking results.

To deconvolve an image, first load up the image, and verify that all the preprocessing is complete. Preprocessing usually includes dark subtraction, flat fielding, and perhaps warm and cold pixel removal. Select the Cross Tool from the toolbar, and mark one to eight isolated, not saturated, stars with the crosses by positioning the cursor over them and clicking the left mouse button.



These stars will be used by the routine to determine the point spread function of the system, which is essential in optimizing the Deconvolution. If a star is selected inadvertently, click it again to remove the cross mark.

Next, select the Rectangle Tool from the toolbar, and select the region to be processed in the image by clicking the left mouse button at the upper-left corner of the region, dragging the mouse to the lower-right corner of the region, then releasing the button.



If the placement of the box is not as desired. Simply do it again. If no box is marked the software will process the whole image. When both isolated stars and the selected region have been chosen, click the GO button in the toolbar. Select the number of iterations from the dialog box that pops up, and the Deconvolution process will begin. The number of iterations that is optimal can best be determined by processing a small portion of the image initially before doing the whole image. The denser the image, the better the signal to noise, the greater the number iterations that can be used. Too few iterations doesn't provide much improvement, and too many gives the background and unfeatured portions of the image a "bubbly" look. Five iterations is a good starting point for a well-exposed deep sky object. Deconvolution can be overdone, so we recommend selecting this parameter conservatively.

When the software deconvolves the image it applies a background limit to the process to minimize the rings around bright stars that plagued early image processing programs. While this limit produces a much more pleasing visual image, it can alter the total counts associated with a star slightly. In mathematical terms, the total counts in the star is not conserved. This means that precision photometric analysis should not be performed on deconvolved images, but rather be restricted to the original images.

Save your images² after Deconvolving them. You may wish to use the Save As command to save the image using a different name so as to preserve the original image. The improvement wrought by the Deconvolution process is best seen by displaying the original image next to the processed image with an identical contrast setting. Viewing some stellar profiles in each image further illustrates the improvement. Finally, the red crosses and selection rectangle can be removed from the final display by clicking on the Broom Tool in the toolbar.



² CCDSharp retains the image format when you save images. If you opened an SBIG format image it will be saved in SBIG compressed format. If you opened a FITS format image it will be saved in FITS format.