



## Image Enhancement using DStretch

Visit <http://www.DStretch.com> for more info.

Email [DStretch@prodigy.net](mailto:DStretch@prodigy.net) for the plugin.

DStretch was created by Jon Harman ([JonHarman@prodigy.net](mailto:JonHarman@prodigy.net)).

DStretch is a digital imaging tool created for the enhancement of rock art images. It can make pictographs visible that are nearly invisible to the naked eye. It needs a hue difference to do its enhancement and so gives best results on pictographs, especially faint red or yellow pictographs. It works on standard digital camera photos.

### Digital photography tips

1. Camera: Bigger sensor is better, DSLR's are good. Lens makes a difference.
2. Megapixels: Higher is not necessarily better, but use all you have (See 6.)
3. Best format is tiff or raw. If you use jpeg use the highest quality setting.
4. Use the lowest ISO setting available on your camera.
5. Use flash in low light settings (rockshelters). Avoid direct sun.
6. If shooting jpegs use the highest camera resolution setting (highest megapixels).

### Other Digital Imaging Tools

I highly recommend Irfanview ([www.irfanview.com](http://www.irfanview.com)) for viewing images and for browsing the images in a directory. It's small, fast and free. It has a thumbnail mode and a slideshow mode. During installation, associate it with image file extensions (.jpg, .tif, etc). Additionally it is possible to make ImageJ the default editor for Irfanview.

For uses beyond browsing (i.e. for color cast corrections) PhotoShop is the standard, but is expensive. I don't own PhotoShop, although I do have an old version of Photoshop Elements that I sometimes use. I also use PaintShop Pro and the Gimp (freely available). Over time I have added many useful corrections to DStretch and now I seldom have a need for the other programs. I continue to add new routines to DStretch and welcome suggestions from users.

### Installation

DStretch is a plugin to the imaging program ImageJ (available for free from <http://rsb.info.nih.gov/ij/>). Install ImageJ first then get the DStretch plugin file DStretch\_.jar by email from [dstretch@prodigy.net](mailto:dstretch@prodigy.net) (also free). Put the plugin file into the ImageJ Plugins directory. When you next start ImageJ DStretch menu items will appear in the Plugins menu. To start DStretch choose Plugins->DStretch->DStretch...Run.

# Using DStretch

## Enhancement Names

DStretch does its enhancement using colorspaces. It names the enhancements after the colorspace used. The colorspaces have names like RGB, LAB, YDS, YBK, LDS, and others. Different colorspaces produce different results. The alphabet soup can be confusing at first so this handout explains which colorspaces give best results on which types of rock art. Many of the colorspaces (YDS, YBR, YBK, LDS, LRE) were designed by myself specifically for rock art enhancements.

## Running the Plugin

Start ImageJ. Open the image file using the File->Open menu item or (on a PC) drag the file onto ImageJ. Then choose the Plugins->DStretch->DStretch...run menu item. A copy of the image will appear with the DStretch panel underneath. That panel has a scale field, a number of buttons with colorspace names, plus some other buttons. To do an enhancement choose a scale then click one of the colorspace buttons. The default scale (15) and the YDS button are good starting points. After doing an enhancement the Auto Contrast button can be used to optimize the image contrast. This sometimes improves the image, sometimes not. If not you can use the ImageJ Edit->Undo command to go back to the enhancement. Press the Reset button to get back to the original image. In Simple mode DStretch automatically resets after a stretch so you can browse the effects of different colorspaces by simply clicking on the different buttons.

## Choosing Colorspaces

The colorspaces in the top row give fast enhancements so I use them first. YDS gives good all-around enhancements and works well on yellow pigments. CRGB does very well on faint red pictographs, but produces some wild colors. YBK can do well on black pigments. YBR can give better red colors than YDS. The “L” enhancements are slower, but can give excellent results. LAB and LDS are good all-around enhancements. LDS enhances yellows better. LAB is less sensitive to artifacts caused by jpeg compression. LRE works very well on reds.

## Adjustable Colorspaces

The YXX and LXX buttons access adjustable colorspaces. A dialog pops up that allows you to modify the parameters that govern the colorspace conversion. This gives you the ability to experiment with your own colorspaces. The dialog contains some suggestions for parameters that I have found useful. I often start with stretch parameters (say those for YBK) and change them slightly using the adjustable colorspace to get optimal results.

## Area Selection

ImageJ has the ability to draw an area selection on the image using rectangles, ellipses, and freehand drawing. If an area selection is present the decorrelation stretch will be based on that area, but applied to the entire image. Use this to exclude extraneous parts

of the image (say green bushes near a panel) that can affect the enhancement. To save the area selection for future reference use “File->Save As->Selection”.

### **Flat Button**

This button accesses a routine that flattens the illumination across an image. It can be useful in images where the rock art is partly in shadow. It can be used either before or after a stretch. Before can change the stretch characteristics, after doesn't.

### **CB Button**

CB stands for color balance. I have found this useful when the background surface is strongly colored. Use before or after a stretch.

### **Sat Button**

This button allows for adjustment of the saturation of an image. I use it after a stretch to tame the sometimes wild colors produced by the decorrelation stretch algorithm. Choose a multiplier (default .5) that will multiply the saturation of the image. Choosing 0 gives a grayscale image.

### **Saving Results**

Save your results by clicking on the Save button. This saves the enhancement as a jpeg file and it first asks for the jpeg quality setting. I use 75 when saving enhancements that will not need to be further enhanced. To save as a tiff file use the ImageJ File->Save command. DStretch creates a new name for the image that reflects the enhancement steps done. Check the Save Matrix checkbox in the save dialog to save matrix and colorspace information in a text file for future use. This can be used in Expert mode later to apply the same enhancement to other images for consistent colors changes. It also documents the parameters used in the adjustable colorspace.

### **Direct Enhancement**

You can perform DStretch enhancements without going through the DStretch user interface. Open an image in ImageJ then under the Plugins->DStretch menu choose one of the DStretch...YDS, etc. menu items. After you choose a scale DStretch will perform the enhancement on the image. If you don't like it choose “Edit->Undo”. Other DStretch routines available in direct mode include flatten (even out illumination across the image), invert, color balance, saturation adjustment, and auto contrast.

### **Batch Mode**

Choose this DStretch menu item to run DStretch on all the files in a directory. The output will go to a second directory. After you choose the two directories you get to choose the enhancement, matrix, and output format. Under the matrix chooser you can access Expert mode choices; usually this should be covariance. You can also do an auto contrast after the enhancement by checking the box. The ‘map back’ check box is another Expert option. Usually it should be checked. The output files will be given names that reflect the enhancement chosen.

## Expert Mode

DStretch originally came with a rather complicated user interface that I used when developing the program. To switch to Expert mode just click the button. This can be done at any time. To go back click on the Simple button. The enhancement functionality is a little different in Expert mode. In Simple mode the program will automatically reset before doing a second stretch. This is not done in Expert mode.

### The Expert Panels

In Expert mode more colorspace and more types of enhancement are available. There are two panels available: DStretch and Hue Mask. The DStretch panel is described here. For information on the Hue Mask panel use the help button when in that mode, or visit the help section of the DStretch web page. Many of the buttons (scale, auto contrast, help, CRGB) are the same in Expert mode as in Simple mode. To do a stretch choose the scale, colorspace, and matrix then hit the DStretch button.

### Colorspace Choice

In Expert mode this choice box is under the DStretch button. It gives a wide range of colorspace to use for stretches. Many are the same as in Simple mode, but there are several others available only in Expert mode.

### Matrix Choice

This choice box is to the right of the colorspace choice. The usual choice for a decorrelation stretch is the covariance matrix. The correlation matrix gives different results and works well in RGB colorspace. Choose 'Built-in' or 'Saved' in the matrix chooser to skip the DStretch computation and use either a built-in or previously saved matrix. In 'Saved' mode when you hit the DStretch button a file chooser opens where you can load a previously saved matrix and colorspace. The built-in matrices are ones that have produced interesting results for me on some image. There is a different one for each colorspace. The built-in RGB matrix proved to be so useful that I put it into the CRGB button. This opened up the built-in RGB slot and I put a slightly different matrix there. The LAB built-in matrix has also proved generally useful.

### Map Back Checkbox

The decorrelation stretch algorithm specifies that the matrix should “map back” to the original colorspace. Not mapping back can sometimes give good results so I have made this optional. The CRGB matrix was originally created by a RGB stretch that was not mapped back.

### Other Enhancements

Use the Other Enhance button to access other enhancement routines. Once I had the colorspace code written for the DStretch routines I then implemented some more conventional enhancement ideas for those colorspace. In addition to the colorspace enhancements there are some other useful routines accessed via this button.

Click the help button for more information on these enhancements.