

[Introduction](#)

[Quick Start Guide](#)

[Navigation](#) through files and directories

[Tune](#) - change image brightness distribution and color intensity

[Red eye](#) - remove red-eye effect from electronic flash

[EXIF data](#) - view EXIF data embedded in an image file

[Crop](#) - cut off unwanted margins around an image

[Rotate](#) - level a tilted image or turn by 90 degrees

[Resize](#) - set a new image pixel size or % of original image size

[HDR](#) - high dynamic range: merge two images with different exposure levels

[Panorama](#) - stitch images together to make an ultra-wide image

[Unbend](#) - remove bending from panorama images

[Stretch](#) - stretch and distort selected areas of an image

[Sharpen](#) - sharpen a fuzzy image

[Reduce noise](#) - smooth the appearance of images taken in low light conditions

[Color Depth](#) - reduce color depth (poster effect)

[Color Intensity](#) - change color intensity

[Parameters](#) - change factors affecting fotox operation

[Misc. Functions](#) - Admin menu

[Technical Notes](#)

## **Fotox Introduction**

Fotox is a free open source Linux program for editing image files from a digital camera.

The following functions are currently provided:

- Image Navigator: show large image collections as a pageable screen of thumbnail images. Click on a thumbnail to view full-size or begin an edit session.
- Adjust overexposed or underexposed areas to improve visibility of detail (change exposure level independently for brighter and darker image areas)
- Reduce haze by removing "whiteness" and intensifying colors
- The above two functions can be carried out on the whole image or on a selected region within the image, with gradual blending into the rest of the image
- HDR - high dynamic range imaging: combine an underexposed and overexposed image of the same subject to improve details visible in both bright and dark areas
- Stitch two or more images together to make a wide "panorama" image
- Crop an image (choose area of interest and cut off surrounding margins)
- Rotate an image (level a tilted image, or rotate by 90 degrees)
- Reduce or enlarge an image (rescale pixel dimensions)
- Remove the red-eye effect from electronic flash photos
- Straighten an image with warped perspective
- Stretch or distort a selected image area to produce strange effects
- Sharpen an image (reduce blur or fuzziness)
- Reduce noise in a photo made under low lighting conditions
- Reduce color depth to 7...1 pixels per color (posterize an image)

## **License and Warranty**

Fotox is licensed under the GNU General Public License V2 (Free Software Foundation).

Fotox is not warranted for any purpose, but if you find a bug, I will try to fix it.

## **Origin and Contact**

Fotox originates from the author's web site: <http://kornelix.squarespace.com/fotox>

Other web sites may offer it for download. Modifications may have been made.

If you have questions, suggestions, or a bug to report, contact [kornelix@yahoo.de](mailto:kornelix@yahoo.de)

## Fotox Quick Start

The following is a 1-page quick-guide to help you get started. To better utilize all available functionality, please read the detailed user guide in the following pages.

### toolbar buttons:



index	open navigation window: thumbnail images of current directory
open	file open dialog: select directory / image file to view or edit
prev	move to previous image in the current directory
next	move to next image in the current directory
undo	undo last edit of current image (last 20 edits can be individually undone)
redo	redo last undo (useful to review previous edits to accept or reject)
1x/2x	magnify image to 100% or 200% (toggle) - as much as can fit in window
fit	scale image to fit within window
kill	stop a long-running function before completion
EXIF	view EXIF data if present
save	save the current (modified) image to a file (JPG)
trash	move the current image to trash folder
clone	start a parallel instance of fotox in a new window
quit	exit fotox

### Edit Image menu functions:

tune	change brightness distribution / color intensity for an image or image area
crop	cut out an area of interest and discard the rest
red eye	remove the red-eye effect from an electronic flash photo
rotate	rotate the image an arbitrary angle or turn 90 degrees
resize	resize or rescale the image to a target pixel size or % of original size
HDR	combine brighter and darker images to improve visible detail
panorama	join two images to make a wide (panorama) image
unbend	remove image bending apparent with some panoramas
stretch	select an image area and stretch/distort by dragging the mouse
sharpen	sharpen a fuzzy image
reduce noise	reduce noise in photos made under low light conditions
color depth	reduce color depth (bits per color) to get a poster effect

**Example operation:** to make an HDR image, adjust the brightness and colors, and crop to final size, use the following functions in sequence:

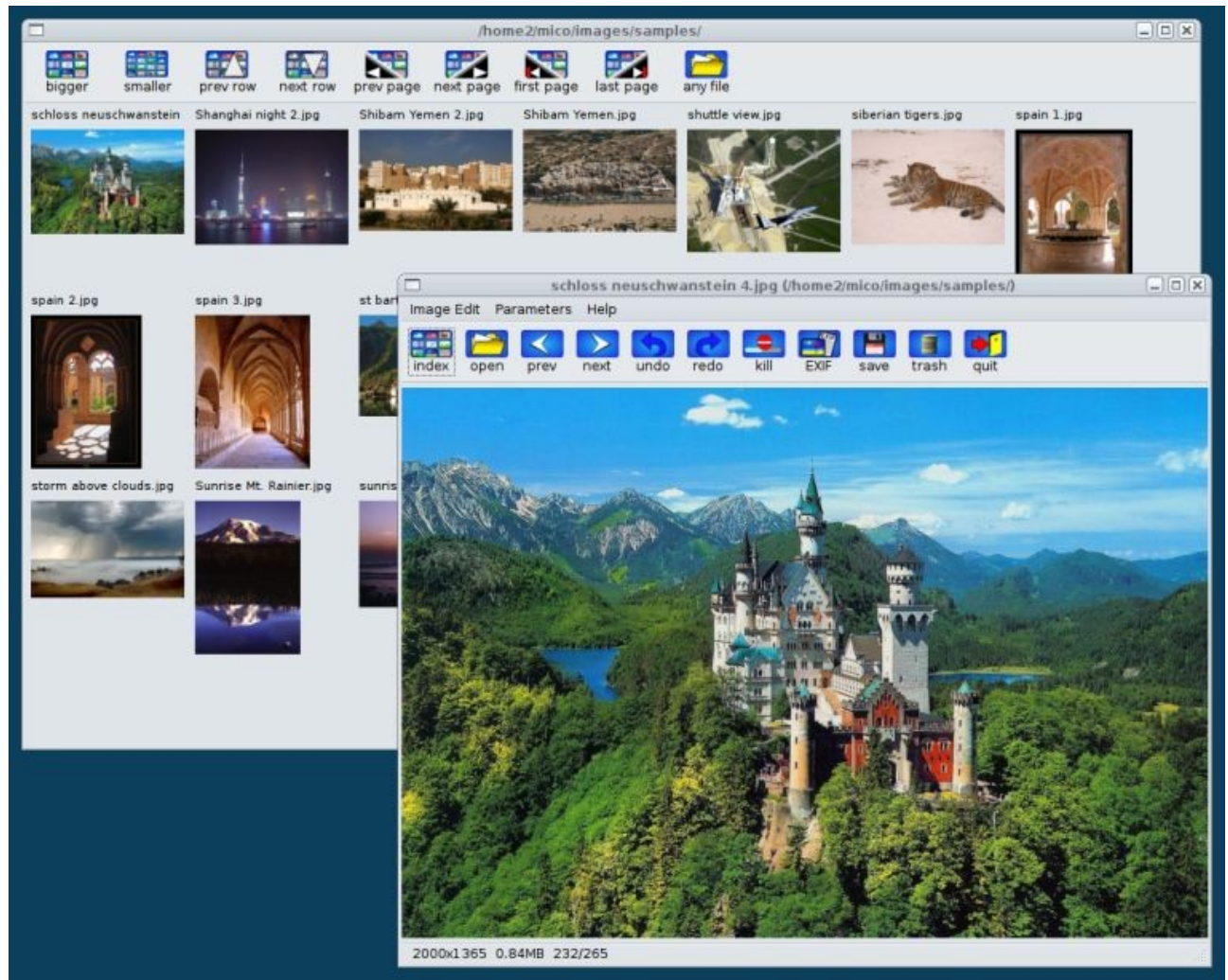
open button	File open dialog: select the first image
HDR menu	Select the 2nd image - will auto-align and merge with the first image. A pop-up dialog allows adjustment of image contribution ratios.
tune menu	Adjust brightness distribution and color for the merged image.
crop menu	Cut image to final size.
save button	Save the image to a new file.

### Keyboard shortcuts for navigation and viewing:

left / right arrow	previous / next image
R / L	rotate clockwise / counterclockwise 90°
S / escape	enter / leave slide show mode (full screen, no menus)
delete	move image to trash

If the image is magnified (1x/2x button) and does not fit in the window, the central portion of the image is visible. A left-mouse click moves the clicked position to the middle.

## Navigation



Begin by opening a file using the [open] button. Choose some image file. Press the [index] button to get a window of thumbnails showing image files in the same directory, starting with the file that was opened. You can now use this window to scroll around the directory and select files by clicking thumbnails. The buttons at the top allow scrolling forward or back by rows or pages. Make the window bigger to show more thumbnails, or use the [bigger] and [smaller] buttons to increase or decrease the thumbnail size and change the number of visible thumbnails accordingly. You can also use the [prev] and [next] buttons in the fotox main window to step through the image files one at a time. Pressing the [index] button in the fotox main window will bring the index window forward with the current file's thumbnail in the upper left corner. Clicking on a thumbnail will bring the fotox main window forward with the selected image.

### Modifying images - general process

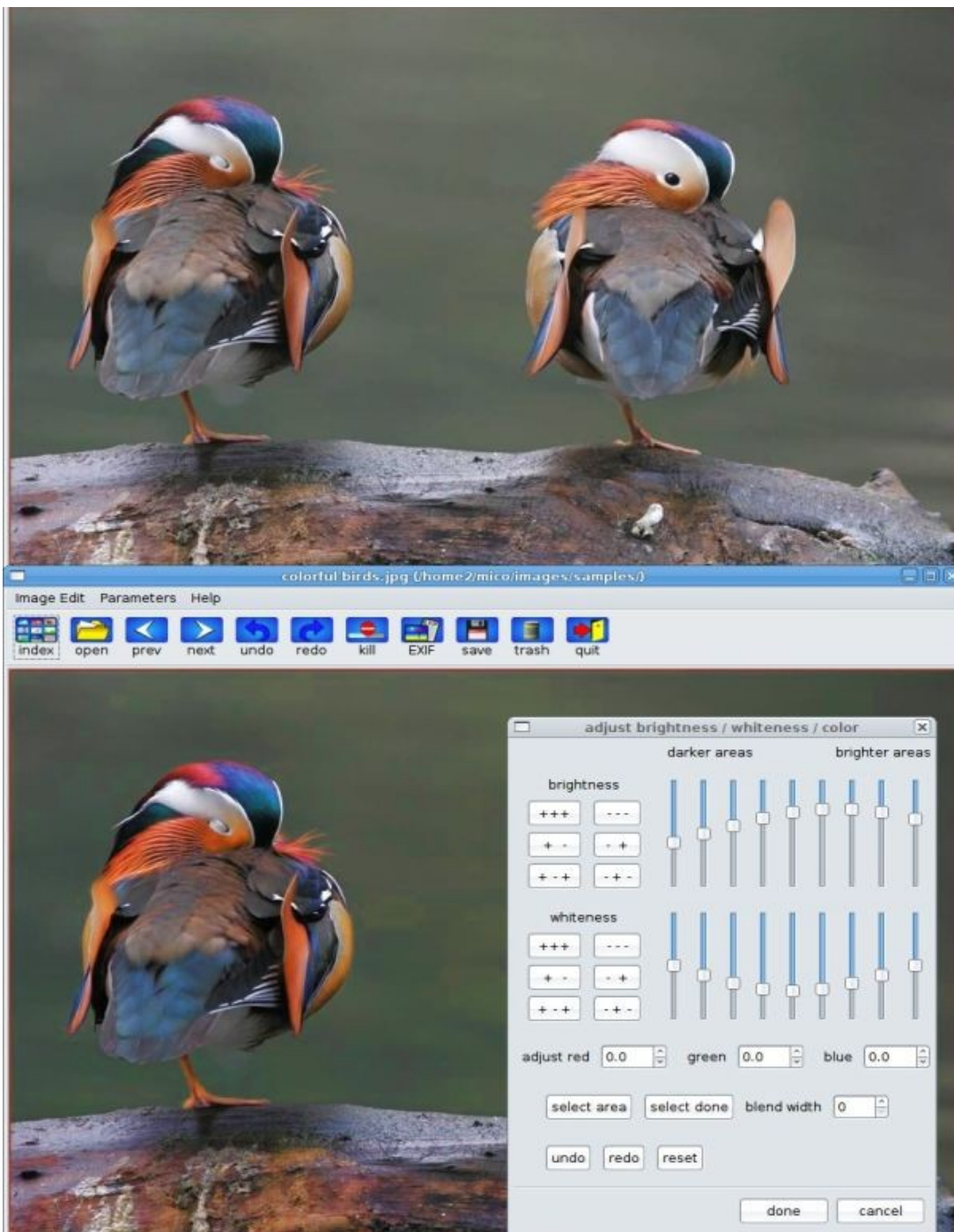
The image in the main window can be operated on with the edit menu functions: tune, crop, red eye, rotate, resize, HDR, panorama, unbend, stretch, sharpen, reduce noise, color depth. You can use these functions in any order, and the changes are accumulated for the current image and shown in the main window. The [undo] and [redo] buttons can be used to review the before/after results for the last 20 edits of the current image. These buttons do not work during an image edit function, but some of these functions have their own method to undo and redo changes during the edit. When finished with an image, use [save] to replace the original file or save as a new file. When you open a new file, the undo memory for the previous file is discarded.



## Tune Function

The tune function adjusts the brightness and whiteness (saturation) of an image independently for 9 brightness zones, using sliding controls. "Whiteness" is the lowest brightness present in all three of the primary colors red, green, and blue. Up to this amount can be removed from all three colors, or added to them. In the above example, the sliding controls show the adjustments made to increase both contrast and color. Compare the modified bird in the lower image with the original bird above.

Usage: Open an image with [open] and then select the tune menu function. The dialog with the sliders starts up. Adjust the sliders and view the results. If the image is large, it may take a few seconds to update after a slider is moved. When you are satisfied, use the [done] button to exit the dialog. The left-side buttons can be used to move all the sliders at once: up, down, or in a profile that slopes or curves up or down. Reset all controls with [reset]. Click [cancel] to abandon the changes. After leaving the tune dialog, the [undo] and [redo] buttons (at the top) can be used to review the before and after results.



It is possible to modify part of an image while leaving the rest unchanged. This can be useful to brighten or soften one area, or make a particular object stand out. Use the [select area] button to start the process. Use the mouse to outline the target area. Hold the left mouse button and drag the mouse to draw a dotted line. Release the button and press again to fix the end of the line and start a new connecting line from that point. Continue around the target area until it is surrounded with connected dotted lines (an arbitrary polygon). You can use the right mouse button to undo the last line(s). Alternatively, just click the left mouse button to define each new point of the surrounding polygon. When the polygon is nearly closed, click the [select done] button to close the last gap. Now you can move the sliders and see the effects within the enclosed area. The [blend width] value determines the number of pixels over which the modified area is blended into the rest of the image. Zero gives a hard edge and higher values give an increasingly wider transition band.

Determining which pixels are inside the polygon, and how far they are from the nearest edge (for the blending calculation) is very processor intensive. If you have enclosed a large area using hundreds of separate lines, up to a minute may be needed. This is done once, when [select done] is pressed. Subsequent slider movements are processed very fast.

If any side of the enclosing polygon hugs the image edge (within 5 pixels), then the blending process is suspended along this edge, where there is nothing to blend with.

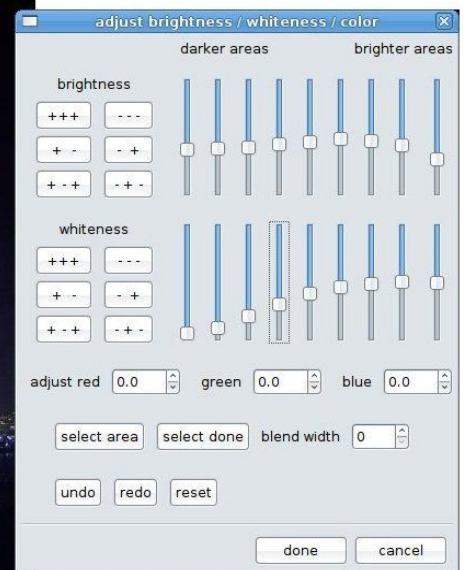


The bird on the right has been color enhanced, and the other bird was not changed.



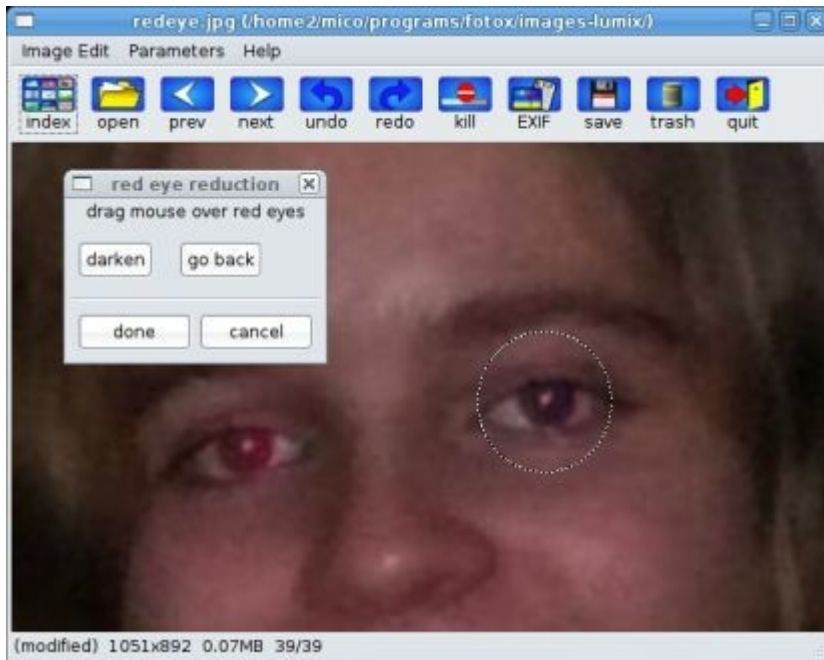
## Tune - Defog

The example below illustrates how to reduce fog or haze. Whiteness has been reduced in the darker image areas where the haze dominates. Contrast has been increased slightly for the dark and midrange areas (ascending brightness adjustments), and decreased for the brightest areas (descending brightness adjustments).



## Red Eye Function

This function reduces the red-eye effect from electronic flash photos. Select an image and then the red eye menu function. The red eye reduction dialog (below) pops-up. Click on a red eye to magnify it and center in the window. Place the cursor "+" over the center of the red eye. Hold the left mouse button while dragging the cursor down and to the right. A dotted circle will appear enclosing the red eye. Repeat if needed to get the red eye centered in the circle (roughly). Press [darken] repeatedly while watching the red eye darken, and stop when it is dark enough. If you go too far, the eyelids may start to darken. The button [go back] can be used to step back. You can do multiple red eyes in sequence. The [cancel] button will discard all accumulated changes. After closing the dialog with [done], you can use [undo] and [redo] to review the before and after status.



## EXIF Data Display

If the package `exiv2` is installed, the button [EXIF] will display EXIF data if available in the current image file. This is data such as photo date and time, shutter speed, focal length, pixel dimensions, etc. that is stored by most cameras inside the image. If the image size is modified (crop, resize, panorama) and the image is then saved, the EXIF data is updated and stored with the new image.



## Crop Function

The HDR and panorama functions will leave some black margins around the edges where the images did not overlap. Use the crop function to remove these areas, or any other unwanted margins.

Select the crop menu function. An initial dotted line rectangle is drawn, encompassing about 60% of the image. Areas outside the final rectangle will be discarded. A dialog pops up asking you to drag the mouse to modify the rectangle as desired. Drag the dialog box out of the way if needed. Click anywhere to redraw the rectangle with the nearest corner at the clicked position. You can also drag any corner of the rectangle to a new position. When done, press the [crop] button in the dialog box. The selected area is cut out and expanded to fill the window. Press the [cancel] button to abandon the operation.

The new pixel dimensions of the cropped image are shown on the status bar while the crop rectangle is being adjusted.

## Rotate Function

The rotate menu function starts a dialog to rotate the image clockwise (+) or counterclockwise (-) in steps of 0.1, 1, 10, or 90 degrees. Use the small steps to level a tilted image and then crop the image. Use the 90 degree steps to convert an image taken in vertical format to horizontal. No resolution is lost with 90 degree rotation. For other angles, the loss of resolution varies up to about 1/2 pixel. The output image is increased to accommodate the rotated input image without size reduction - e.g. a 100 x 100 image rotated 45 degrees will be inside a new image box of 141 x 141 pixels.

To make a panorama image from two images made in vertical format:



## Resize Function

This function allows setting a new image width and height in pixels, or as a percent of the original size. Open an image and then select the resize menu function. A dialog is initiated. You can input the new width and height directly. Buttons are present for setting the new size to 2/3, 1/2, 1/3, or 1/4 of the original size. Using one of these ratios will minimize loss of resolution. If the lock ratio box is checked, the original width / height ratio will be preserved, meaning that if one dimension is changed, the other dimension will be changed to match. After setting the desired new dimensions, use the [apply] button to perform the rescale. The window may look the same, but the image behind it is rescaled. The status bar shows the new dimensions. The file size is not updated until the modified image is saved.

## **HDR Function** (high dynamic range imaging)

HDR combines (overlays) two images of the same subject with different exposure levels (underexposed and overexposed). The combined image has improved visibility of detail in both the darker and brighter areas, in effect using information from the brighter image for the darker areas, and from the darker image for the brighter areas.

Many digital cameras do exposure bracketing: take multiple shots in quick succession with different exposure levels. You can combine two such images to make a better one.

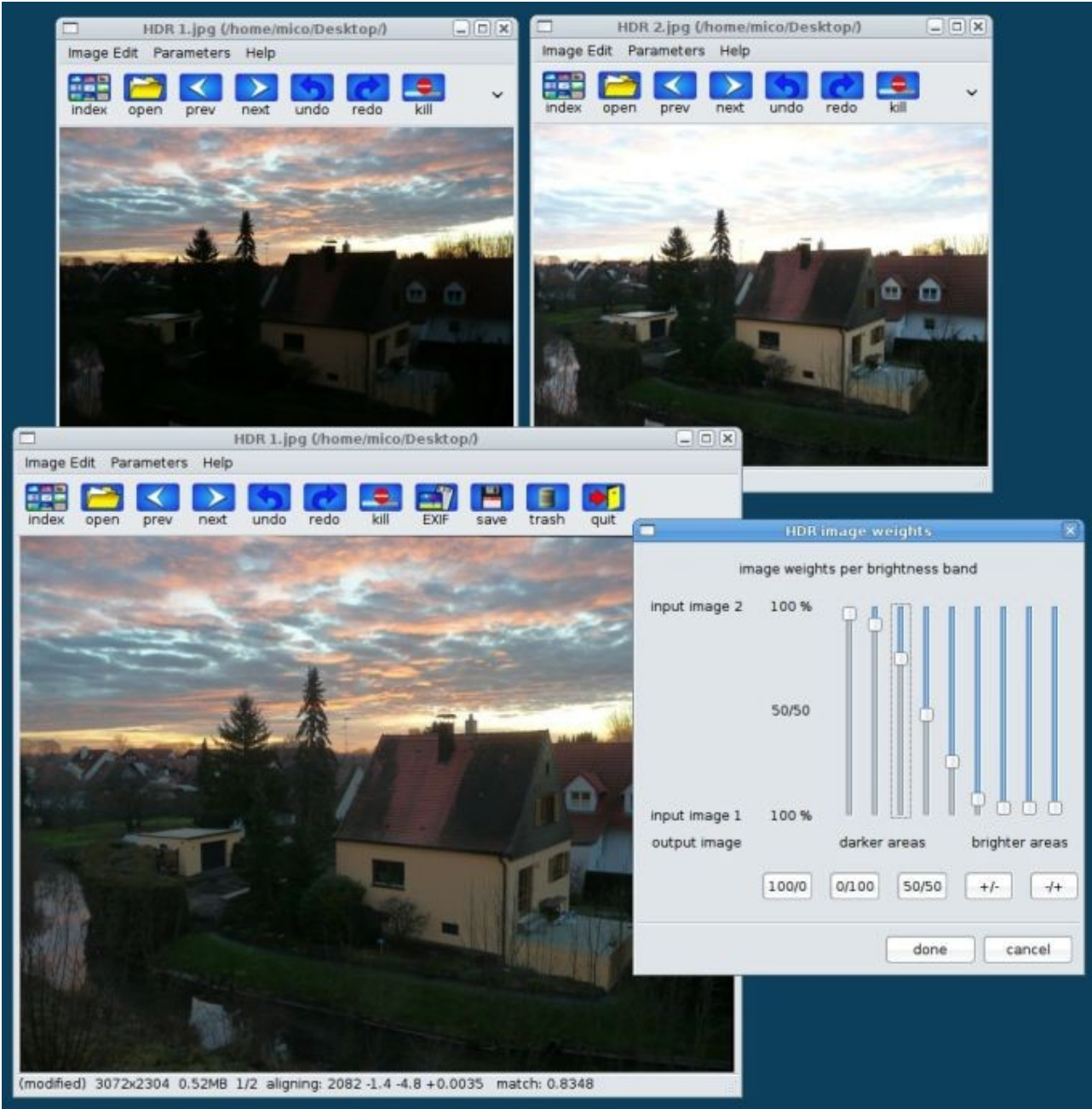
Usage: Open the 1st image file with the [open] button, then select the HDR menu function. A file open dialog is started to select the 2nd image file. The two images are aligned and combined automatically. The images may have a significant relative offset and rotation (especially if the camera was manually adjusted between shots), and some time may be required for the program to find the best alignment. When done, the combined image is shown, along with a dialog for manual fine adjustment.

The example below shows the two input images and the output image, as adjusted by the sliding controls in the dialog box.

The 9 sliders define 8 brightness bands where the contribution from each image (image weights in the dialog) can be adjusted independently. The left sliders govern the darkest areas of the combined image, and the remaining sliders govern progressively brighter areas. The initial settings define a ramp whereby the darkest areas are taken mostly from the brighter image, and the brightest areas mostly from the darker image. Play with the sliders to find the best settings. The sliders are very responsive, but the image may need a few seconds to catch up with the slider values, especially if the image is large.

The image alignment algorithm is accurate up to about 3 degrees of rotation and 5% image offset. If you make the exposure adjustment manually between shots, take reasonable care to aim at the same distant point and keep the camera level. If things move between the two shots (clouds, windblown trees), fuzziness and ghosting cannot be avoided.

Adjustment of HDR image blending



## Panorama Function

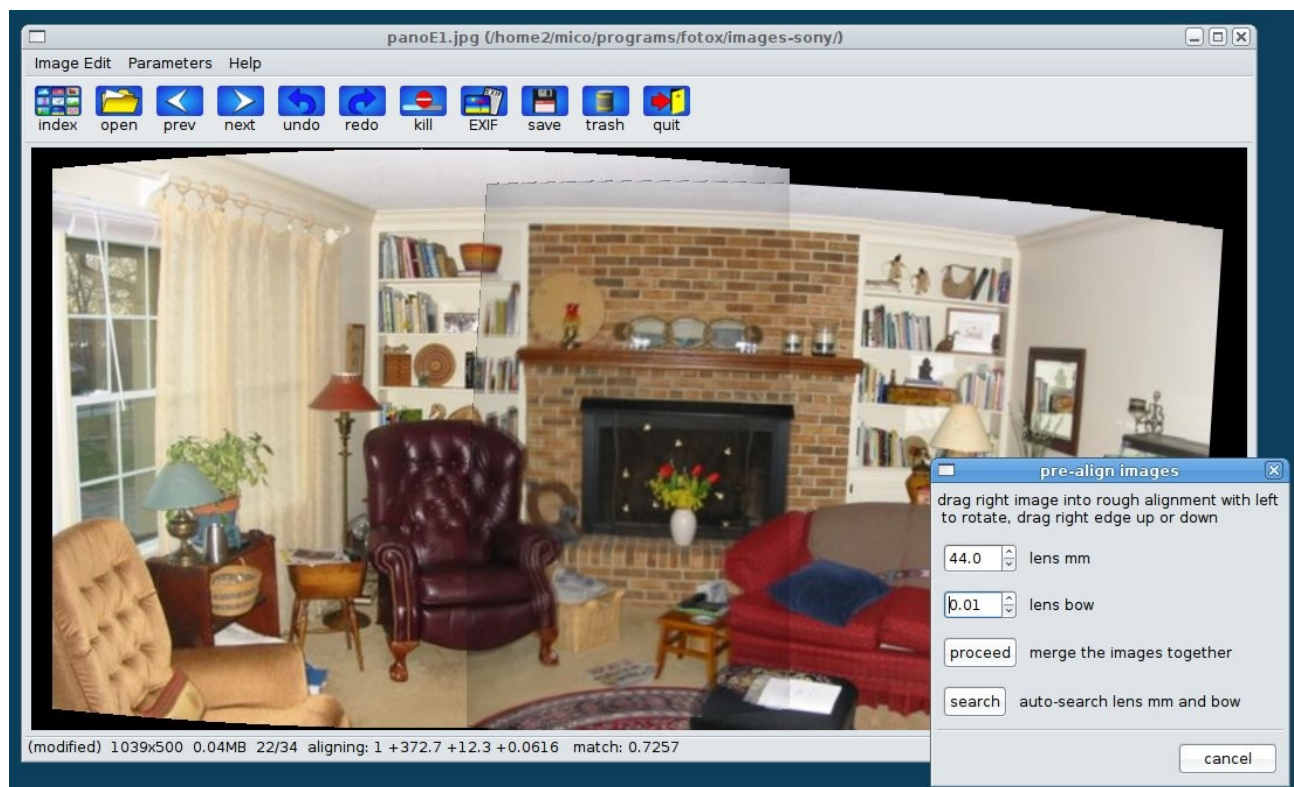
This function stitches two images together to make a wide image or panorama. The images must overlap by 10% or more, so that the program can find where they coincide and put them together.

Before using panorama, you need to set two parameters (lens\_mm and lens\_bow) to match your camera lens. This small one-time job is required for each camera lens you plan to use for panoramas. The procedure for this is described later, but read this section first.

Press the [open] button and select the left image file. Select the panorama menu function. A file open dialog is started to select the right image file. The two images are initially joined with a small transparent overlap. A dialog pops up (below) asking you to move the right image into rough alignment with the left image. Do this with the mouse, dragging the right image leftwards until it is within a few pixels of the best match with the left image. Rotate the right image if needed, by dragging the right edge up or down.

The images should be correctly curved and fit together well. If they do not fit, you need to do the one-time job mentioned above, to set the lens parameters for your camera. You can adjust these parameters within the dialog until the images fit reasonably well, and this may be good enough for most panorama jobs.

### Image alignment, showing rotation and curvature

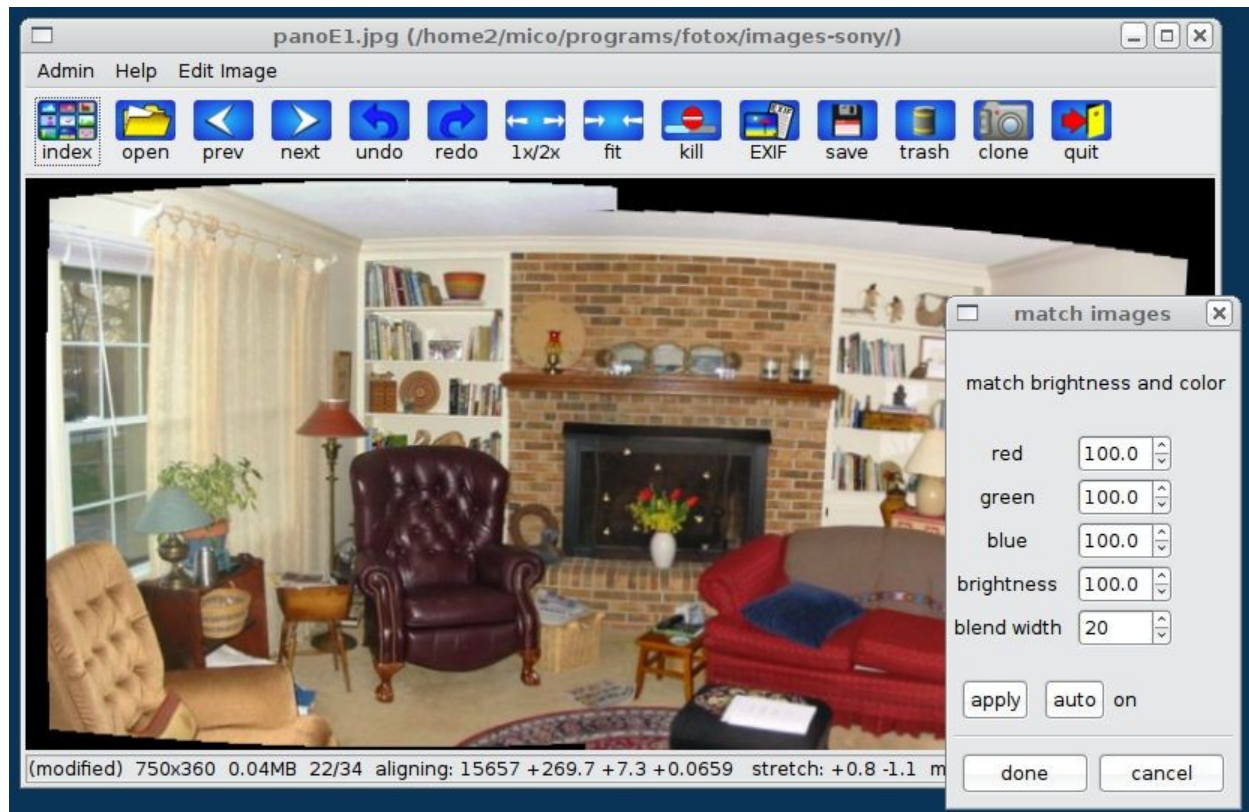


Press [proceed] when rough alignment is finished, and the program will do fine alignment and join the images. Internally, the right image is shifted and rotated and the degree of match is evaluated. This is done with increasing image sizes until the best match is found within a fraction of a pixel. The process needs 30 seconds or more depending on CPU speed.



When fine alignment is complete, the combined image is displayed. A dialog pops up for fine adjustment of brightness and color match (below). You will usually see a sharp border because the two images do not have the same brightness and color balance. The [auto] button can be used to perform an automatic color match, which is usually the best starting point. This button toggles the auto color match on and off. The other controls allow you to make additional changes to better match the two images. Changes are made to both images, in opposite directions. Change the values for brightness and color and press the [apply] button to see the results. The "blend width" input governs how the two images are blended together: the color balance is gradually shifted over this many pixels, to mask imbalances that cannot be fully corrected. The default is 1 pixel, which makes any brightness or color differences look obvious.

### Brightness and color matching and image blending



When done, you can use the unbend, rotate, crop, and tune functions for final adjustments, and then save the image to a file using the save function. The example above needs to be rotated a few degrees to level the room, unbent, and the black areas need to be cut off.

Panoramas of three or more images can be done as follows: After joining the first two images, Start the panorama function again to open and join a 3rd image. In this manner you can string together several images. New images are always joined on the right.

### **Automatic lens adjustment function**

The [search] button in the pre-alignment dialog initiates an automated search for optimum lens parameters, lens\_mm (focal length) and lens\_bow (barrel or pincushion distortion).

Use a suitable image pair: the subject is 20+ meters away, and the images have a low horizon difference and relative rotation. Input your nominal lens focal length for lens\_mm. (for digital cameras, use the 35 mm film camera equivalent). Use zero for lens\_bow. After doing a decent pre-align, press the [search] button and wait a while for the results. Do this a second time and observe the changes. If the values remain consistent, you can use them for your panoramas. Use the parameter edit function (parameters menu) to input your new default values for lens\_mm and lens\_bow, and then save the parameters file so the values will be preserved for the next session. See the parameter edit function below.

The auto\_lens function steps through a range of values for lens\_mm, lens\_bow, and the image alignment offsets for x, y, and theta. It searches for the lens values that give the best alignment results for the given images. Each iteration takes a minute or more, but you only need to do this once to characterize a given camera lens. The next section describes an alternative manual method for setting these parameters.

### **Setting the lens parameters manually**

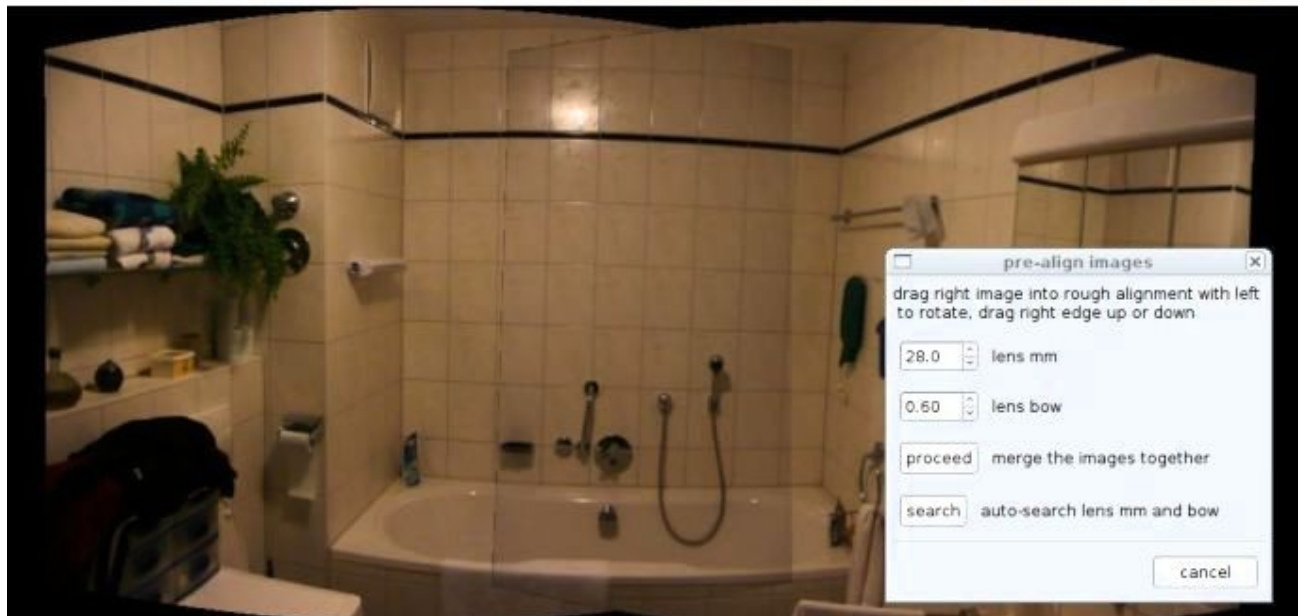
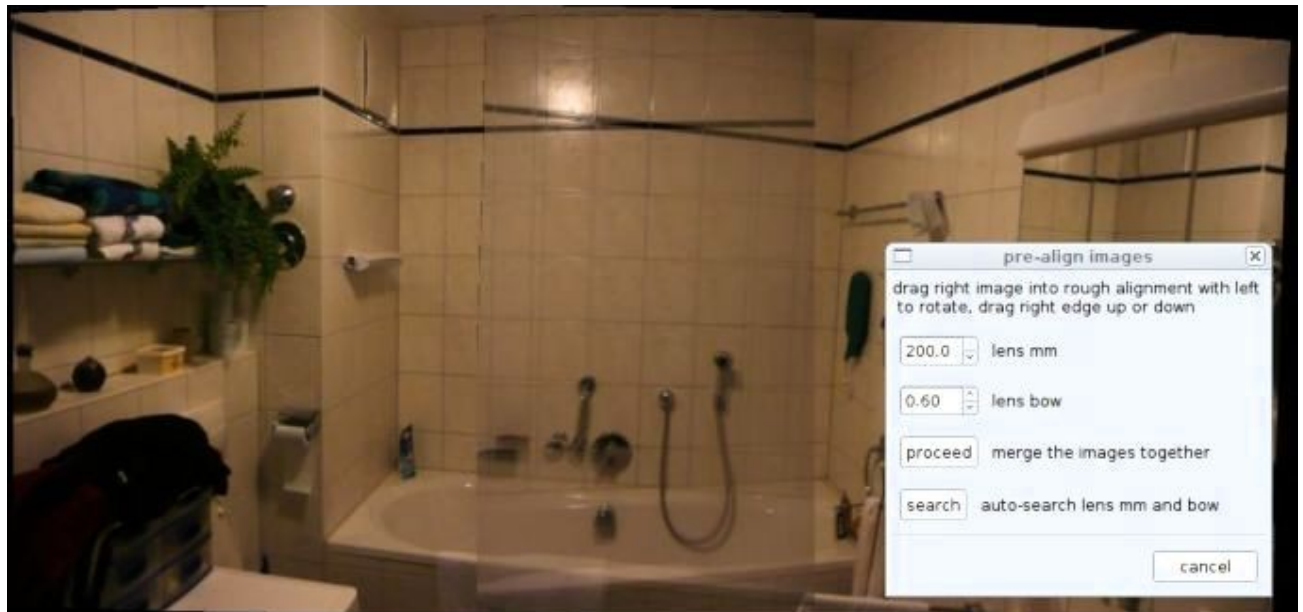
Making two partly-overlapping images align with each-other requires them to be curved inward or shrunk in the overlapping areas. Also, a lens may have barrel or pincushion distortion, adding curvature at the image edges and reducing how well they can fit.

Make a panorama image of a brick or tile wall with about 40% image overlap. Within the panorama pre-align process, adjust lens\_mm and lens\_bow until the overlapping vertical and horizontal lines coincide. The example below shows a tiled wall before and after these adjustments. When making the two images, be sure to turn the camera on a vertical axis through the lens, minimizing lateral movement and rotation in other axes - otherwise the images may fit poorly and your factors may not be optimum.

The lens\_mm factor is roughly the focal length of the camera lens (35mm film camera equivalent). This may be used as a starting point for a more precise adjustment. The lens\_bow factor depends on the lens and may be positive or negative.

After setting the values for lens\_mm and lens\_bow manually, try the auto\_lens button to find more precise values automatically. Do this again to check that the values are stable. When done, save the values for lens\_mm and lens\_bow using the parameter edit function.

## Setting the lens parameters



## Unbend Function

Panoramas of nearby subjects (typically buildings or interior rooms) may show a noticeable bending effect (e.g. flat walls look curved). This bending of the images was necessary in the panorama process in order for the images to fit together. For remote subjects (typically landscapes) this is barely noticeable.

Usage: Select the unbend menu. The dotted lines are the vertical and horizontal "horizons" that are the unbend axes. Click the mouse near the ends of these lines to move them. Input values for horizontal and vertical unbend and press the [apply] button to see the effect. Increase or decrease the values and repeat until satisfied. Move the axes and press [apply] to change the centers of unbending.

input images



completed panorama



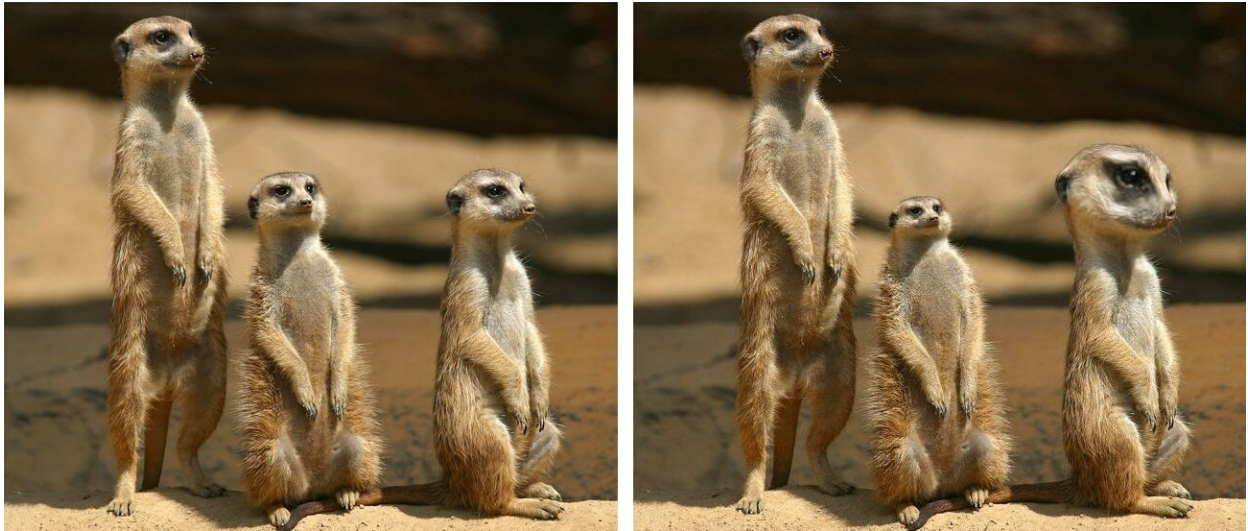
unbent panorama





## Stretch Function

This function can make deliberate distortions in an image. You can select an image area and drag the mouse to stretch this area with respect to the rest of the image. The image reacts like it was made of rubber. The movement is maximum at the mouse pointer and declines to zero at the edges of the selected area. Many mouse drags of different lengths and directions can be combined to achieve the desired results. The example below illustrates the potential.



Usage: select the stretch menu function. A dialog pops up with a few instructions and buttons. Select the button [select area] to start the process of selecting the target area. Use the mouse to outline the target area. Hold the left mouse button and drag the mouse to draw a dotted line. Release the button and press again to fix the end of the line and start a new connecting line from that point. Continue around the target area until it is surrounded with connected dotted lines (an arbitrary polygon). You can use the right mouse button to undo the last line(s). Alternatively, just click the left mouse button to define each new point of the surrounding polygon. When the polygon is nearly closed, click [start stretch] to close the final gap and activate stretching for this area. Now drag the mouse anywhere within the selected area and the picture will move with the mouse pointer. You can drag many times and in many directions within the same area until you get the desired result. This may take a little practice. The [undo stretch] button will remove the most recent stretch (up to the last 100 can be undone). When finished, select [select area] to select another area and do some more stretches, or select [done] to exit the function. The [cancel] button removes all stretches made during the session.

## Sharpen Function

This function sharpens an image by moving brightness from darker pixels to adjacent brighter pixels, this increasing contrast along edges. This is done separately for each primary color.

The test images below show the capabilities and limitations. The left image is the original sharp image. The middle image was made from the left image by resizing to 67%, then to 150%, then to 67%, then to 150% (each pixel averages 5.1 of the original pixels). The right image was sharpened from the middle image (view this page at >100% size to better see the differences).



Usage: after starting the function, a dialog pops up. Enter a value in the sharpen control and wait for the sharpen process to complete. Repeat with a higher or lower value and watch the image until satisfied. If you go too far, meaningless noise will start to appear. Values around 10 seem to work the best. The processing time increases with both the sharpness value and the image size, and can take several seconds to complete.

When done, you can use the [undo] and [redo] buttons to review the result.

## Noise Reduction function

This function reduces the noise present in photos taken under poor lighting conditions (uniformly colored surfaces appear mottled). In the pop-up dialog, press the [reduce] button repeatedly while watching the image. If you go too far, sharpness and detail will be lost. Use the [reset] button to start over. When done, you can use the [undo] and [redo] buttons to review the result.





## Color Depth reduction

This function changes the color depth from the JPEG normal of 8 bits per color to any value between 1 and 8 bits per color. At 8 bits per color, there are 256 shades available for each of the primary colors red, green and blue, giving  $256 \times 256 \times 256 = 16.77$  million colors. At 4 bits per color there are 16 shades per color available, or 4096 colors.

After starting the function, a dialog pops up. Use the spin control to choose a color depth of 1 to 8 bits per color, and press the [apply] button. Real differences start to become apparent below 6 bits per color. The example here is 8 bits and 3 bits per color.





## Color Intensity function

This function changes the color intensity on a scale from 0 to 100.

Use the dialog to enter a new color intensity from 0 to 100:

- 0 no color (black/white or gray scale image)
- 50 normal color, defined by the original, unmodified image
- 100 intensified color

In-between values give in-between results.

Press the [apply] button after entering a new color value.

The example below was done with color values of 0, 50, and 100.



Between 0 and 50, all RGB color values are ramped linearly from the mean gray-scale value of  $(R+G+B)/3$  to the original, unmodified values R,G,B. Between 50 and 100 the color values are increased by the same ratio until the largest RGB value reaches the maximum allowed value of 255. This is deliberately scaled back for darker pixels and "grayer" pixels, because the results are useless if dark areas become as bright as bright areas, and gray areas become white.

The table below illustrates what happens:

intensity	B&W 0	normal 50	max. 100	
red	200	150	151	bright pixel
green	200	200	201	
blue	200	250	252	
red	20	10	21	dark pixel
green	20	20	42	
blue	20	30	64	
red	0	0	0	black pixel
green	0	0	0	
blue	0	0	0	
red	50	50	50	gray pixel
green	50	50	50	
blue	50	50	50	
red	50	0	0	colorful pixel
green	50	50	80	
blue	50	100	159	

## Parameter Edit function

The HDR and panorama functions superimpose and compare two images, pixel by pixel. Their relative x/y offsets and rotation are varied to search for the best overlay position. The initial image sizes are small, and get larger with each stage. The best fit at each stage is the starting point for the next stage. The parameters described here control the process.

Use the edit parameters menu to start the function. Change the values shown in the dialog and use the [save] button to save them to the default file "parameters", which is loaded each time fotox is started (/home/<user>/.fotox/parameters).

The parameter "pixel sample size" determines how many pixels are compared at each stage, for both comp and panorama. The remaining parameters relate only to panorama.

The panorama lens factors depend on the camera lens (focal length and distortion), and are more likely to need customizing. This process was described previously.

The default values for the other parameters should work fine, but if you have an image that does not align correctly, you can adjust these parameters to be more conservative (and slower). More details can be found below.

You can have multiple profiles, for different cameras/lenses or normal vs. problem images. The default parameter file /home/<user>/.fotox/parameters is loaded each time fotox is started. If you need multiple parameter files, you must manage their names and load and save them on your own. In the parameter dialog, use the buttons [load] and [save] to load or save a parameters file.

parameter name	default	description
pixel sample size	5	How many pixels (x1000) are sampled to compare images during alignment. Impacts execution time.
jpg save quality	80	Quality vs compression for saved jpg files. Explained below.
pano lens mm	40	This factor curves images in the overlap area to make overlay and alignment possible.
pano lens bow	0	Compensates for lens barrel distortion.
pano prealign size	500	Image size (pixels) for prealignment. Explained below.
pano mouse leverage	2	How many pixels the mouse pointer moves to drag the image by 1 pixel. This makes precise control easier.
pano align size increase	1.6	Image size increase factor at each stage of image alignment. Reduce if you have problems. Impacts execution time.
pano blend reduction	0.7	Image comparison area reduction factor at each stage of image alignment.
pano minimum blend	10	Final image comparison area, in percent of image size.
pano image stretch	0	0: Do not use the image stretch / shrink algorithm. 1: Do use this algorithm (slower). Explained below.

**If you install a new version of fotox, you should delete the old parameter file and let fotox make a new one.** This is because some parameters may have been added or removed in the new version. Note your customizations (lens mm and lens bow) and make these same changes to the new file.

### **pano image stretch parameter**

Panoramas made with images from a wide-angle lens may have alignment problems. This can happen if the two images have significant relative rotation, or if the vertical aiming level (horizon) is significantly different (i.e. a large vertical offset is needed to make the two images fit together). The more an object is displaced from the image center, the bigger it is on the image, and with wide-angle lenses this effect can be large enough to cause visible alignment errors in the joined images. Starting with v.23, fotox has an optional additional algorithm to stretch or shrink the right side image as needed to make a better match to the left side image. The upper and lower image halves are stretched or shrunk separately. This algorithm is slow and is not used unless the parameter "pano image stretch" is set to 1 or more. The value determines the algorithm search range and ultimately the amount of stretching or shrinking that can be applied. It is OK to leave it at zero for most cases. If you notice a vertical step at the image joint, you can set this parameter to 1 or 2 to engage the algorithm. The run time will be 10-20 seconds longer (based on a 2 GHz CPU).

### **pano pre-alignment image size**

You can decrease this parameter to obtain smoother mouse control during pre-alignment. This may be helpful for computers without fast graphics processors (some notebooks). The alignment image may be fuzzier but the final results are not affected.

### **other parameters**

You can adjust the alignment parameters to make them more conservative and robust (and slower): increase the pixel sample size, reduce the pano align size increase, make the pano minimum blend smaller (alignment focuses more on the immediate area around the joint line), and enable pano image stretch. This may help in the case of images that do not fit well together, or have large areas (e.g. sky) with few details that can help alignment.

## Misc. Administrative Functions

These functions are available in the Admin menu.

### check monitor

Eight color bands are written across the screen with brightness from zero (black) to 100%. You can use this to adjust the brightness and gamma of your monitor. The left end of each stripe should be as black as possible, but you should start to see weak color within a few mm from the left edge. If the completely black portion is wider than this, adjust the monitor. There are 255 brightness steps from black to 100%. The steps are too small to distinguish. This evaluation should be done in a darkened room (no external light falling on the monitor screen).

### create thumbnails

In a directory with hundreds or thousands of images, navigation can be slow - a few seconds may be needed to generate the thumbnail screen when a new page is selected. This is because the thumbnails must be created each time by reading and compressing the image files. Most of this overhead can be avoided by storing the thumbnails permanently on disk, and navigation will be about 5X faster as a result. Use the "create thumbnails" function to do this job (open some image file first, to set the directory that will be processed). Missing or outdated thumbnails will be generated at a rate up to 1000 per minute, depending on image sizes and processor speed. The thumbnails are saved in a subdirectory named ".thumbnails" under the directory containing the image files. Once this directory is present, new and modified images will have their thumbnails updated automatically. The thumbnail size is typically < 0.1 MB (tiny compared to a typical image file).

### about fotox

This displays a short message about the fotox version number, license, and home page.

### fotox user guide

The user guide (this document) is displayed. The first page is an index of topics which can be clicked to jump to the corresponding section of the document.

### README file

Displays the README file distributed with fotox, which may contain new information about installation or dependencies.

### change log

Displays the changelog file distributed with fotox, containing details about functional changes, additions, or bug fixes for the current release and previous releases. When you install a new release of fotox, **you should at least look at this file to check if there is anything special you need to do.**



## Technical Notes

### Command line options and desktop launchers

The following command line options can be used in launchers to simplify fotox startup:

-i <initial directory for image files>	# full absolute path
-f <initial image file to open>	# absolute, or relative to -i path
-p <parameter file to use>	# absolute, or relative to /home/<user>/fotox
<initial image file to open>	# same as -f but without the -f

You can use fotox as the application to launch when a .jpg file (or other image file type) is selected in the Nautilus browser. Right click a .jpg file, select properties, open with, add, and custom command. Locate and select the fotox executable.

### Status Bar information

The main window status bar contains information relevant to the current activity.

during navigation: (modified) 1234x987 0.45MB 5/67  
during alignment: aligning: 2345 +12.3 -23.4 +0.0023 match: 0.9123  
during crop: crop: 1234x978

explanation of the above fields:

(modified)	the current image has been modified
1234x987	image pixel size, width x height
0.45MB	image file size (updated when a modified image is saved)
5/67	image file position and total image files in the current directory
2345	HDR or panorama alignment cycles done (progress indicator)
+12.3 etc.	alignment values: x and y offsets in pixels, theta offset in radians
0.9123	image match (creeps up as alignment improves, reset each stage)
1234x978	new image size during crop operation

If panorama image stretching has been enabled, two more alignment values will show up: stretch/shrink values for the upper half and lower half of the right side image.

### KDE and fotox

I tried fotox with Open Suse 10.2 (KDE) and it worked fine. The toolbar button text was missing by default, but this can be added using KDE's customization menus.

### Multiple Threads on SMP processors

I was not able to make HDR and panorama run significantly faster by dividing the work between two threads on an SMP system (2 processors). A possible explanation is limited memory bandwidth: the threads were contending for the same memory and slowing each other down. Fotox uses uncompressed image files in memory that often exceed 20 MB, which is far more than the typical processor L2 cache size of 1-4 MB.

### Non-English locales

A number of locale issues were fixed in v.23, and fotox was tested with a non-English locale (DE) for the first time. Entering parameters with comma decimal points and resize above 100% should now work OK. Please let me hear if there are still any problems.

### Trash folder

There is no standard location for the trash folder in Linux, and in practice it varies. Starting with v.43, discarded images are moved into a desktop folder named "fotox trash". You can delete it or move it to your system-specific trash folder.

## JPG file quality

Starting with v.28 the JPG output quality can be set when a file is saved. Look for the button [quality] in the file save dialog, which allows you to set the quality. The default quality is defined in the parameter `jpg_save_quality`. If you set a different quality, this value will be used for subsequent file saves. A new fotox session begins with `jpg_save_quality`. Therefore set your default here, and change it on a case by case basis, remembering that the changed value will continue to be used in the current session until changed again.

I made some simple evaluations which are summarized in the table below. The test file was a 7 megapixel JPG file of 2.7 MB from my digital camera, which I repeatedly saved with a quality of 0, 10, 20 ... 100. I viewed these files on an LCD monitor using the gThumbs image viewer at 100% image size. I compared the images by flipping back and forth in the same window (instant replacement). My conclusion is that quality 50 is usually good enough, and 70 is uncompromising (at least for my eyes and monitor).

The files that come out of a camera are generally huge (presumably because of the limited time and processing power available for compression). These huge files can be replaced with much smaller ones by using a quality setting of 50-70.

quality	size MB	visual differences
100	3.3	no visible differences (saved file is larger than the original)
90	1.3	no visible differences
80	0.90	no visible differences
70	0.71	no visible differences
60	0.59	small differences can be seen, but no loss in quality
50	0.52	color banding can be seen if you look hard
40	0.45	slight color banding can be seen
30	0.38	noticeable color banding, slight loss of sharpness
20	0.30	moderate color banding and loss of sharpness
10	0.21	obvious color blocking and banding, loss of sharpness
0	0.13	severe blocking (8x8 pixel squares) and color loss

## Alignment Algorithm

A new method for HDR and panorama image alignment was introduced with v.25: instead of using 100,000 or more pixels scattered evenly over the entire image overlap area, a few thousand high-contrast or "edge" pixels are selected to control alignment. The execution time was cut almost 50%. The number of pixels sampled is an adjustable parameter. I have set the default value to 5 (5000 pixels). The actual pixels used are shown in red during the alignment process, which is also more entertaining.

## Red eye algorithm

I tried several methods based on the absolute level of red, which worked poorly: the eyelids started to darken before the red eye was gone. Using the ratio of red / (red+green+blue) seems to work well. The current method is to reduce red for pixels with the highest ratio.

## Alpha channels

Images having alpha channels (transparency information) can be processed, but the alpha channel is lost when the processed file is saved as a .jpg file.

## Panorama Limitations

My testing with panoramas of nearby objects revealed some issues: when the two photos are made, be careful to turn the camera on a vertical axis through the lens, with minimum lateral movement, otherwise the images will not align very well. This is not an issue when the subject is 10+ meters away, since a small lateral movement has little impact. Interior panoramas may show walls that look curved, but this can be largely eliminated using the unbend function introduced in ftoox v.32.

Sometimes the two images may not be joined at the optimum place. Ftoox converges on a local optimum instead of the global optimum. I have always been able to overcome this by making the alignment parameters more conservative or the pre-alignment more precise.

I have two cameras for which the auto-lens function gives inconsistent results. For images made at 38mm focal length (according to the EXIF data), the auto\_lens function gives 38mm for one camera and 46mm for the other one. These values do work for ftoox even if they are inconsistent. Inspection of the images revealed that the barrel distortions are vastly different (auto\_lens gives bow values of 0.2 and 1.5). Apparently the bow compensation for the greater barrel distortion is reducing the curvature needed to obtain best fit, which makes ftoox think that the focal length is longer. This is not really a problem, but may be a source of confusion because ftoox gets a wrong opinion about the focal length.

## Image deterioration from repeated editing

If you save an edited image file and then use this file later to perform additional edits, pixel resolution may be lost. It is better if you do all edits when the image files are first processed, to minimize image deterioration (or go back to the originals if you still have them). The following edit functions reduce resolution about 1/2 pixel, and this error can accumulate from repeated edits: rotate (other than 90 degrees), HDR, panorama, unbend. Resize will of course reduce resolution, but using the fraction 1/2, 1/3, or 1/4 gives the best results. The following functions do not reduce resolution: tune, crop, red eye, sharpen, noise, and color depth.

## Thumbnail images

Starting with ftoox v.43, the file names for the thumbnail images were revised. Instead of using random names, the image file names are used, with ".png" appended. Ftoox will still work normally, but large image directories will be slower to navigate with the thumbnail viewer, since existing thumbnail files are not being used.

### What you should do for optimal navigation performance:

- delete the old thumbnails directory: `/your-image-directory/.thumbnails`
- use the menu `Admin > create_thumbnails` to generate new thumbnails

## **Source code**

The C++ source code is heavily commented in the hope that others can understand and use the code for their own projects. If you have a technical question about how something works, or a better idea to pass along, please write me at [kornelix@yahoo.de](mailto:kornelix@yahoo.de)

## **Translations**

The Fotox GUI can be used with non-English languages. German and Spanish are available, and I am hoping for more. Look at the files `fotox.xtext` and `zfuncs.xtext` to see how this is done. Other languages can simply be added to the same files. English can be terse compared to other languages (e.g. "undo" becomes "rückgängig machen" in German), which can cause ugliness in the GUI layout. If you do a translation, try to make the menus and buttons short, and carefully inspect all dialogs. I can consolidate the translations and redistribute them with fotox.

## **Help**

If you have a question or run into a problem, you may write me at [kornelix@yahoo.de](mailto:kornelix@yahoo.de). If you send any images that work poorly, I can use these to try to improve fotox. If there are error messages in the log file ( `/home/<user>/.fotox/fotox.log` ) please send these also.