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## **Fotox Introduction**

Fotox is a free open source Linux program for processing image files from a digital camera. The following functions are currently provided:

- 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.
- Combine an underexposed and overexposed image of the same subject to improve details visible in both bright and dark areas (HDR - high dynamic range imaging)
- Stitch two images (left and right) together, to make a wide "panorama" image (and more images can be added in the same way)
- 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 (pixel dimensions)
- Remove the red-eye effect from electronic flash photos

## **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 Guide

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.

### Fotox toolbars and buttons:

Main Toolbar		
	parms	edit custom parameters, load from or save to a file
	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 change to current image (revert to prior status)
	redo	redo last undo
	kill	stop a long-running function before completion
	save	save the current (modified) image to a file (JPG)
	trash	move the current image to trash can
	exif	view EXIF data if present
	quit	exit fotox
	help	view the help file (this file)

Admin Functions (Top)		
	tune	change the brightness distribution and color intensity
	crop	cut out an area of interest and discard the rest
	redeye	remove the red-eye effect from an electronic flash image
	rotate	rotate the image an arbitrary angle or turn 90 degrees
	resize	resize the image to a target pixel size or % of original size
	HDR	combine brighter and darker images to improve detail
	pano	join a left and right image to make a wide (panorama) image
	unbend	remove image bending apparent with some panoramas

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

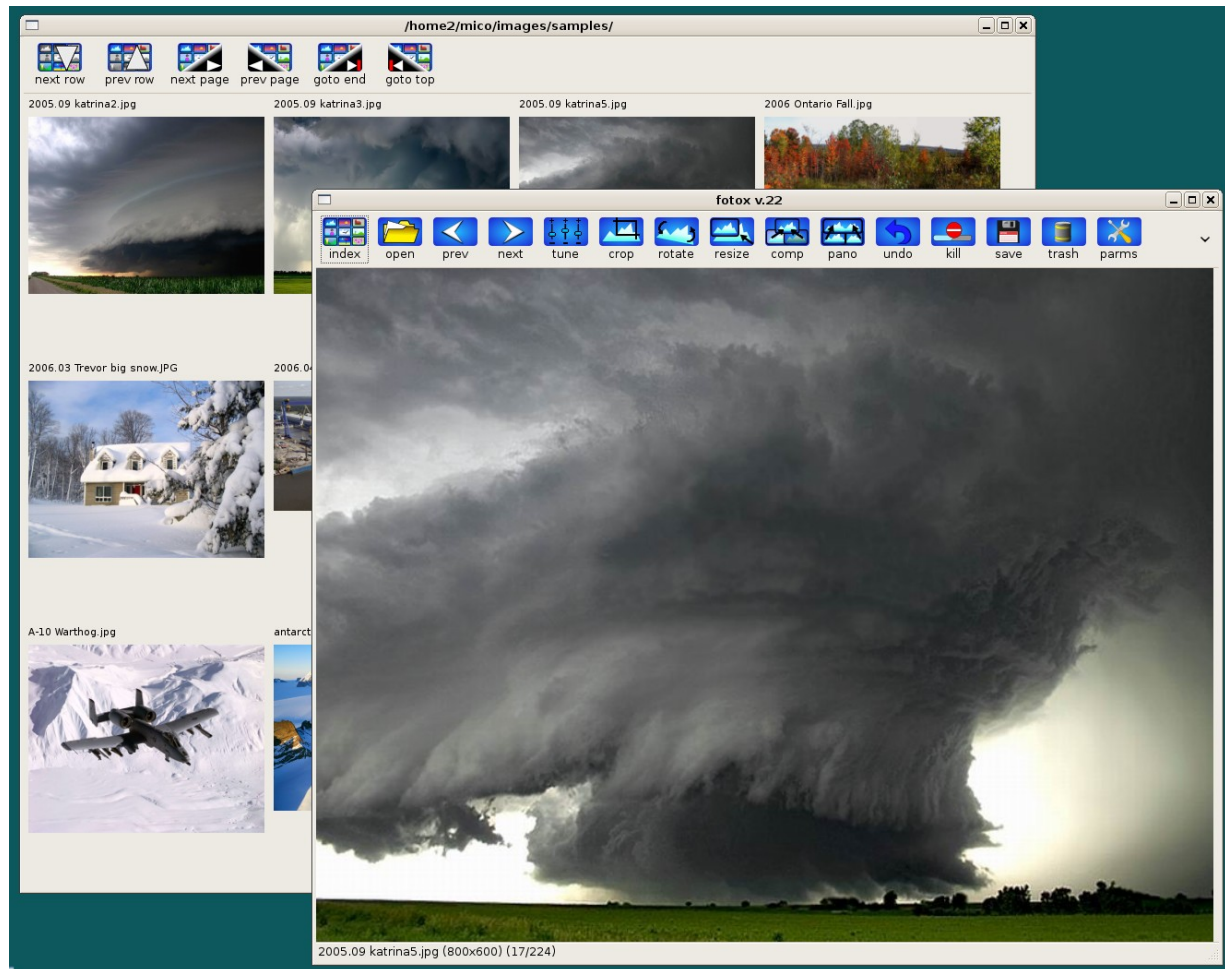
- |      |   |
|------|---|
| open | File open dialog: select the first image  |
| HDR  | Select the 2nd image - will auto-align and merge with the first image.<br>Pop-up dialog allows adjustment of the image contribution ratios. |
| tune | Adjust brightness, contrast, and color intensity for the merged image.  |
| crop | Cut image to final size.  |
| save | Save the image to a new file.   |

Keyboard shortcuts for navigation and viewing:

- |                              |                                 |
|------------------------------|---------------------------------|
| left-arrow = previous image  | R = rotate clockwise 90°        |
| right-arrow = next image     | L = rotate counterclockwise 90° |
| delete = move image to trash |                                 |

A left mouse-click anywhere on an image will show that area at 100% size. Another left click magnifies to 200%. A right click brings back the whole image (fit to window size).

## Navigation

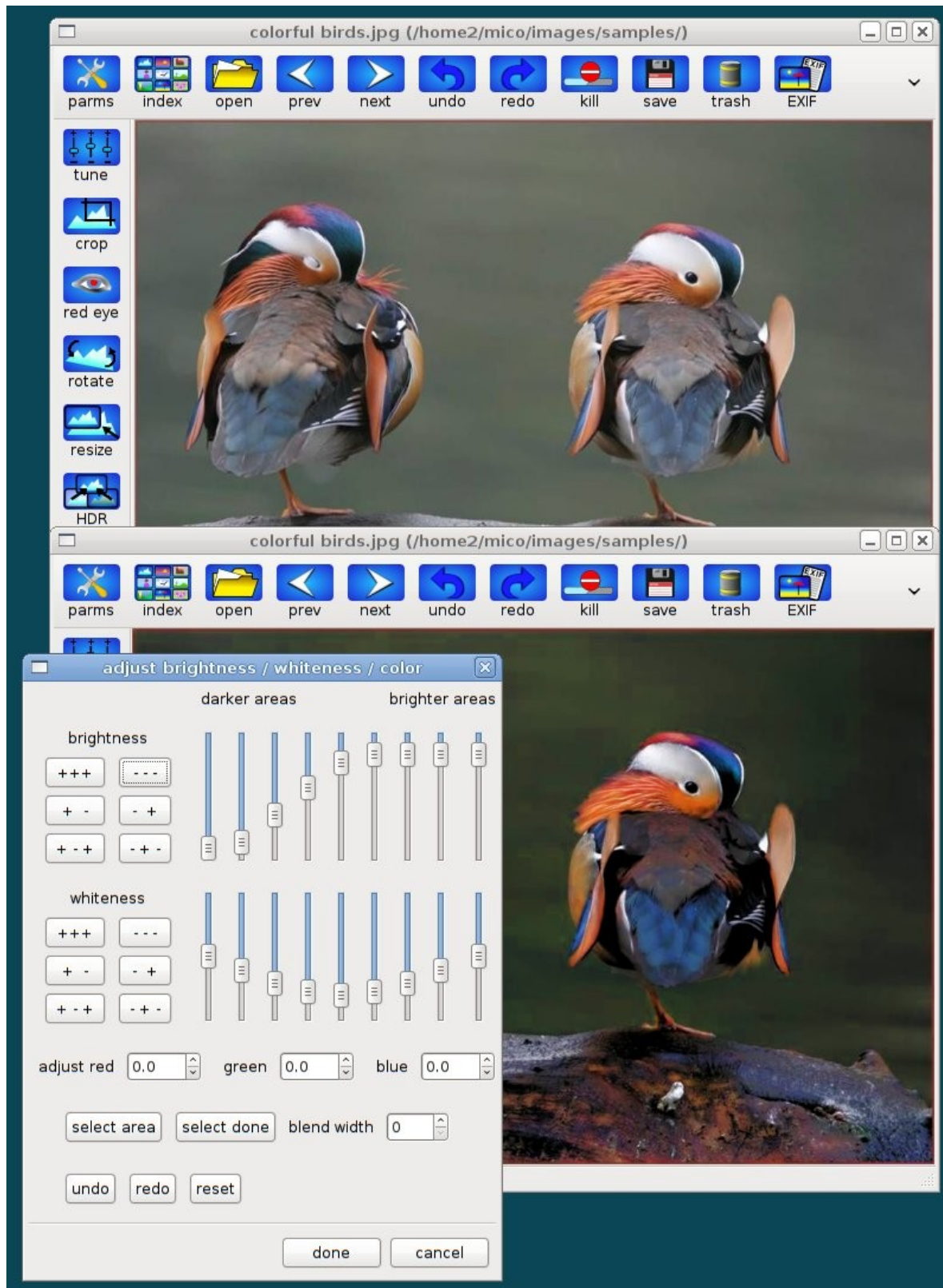


Begin by opening a file using the [open] button. Choose some image file. Press the [index] button to get a window of thumbnails showing image files in the same directory, starting with the file that was opened. You can now use this window to scroll around the directory and select files by clicking thumbnails. The buttons at the top allow scrolling up and down by rows and pages. Make the window bigger to show more thumbnails if desired. 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 (thumbnail) at the home position (upper left). 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 buttons: tune, red eye, crop, rotate, resize, HDR, pano, and unbend. 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 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 increased contrast and color.



Tune Usage: Open an image with [open] and then click the [tune] button. The dialog with the sliders starts up. Adjust the sliders and view the results. 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 up to the last 20 changes to the same image.

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 fixed point (undo a mistake). 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. "0" gives a hard edge and higher values give an increasingly wider transition band.

In the image below, the right bird was color enhanced and the left bird was not changed.

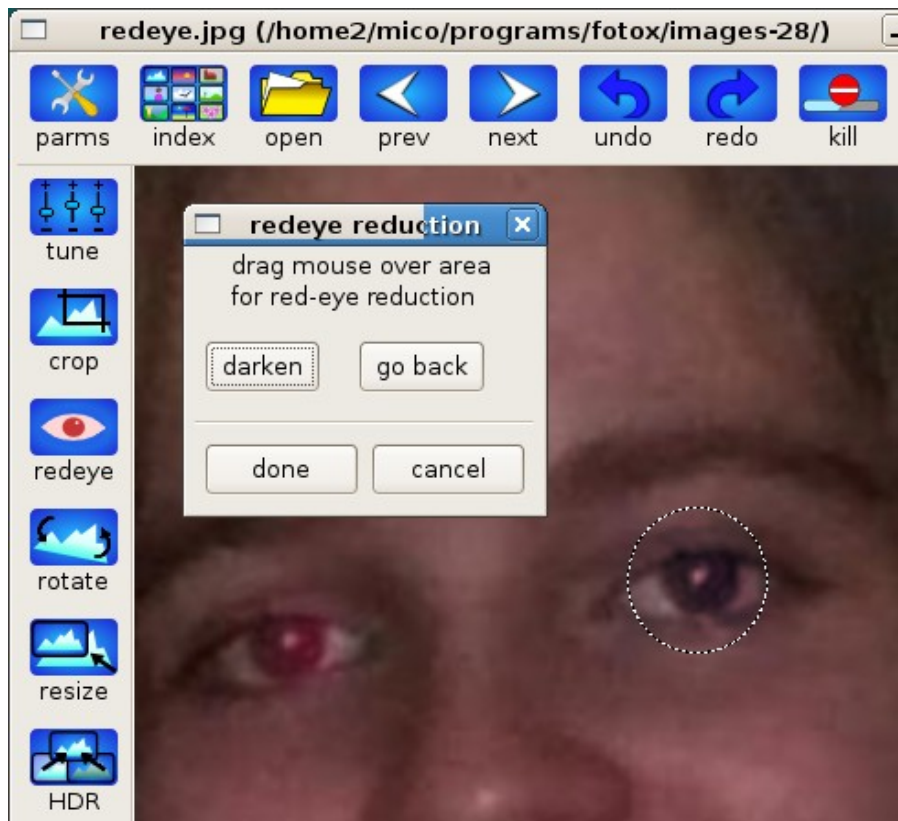


Determining which pixels are inside the polygon, and how far they are from the nearest edge (for the blending calculation) is very processor intensive. If you have enclosed a large area using hundreds of separate lines, up to a minute may be needed for this calculation. This is done only once, when [select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

## red eye function

This function reduces the red-eye effect from electronic flash photos. Select an image and press the [red eye] button. 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 away to the southeast. 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

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, pano) and the image is then saved, the EXIF data is updated and stored with the new image.

## crop function

The HDR and pano 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] button. 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 will be 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] button 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 width and height in pixels, or as a percent of the original size. Convenience buttons are provided for setting the new size to 2/3, 1/2, 1/3, or 1/4 of the original size. 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 forced to comply. After setting the desired new dimensions, use the [execute] button to perform the rescale. The window may look the same, but the image behind it is rescaled.

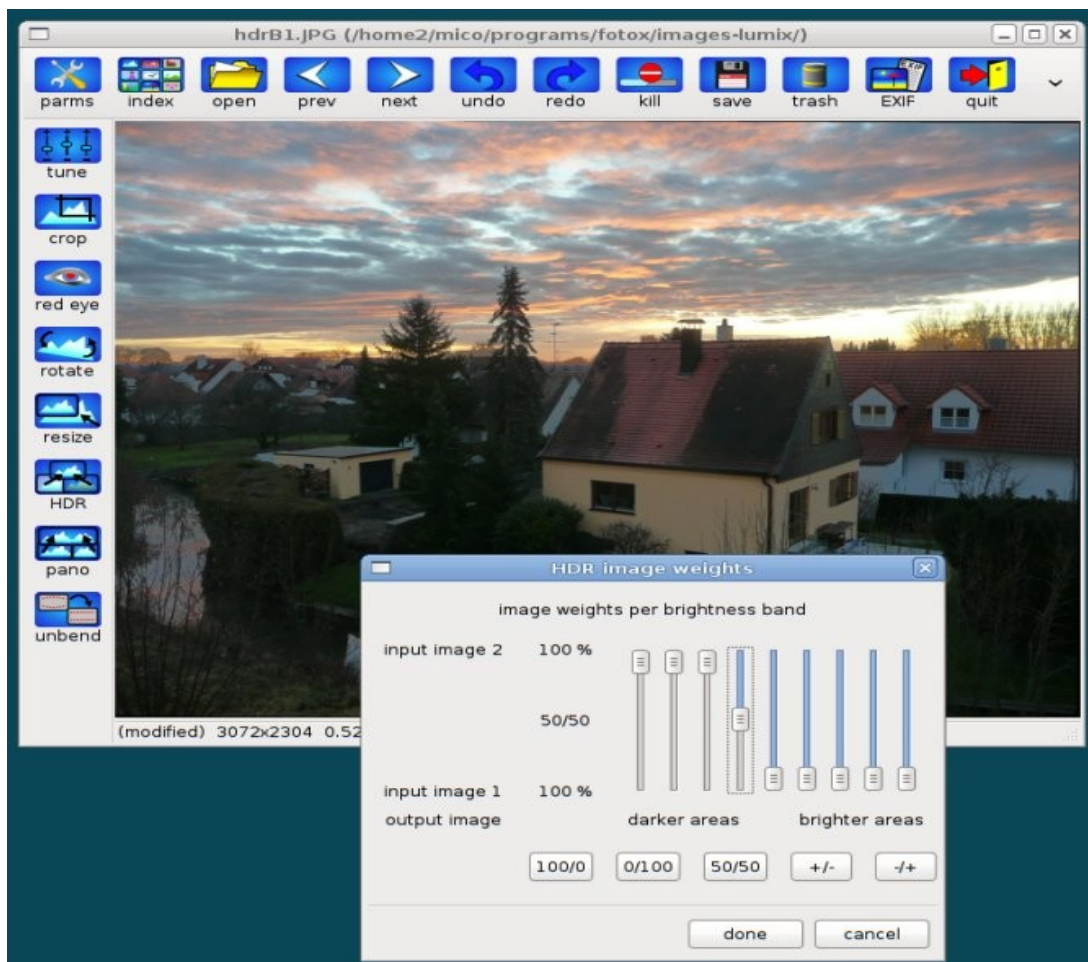


## HDR function (high dynamic range imaging)

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 lighter areas, in effect using information from the brighter image for the darker areas, and from the darker image for the lighter 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 2nd image using the [HDR] button. The two images are combined. The images are likely offset and rotated from each-other (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 the following dialog for fine adjustments.



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 lighter 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 and the CPU slow.

The image alignment algorithm is accurate up to about 3 degrees of rotation. 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, fuzziness and ghosting cannot be avoided.

## pano function

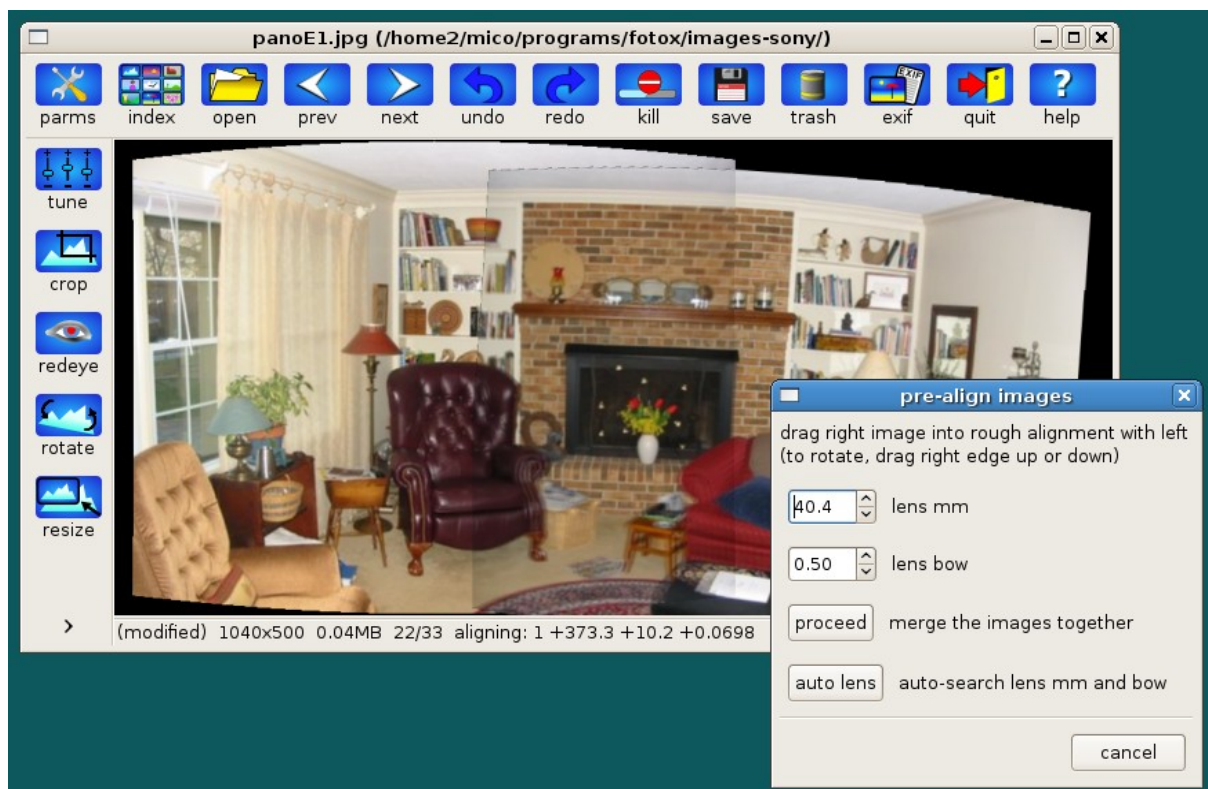
Stitch two images together to make a wide image or panorama. The images must overlap by 10% or more, so that the program can find where they coincide and put them together.

The following describes how to use the pano function. Before using pano, 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 and 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. Press the [pano] button and 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 likely adjust these parameters within the dialog until the images fit reasonably well, and this may be good enough for most panorama jobs.

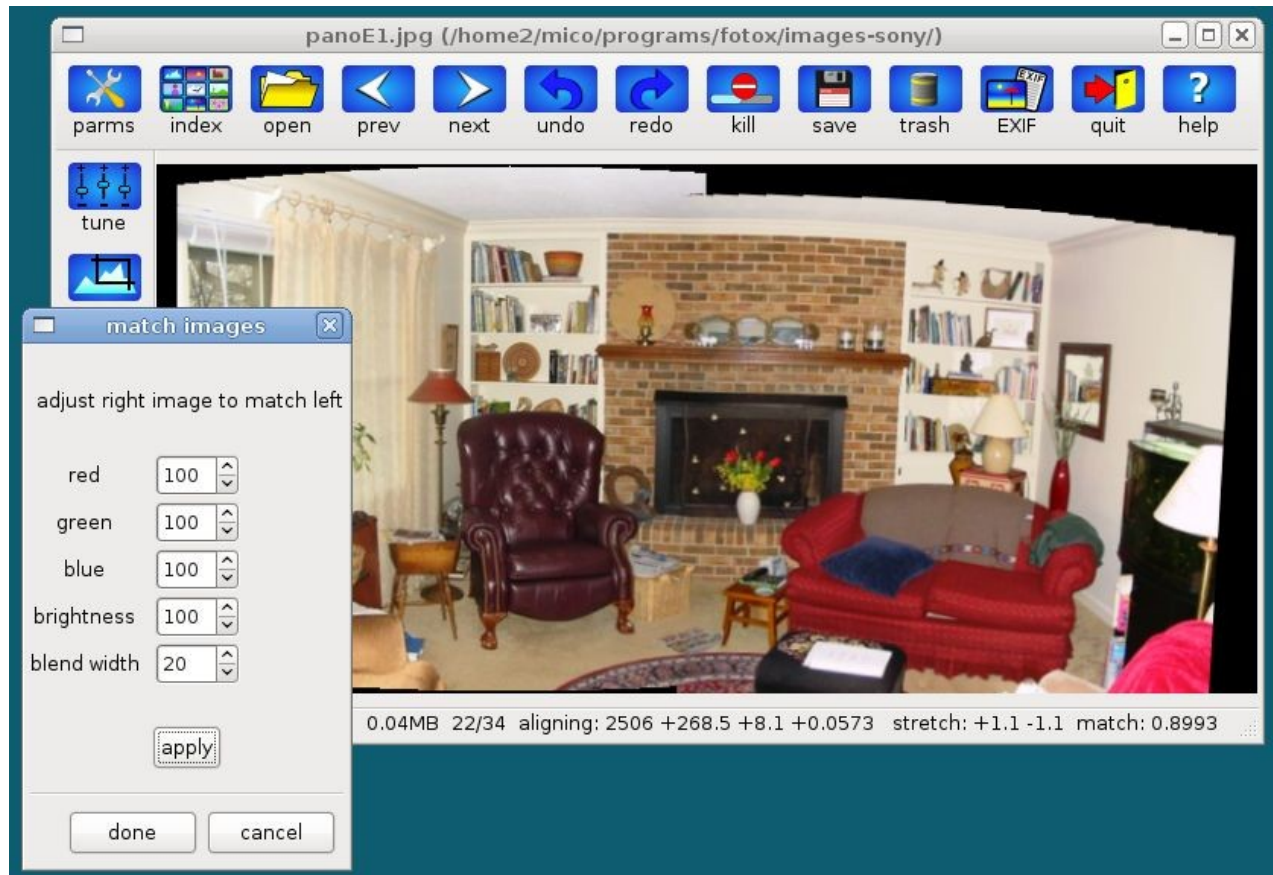
### image alignment, showing rotation and curvature



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 (see below). The starting point is a guess by fotox. If you can see a border between the images, then you need to adjust. 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.

## brightness / color balance / 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, select [pano] 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.

### [auto lens] function

The [auto\_lens] function automatically determines 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 a low relative rotation. Input your nominal lens focal length (35 mm film camera equivalent, typically 35-38 mm) and use zero for lens\_bow. After doing a decent pre-align, press the [auto lens] button and wait a while for the results. Do this a second time and observe the changes. If the values are consistent, you can use them for your panoramas. Use the parameter edit function [parms] 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 parms 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 images. Each iteration takes a minute or more, but you only need to do this once to characterize a given camera and lens. The next section describes a manual method for setting these parameters.



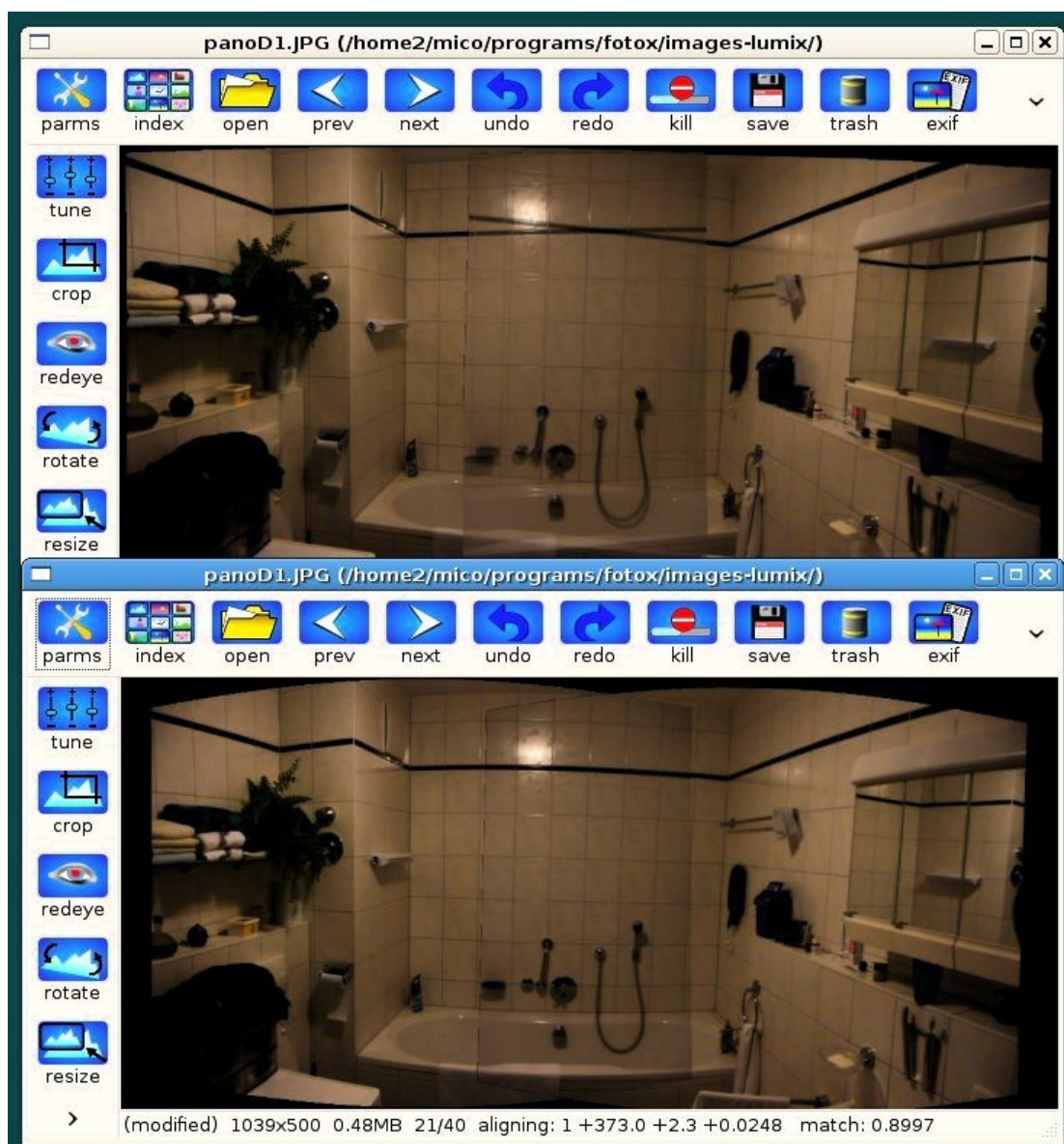
### setting the lens parameters manually

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 pano 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 `[parms]` function.



## 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.

After making a panorama, use the [unbend] function to straighten the image. The input values in the dialog are roughly the percent by which the image will be unbent. Input values for horizontal and vertical unbend and press the [execute] button to see the effect. Increase or decrease the values and press [execute] again, until satisfied.

input images



completed panorama



unbent panorama





## editing parameters

The HDR and pano 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 button [parms] to enter the parameter edit dialog. 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/username/.fotox/parameters).

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

The pano 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/username/.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.

### **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.

## 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 pano 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 pano 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.

### Thumbnail Caching

This is turned on for a target image directory by creating a directory called .thumbnails within the image directory (the spelling must be exact and the 1st character is a period). The next time you use the thumbnail index view for this directory, all images seen on the thumbnail window will get thumbnails cached. This slows down navigation for the first pass through the directory, but later passes will be about five times faster than before. A directory with many images that is frequently visited will benefit from thumbnail caching.

### 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 the KDE system menu.

### Multiple Threads on SMP processors

I was not able to make HDR and pano 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.

## 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 pano 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.

## Trash folder

Fotox expects this folder to be located at `/home/<user>/.Trash`, the Gnome standard. Some KDE users have reported that this can be elsewhere. I suggest you add such a folder if there is none and you want the trash function to work inside Fotox.

## **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 ftofox v.32.

Sometimes the two images may not be joined at the optimum place. Ftofox 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 ftofox 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 ftofox think that the focal length is longer. This is not really a problem, but may be a source of confusion because ftofox 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, pano, 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

## **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.

## **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 Ftofox GUI can now be used with non-English languages. A German interface is available starting with v.34. Look at the files ftofox.xtext and zfuncs.xtext to see how this is done. Other languages can be added to the same files, which is simple for western languages. A small problem is apparent in the German translation: sometimes English is more compact than German (e.g. undo > rückgängig machen), causing problems 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.

## **Help**

If you have a question or run into a problem, you may write me. If you send any images that work poorly, I will use these to try to improve ftofox. If there are any error messages in the log file ( /home/<user>/.fotox/fotox.log) then please send these also.