Image editing

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Image editing encompasses the processes of altering images, whether they be digital photographs, traditional analog photographs, or illustrations. Traditional analog image editing is known as photo retouching, using tools such as an airbrush to modify photographs, or editing illustrations with any traditional art medium. Graphic software programs, which can be broadly grouped into vector graphics editors, raster graphics editors, and 3d modelers, are the primary tools with which a user may manipulate, enhance, and transform images. Many image editing programs are also used to render or create computer art from scratch.

Contents

Basics of image editing

Raster images are stored in a computer in the form of a grid of picture elements, or pixels. These pixels contain the image's color and brightness information. Image editors can change the pixels to enhance the image in many ways. The pixels can be changed as a group, or individually, by the sophisticated algorithms within the image editors. The domain of this article primarily refers to bitmap graphics editors, which are often used to alter photographs and other raster graphics. However, vector graphics software, such as Adobe Illustrator or Inkscape, are used to create and

modify vector images, which are stored as descriptions of lines, Bézier splines, and text instead of pixels. It is easier to rasterize a vector image than to vectorize a raster image; how to go about vectorizing a raster image is the focus of much research in the field of computer vision. Vector images can be modified more easily, because they contain descriptions of the shapes for easy rearrangement. They are also scalable, being rasterizable at any resolution.

Automatic image enhancement

Camera or computer image editing programs often offer basic automatic image enhancement features that correct color hue and brightness imbalances as well as other image editing features, such as red eye removal, sharpness adjustments, zoom features and automatic cropping. These are called automatic because generally they happen without user interaction or are offered with one click of a button or mouse button or by selecting an option from a menu. Additionally, some automatic editing features offer a combination of editing actions with little or no user interaction.

Digital data compression

Many image file formats use data compression to reduce file size and save storage space. Digital compression of images may take place in the camera, or can be done in the computer with the image editor. When images are stored in JPEG format, compression has already taken place. Both cameras and computer programs allow the user to set the level of compression.

Some compression algorithms, such as those used in PNG file format, are **lossless**, which means no information is lost when the file is saved. By contrast, the JPEG file format uses a **lossy** compression algorithm by which the greater the compression, the more information is lost, ultimately reducing image quality or detail that can not be restored. JPEG uses knowledge of the way the human brain and eyes perceive color to make this loss of detail less noticeable.

Image editor features

Listed below are some of the most used capabilities of the better graphic manipulation programs. The list is by no means all inclusive. There are a myriad of choices associated with the application of most of these features.

Selection

One of the prerequisites for many of the applications mentioned below is a method of selecting part (s) of an image, thus applying a change selectively without affecting the entire picture. Most graphics programs have several means of accomplishing this, such as a marquee tool, lasso, vector-based pen tools as well as more advanced facilities such as edge detection, masking, alpha compositing, and color and channel-based extraction.

Layers

Main article: Layers (digital image editing)

Another feature common to many graphics applications is that of Layers, which are analogous to sheets of transparent acetate (each containing separate elements that make up a combined picture), stacked on top of each other, each capable of being individually positioned, altered and blended with the layers below, without affecting any of the elements on the other layers. This is a fundamental

workflow which has become the norm for the majority of programs on the market today, and enables maximum flexibility for the user while maintaining non-destructive editing principles and ease of use.

Image size alteration

Image editors can resize images in a process often called image scaling, making them larger, or smaller. High image resolution cameras can produce large images which are often reduced in size for Internet use. Image editor programs use a mathematical process called resampling to calculate new pixel values whose spacing is larger or smaller than the original pixel values. Images for Internet use are kept small, say 640 x 480 pixels which would equal 0.3 megapixels.

Cropping an image

Main article: Cropping (image)

Digital editors are used to crop images. Cropping creates a new image by selecting a desired rectangular portion from the image being cropped. The unwanted part of the image is discarded. Image cropping does not reduce the resolution of the area cropped. Best results are obtained when the original image has a high resolution. A primary reason for cropping is to improve the image composition in the new image.

Uncropped image from camera

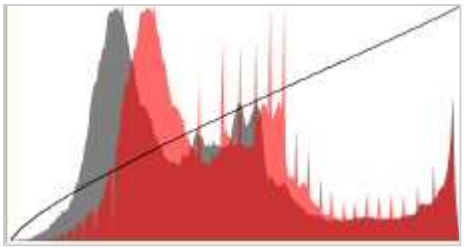
Lilly cropped from larger image

Histogram

Main article: Curve (tonality)

Image editors have provisions to create an image histogram of the image being edited. The histogram plots the number of pixels in the image (vertical axis) with a particular brightness value (horizontal axis). Algorithms in the digital editor allow the user to visually adjust the brightness value of each pixel and to dynamically display the results as adjustments are made. Improvements in picture brightness and contrast can thus be obtained.

Sunflower image



Histogram of Sunflower image

Noise reduction

Main article: Noise reduction

Image editors may feature a number of algorithms which can add or remove noise in an image. JPEG artifacts can be removed; dust and scratches can be removed and an image can be de-speckled. Noise reduction merely estimates the state of the scene without the noise and is not a substitute for obtaining a "cleaner" image. Excessive noise reduction leads to a loss of detail, and its application is hence subject to a trade-off between the undesirability of the noise itself and that of the reduction artifacts.

Noise tends to invade images when pictures are taken in low light settings. A new picture can be given an 'antiquated' effect by adding uniform monochrome noise.

Removal of unwanted elements

Main article: Inpainting

Most image editors can be used to remove unwanted branches, etc., using a "clone" tool. Removing these distracting elements draws focus to the subject, improving overall composition. Introduced in Photoshop CS5, the "Content-Aware Fill" could be used to select an object (unwanted branches) and remove it out of the picture by simply pressing "Delete" on the keyboard, without destroying the image. The same feature is available for GIMP in form of the plugin "Resynthesizer" developed by Paul Harrison

Notice the branch in the original

The eye is drawn to the center of the globe

Selective color change

Some image editors have color swapping abilities to selectively change the color of specific items in an image, given that the selected items are within a specific color range.

An example of selective color change, the original is on the left.

The original car is on the right.

Image orientation

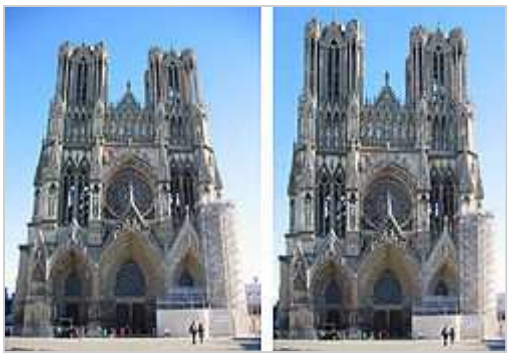
Image editors are capable of altering an image to be rotated in any direction and to any degree. Mirror images can be created and images can be horizontally flipped or vertically flopped. A small rotation of several degrees is often enough to level the horizon, correct verticality (of a building, for example), or both. Rotated images usually require cropping afterwards, in order to remove the resulting gaps at the image edges.

Image orientation (from left to right): original, -30° CCW rotation, and flipped.

Perspective control and distortion

Main article: Perspective control

Some image editors allow the user to distort (or "transform") the shape of an image. While this might also be useful for special effects, it is the preferred method of correcting the typical perspective distortion which results from photographs being taken at an oblique angle to a rectilinear subject. Care is needed while performing this task, as



Perspective control: original (left), perspective distortion removed (right).

the image is reprocessed using interpolation of adjacent pixels, which may reduce overall image definition. The effect mimics the use of a perspective control lens, which achieves a similar correction in-camera without loss of definition.

Lens correction

Photo manipulation packages have functions to correct images for various lens distortions including pincushion, fisheye and barrel distortions. The corrections are in most cases subtle, but can improve the appearance of some photographs.

Enhancing images

In computer graphics, the process of improving the quality of a digitally stored image by manipulating the image with software. It is quite easy, for example, to make an image lighter or darker, or to increase or decrease contrast. Advanced photo enhancement software also supports many filters for altering images in various ways.[1] Programs specialized for image enhancement are sometimes called image editors.

Sharpening and softening images

Graphics programs can be used to both sharpen and blur images in a number of ways, such as unsharp masking or deconvolution.[2] Portraits often appear more pleasing when selectively softened (particularly the skin and the background) to better make the subject stand out. This can be achieved with a camera by using a large aperture, or in the image editor by making a selection and then blurring it. Edge enhancement is an extremely common technique used to make images appear sharper, although purists frown on the result as appearing unnatural.

Selecting and merging of images

Many graphics applications are capable of merging one or more individual images into a single file. The orientation and placement of each image can be controlled.

Photomontage of 16 photos which have been digitally manipulated to give the impression that it is a real landscape. *Software used: Adobe Photoshop*

When selecting a raster image that is not rectangular, it requires separating the edges from the background, also known as silhouetting. This is the digital version of cutting out the image. Clipping paths may be used to add silhouetted images to vector graphics or page layout files that retain vector data. Alpha compositing, allows for soft translucent edges when selecting images. There are a number of ways to silhouette an image with soft edges including selecting the image or its background by sampling similar colors, selecting the edges by raster tracing, or converting a clipping path to a raster selection. Once the image is selected, it may be copied and pasted into another section of the same file, or into a separate file. The selection may also be saved in what is known as an alpha channel.

A popular way to create a composite image is to use transparent layers. The background image is used as the bottom layer, and the image with parts to be added are placed in a layer above that. Using an image layer mask, all but the parts to be merged are hidden from the layer, giving the impression that these parts have been added to the background layer. Performing a merge in this manner preserves all of the pixel data on both layers to more easily enable future changes in the new merged image.

Slicing of images

A more recent tool in digital image editing software is the image slicer. Parts of images for graphical user interfaces or web pages are easily sliced, labeled and saved separately from whole images so the parts can be handled individually by the display medium. This is useful to allow dynamic swapping via interactivity or animating parts of an image in the final presentation.

See also: Slicing (interface design)

Special effects

An example of some special effects that can be added to a picture.

Image editors usually have a list of special effects that can create unusual results. Images may be skewed and distorted in various ways. Scores of special effects can be applied to an image which include various forms of distortion, artistic effects, geometric transforms and texture effects,[3] or combinations thereof.

Change color depth

It is possible, using software, to change the color depth of images. Common color depths are 2, 4, 16, 256, 65.5 thousand and 16.7 million colors. The JPEG and PNG image formats are capable of storing 16.7 million colors (equal to 256 luminance values per color channel). In addition, grayscale images of 8 bits or less can be created, usually via conversion and down-sampling from a full color image.

Contrast change and brightening

An example of converting an image from color to grayscale.

An example of contrast correction. Left side of the image is untouched.

Image editors have provisions to simultaneously change the contrast of images and brighten or darken the image. Underexposed images can often be improved by using this feature. Recent advances have allowed more intelligent exposure correction whereby only pixels below a particular luminosity threshold are brightened, thereby brightening underexposed shadows without affecting the rest of the image. The exact transformation that is applied to each color channel can vary from editor to editor. GIMP applies the following formula[4]:

```
if (brightness < 0.0)  value = value * ( 1.0 + brightness);
                  else value = value + ((1.0 - value) * brightne
value = (value - 0.5) * (tan ((contrast + 1) * PI/4) ) + 0.5;
```

where `value` is the input color value in the 0..1 range and `brightness` and `contrast` are in the -1..1 range.

Gamma correction

Main article: Gamma correction

In addition to the capability of changing the images' brightness and/or contrast, most current image editors provide an opportunity to manipulate the images' gamma value.

Color adjustments

Color retouched photo (cycles every 3 seconds)

The color of images can be altered in a variety of ways. Colors can be faded in and out, and tones can be changed

An example of color adjustment using raster graphics editor

using curves or other tools. The color balance can be improved, which is important if the picture was shot indoors with daylight film, or shot on a camera with the white balance incorrectly set. Special effects, like sepia and grayscale, can be added to an image. In addition, more complicated procedures such as the mixing of color channels are possible using more advanced graphics editors.

The red-eye effect, which occurs when flash photos are taken when the pupil is too widely open (so that light from the flash that passes into the eye through the pupil reflects off the fundus at the back of the eyeball), can also be eliminated at this stage.

Printing

Control printed image by changing ppi.

Controlling the print size and quality of digital images requires an understanding of the pixels-per-inch (ppi) variable that is stored in the image file and sometimes used to control the size of the printed image. Within the Image Size dialog (as it is called in Photoshop), the image editor allows the user to manipulate both pixel dimensions and the size of the image on the printed document. These parameters work together to produce a printed image of the desired size and quality. Pixels per inch of the image, pixel per inch of the computer monitor, and dots per inch on the printed document are related, but in use are very different. The Image Size dialog can be used as an image calculator of sorts. For example, a 1600 x 1200 image with a ppi of 200 will produce a printed image of 8 x 6 inches. The same image with a ppi of 400 will produce a printed image of 4 x 3 inches. Change the ppi to 800, and the same image now prints out at 2 x 1.5 inches. All three printed images contain the same data (1600 x 1200 pixels) but the pixels are closer together on the smaller prints, so the smaller images will potentially look sharp when the larger ones do not. The quality of the image will also depend on the capability of the printer.

See also

- Adobe Photoshop
- Color space
- Comparison of raster graphics editors
- Computer graphics
- Curve (tonality)
- Digital darkroom
- Digital image processing
- Digital painting
- Dynamic imaging
- GIMP
- Graphics file format summary
- Graphic art software
- Homomorphic filtering
- Image development (visual arts)
- Image distortion
- Image processing
- Image retrieval
- Image warping
- Inpainting
- Layers (digital image editing)
- Paint.NET

- Photo manipulation
- Photoshop contest
- Raster graphics

References

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2. ^ Implementations include FocusMagic (http://www.focusmagic.com/) , and Photoshop (http://livedocs.adobe.com/en_US/Photoshop/10.0/WS53AAF857-B3B3-49e6-99FF-56E162336590.html)
3. ^ JPFix. "Skin Improvement Technology" (http://www.jpfix.com/About_Us/Articles/JPFix_Skin_Improvement_Technol/jpfix_skin_in http://www.jpfix.com/About_Us/Articles/JPFix_Skin_Improvement_Technol/jpfix_skin_improvement_te Retrieved 2008-08-23.
4. ^ [1] (http://www.google.com/codesearch?q=GIMP+brightness_contrast_lut_setup) GIMP source code for brightness and contrast image filtering.

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- "It's hard to tell where pixels end and reality begins," The San Francisco Chronicle; September 26, 2006.
- "Virtual Art: From Illusion to Immersion," MIT Press 2002; Cambridge, Mass.

External links

Easy online image editor: Image ReCreator (http://imagerecreator.joosthoeks.com/) .

Automatic image enhancement: Elpical (http://www.elpical.com/) .

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