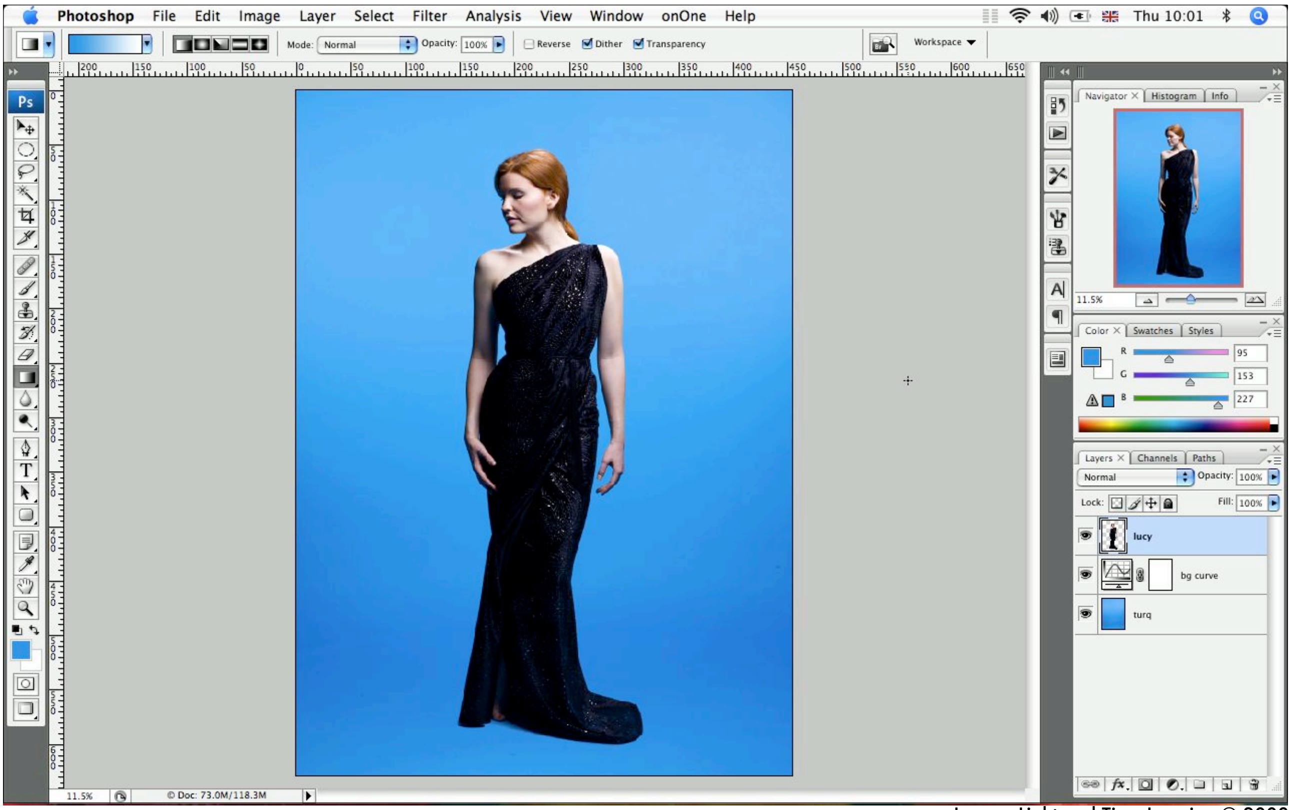

Image: Light and Time Imaging © 2008

Complex selections and masking in digital images.

In the era of digital image manipulation, and especially in compositing and CGI, the selection of areas to be processed (or made transparent) can be extremely complicated. We take a brief look at the tools and techniques available to assist in the process.

From the earliest days of photographic printing, burning and dodging, contrast masking and optical compositing techniques have been used to manipulate specific areas of an image independently to the image as a whole. Though many of the same techniques have followed through to the digital era the scope for their use and the complexity required has made selection or masking techniques one of the most crucial and time consuming aspects of digital post production.

In stills imaging it is often relatively simple to manually select an area by drawing it as a vector shape or a pixel based selection. However, in moving images or where the selection is complex and partially transparent, such as leafy branches or human hair, this process becomes extremely intensive and sometimes impossible.

Thankfully though there is a number of techniques on offer to automate the process. Some that have migrated from the era of optical compositing and others that are completely new to digital imaging.

Thresholding

This is the most widely used method of automatic selection. In it's simplest form a specific range of grey tones are selected and all others rejected.[1] If we consider the selection or mask this creates as a grey scale image, where white is areas selected and black is areas rejected, then this would produce a mask that is white wherever the colours are within the specified range and black where they are not.

In colour images the threshold is multidimensional and rather than apply it to the RGB numbers, Hue, Saturation and Luminance measures are usually used to determine if the colour is within the range or not.[2] This way thresholds can be weighted to give more latitude in saturation and luminance than in hue, which often produces better results. The way light falls in real world situations often cause variations in luminance and saturation across a surface but it is less likely to cause variations in hue.

Many image processing adjustments use thresholding to limit the scope of their effects. When a saturation adjustment is made to just the blues then this is selecting the blues by thresholding out all the other colours.[3] Much the same effect could be achieved by manually selecting the blue areas and then adding general saturation. In Photoshops *Hue/Saturation* adjustment, both upper and lower hue thresholds and their hardness can be adjusted. Setting soft edges causes colours around the selected range to be partially processed by an amount relative to their distance from the edge. In this way edge artifacts can often be avoided.

The Photoshop *Magic Wand* tool uses a localized version of thresholding to select an area. The *central* colour in the *passband* is selected by clicking in the image. The amount of colours either side of this *central colour* included is adjusted using the *threshold* setting. The *magic wand* tool does not however process the whole image by default. It looks at the pixels around the point at which the user clicked, radiating out until it finds a boundary where the threshold is exceeded all around. At this point it stops selecting. So if two identical blue areas are present in an

Fig1.1 Shows how the magic wand tool can be used to simplify selection. (a) shows the original image. (b) Shows the mask created with a single click of the magic wand (in blue). (c) Show the manually adjusted mask. (d) The results.

image, completely separated by a green area, then clicking in one blue area with an appropriate threshold setting will select that blue area but not the other. It should be noted also that the *magic wand* produces binary masks, pixels are either included or not (black or white in our grey scale), there is no partial selection or transparency.

This tool can be extremely useful for quickly selecting isolated areas of fairly continuous colour. In the image shown in fig 1.1(a), the white background has not been lit totally smoothly. However, it is easy to select it (without selecting the whites of the eyes) using the *magic wand*. Clicking in the area where the light begins to drop off with a threshold of 32 has produced the mask in (b). As you can see it is not a bad selection but has missed a few areas of white that are bounded by hair. It's also spilled into the brightest parts of the skin and has left a thin outline around many other edges. This can be tidied up by adding to or subtracting from the selection with the *magic* wand, adjusting the threshold where necessary, but the edges will always remain hard using this tool.

In this situation only the lower parts of the background need to be processed, and some less than others. We can refine the mask to process only those areas and to apply a graduated amount as required by the image. The mask in (c) has been produced by drawing a gradient within the mask in (b) and then blurring the results slightly, to produce transparency in the gradient and at the edges, matching the light gradient and the softness of the edges in the image. Applying a curves adjustment to just the areas selected by this mask has corrected the problem without any visible artifacts (d).

The *Select/Color Range* option also uses thresholding techniques to make selections but in a way more similar to the *Hue/Saturation* adjustment. As with the *magic wand* the user can click the colour to be selected in the image (or use several other options). Like *hue/saturation* it is not localized and will find the selected colour throughout the image. Further colours can be added to the selection by holding *shift* or using the *add color* option. The *Fuzziness* control sets how colours close to those in the selection will be effected. With a low setting they will be effected hardly at all. A higher setting will partially include more colours around the selection. So this tool produces masks with transparency. If we again consider our mask as a grey scale image, it can include shades of grey as well as black and white, much as the finished mask in fig1.1 did.

This tool could be used to produce the mask in fig1.1(c) pretty much in one go but unfortunately it would have included the whites of the eyes and some of the brightest skin tones, thus requiring a fair amount of manual cleaning up to produce results like those in fig1.1(d). However, if the background was a colour not present anywhere else in the image, this technique could be used to produce a mask which even maintains the transparency of hair and blurred edges, in a totally automated way.

Chroma-Key Masking

This technique dates back to the 1930s[4] where it was used to optically composite film images. The principal remains the same in digital imaging. The subject is photographed against a smooth, saturated colour background (usually blue or green as they are considered the furthest from human skin tones) and then a mask is created using similar soft thresholding techniques to those used by the *Color Range* option in Photoshop. However, rather than simply removing the masked areas, most chroma-key systems subtract the chroma-key colour and replace it with a proportionate amount of transparency. Thus semi-transparent areas in the subject will not acquire a colour cast but will retain their transparency.

With a good smooth background and careful setting of the thresholding parameters chroma-key masking or *keying* can produce excellent results, even being used to extract glass objects or ice from a background while maintaining the transparency of the object.

Chroma-key techniques are widely used in both photography and cinematography where images are to be com-

Fig1.2 Show a studio designed for green screen chroma-key photography. Courtesy of @ de Studio. 2007.

posited with each other or with CGI (Computer Generated Imagery). However, this is a two stage process and colour thresholding does not work so successfully in most real world images.

Edge Detection

Another technique for separating objects in images is image segmentation. This is used less in creative imaging and more in industrial and scientific applications. It includes a number of methods including point detection, line detection and edge detection. By far the most common is edge detection.[5]

This relies on measuring gradients or rates of change in pixel values within the image. In this way obvious edges can be identified. In practice most edges in real images are broken by shadows or degraded by noise so edge linking is required to fill in the gaps and further processing to identify object or areas of interest.[6]

This method is used in many industrial processes, including the now ubiquitous number plate recognition systems; but it is rarely used in creative image manipulation (except in sharpening filters). However, some of the more advanced masking applications (such as Vertus *Fluid Mask*) do use segmentation techniques in combination with thresholding, as well as methods borrowed from chroma-keying and other often proprietary algorithms.

Dedicated Masking Applications

These systems, often available as plug-ins for image processing applications such as Photoshop and Aftereffects, generally require a fair degree of user input but they can produce excellent results in very difficult situations. Each one is different and all require the user to learn a new user interface and practice in order to produce good results. Some can be almost as time consuming as manual masking but in difficult situations they can handle background reflections and foreground transparency in a way that would be virtually impossible to do manually.

The image in fig1.3 was produced for compositing with hand drawn art work (yet to be produced). Though the model was shot in front of the background intended for the final composition, other items will need to be layered in between. To achieve this (and to remove the shadow to the left of the model) the background was shot without the model in frame. Vertus *Fluid Mask* was then used to extract the model from the background. This software uses edge detection to segment the image. The user is then required to identify areas to keep and areas to delete. In between these *Fluid Mask* draws a *blend mask* which the user can edit and extend. Within this blend mask thresholding and colour removal techniques are used, based on the colours in the keep and delete masks.[7]

With a little care this has produced a good cut out. Even the odd stray hairs have been preserved. Note also that the shadow at the front of the dress has been kept, with full transparency and no colour contamination. Background reflections at the sides of the dress and face are also transparent and though I have layered this image

Fig1.3 Shows a model being cut out from a background using Verus *Fluid Mask*. (a) shows the original image. (b) Shows the *Fluid Mask* user interface. (c) Show cut out. (d) The image layered back onto a background shot with no model and thus no shadow to the left. The model and background are now on separate layers for further compositing.

onto a background of the same colour as the one it was shot against, with this cut out it would be possible to change the background completely.

Conclusions

There are so many different techniques for masking images and each has it's appropriate uses. Experimentation is the key, each image is different and will require a different approach. I find that a combination of Photoshops built in tools and manual masking produces the results for most image adjustment. I only really reach for the plug-in options when compositing or dealing with hair. Of these each has it's uses but much is down to personal taste and how well you get on with the user interface.

Andy Schonfelder. 2008.

Bibliography

R. C. Gonzales and R. E. Woods.
Digital Image Processing with MATLAB. Addison-Wesley Publishing. 2002.

John C. Russ.
The Image Processing Handbook. CRC Press. 1995.

E. Allen.
Lecture Notes from Digital Image Processing. University of Westminster. 2007-8.

Martin Evening.
Photoshop CS3 for Photographers. Focal Press. 2007.

Ralph E Jacobson & Sidney F Ray & Geoffrey G Attridge and Norman R Axford.
The Manual of Photography. Focal Press. 2000.

Blain Brown.
Cinematography. Theory and Practice. Focal Press. 2002.

Michael Langford.
Advanced Photography. Focal Press. 1998.

Wikipedia [Online]
http://en.wikipedia.org, GNU Free Documentation License. Accessed in April 2008.

Vertus [Online].
http://www.vertustech.com. Vertus Inc. Accessed in April 2008.

[1] R. C. Gonzales and R. E. Woods. Digital Image Processing with MATLAB. Addison-Wesley Publishing. 2002.

[2] John C. Russ. The Image Processing Handbook. CRC Press. 1995.

[3] B Martin Evening. Photoshop CS3 for Photographers. Focal Press. 2007.

[4] Wikipedia [Online]. http://en.wikipedia.org, GNU Free Documentation License. Accessed in April 2008.

[5-6] John C. Russ. The Image Processing Handbook. CRC Press. 1995.

[6] Michael Langford. Advanced Photography. Focal Press. 1998.

[7] Vertus [Online]. http://www.vertustech.com. Vertus Inc. Accessed in April 2008.

Fig1.1 & 1.3. Andy Schonfleder. 2008.

Fig1.2. @ de Studio. 2007.

Digital and Photographic Imaging
2DPI604 - Image Processing
Written Coursework 1 - Complex Selections and Masking in Digital Images

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