AN INTRODUCTION TO PHOTO STITCHING

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Why would I want to stitch photographs together?

- 1) It saves money on lenses – photo stitching can produce images which are the equal of pictures taken using wide-angled lenses, and it removes the necessity to either pay for or carry around expensive lenses. This is especially useful when travelling when weight is a crucial consideration.
- 2) It's effective ~ photo stitching can produce stunning images which sometimes cannot be produced any other way.
- 3) It's free – at least for basic stitching. There are software packages which you can download at no cost, and the techniques involve no costly equipment – in fact any camera can do what is required.
- 4) It's really easy (it just looks hard from the outside)

What this tutorial won't teach you.

There are many software packages dedicated to stitching photographs together. Some are stand alone packages and others are a part of a larger program (eg photoshop). It is beyond the scope of this tutorial to provide detailed instructions for any of these individual packages. This tutorial is directed to the more important task of creating the images to be stitched, as this is where the real success story lies. The good news is that most stitching programs are fairly intuitive and easy to follow, and provided you have followed the basic guidelines explained here, then the final stitching process should be very easy. This is a guide to taking the images – the actual stitching is the easy part. The following photos show why photo stitching is so important.

Which of the above images best represents what I saw? In this case, a single shot (left) revealed very little of this 380 year old galleon, yet after a few images were stitched together we can see the full story. The above (Right) completed image took around 3 minutes to complete using automated software and 8 individual images. It reveals the whole story and better illustrates and records what I actually saw..

What's the difference between panoramas and photo-stitching?

- A **panorama** is generally thought of as a long horizontal picture – it consists of images joined side-by-side.
- **Photo stitching** broadens this to join images vertically as well, to create bigger pictures, not just longer ones. An image may look as if it was taken using a regulation 6X4 format when in fact it is the result of multiple images stitched together. The preceding image is an example of this, using both horizontal and vertical images in a matrix to produce one normal image.

Are there other benefits ?

A stitched image consists of two or more images stitched together. It follows that the amount of digital information increases with the number of images stitched. Therefore, the resultant image will be of a much higher resolution. If, for example, you take one picture using a wide angle lens, then you might have a 3 megapixel image. However, if you zoom in and take a number of close-up images of the same scene and stitch them together, then you will end up with the same basic picture, however the second image will contain perhaps 12 megapixels.

Now to the nitty-gritty – let's talk stitching!

Image stitching is actually quite easy, but there are two basic approaches. I liken these two approaches to romance and dating (something we can all relate to). Sometimes in either photography or dating you can achieve the desired result after much preparation and planning. However, it is equally true that even if you skip most of the time honoured steps you can still end up with a perfectly good outcome. The first approach to taking panoramic sequences is what I call the "chocolates and roses" method, where you painstakingly follow all of the steps. The other alternative is what I call the "quick 'n easy" approach which ends up with much the same result. Once you understand the theory of the first path you will probably find that the secondary route is how you will take most of your panoramic shots. We'll start by exploring the first, "paint by numbers" path, and then move on to the second.

The Chocolates and Roses approach to Panoramas.

The main difference in the two approaches lies in the taking of the images to be stitched. The final stitching process is much the same either way. The secret to good panoramas lies in the taking of the photos rather than the final merging into one picture. The actual stitching is (surprisingly) comparatively easy.

Firstly you need to be clear in your mind what you are trying to achieve. Your aim is to:-

- Create a series (sequence) of images with similar characteristics so that each adjoining image contains some common information. It is this matching information which will be used to seamlessly blend the adjoining images.
- Combine these images seamlessly into one photo
- Ensure that the resultant image does not have mis-matches, obvious lighting variations or anything to suggest that the final image is actually a combined image.
- Take the series of photos in such a way that automatic stitching software will be able to identify what needs to be stitched. The key to making life easier is to maximise the similarities and avoid hard-to-stitch features of your images.

What will I need ?

If you really want to go down the purist's "Chocolates and Roses" path, then you'll need:-

- a tripod with a panoramic head.
- good quality stitching software
- lots of time to take your photo.
- an understanding of what a "Nodal point" is, and how to calculate it.

Of course once you've considered the more basic approach to taking panoramic shots (explained later) you may well find that none of the above is really all that vital.

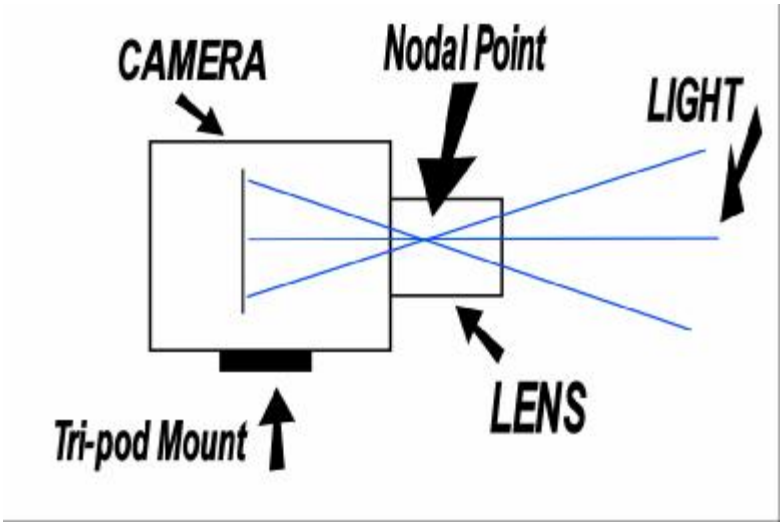
The Nodal Point : What is it? …. And do we care?

Having some idea of the more esoteric aspects of photo stitching is useful, even if you don't consciously use this knowledge. The "Nodal Point" is one of these concepts.

When you place a camera on a tripod and move it from side to side, you rotate the camera around a point which varies from camera to camera. This point is the screw fitting underneath your camera into which you screw the tripod connection. However, this point is not necessarily the optimum rotation point for taking panoramic sequences.

One of the basic bits of technical knowledge we acquire along the way to photographic nirvana is the fact that light enters the lens of a camera. Its rays travel through the lens to create an inverted image on the film plane (or sensor). As shown in the diagram, these light rays cross over at a central point approximately halfway down the lens. That intersection is the "nodal point" and for panoramic sequences it is around this point that your camera should rotate. This is unlikely to be the same point as the tripod fixing point, and so for optimum results your camera needs to be mounted on a special panoramic tripod head which changes the point of rotation from the normal fixing point to the nodal point.

Is this important? In an ideal world and if you want the best possible result, then it is important. However, in terms of most panoramic sequences it is unlikely to make any noticeable difference whatsoever. It is mentioned here simply as part of the "Chocolates and Roses" approach. Modern stitching software is sophisticated enough to ignore the errors introduced by less than perfect rotation points, and it is unlikely that a panoramic head will be of value in day-to-day photo stitching. Perhaps useful to the professional or in extremely complex stitching situations, for the most part it is a luxury we can do without.



The Nodal Point Illustrated

The Rules of Image Stitching

The next step in preparing to take your panoramic sequence is to understand the "Rules" of panoramas.

Rule 1. Use a tripod whenever possible. This will ensure that your photos are taken on the same plane, and from the same perspective. Hand holding introduces a greater chance of mismatched images.

Rule 2. Make sure that the camera is level, otherwise the image sequence will tend to create an final image which is tilted. This becomes more important the greater the number of images, because any slant will be compounded. Many tripods have a built-in spirit level, however a small level can also be obtained from hardware stores and glued to the top of the tripod. Failing this, aligning the camera with the horizon will suffice, rotating the camera back and forth to ensure that the field of view is level before taking the proposed sequence.

Rule 3. Shoot your pictures in portrait mode rather than landscape mode. Most photostitching tends to be in panoramic mode rather than layered, square mode. If the shots are taken with the camera in landscape mode there is more likelihood of a long skinny panorama (see diagram). This is accentuated after cropping. Shooting in portrait mode maximises the height of the end image relative to the width.

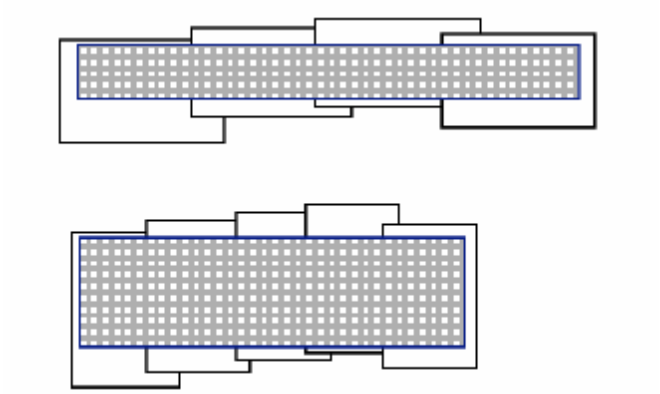


Diagram of horizontal and vertical modes

Rule 4. Choose your camera settings from an area of average light for the whole scene. The images which will be combined may have significantly different levels of light and shade. Taking your light reading from part of the scene which represents an average light level will provide the best overall exposure and reduce the possibility of over or under exposure in the final picture.

Rule 5. Lock the focus, white balance and exposure, and do not use flash unless there is no other option. Use the same settings for all photos. Image stitching software requires that you take image sequences which are as closely matched as possible in terms of exposure and other variables. If you take each image with separate settings it creates problems for the subsequent matching of those images and hampers the invisible blending of their overlapping points.

Rule 6. Overlap photos 25% to 50% (no more). All stitching software looks for identical information in adjoining images. Unless the area of overlap is significant, the software will struggle to align images correctly. However, too much overlap should also be avoided as the software needs to be able to differentiate between images as well as matching them.

Rule 7. Take the sequence quickly before the light changes. This ensures that subsequent images maintain their uniform lighting and are compatible for stitching.

When taking the sequential photos there are a number of other things you can do to aid the whole process. Just as with normal photography it pays to take several sequences using different settings so as to ensure that you have captured the scene using optimum settings. Some stitching software packages are so sophisticated that they can differentiate between sequences for you, making human intervention even less of a pre-requisite. In order to assist the software to identify where one sequence ends and another starts it can be useful to take one shot in between with the lens cap on. This introduces a black photo into the range which is so totally different that it provides a clear marker for either you or the software to note the start of the next sequence.

Other tips to producing a good sequence are:-

- Try to keep the main feature in one photo rather than split down the middle. It is easier to match less complex joins than to do so where a number of complicated points must match. If your main subject stands alone there is no possibility of it being distorted or poorly stitched.
- Avoid scenes with moving objects. Any photo stitching involving moving objects is fraught with difficulties. Some software packages will cope better than others.
- Try to avoid totally featureless scenes like sky. A blue sky or a featureless sea provides no recognisable points for the software to match.
- Take the same image size and resolution for all shots. Very few software packages will cope well with sequential photos which are not of the same size and resolution. In any event, changing settings between images is not recommended as explained before.
- Take more of the scene than you need. That way you allow for subsequent cropping. It is far easier to crop out surplus parts of the total image than to add in material later. There will generally be a need to crop most stitched photos.

When things go badly.

You will know when you have broken the rules because the end result will be dreadful. Parts of the image will be ghosted and things just won't connect seamlessly. However, it is equally true to say that if these rules are followed you are almost guaranteed a good result. However, when things go wrong, it is possible to correct errors by stitching the images manually. It is far easier to take the sequence correctly in the first place!

Sometimes you need Photoshop

Despite everything, it is sometimes necessary to photoshop the end result, as shown in the rather extreme example below. There are various ways of achieving this transition and these are beyond the scope of this tutorial. Provided the rules of photostitching are followed, subsequent manipulation should rarely be required.

BEFORE: A less than perfect stitched horizon.

AFTER: Horizon re-worked in a graphics program.

Now we have looked at the ideal world, where we have time, money and the inclination to do everything “by the book”. However, most day-to-day photography is more ad-hoc than that, and often panoramas and the need for a “bigger picture” sneak up on us when we have neither the time nor the equipment to follow the “Chocolates and Roses” approach. Let’s move on to practical photo stitching in the real world.

The “Quick ‘n Easy” approach is really just that – quick and easy – and it is the method most people will use in practical, everyday photo stitching. The majority of day-to-day photography is carried out without a tripod and without the luxury of time and planning. This need not exclude successful panoramas and photos stitching from the range of photos produced.

Panoramic heads are extremely costly, and unless you are a professional generally they are a waste of money which can be better spent on other, more useful accessories. No matter how much you spend, the money will be wasted if you are travelling or caught without it when that panoramic situation beckons. Similarly, unless you do a lot of wide-angle work it is not necessary to spend a lot of money on wide angle lenses when rectangular, stitched sequences can produce the same or better results. Photo stitching will produce equally satisfying results without having to carry or change lenses and the weight of additional lenses and tripods can be prohibitive when flying or travelling light.

The “Chocolates and Roses” approach is fine if time and money are no object – but time is frequently a major consideration, and so again the “Quick ‘n Easy” approach is more practicable.

The “Quick ‘n Easy” approach simply means keeping the main principles in mind when shooting sequential photographs. Instead of using a tripod, try bracing yourself and rotating your camera as best you can over the same spot. Today’s software is so good that it can stitch photos even though the photographer had no regard for nodal points or tripods. One substitute process is the “virtual tripod” which simply consists of a piece of string and a bolt. (see later explanation).

As long as you remember the basics, excellent sequences can be obtained simply by following these basic rules:-

- Remember to lock your exposure /focus
- Remember to overlap each shot
- Remember to keep the camera horizontal and rotate it on its own axis rather than rotating the camera in an arc.
- Take more than one sequence to be safe
- Take the photos quickly before something in the scene changes.
- Opt for a portrait mode rather than landscape in most situations.

The more care you take in taking the photos -The easier will be the stitching.

The majority of my own shots are hand held, spur of the moment compilations which are often rushed and sometimes not even taken with a view to subsequent stitching. However, such is the sophistication of programs such as Panorama Maker 4 that a successful outcome is possible from most hand-held sequences. A knowledge of the purist approach certainly helps, but the tedious and time consuming preparation of old is no longer an issue. The original stitching of the old galleon pictured earlier took some three days when those pictures were originally taken several years ago. Today, the same result – or better – can be achieved in 3 minutes without any intervention on my behalf.

On a recent trip to Athens I received peculiar looks from other tourists when I “strafed” a building from top to bottom with my camera because I was so close that I could not fit it all in with one photo. I could not step back to see the complete building, and so I simply photographed each bit in segments from fairly close up. When I got home I stitched them all together. There is little doubt that I was the only tourist there who ended up with a picture of the complete building. No tripod, no special preparation and yet a perfect result – that’s what the “Quick ‘n easy” approach can achieve.

Photo-stitching isn't just for BIG pictures

There are situations where photo stitching can be equally useful on a smaller scale. In this situation the photographs were taken using an extension tube, making the jewellery take up more than the available image size. Macro photography of this sort involves very shallow DOF and little margin for changing the proportion of the subject which is visible in the viewfinder. In this case, both images have been stitched to produce the final macro image.

STITCHING

Now you've taken your sequence of photos – how do we stitch them ??

Easily, is the basic answer ….however before you do, let's consider your computer. Is it powerful enough ??

The more images in your sequence, the larger will be your final image, and the greater drain on your computer's resources. Very large stitched images might contain maybe a dozen separate images, and at 3 megapixels each you are potentially looking at an end result of 30 meg for one image! (There are much larger ones, but here we are considering only those within normal parameters.)

Processing a dozen images takes a lot of processing power, so beware of the size trap if you plan on using many images of this size. Generally, however, you will be stitching fewer than this. Nevertheless, you should be aware that older computers may struggle or take a long while to process panoramic images. The only way to determine whether your computer will handle the load is to try it, for each person's PC will be different.

One solution if you find that your computer is struggling a bit is to shrink the individual images prior to stitching, as this will lessen the load. However, bear in mind that if they are reduced too far, loss of quality may result.

Which stitching program should I use ??

Your choices are many and will be governed by cost and personal preference. My personal favourites are as follows:-

Free programs.

- Free choices include programs included with your Camera (eg Canon stitch). These are generally fairly limited, but will handle basic stitching quite well provided that you have generally followed the rules. A better free choice is Autostitch which is free with limitations. Hugin is another free program which is more complex and has a steeper learning curve than other free programs.

Commercial Programs

- Commercial products include AutoPano Pro which is based on the free Autostitch software. The transition to a commercial alternative is significant and it is a far better program than Autostitch. It costs 99 Euros (around AUD$161.00). A very well regarded program is PTGui which costs 65 Euros (AUD$106.00) and is a high end program with great capabilities. Panorama Maker 4 (US$80 or around AUD$97) is one of my personal favourites and very efficient. These prices are mid-2007 prices.

It should be noted that most (not all) programs have the ability to stitch photos automatically to a greater or lesser extent. Some will locate the sequence, work out the correct order and stitch and crop all without intervention. Other will require you to identify the photos and the correct order. The ability to manually align the photos is a very useful one for those occasions when the automatic approach fails, so you should choose a program which allows manual stitching as well as automatic alignment.

What's the difference between software packages ?

- The commercial products are generally easier to use, more intuitive and more effective. They often offer a great flexibility and will stitch images in both horizontal, vertical or matrix shapes.
- Some cheaper products will only stitch horizontally. The cheaper products may also sometimes require greater skill and manual alignment of photos, or simply be less effective at what they do.

How do they work?

The software packages work in much the same way as you would work if you stitched the sequences manually, and indeed they often offer the choice of manual alignment for those tricky compositions or sequences which have not been properly taken in the first instance.

Whether manual or automatic, the program finds identical points in each of the adjoining images, and locks them to the corresponding point in the adjacent image. When doing it manually, the operator is provided with "flags" or "pointers" which can be placed wherever you like on the images – whether colour coded or numbered, the aim is to use your mouse to locate corresponding points and link them together.

Once you have identified the corresponding points, the computer will then align the images and do most of the final blending. The software will often provide suggested cropping points and essentially does the whole process for you. In the case of some programs (eg AutoPano Pro) all that is required is for the user to point the software at the directory with your images. It will then automatically sort out all the potential panoramas, stitch them together and present you with a final image! The stitching process is really so automated now that provided you have done a halfway decent job of taking the images, the software will do the rest. Final adjustment of colour saturation etc is sometimes possible from within the program but otherwise can be completed using the graphics program of your choice.

The key point to remember is that it is the taking of the images rather than the stitching which will determine your level of success of failure. Modern software will stitch together almost any image that can be reasonably expected to form part of a larger picture, but the ease with which this will be achieved is dependent upon your skills in taking the photos in the first place. However, if you follow the basic rules outlined in this tutorial, success should be an expectation rather than a hope.

The Virtual Tripod.

One of the most useful aids to successful panoramas is the virtual tripod, which is a free and easy alternative to a normal tripod and which you can carry with you at all times. It consists of a threaded eyelet and a piece of string, and it fits in your pocket!

All you need to do is to find a bolt or eyelet which has a thread the same as your tripod mount, and which can be screwed into the tripod socket underneath your camera. Tied to this bolt is a piece of string long enough to hang under the camera and reach the ground when the camera is held at eye level.

Here is how it works ….

1. When taking a panoramic sequence, hold the camera to the eye as normal, and allow the string to hang down to the ground.
2. Step on the string with your foot and hold the end securely under your shoe.
3. Now bring the camera to your eye so that the string is taut. Take your sequence of photos with the string taut, rotating it over the vertical line of the string.

This simple technique will ensure that the vertical alignment of the camera remains the same throughout the sequence and the lateral movement will be easier to control. Turning the camera over the vertical string provides a visual and tactile sign of where the camera should remain in space as you rotate the field of view. You will find that this is quite sufficient for most panoramic sequences. It may look a little odd to the casual observer, but it is an effective, free and easy means of placing your camera in such a way that the movement is readily easy to control. Primarily it is a great gadget to carry in a spare pocket of your camera bag for those occasions when you encounter a need for a panoramic sequence.

(This tutorial was produced by Bob Thomas for a workshop of the Eastern Suburbs Photographic Society, Melbourne, Australia. in 2007)