

Focus Stacking

What is It?

Focus Stacking is a technique similar to HDR (High Dynamic Range) in that a number of images are taken of a subject or object and then the 'best' parts of the images are taken and combined to form the final image. With HDR it is exposure that is the variable whereby the series of images are taken at different exposures from under exposed through to over exposed and then 'blended' to create a more evenly exposed image. HDR is normally used to overcome the inherent shortcomings of camera sensors in terms of dynamic range as compared with our own eyes.

With Focus Stacking not surprisingly it is the point of focus that is the variable and it is particularly useful in macro and close up photography where the depth of field can be very limited. We have all seen images of insects whereby part of it is perfectly in focus but the extremities are out of focus.

To put it into perspective the table below shows the depth of field for a 100mm macro lens with a subject distance of 300mm, which is the typical minimum focus distance for this type of lens.

| Application: Macro Lens 100 mm Subject Distance 300 mm | | | | |
|---|-----------------------|-----------------------|---------------------|---------------------|
| F Stop | Nikon D300 | Nikon D800 | Canon 7D | Canon 5D |
| | DoF | DoF | DoF | DoF |
| | mm | mm | mm | mm |
| 2.8 | 1.01 | 1.51 | 0.96 | 1.51 |
| 4 | 1.44 | 2.16 | 1.37 | 2.16 |
| 5.6 | 2.02 | 3.02 | 1.92 | 3.02 |
| 8 | 2.88 | 4.32 | 2.74 | 4.32 |
| 11 | 3.96 | 5.94 | 3.76 | 5.94 |
| 16 | 5.76 | 8.64 | 5.47 | 8.64 |
| 22 | 7.92 | 11.88 | 7.53 | 11.88 |
| 32 | 11.52 | 17.29 | 10.95 | 17.29 |

You can see that the depth of field is very shallow indeed especially on cropped sensor cameras such as the Nikon D300 & Canon 7D. On a full frame cameras such as the Nikon D800 & Canon 5D at f/22 it is around 12mm and obviously even better at f/32 at 17mm. Even so that still may be a challenge for some insects, which is why for example photographers try to keep butterflies in the same plane as the sensor to minimise the overall depth of field. In the case of the higher resolution or rather higher pixel density cameras such as the Nikon D800, D7100, Canon 70D etc. there is also the question of diffraction that occurs, which will limit how sharp the image will be. Diffraction happens at smaller apertures and so whilst the macro lens might very well go to f/32 and give the best depth of field the image will not be as sharp as at f/16. If you were to look at the sharpness of a lens across its aperture range you will see it is bell shaped with it being less sharp fully open then it probably gets to be sharpest when one or two stops down and then as the aperture gets smaller it will get less sharp again.

At a longer subject distance the depth of field improves as is shown in the following table but then you have to revert to cropping with its inherent issues.

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| Application: Macro Lens 100 mm Subject Distance 500 mm | | | | |
|--|------------|------------|----------|----------|
| F Stop | Nikon D300 | Nikon D800 | Canon 7D | Canon 5D |
| | DoF | DoF | DoF | DoF |
| | mm | mm | mm | mm |
| 2.8 | 2.8 | 4.2 | 2.66 | 4.2 |
| 4 | 4 | 6 | 3.8 | 6 |
| 5.6 | 5.6 | 8.4 | 5.32 | 8.4 |
| 8 | 8 | 12 | 7.6 | 12 |
| 11 | 11 | 16.5 | 10.45 | 16.5 |
| 16 | 16 | 24.01 | 15.2 | 24.01 |
| 22 | 22.01 | 33.04 | 20.91 | 33.04 |
| 32 | 32.03 | 48.11 | 30.43 | 48.11 |

If the subject can be persuaded not to move, easy if it is an inanimate object but a little harder if it is an insect, then focus stacking can be used.

Focus stacking works by taking a series of shots with different parts of the subject, front to back in focus. For focus stacking to work the camera must be on a tripod or firmly held in position so there is no movement, just the same as for HDR photography. The number of shots that are needed to get a sharp final image when all of the images are put together can be calculated if you know the subject distance, the aperture you are going to work with and the distance of the subject front to back. Of course you can just guess, or you can use the technology to do it for you.

So you have got your images, what now?

What you do now is really down to what software you have.

If you have **Photoshop CS5/6** or **CC** then it is straight forward to load the images, auto align them, blend them and stack the layers. You simply then flatten the image and save it and job done.

If you have **Photoshop Elements** then it may be possible to blend the layers to create a stack although a search on the Internet did not reveal any straightforward way of doing it.

There is some free software called **CombineZP** that runs on Windows and will stack the images very efficiently. For Mac users Hugin does panorama stitching as well as focus stacking, according to a Google search.

Zerene Stacker is specific software that is commercially available, which is a way of saying you have to pay for it. There are a number of packages ranging in price from a Student version at \$39 through to a professional version at \$289. Obviously the more you pay, the more features you get, however you do have to manually take the images.

Helicon Soft differs from the other vendors in that they have two applications. **Helicon Remote** controls a camera tethered to a computer and can automatically determine how many images need to be taken based on you focussing on the closest point of the subject and recording it and then the furthest point. **Helicon Remote** knows from the camera what aperture it is set to, or indeed you can

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change it via the PC, and then it calculates how many images need to be taken to get the entire subject in focus when the images are stacked. You simply hit the start button and then sit back and watch in amazement as the camera is controlled including the focussing and shooting to take all of the required images.

When all of the images have been taken **Helicon Focus** will be started and the images automatically stacked to produce the final output image. Again you tend to stare in amazement as the process is completed. Helicon Remote is typically \$53 and Helicon Focus \$115 to \$200 depending on the version.

If you were doing a lot of Focus Stacking then **Helicon Soft** would be the logical choice given that it controls the camera and effectively automates the process.

For those who do not have **Photoshop CS5/6** or **CC** and have a Windows PC and want to give Focus Stacking a try then **CombineZP** is the logical choice. You do have to manually take the images but that is a small price to pay.

Focus Stacking in Landscape.

Focus stacking is not just limited to macro and close-up work. As the following table will show it also has its uses in landscape where you have a subject that is very close that you want to in focus along with the background. You could try a small aperture however that will result in diffraction and a less sharp image.

| Application: Landscape Lens 50 mm Subject Distance 2 metres | | | | |
|---|------------|------------|----------|----------|
| F Stop | Nikon D300 | Nikon D800 | Canon 7D | Canon 5D |
| | DoF | DoF | DoF | DoF |
| | m | m | m | m |
| 1.4 | 0.2 | 0.3 | 0.19 | 0.3 |
| 1.8 | 0.26 | 0.39 | 0.25 | 0.39 |
| 2.8 | 0.41 | 0.61 | 0.38 | 0.61 |
| 4 | 0.58 | 0.88 | 0.55 | 0.88 |
| 5.6 | 0.82 | 1.26 | 0.78 | 1.26 |
| 8 | 1.2 | 1.88 | 1.13 | 1.88 |
| 11 | 1.7 | 2.82 | 1.61 | 2.82 |
| 16 | 2.7 | 5.17 | 2.52 | 5.17 |
| 22 | 4.39 | 12.75 | 4.02 | 12.75 |
| 32 | 11.23 | Infinite | 9.36 | Infinite |

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Example Images using Focus Stacking for Landscape.



In this image the focus was on the foreground and the background is left out of focus.



Here the focus was on the background letting the foreground go out of focus.



The output image has the foreground and the background in focus.

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