Rehan's Zone System

Rehan Zia
Bournemouth University
Poole, U.K.
rehanzia@gmail.com

Contemporary digital photographic tools, technologies and techniques such as high dynamic range (HDR) photography, focus stacking and digitally-stitched panoramas have enabled photographers to have an unprecedented level of creative control over the final image. Rehan's Zone System provides a systematic, adaptive workflow that makes use of these techniques to maximise tonal latitude, extend creative control, and, provide a greater opportunity to capture the decisive moment using faster shutter speeds.

Previsualisation. Zone system. High dynamic range imaging. Landscape photography. Focus stacking.

1. INTRODUCTION

Rehan's Zone System (RZS) for digital photography makes use of high dynamic range (HDR) photography, focus stacking and digital panorama techniques. It builds on the idea of the Zone System developed by Ansel Adams and Fred Archer (Adams & Baker 1981) by providing a flexible framework for digital landscape photography that facilitates both previsualisation and postvisualisation. RZS can be adapted to the individual needs of the photographer, the camera sensor and focal length of their lens, and, the scene being photographed. It is designed to allow landscape photographers more extensive control during RAW file processing and postproduction. It also allows the photographer better flexibility to improvise when photographing the landscape and enables them to respond and adapt to changes in light and movement within the scene as it is being photographed. RZS takes into account the reflected light values in the scene and adds a temporal, and, a spatial dimension, enabling the photographer to have more control over scene elements based on the distance from the camera. It enables the photographer to use faster shutter speeds at wider apertures whilst still retaining sharp focus and extended depth of field in the final image, and, reducing diffraction artifacts. RZS also provides a systematic workflow to make it easier and more likely for the photographer to capture the decisive moment.

2. THE RZS OVERVIEW

RZS framework can be viewed as a system of nested, iterative loops. At its most basic level, it defines best practice for the acquisition of high dynamic range landscape photographs. The next level looks at how this HDR acquisition best practice can be used in conjunction with focus stacking where the region in focus for each focus distance, or, depth slice, is considered as a separate scene. The final level looks at how this combined workflow for HDR and focus stacking can be applied to digital panoramas where the panorama tiles are photographed as exposure brackets for one focus distance and then the next till all depth slices have been photographed.

One way to visualise this is to consider the scene as a single block at the first level, an array of blocks extending from the camera to infinity at the second level, and, rows and columns of blocks that extend from the camera to infinity at the third level. Each block is essentially treated as an independent scene with its own individual dynamic range.

3. HDR ACQUISITION

High dynamic range photography allows the photographer to capture a wider dynamic range than is possible using a single 8 or 16-bit digital photographic exposure. This is achieved by photographing a number of different exposures and blending them together to create a 32-bit image. The photographer can then tonemap this image to extract specific tonal and textural details to suit the desired look of the final image.

The Zone System developed by Ansel Adams and Fred Archer categorised scene luminance into 11 zones ranging from pure white to pure black with Zone V being the middle-gray value (Adams & Baker 1981).

RZS has been designed to capture all scene luminance values at, or close to, Zone V, in order to maximise creative control during postproduction. In this sense, RZS puts greater emphasis on postvisualisation, where the photographer, having a much greater amount of dynamic range, can tweak the values after the photograph has been taken.

3.1 Camera RAW and exposing to the right

In order to maximise image latitude and minimise noise, it is important when photographing in the camera RAW format, to push the image pixel values as close to the right edge of the image histogram as possible, albeit without the pixel values actually falling over the edge and resulting in highlight clipping. This is because half of the total bits in camera RAW are reserved for the brightest stop, half of the remaining bits reserved for the second brightest stop and so on (Fraser, 2004). It should be noted that the image histograms on camera are based off JPEG previews and not camera RAW (Fisher 2016).

Whilst digital 35mm sensor camera manufacturers may claim to record dynamic ranges of over 10 exposure values (EVs) in a single exposure, the number of actual usable stops depends on the individual photographer's preference, their acceptable level of noise and banding in a particular image, and, how extreme the image processing may be.

3.2 Exposure bracketing for HDR

Both Bloch (2013) and Fisher (2016) suggest taking spot meter readings for the brightest and darkest values in the scene and using these as reference points for the HDR exposure range. However, this reflected spot meter reading is for exposing for the middle-gray value. In order to maximise image latitude, we need to incorporate the ETTR approach. This means increasing the exposure and offsetting the entire bracketing range by a constant factor so that the read values fall in the brightest EVs of their respective exposures.

3.3 ISO and bracketing and interval

Increasing the ISO also increases noise and has a detrimental effect on image latitude. The actual response of the camera set to a particular ISO may also be slightly different from the set value (Fraser 2004). ETTR is only beneficial as long as the sensor dynamic range drops by less than 1 stop for each 1 stop ISO level increment (Fisher 2016).

In order to have a better understanding of the range of usable stops at specific ISOs for a particular camera, it is important for the photographer to test and see what range of EVs within the individual RAW exposure at each ISO works for them, starting from the brightest EV in the individual exposure, working down to the next EV(s). For example, at ISO 100, the acceptable EV range (AEVR) might comprise of the brightest three EVs, whereas at ISO 400, it may drop to only one EV. The AEVR can thus be used as the bracketing interval for the HDR sequence.

4. ADDING THE SPATIAL AND TEMPORAL DIMENSION

4.1 The decisive moment

Henri Cartier-Bresson (1952) saw photography as a process of capturing the decisive moment in "the simultaneous recognition, in a fraction of a second, of the significance of an event as well as of a precise organization of forms which give that event its proper expression."

In landscape photography, the decisive moment can last a fraction of a second, several minutes or even hours. Light is arguably the most significant factor when it comes to the decisive moment in landscape photography. If the photographer can capture as much scene information as possible in terms of tonal detail, and, have a method of control for selectively manipulating specific regions within the scene, key decisions can be delayed and different alternatives can be tried and compared in postproduction.

By photographing multiple exposure brackets and depth slices, the photographer can have more control of specific elements in the scene in terms of tonality and relative distance from the camera.

4.2 The region of critical motion and decisive movement

The region of critical motion refers to the physical scene space bounds in the X, Y and Z directions where the decisive movement takes place. The decisive movement can be defined as the motion of an object, animal, person or natural world phenomenon etc., that is key in making the decisive moment happen.

It is important to determine where this movement would take place in relation to the distance from the camera (z-axis) and across the frame (x and y axis). This region needs to be photographed first when the decisive moment occurs so as not to miss the event. Everything else in the scene can be photographed afterwards. This approach of photographing the region of critical motion is similar to the Brenizer method.

4.3 Focus stacking

Landscape photographers are able to reduce the amount of light coming into the lens through the use of neutral density filters but there is no way of actually increasing the amount of natural light in a scene. Deep focus is required to cover the entire depth of the scene which necessitates the use of smaller apertures. Exposures made using these small apertures may need to be compensated by the use of slower shutter speeds. This creates a number of problems:

- Smaller apertures can result in diffraction and a reduction in image sharpness
- The photographer may want to use faster shutter speed to create a specific look which may not be possible under low light and with a small aperture
- Under windy conditions, the longer the exposure time is, the more there is the risk of camera shake
- The photographer may not be able to use the sweet spot of the lens, i.e. the aperture at which the lens produces the sharpest image, as this aperture may not provide the depth of field necessary to cover the entire scene

One solution to these issues is focus stacking where images are photographed at different focus distances and blended together so that the combined depth of field of all the exposures extends across the entire scene. This technique allows for the use of wider apertures that can reduce exposure times and the risk of camera shake. The use of wider apertures also means that faster shutter speeds can be employed. Photographing the scene as depth slices means that for any light changes or movement within the scene, the photographer can improvise fairly quickly and reshoot a particular depth slice again.

Focus stacking requires a careful approach to ensure that there are no gaps in the depth of field across different exposures. The lens aperture does not need to be constant between depth slices but the implication of the changing the shutter speed to compensate for aperture changes should be considered.

Having specific depth of field volumes in focus allows the photographer an extra level control for selective image manipulation that is localised to region in focus before the images are blended together. For example, the contrast of the foreground can be increased using the depth slice where the foreground is in focus before all the images are blended together.

Focus stacking can be used in conjunction with HDR. Each depth slice can be treated as a separate scene, and, the exposure bracketing range for each depth slice can be measured from the brightest and darkest surface luminosity values within each respective depth slice.

4.4 Determining the number of focus distances to photograph

It is worth considering the following factors that can help determine the number of focus distances to photograph:

- Aperture size(s)
- Depth of the volume of critical motion
- Desired shutter speed
- Depth of the overall scene
- Level of control required in post
- Rate of change of critical element(s)
- Focal length of the lens
- Overall depth of the scene required to be in focus

5. PANORAMAS

Digital panoramas can be created by taking a series of photographs that have 25%-50% overlap between one frame to the next. Using software such as Adobe Photoshop (2018) these frames can be stitched together seamlessly.

Digital panoramas require the camera to be panned and/or tilted from one framing, or "tile", to the next. When photographing panoramas in conjunction with HDR and focus stacking it is important to follow a specific sequence as a matter of best practice:

- Set the first focus distance.
- Frame the first tile and photograph the exposure brackets based on that particular depth slice and framing.
- Do not change the focus distance.
- Photograph all other remaining tiles required for that depth slice in the same manner.
- Change focus to the next focus distance and repeat the process till all focus distances, tiles within those focus distances, and, exposure brackets within those tiles have been photographed.

Once the images have been downloaded to the computer, the bracketed exposures need to be combined for each tile to create a tonemapped image. These tonemapped images then have to be stitched together to create a digital panorama for every depth slice. Lastly, the panoramas need to be focus stacked to create the final image.

Where possible, the tiles that cover the region of critical motion should be identified and photographed first.

6. CASESTUDIES

6.1 Case study 1: Splash!

Figure 1: *"Splash!" was created using a combination of HDR and focus stacking techniques*

Figure 2: *A tonemapped depth slice from "Splash"*

This case study demonstrates:

- how RZS can enable photographers to use faster shutter speeds under low light conditions
- how RZS can make it easier to capture the decisive moment

The images were photographed using a Canon 5D Mark III camera with a Sigma 35mm f/1.4 Art lens. A cable remote as well as HeliconSoft Remote (2018) app on a Samsung Note 8 (Android) phone was used to control the camera.

The intention was to use a fast shutter speed to freeze the motion of the breaking wave. A camera spot meter reading was taken off the surf which came to 1/1000 sec., at f/1.4, ISO 400. Given the overcast sky and low scene contrast, an exposure bracketing interval of 3 stops was chosen with one exposure either side of the base exposure. The reason behind choosing a 3-stop interval was to minimise ghosting by: a) having a large enough contrast difference between exposures, and, b) keeping the number of brackets to a minimum so that there was not much time gap between the total number of brackets. The aperture was set to f/1.4 and the ISO to 400 (Given prior experience with this camera has taught that going over ISO 400 can introduce too much noise which would not have worked for the desired look). The shutter speeds used were 1/250th sec., 1/1000th sec. and 1/4000th sec. The overall dynamic range of the scene was adequately covered within this exposure range.

The priority was to capture the decisive moment when the wave broke and initially the lens was focused at the distance where the waves were breaking. A cable remote was used to capture a number of bracketed sequences at this focus distance for multiple waves till a sequence was found to be satisfactory in terms of the timing of the breaking wave. The camera was then connected to the phone and the camera settings (aperture, ISO, base shutter speed, number of exposures, bracketing interval), and, near and far focus distances were set in the HeliconSoft Helicon Remote (2018) app that was used to photograph all the bracketed exposures at all of the necessary focus distances.

The RAW files were imported into Adobe Lightroom (2018) and exported out as TIFFs. Using batch automation in Photomatix (2018), these TIFF exposure brackets were tonemapped and saved again as TIFFs. There was no visible ghosting in the tonemapped images given the large exposure interval.

The next step was focus stacking the tonemapped images which proved challenging, given the motion of the sea, in both HeliconSoft Helicon Focus (2018) and Adobe Photoshop (2018). The final solution was to open the tonemapped images in Adobe Photoshop (2018) as layers and mask out the areas that were out of focus in each image. The final result seen in Fig. 1 requires some tweaking but it is very much the previsualised look. Without the combination of HDR tonemapping and the fast shutter speed made possible through the use of focus stacking, this result would not have been possible.

This is more of a brute force approach.

6.2 Case study 2: Bournemouth in snow

Figure 3: *"Bournemouth in snow" is a combination of HDR, focus stacking and digital panorama techniques*

This case study demonstrates:

- how RZS can be used to create high dynamic range digital panoramas and giga-pixel images
- how RZS can be used to minimise diffraction
- how photographers using RZS can quickly respond and adapt to changes in the scene
- how RZS can potentially reduce the overall image capture duration as compared to using a small aperture
- how RZS provides better creative control over the final image

The images were photographed using a Sony A7R II camera and a Canon EF 135mm F/2.0 lens. The camera was set up in portrait orientation to capture as much of the sky and land as possible in a single pan limiting the panorama tiles to one row. The exposure brackets were set 2 stops apart with one exposure bracket either side of the base exposure. The ISO was set to 400. The shutter speeds used were 1.3 sec., 10 sec. and 30 sec. Six tiles were used for the foreground and eleven tiles were used for the background. The foreground was photographed first using an aperture of f/16 which provided enough depth of field to cover the entire section of the hill ad bushes close to the camera. Six tiles were sufficient to cover this section. In hindsight, this could have been achieved in less tiles had the camera been in landscape orientation. The light had decreased by the time the photography for the background tiles started and thus the aperture was opened wider to f/8 whilst keeping the same shutter speeds. Not changing the shutter speeds allowed for consistency in motion blur between foreground and background elements. The depth of field available at f/8 was enough to cover the midground and background.

The images were combined to HDR and tonemapped in Photomatix (2018) using batch

automation. The images were then stacked in Adobe Photoshop (2018).
The final stitched panorama is 34466 x 7694 pixels.

Figure 4: *The left side of the image shows the tonemapped foreground depth slice whilst the right side of the image shows the background depth slice*

7. BENEFITS OF USING RZS

There are a number of advantages of using RZS:

- More extensive control in post: The individual exposure brackets allow the photographer to make image adjustments based on different exposure levels before they are combined as a HDR file. The tonemapping or exposure blending stage is another point where further image manipulation takes place. Having a set of images at varying depth of field allows splitting the photographed scene in different depth slices, thus allowing the photographer to make adjustments on specific sections of the scene based on the distance from the camera.
- Decisive moment: Capturing the decisive moment where the critical motion is relatively fast, and, the intention is to freeze motion, requires the use of faster shutter speeds. This can be particularly challenging under low light conditions. RZS allows the use of faster shutter speeds that gives the photographer a better chance of capturing the decisive moment. The faster shutter speeds also allow the photographer to fire off another burst of exposure brackets in case the first set of exposures was fired early before the moving object or light was in the correct place.
- Low or fast changing light: In instances where the light is low, and, the photographer wants, but is unable to, use the desired shutter speed. By opening the aperture wider, the photographer is able to use faster shutter speeds. This can be a better solution than increasing ISO as it does not increase the noise in the image.
- Minimising diffraction/starburst: Diffraction artifacts, that occur when light passes through smaller apertures, can be reduced by the used of wider apertures resulting in sharper images.
- Reduced ISO noise: The ability to capture images with a combined depth of field that extends across the entire scene at wider apertures means that the photographer can stick to/closer to the base ISO.
- Better flexibility and ability to improvise during photography: As the scene is being recorded in depth slices and tiles, the photographer is only concerned with the movement taking place in that particular depth slice and tile during the period it is being photographed. Any unwanted movement that takes place in a different depth volume or tile can be ignored. Any change of light in the depth slices or tiles to be photographed can be taken into account and the exposure brackets adjusted accordingly.
- Adaptability: RZS provides a framework that can be adapted to the needs of the photographer, the scene and the control required in post.

8. KEY CONSIDERATIONS

RZS requires a higher number of exposures to allow for better flexibility in post. Capturing these exposures takes time and considerable space on the memory cards and on disk. The blended HDR files, stitched panoramas and stacked final results

can take up even more disk space and also require considerable processing power and memory.
As the workflow relies on taking a large number of exposures photographed over time, the number of brackets, depth slices and panorama tiles should be considered carefully as misalignments will create ghosting errors. The sheer number of images captured can also be daunting to work with especially when these needs to be processed and combined before one can see the final result.

There is a correlation between number of depth slices photographed and the shutter speed used; the faster the shutter speed required, the wider the aperture would need to be resulting in shallower DOFs and a higher number of depth slices.

9. CONCLUSION

Rehan's Zone System gives the photographer better latitude and control over the final image that they create. Whilst the workflow is very photography intensive, it allows the photographer to delay making key decisions at the photography stage and leaves these decisions for the digital image development and postproduction stages. This allows the photographer to test, compare and postvisualise the look of the image before locking it down.

10. REFERENCES

Adams, A., & Baker, R. (1981). *The Negative* (2nd edition). Little, Brown and Company, Boston.

Bloch, C. (2013). *The HDRI handbook 2.0: High Dynamic Range Imaging for Photographers and CG Artists*. Rocky Nook, Inc., California.

B & H, 2011. *The Brenizer Method: Bokeh Panorama* https://www.youtube.com/watch?v=UsMnRxmeJ74 (retrieved 19 March 2018).

Fisher, R. (2016). *The Anti-HDR HDR Photography Book: A Guide to Photorealistic HDR and Image Blending.* Taylor & Francis, New York

Fraser, B. (2004). *Raw Capture, Linear Gamma, and Exposure. https://wwwimages.adobe.com/content/dam/Adobe/en/products/photoshop/pdfs/linear_gamma.pdf* (retrieved September 10, 2017).

Helicon Focus. (2018). HeliconSoft. http://www.heliconsoft.com/heliconsoft-products/helicon-focus/ (retrieved 19 March 2018).

Helicon Remote. (2018). HeliconSoft. http://www.heliconsoft.com/heliconsoft-products/helicon-remote/ (retrieved 19 March 2018).

Henri Cartier-Bresson (1952). *The Decisive Moment*. Simon and Schuster, New York.

Lightroom. (2018). Adobe https://www.adobe.com (retrieved 19 March 2018).

Photomatix. (2018). Hdrsoft https://www.hdrsoft.com/ (retrieved 19 March 2018).

Photoshop. (2018). Adobe https://www.adobe.com (retrieved 19 March 2018).