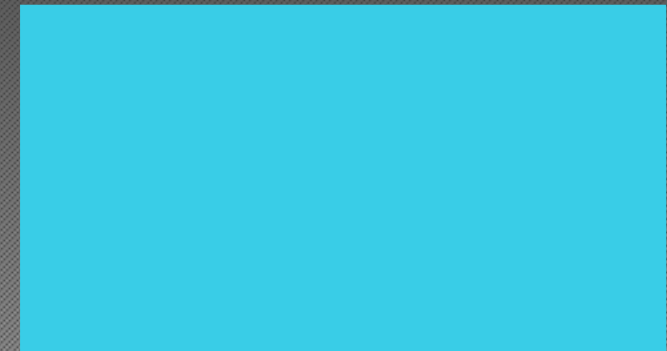


Combining Multiple Images

Focus Stacking and Panoramas

Norm Reid and Jeff Fleisher



Problem: Out of Focus Details

- Usually want sharpness throughout scene
- Mirrors what we perceive when viewing live scenes
- But, cameras limited in focusing ability
- Results:
 - Foreground sharp, background fuzzy
 - Foreground fuzzy, background sharp

Traditional Techniques Helpful

- Two methods come from days of using film
 1. Stopping down the lens
 2. Focusing 1/3 of the way into the frame

Technique 1: Stopping Down the Lens

- Largest diaphragm opening lets in most light
- Larger diaphragm gives less depth of field
 - E.g., $f/2.8$
- Smaller diaphragm lets in less light
- Smaller diaphragm gives most depth of field
 - E.g., $f/22$

Stopping Down Gives More Depth of Field

- Lens at f/2.8



- Lens at f/22



Technique 2: Circle of Confusion

- Only one point is ever in perfect focus
- Eye perceives zone in front and behind as in focus
- Called “Circle of Confusion”
- Get best perception of focus with focus $1/3$ into the frame

Example: Circle of Confusion

- Focus is 1/3 of the way into frame
- Aperture f/22



Traditional Techniques Limited

- Both techniques help
- They should be used first
- But digital technology enables new method
- Called “focus stacking”
- Other names:
 - Focus shifting (Nikon)
 - Focus bracketing

Focus Stacking: What Is It?

- Make series of photos at different focus points
- Combine images in “stacks”
- Use special software to merge the stacks into sharp images

Two Focus Stacking Methods

1. Rotate the focusing ring
2. Move the camera's position

Moving the Lens's Focusing Ring

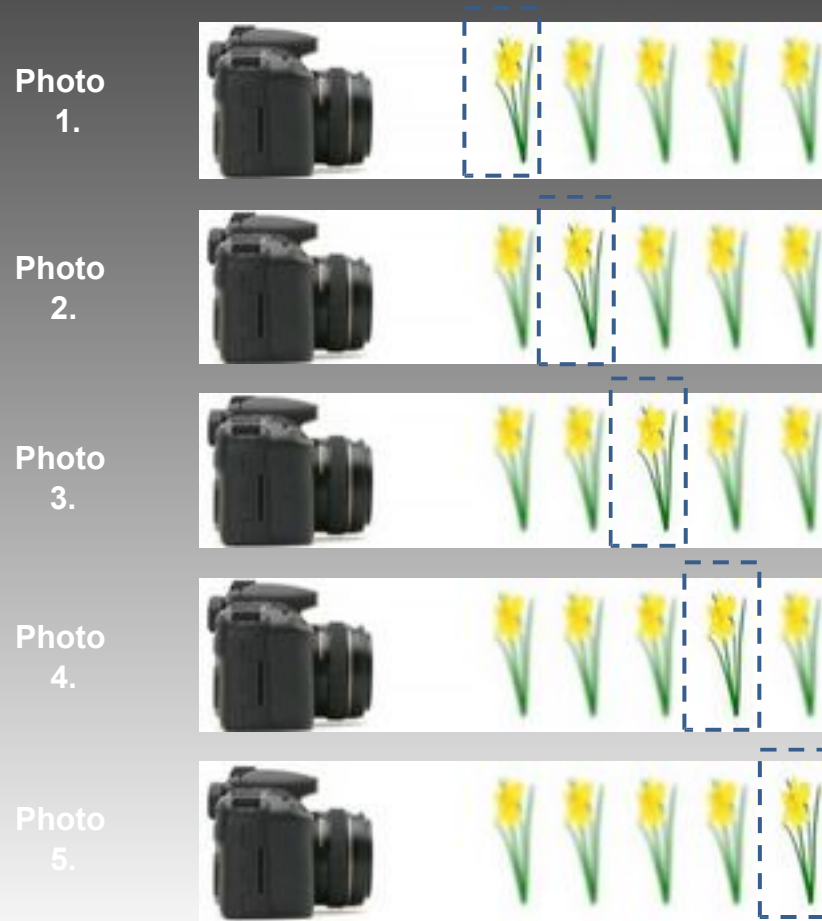
- Can be done manually in steps
- Can be done with software and wired or wireless tethering
 - Helicon Remote
 - FocusMaker DSLR Focusing Tool
 - Tether Tools Case Air Wireless Tethering System
- Can be done in camera with some cameras
 - Canon EOS RP
 - Nikon's D850, Z6 and Z7
 - Olympus OM-D
 - Panasonic Lumix G95

Focusing by Moving the Camera

- Can be done manually, but imprecise
- Use focusing rail for more precise movements
- Motorized camera movements
 - Cognisys Stackshot

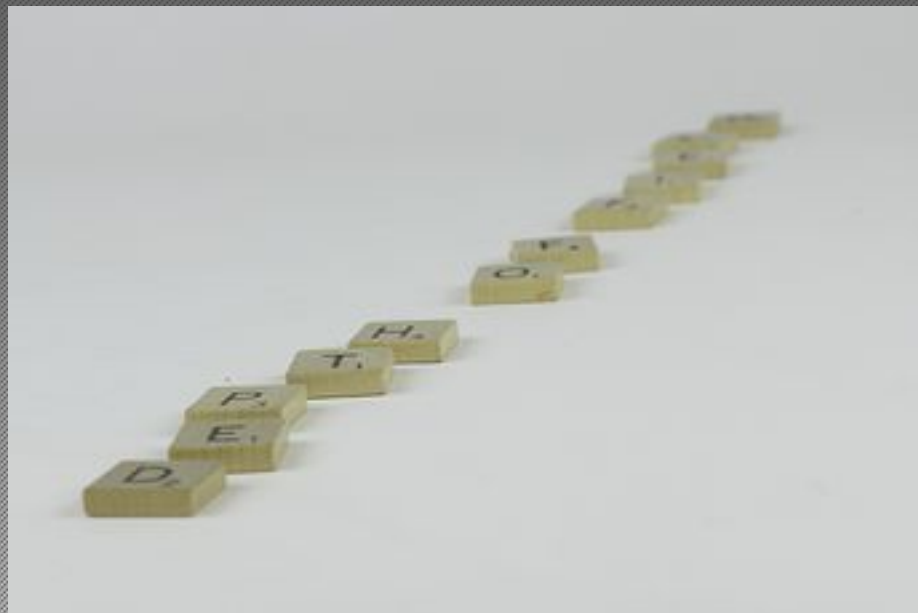
How Focus Stacking Works

- Make a series of images at different focus points
- Combine images into one stacked image via software

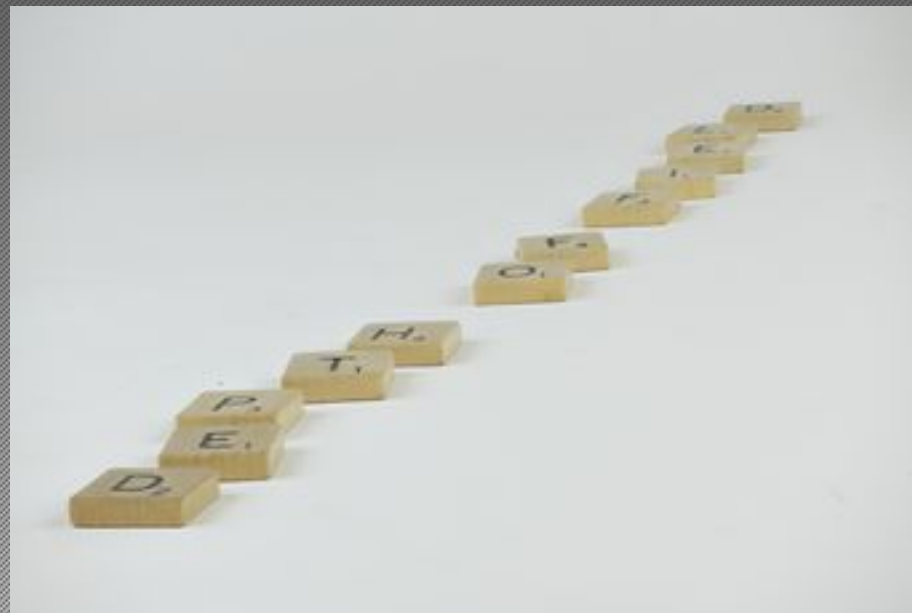


Example 1: Scrabble Tiles

- Focus at 1/3 point, f/22



- 22 images Focus Stacked



Example 2: Model Railroad Locomotive

- Focus at 1/3 point, f/22



- 18 Images Focus Stacked



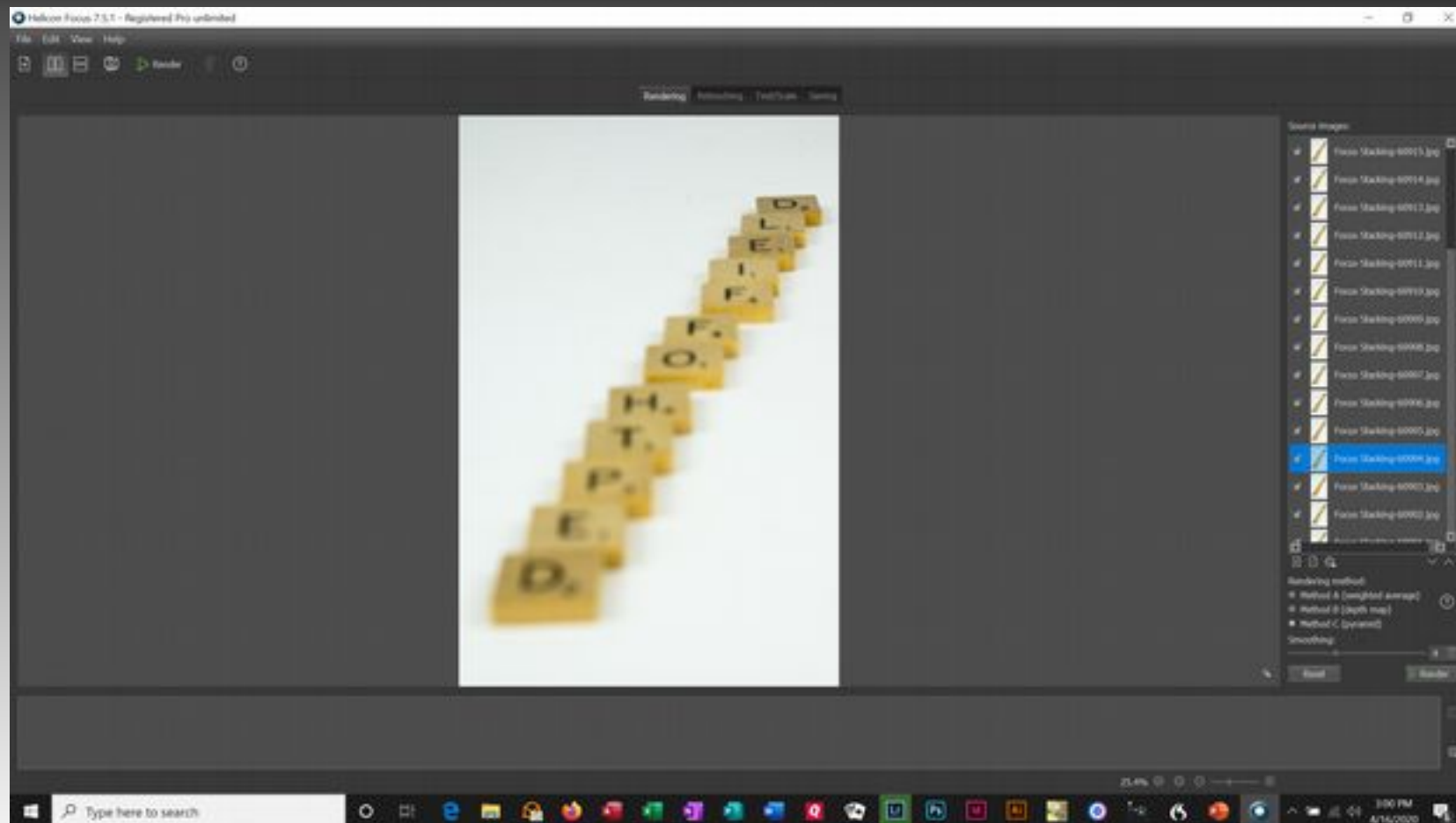
Processing Focus Stacks

- Uses special software
- Software chooses best in-focus points from each photo
- Combine images using several algorithms
- User can decide which algorithm give best results
- Software enables editing to remove artifacts

Focus Stacking Software

- Special Focus Stacking Software
 - Helicon Focus
 - Zerene Stacker
 - Other 3rd party software
- Adobe Photoshop
- On1 Photo Raw

Helicon Focus Screen



Demo of Helicon Focus

- f/11
- 1/10 sec.
- Start sequence with focus in front of first tile
- Interval set at 3 for narrow slices
- 55 images to reach beyond end of last tile

The Result

- A sharply focused photo from front to back
- No fringing or distortions
- Only adjustments were cropping and exposure

