Photography Techniques
Intermediate Skills
Contents

Articles

Bokeh 1
Macro photography 5
Fill flash 12
Light painting 12
Panning (camera) 15
Star trail 17
Time-lapse photography 19
Panoramic photography 27
Cross processing 33
Tilted plane focus 34
Harris shutter 37

References

Article Sources and Contributors 38
Image Sources, Licenses and Contributors 39

Article Licenses

License 41
**Bokeh**

In photography, **bokeh** (Originally /ˈboʊkə/,[1] /ˈboʊket/ BOH-kay — also sometimes heard as /ˈboʊkə/ BOH-ke,[1] Japanese: [boke]) is the blur,[2][3] or the aesthetic quality of the blur,[4][5] in out-of-focus areas of an image. Bokeh has been defined as "the way the lens renders out-of-focus points of light".[6] However, differences in lens aberrations and aperture shape cause some lens designs to blur the image in a way that is pleasing to the eye, while others produce blurring that is unpleasant or distracting—"good" and "bad" bokeh, respectively.[2] Bokeh occurs for parts of the scene that lie outside the depth of field. Photographers sometimes deliberately use a shallow focus technique to create images with prominent out-of-focus regions.

Bokeh is often most visible around small background highlights, such as specular reflections and light sources, which is why it is often associated with such areas.[2] However, bokeh is not limited to highlights; blur occurs in all out-of-focus regions of the image.

**Origin**

The term comes from the Japanese word *boke* (暈け or ボケ), which means "blur" or "haze", or *boke-aji* (ボケ味), the "blur quality". The Japanese term *boke* is also used in the sense of a mental haze or senility.[7] The term *bokashi* (暈かし) is related, meaning intentional blurring or gradation.

The English spelling *bokeh* was popularized in 1997 in *Photo Techniques* magazine, when Mike Johnston, the editor at the time, commissioned three papers on the topic for the March/April 1997 issue; he altered the spelling to suggest the correct pronunciation to English speakers, saying "it is properly pronounced with bo as in bone and ke as in Kenneth, with equal stress on either syllable".[3] The spellings *bokeh* and *boke* have both been in use at least since 1996, when Merklinger had suggested "or Bokeh if you prefer."[8] The term *bokeh* has appeared in photography books at least since 1998.[1] It is sometimes pronounced /ˈboʊkə/ (boke-uh).[1]

**Description**

The depth of field is the region where the size of the circle of confusion is less than the resolution of the human eye.

An extremely shallow depth of field, a common effect in macrophotography, emphasizes bokeh.
Bokeh 2

200 mm lens at f/2.

An example of the bokeh produced by the Canon 85 mm prime f/1.8 lens. The polygonal shapes are due to the 8-bladed aperture diaphragm being slightly closed. At its full aperture (f/1.8) these shapes would be smooth and not polygonal.

The bokeh produced by a catadioptric lens (also called a mirror lens).

Catadioptric lens bokeh seen in more detail.

Though difficult to quantify, some lenses have subjectively more-pleasing out-of-focus areas. "Good" bokeh is especially important for macro lenses and long telephoto lenses, because they're typically used in situations that produce shallow depth of field. Good bokeh is also important for medium telephoto lenses (typically 85–150 mm on 35 mm format). When used in portrait photography (for their "natural" perspective), the photographer usually wants a shallow depth of field, so that the subject stands out sharply against a blurred background.

Bokeh characteristics may be quantified by examining the image's circle of confusion. In out-of-focus areas, each point of light becomes an image of the aperture, generally a more or less round disc. Depending how a lens is corrected for spherical aberration, the disc may be uniformly illuminated, brighter near the edge, or brighter near the center. Lenses that are poorly corrected for spherical aberration will show one kind of disc for out-of-focus points in front of the plane of focus, and a different kind for points behind. This may actually be desirable, as blur circles that are dimmer near the edges produce less-defined shapes which blend smoothly with the surrounding image. Lens manufacturers including Nikon, Minolta, and Sony make lenses designed with specific controls to change the rendering of the out-of-focus areas.
The shape of the aperture has an influence on the subjective quality of bokeh as well. For conventional lens designs (with bladed apertures), when a lens is stopped down smaller than its maximum aperture size (minimum f-number), out-of-focus points are blurred into the polygonal shape formed by the aperture blades. This is most apparent when a lens produces hard-edged bokeh. For this reason, some lenses have many aperture blades and/or blades with curved edges to make the aperture more closely approximate a circle rather than a polygon. Minolta has been on the forefront of promoting and introducing lenses with near-ideal circular apertures since 1987, but most other manufacturers now offer lenses with shape-optimized diaphragms, at least for the domain of portraiture photography. In contrast, a catadioptric telephoto lens renders bokehs resembling doughnuts, because its secondary mirror blocks the central part of the aperture opening. Recently, photographers have exploited the shape of the bokeh by creating a simple mask out of card with shapes such as hearts or stars, that the photographer wishes the bokeh to be, and placing it over the lens.[9]

Leica lenses, especially vintage ones, are often claimed to excel in bokeh quality because they used to have 11, 12, or 15 blades. Because of this, the lenses don't need to reach high apertures to get better circles (instead of polygons). In the past, high aperture lenses (f/2, f/2.8) were very expensive due to their complex mathematical design and manufacturing know-how, at a time when all computations and glass making were done by hand. And Leica could reach a good bokeh at f/4.5. Today it is much easier to make f/1.8 lens, and a 9-bladed lens at f/1.8 is enough for an 85mm lens to achieve a great bokeh.

The Minolta/Sony STF 135mm f/2.8 [T4.5] (with STF standing for smooth trans focus) is a lens specifically designed to produce pleasing bokeh. Is possible to choose between two diaphragms: one with 9 and another with 10 blades. An apodization filter is used to soften the aperture edges which results in a smooth defocused area with gradually fading circles. Those qualities make it the only lens of this kind currently on the market.

The Nikon 105 mm DC and 135 mm (9-bladed) DC lenses (DC stands for "Defocus Control") have a control ring that permits the over-correction or under-correction of spherical aberration to change the bokeh in front of and behind the focal plane.

**Emulation**
Bokeh can be simulated by convolving the image with a kernel that corresponds to the image of an out-of-focus point source taken with a real camera. Unlike conventional convolution, this convolution has a kernel that depends on the distance of each image point and—at least in principle—has to include image points that are occluded by objects in the foreground.\(^\text{[10]}\) Also, bokeh is not just any blur. To a first approximation, defocus blur is convolution by a uniform disk, a more computationally intensive operation than the "standard" Gaussian blur; the former produces sharp circles around highlights whereas the latter is a much softer effect. Diffraction may alter the effective shape of the blur. Some graphics editors have a filter to do this, usually called "Lens Blur."\(^\text{[11]}\)

An alternative mechanical mechanism has been proposed for generating bokeh in small aperture cameras such as compacts or cellphone cameras, called image destabilisation,\(^\text{[12]}\)\(^\text{[13]}\) in which both the lens and sensor are moved in order to maintain focus at one focal plane, while defocusing nearby ones. This effect currently generates blur in only one axis.

### Other applications

In 2009,\(^\text{[14]}\) a research group at MIT Media Lab showed that the bokeh effect can be used to make imperceptibly small barcodes, or bokodes. By using barcodes as small as 3 mm with a small lens over them, if the barcode is viewed out of focus through an ordinary camera focused at infinity, the resulting image is large enough to scan the information in the barcode.\(^\text{[15]}\)

### References


### External links

- Aperture Simulator (http://www.screamyguy.net/iris/index.htm) Java iris and effect simulator
- How to evaluate bokeh (http://www.rickdenney.com/bokeh_test.htm)
- Understanding Bokeh (http://www.luminous-landscape.com/essays/bokeh.shtml)
- Bokeh in olypedia.de (http://olypedia.de/Bokeh) (German)
Macro photography

Macro photography (or photomacrography\textsuperscript{[1]} or macrography\textsuperscript{[2]} and sometimes macrophotography\textsuperscript{[3]}), invented by Fritz Goro,\textsuperscript{[4]} is extreme close-up photography, usually of very small subjects, in which the size of the subject in the photograph is greater than life size (though macrophotography technically refers to the art of making very large photographs).\textsuperscript{[2][5]} By some definitions, a macro photograph is one in which the size of the subject on the negative or image sensor is life size or greater.\textsuperscript{[1]} However in other uses it refers to a finished photograph of a subject at greater than life size.\textsuperscript{[1]}

The ratio of the subject size on the film plane (or sensor plane) to the actual subject size is known as the \textit{reproduction ratio}. Likewise, a \textit{macro lens} is classically a lens capable of reproduction ratios greater than 1:1, although it often refers to any lens with a large reproduction ratio, despite rarely exceeding 1:1.\textsuperscript{[1][6]}

Apart from technical photography and film-based processes, where the size of the image on the negative or image sensor is the subject of discussion, the finished print or on-screen image more commonly lends a photograph its \textit{macro} status. For example, when producing a 6×4 inch (15×10 cm) print using 135 format film or sensor, a life-size result is possible with a lens having only a 1:4 reproduction ratio.\textsuperscript{[1]}

Reproduction ratios much greater than 1:1 are considered to be photomicrography, often achieved with digital microscope (photomicrography should not be confused with microphotography, the art of making very small photographs, such as for microforms).

Due to advances in sensor technology, today's small-sensor digital cameras can rival the macro capabilities of a DSLR with a "true" macro lens, despite having a lower reproduction ratio, making macro photography more widely accessible at a lower cost.\textsuperscript{[1]} In the digital age, a "true" macro photograph can be more practically defined as a photograph with a vertical subject height of 24 mm or less.\textsuperscript{[1]}

Equipment and techniques

"Macro" lenses specifically designed for close-up work, with a long barrel for close focusing and optimized for high reproduction ratios, are one of the most common tools for macro photography. (Unlike most other lens makers, Nikon designates its macro lenses as "Micro" because of their original use in making microform.) Most modern macro lenses can focus continuously to infinity as well and can provide excellent optical quality for normal photography. True macro lenses, such as the Canon MP-E 65 mm f/2.8 or Minolta AF 3x-1x 1.7-2.8 Macro, can achieve higher magnification than life size, enabling photography of the structure of small insect eyes, snowflakes, and other minuscule objects. Others, such as the Infinity Photo-Optical's TS-160 can achieve magnifications from 0-18x on sensor, focusing from infinity down to 18 mm from the object.

Macro lenses of different focal lengths find different uses:
- Continuously-variable focal length – suitable for virtually all macro subjects
- 45–65 mm – product photography, small objects that can be approached closely without causing undesirable influence, and scenes requiring natural background perspective
- 90–105 mm – insects, flowers, and small objects from a comfortable distance
- 150–200 mm – insects and other small animals where additional working distance is required

Extending the distance between the lens and the film or sensor, by inserting either extension tubes or a continuously adjustable bellows, is another equipment option for macro photography. The further the lens is from the film or sensor, the closer the focusing distance, the greater the magnification, and the darker the image given the same aperture. Tubes of various lengths can be stacked, decreasing lens-to-subject distance and increasing magnification. Bellows or tubes eliminate infinity focus. They can be used in conjunction with some other techniques such as reversing the lens.

Placing an auxiliary close-up lens (or close-up "filter") in front of the camera's lens is another option. Inexpensive screw-in or slip-on attachments provide close focusing. The possible quality is less than that of a dedicated macro lens or extension tubes, with some two-element versions being very good while many inexpensive single element lenses exhibit chromatic aberration and reduced sharpness of the resulting image. This method works with cameras that have fixed lenses, and is commonly used with bridge cameras. These lenses add diopters to the optical power of the lens, decreasing the minimum focusing distance, and allowing the camera to get closer to the subject. They are typically designated by their diopter, and can be stacked (with an additional loss of quality) to achieve the desired magnification.

Photographers may employ view camera movements and the Scheimpflug principle to place an object close to the lens in focus, while maintaining selective background focus. This technique requires the use of a view camera or perspective control lens with the ability to tilt the lens with respect to the film or sensor plane. Lenses such as the Nikon PC-E and Canon TS-E series, the Hartblei Super-Rotator, the Schneider Super Angulon, several Lensbaby models, the Zoerk Multi Focus System, and various tilt-shift adapters for medium format, allow the use of tilt in cameras with fixed lens mounts. Traditional view cameras permit such adjustment as part of their design.

Ordinary lenses can be used for macro photography by using a "reversing ring." This ring attaches to the filter thread on the front of a lens and makes it possible to attach the lens in reverse. Excellent
Macro photography

quality results up to 4x life-size magnification are possible. For cameras with all-electronic communications between
the lens and the camera body specialty reversing rings are available which preserve these communications. When
used with extension tubes or bellows, a highly versatile, true macro (greater than life size) system can be assembled.
Since non-macro lenses are optimized for small reproduction ratios, reversing the lens allows it to be used for
reciprocally high ratios.

Macro photography may also be accomplished by mounting a lens in reverse, in front of a normally mounted lens of
greater focal length, using a macro coupler which screws into the front filter threads of both lenses. This method
allows most cameras to maintain the full function of electronic and mechanical communication with the normally
mounted lens, for features such as open-aperture metering. The magnification ratio is calculated by dividing the focal
length of the normally mounted lens by the focal length of the reversed lens (e.g., when an 18 mm lens is reverse
mounted on a 300 mm lens the reproduction ratio is 16:1). The use of automatic focus is not advisable if the first lens
is not of the internal-focusing type, as the extra weight of the reverse-mounted lens could damage the autofocus
mechanism. Working distance is significantly less than the first lens.

Increasingly, macro photography is accomplished using compact digital cameras and small-sensor bridge cameras,
combined with a high powered zoom lens and (optionally) a close-up diopter lens added to the front of the camera
lens. The deep depth of field of these cameras is an advantage for macro work. The high pixel density and
resolving power of these cameras’ sensors enable them to capture very high levels of detail at a lower reproduction
ratio than is needed for film or larger DSLR sensors (often at the cost of greater image noise). Despite the fact that
many of these cameras come with a “macro mode” which does not qualify as true macro, some photographers are
using the advantages of small sensor cameras to create macro images that rival or even surpass those from DSLRs.

Macro photography techniques

![Optical scheme of close-up macro photography](image1)

![Reversed-lens macro photography optical scheme](image2)

![Optical scheme of macro photography using reversed lens and telephoto lens](image3)

![Optical scheme of macro photography using infinity corrected microscope objective and telephoto lens](image4)

![Optical scheme of macro photography using extension tube](image5)
Macro photography lenses

For those looking to purchase a Macro lens, here is a list of Macro lenses produced by major DSLR manufactures.

<table>
<thead>
<tr>
<th>Lens</th>
<th>Focal Length</th>
<th>Reproduction Ratio</th>
<th>Closest Focus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canon EF Compact f/2.5</td>
<td>50mm</td>
<td>1:2 (half life size)</td>
<td>6in.</td>
</tr>
<tr>
<td>Canon EF-S f/2.8 USM</td>
<td>60mm</td>
<td>1:1 (life size)</td>
<td>8in.</td>
</tr>
<tr>
<td>Canon MP-E f/2.8 1-5x</td>
<td>65mm</td>
<td>5:1 (life size)</td>
<td>7in.</td>
</tr>
<tr>
<td>Canon EF f/2.8 USM</td>
<td>100mm</td>
<td>1:1 (life size)</td>
<td>5.9in.</td>
</tr>
<tr>
<td>Canon EF f/2.8L IS USM</td>
<td>100mm</td>
<td>1:1 (life size)</td>
<td>12in.</td>
</tr>
<tr>
<td>Canon EF f/3.5L USM</td>
<td>180mm</td>
<td>1:1 (life size)</td>
<td>10in.</td>
</tr>
<tr>
<td>Nikon AF-S DX f/2.8G</td>
<td>40mm</td>
<td>1:1 (life size)</td>
<td>6.4in.</td>
</tr>
<tr>
<td>Nikon AF Nikkor f/2.8D</td>
<td>60mm</td>
<td>1:1 (life size)</td>
<td>8.75in.</td>
</tr>
<tr>
<td>Nikon AF-S Nikkor f/2.8G ED</td>
<td>60mm</td>
<td>1:1 (life size)</td>
<td>6in.</td>
</tr>
<tr>
<td>Nikon AF-S DX Nikkor f/3.5G ED</td>
<td>85mm</td>
<td>1:1 (life size)</td>
<td>9in.</td>
</tr>
<tr>
<td>Nikon AF-S VR Nikkor f/2.8G IF-ED</td>
<td>105mm</td>
<td>1:1 (life size)</td>
<td>12in.</td>
</tr>
<tr>
<td>Nikon AF Nikkor f/4D IF-ED</td>
<td>200mm</td>
<td>1:1 (life size)</td>
<td>9in.</td>
</tr>
<tr>
<td>Nikon PC-E Nikkor f/2.8D ED</td>
<td>45mm</td>
<td>1:2 (half life size)</td>
<td>9.9in.</td>
</tr>
<tr>
<td>Nikon PC-E Nikkor f/2.8D</td>
<td>85mm</td>
<td>1:2 (half life size)</td>
<td>15in.</td>
</tr>
<tr>
<td>Pentax DA 35mm f/2.8 Macro Limited</td>
<td>35mm</td>
<td>1:1 (life size)</td>
<td>5.4in.</td>
</tr>
<tr>
<td>Pentax D-FA 50mm f/2.8 Macro</td>
<td>50mm</td>
<td>1:1 (life size)</td>
<td>7.67in.</td>
</tr>
<tr>
<td>Pentax D-FA 100mm f/2.8 Macro WR</td>
<td>100mm</td>
<td>1:1 (life size)</td>
<td>9.9in.</td>
</tr>
<tr>
<td>Sony DT 30mm f/2.8 Macro Lens</td>
<td>30mm</td>
<td>1:1 (life size)</td>
<td>4.8in.</td>
</tr>
<tr>
<td>Sony 50mm f/2.8 Macro Lens</td>
<td>50mm</td>
<td>1:1 (life size)</td>
<td>7.8in.</td>
</tr>
<tr>
<td>Sony 100mm f/2.8 Macro Lens</td>
<td>100mm</td>
<td>1:1 (life size)</td>
<td>14.4in.</td>
</tr>
</tbody>
</table>

[7] [8] [9] [10]
35 mm equivalent magnification

35 mm equivalent magnification, or 35 mm equivalent reproduction ratio, is a measure that indicates the apparent magnification achieved with a small sensor format, or "crop sensor" digital camera compared to a 35 mm-based image enlarged to the same print size. The term is useful because many photographers are familiar with the 35 mm film format.

While a "true" macro lens is defined as a lens having a reproduction ratio of 1:1 on the film or sensor plane, with small sensor format digital cameras an actual reproduction ratio of 1:1 is rarely achieved or needed to take macro photographs. What macro photographers often care about more is simply knowing the size of the smallest object that can fill the frame. For example, the 12 megapixel Micro Four Thirds Panasonic Lumix DMC-GH1 camera with a 2x crop sensor only requires a 1:2 reproduction ratio to take a picture with the same subject size, resolution, and apparent magnification as a 12 megapixel "full-frame" Nikon D700 camera, when the images are viewed on screen or printed at the same size. Thus a Four Thirds system macro lens like the Olympus Zuiko Digital 35 mm F3.5 Macro lens with a true maximum image magnification of 1.0x is rated as having a "2.0x 35 mm equivalent magnification".

To calculate 35 mm equivalent reproduction ratio, simply multiply the actual maximum magnification of the lens by the 35 mm conversion factor, or "crop factor" of the camera. If the actual magnification and/or crop factor are unknown (such as is the case with many compact or point-and-shoot digital cameras), simply take a photograph of a mm ruler placed vertically in the frame focused at the maximum magnification distance of the lens and measure the height of the frame. Since the object height of a 1.0x magnified 35 mm film image is 24 mm, calculate 35 mm equivalent reproduction ratio and true reproduction ratio by using the following:

\[
(35 \text{ mm equivalent reproduction ratio}) = 24 / (\text{measured height in mm})
\]

\[
(\text{True reproduction ratio}) = (35\text{mm equivalent reproduction ratio}) / \text{Crop factor}.
\]

Since digital compact camera sensor sizes come in a wide diversity of sizes and camera manufacturers rarely publish the macro reproduction ratios for these cameras, a good rule of thumb is that whenever a 24 mm vertical object just fits, or is too tall to fit in the camera viewfinder, you are taking a macro photograph.
35 mm equivalent reproduction ratio: the photograph on the left was taken with a full-frame (35 mm) sensor digital SLR camera and a 100 mm macro lens at 1:1 magnification. The photograph on the right was taken with a Micro Four Thirds (2x crop) sensor camera and a 50 mm macro lens at 1:2 magnification. The photographs are practically indistinguishable and therefore equivalent.

Technical considerations

Depth of field

Limited depth of field is an important consideration in macro photography. Depth of field is extremely small when focusing on close objects. A small aperture (high f-number) is often required to produce acceptable sharpness across a three-dimensional subject. This requires either a slow shutter speed, brilliant lighting, or a high ISO. Auxiliary lighting (such as from a flash unit), preferably a ring flash is often used (see Lighting section).

Like conventional lenses, macro lenses need light, and ideally would provide similar f/# to conventional lenses to provide similar exposure times. Macro lenses also have similar focal lengths, so the entrance pupil diameter is comparable to that of conventional lenses (e.g., a 100 mm f/2.8 lens has a 100 mm/2.8 = 35.7 mm entrance-pupil diameter). Because they focus at close subjects, the cone of light from a subject point to the entrance pupil is relatively obtuse (a relatively high subject numerical aperture to use microscopy terms), making the depth of field extraordinarily small. This makes it essential to focus critically on the most important part of the subject, as elements that are even a millimetre closer or farther from the focal plane might be noticeably blurred. Due to this, the use of a microscope stage is highly recommended for precise focus with large magnification such as photographing skin cells. Alternatively, more shots of the same subject can be made with slightly different focusing lengths and joined afterwards with specialized focus stacking software which picks out the sharpest parts of every image, artificially increasing depth of field.

Compact digital cameras and small-sensor bridge cameras have an incidental advantage in macro photography due to their inherently deeper depth of field.\[1\] For instance, some popular bridge cameras produce the equivalent magnification of a 420 mm lens on 35-mm format but only use a lens of actual focal length 89 mm (1/1.8”-type CCD) or 72 mm (1/2.5”-type CCD). (See crop factor.) At the same f/#, that corresponds to an entrance pupil 89/420 = 0.21 times the size—much smaller. Since depth of field appears to decrease with the actual focal length of the lens, not the equivalent focal length, these bridge cameras can achieve the magnification of a 420 mm lens with the greater depth of field of a much shorter lens. High-quality auxiliary close-up lenses can be used to achieve the needed close focus; they function identically to reading glasses. This effect makes it possible to achieve very high quality macro photographs with relatively inexpensive equipment, since auxiliary closeup lenses are cheaper than dedicated SLR macro lenses. However, the amount of light gathered goes by the area of the entrance pupil, so with
the smaller entrance pupil only 4.5% as much light is captured; alternately the full-frame camera would produce the same image by stopping down, increasing the f/# by a factor of $\frac{420}{89} = 4.7$ (e.g., from f/2.8 to f/13.16).

**Lighting**

The problem of sufficiently and evenly lighting the subject can be difficult to overcome. Some cameras can focus on subjects so close that they touch the front of the lens. It is difficult to place a light between the camera and a subject that close, making extreme close-up photography impractical. A normal-focal-length macro lens (50 mm on a 35 mm camera) can focus so close that lighting remains difficult. To avoid this problem, many photographers use telephoto macro lenses, typically with focal lengths from about 100 to 200 mm. These are popular as they permit sufficient distance for lighting between the camera and the subject.

Ring flashes, with flash tubes arranged in a circle around the front of the lens, can be helpful in lighting at close distances. Ring lights have emerged, using white LEDs to provide a continuous light source for macro photography, however they are not as bright as a ring flash and the white balance is very cool. Good results can also be obtained by using a flash diffuser. Homemade flash diffusers made out of white Styrofoam or plastic attached to a camera's built-in flash can also yield surprisingly good results by diffusing and softening the light, eliminating specular reflections and providing more even lighting.

**References**

[10] Macro Lenses | Sony | Sony Store USA (http://store.sony.com/webapp/wcs/stores/servlet/CategoryDisplay?catalogId=10551&storeId=10151&langId=-1&categoryId=32332)

**External links**

- Photo.net how-to (http://photo.net/learn/macro/) — Guide to macro photography
- Make your own reversing ring (http://photocritic.org/macro-photography-on-a-budget/) out of a Pringles can by Haje Jan Kamps
- Information on inverted lenses (http://home.comcast.net/~flash19901/tech tips.htm)
- Insects-macrophotography (http://www.nature-pictures.org/en/Insects-macrophotography/) Photos of insects
- Inexpensive Macro Photography (http://sites.google.com/site/inexpensivemacrophotography/) DSLR with Manual Focus Lens
- Macro Photography Tips (http://www.macro-photography.eu)
- Macro Photography Tips (http://www.macro-photography.eu)
- How to use a macro reverse ring (http://www.ares-foto.de/blog/montage-eines-makro-umkehrringes/)
Fill flash

**Fill flash** is a photographic technique used to brighten deep shadow areas, typically outdoors on sunny days, though the technique is useful any time the background is significantly brighter than the subject of the photograph, particularly in backlit subjects. To use fill flash, the aperture and shutter speed are adjusted to correctly expose the background, and the flash is fired to lighten the foreground.

Most point and shoot cameras include a fill flash mode that forces the flash to fire, even in bright light.

Depending on the distance to the subject, using the full power of the flash may greatly overexpose the subject especially at close range. Certain cameras allow the level of flash to be manually adjusted e.g. 1/3, 1/2, or 1/8 power, so that both the foreground and background are correctly exposed, or allow an automatic flash exposure compensation.

Light painting

**Light painting** is a photographic technique in which exposures are made by moving a hand-held light source or by moving the camera. The term light painting also encompasses images lit from outside the frame with hand-held light sources. Light Painting Photography can be traced back to the year 1914 when Frank Gilbreth, along with his wife Lillian Moller Gilbreth, used small lights and the open shutter of a camera to track the motion of manufacturing and clerical workers. Man Ray, in his 1935 series "Space Writing," was the first known art photographer to use the technique and Barbara Morgan began making light paintings in 1940.

**Techniques**

By moving the light source, the light can be used to selectively illuminate parts of the subject or to "paint" a picture by shining it directly into the camera lens. Light painting requires a slow shutter speed, usually a second or more. Light painting can take on the characteristics of a quick pencil sketch.

Light painting by moving the camera, also called **camera painting**, is the antithesis of traditional photography. At night, or in a dark room, the camera can be taken off the tripod and used like a paintbrush. An example is using the night sky as the canvas, the camera as the brush and cityscapes (amongst other light sources) as the palette. Putting energy into moving the camera by stroking lights, making patterns and laying down backgrounds can create abstract artistic images.
Light painting can be done interactively using a webcam. The painted image can already be seen while drawing by using a monitor or projector.

Another technique used in the creation of light art is the projection of images on to irregular surfaces (faces, bodies, buildings etc.), in effect "painting" them with light. A photograph or other fixed portrayal of the resulting image is then made.

**History**

In 1949 Pablo Picasso was visited by Gjon Mili, a photographer and lighting innovator, who introduced Picasso to his photographs of ice skaters with lights attached to their skates. Immediately Picasso started making images in the air with a small flashlight in a dark room. This series of photos became known as Picasso's "light drawings." Of these photos, the most celebrated and famous is known as "Picasso draws a centaur in the air."[1] During the 1970's and 80's Eric Staller[2] used this technology for numerous photo projects. Picasso and Mili's images should be regarded as some of the first light drawings. Now, with modern light painting, one uses more frequently choreography and performance to photograph and organize.

Since spring 2007 the term Light art performance photography or LAPP has been in use, used to describe the work of the Light Painting team of LAPP-PRO. In this photography the integration of the background, the execution of performance and choreography is a very important element.[3]

This artform is currently enjoying a surge in popularity, partly due to the increasing availability of dSLR cameras, advances in portable light sources such as LEDs, and also in part due to the advent of media sharing websites by which practitioners can exchange images and ideas.

**Equipment**

A variety of light sources can be used, ranging from simple flashlights to dedicated devices like the Hosemaster, which uses a fiber optic light pen.[4] Other sources of light including candles, matches, fireworks, lighter flints, glowsticks, and Poi are also popular.

A tripod is usually necessary due to the long exposure times involved. Alternatively, the camera may be placed on or braced against a table or other solid support. A shutter release cable or self timer is generally employed in order to minimize camera shake. Color Gels can also be used to color the light sources.
Light painting

Gallery

- Portrait illuminated by light painting with a sparkler
- Star image produced with light painting
- Long exposure photo of a light show dance using finger lights.
- Stick figure image produced with light painting.
- Light painting with steel wool
- Urban Light Painting by Lichtfaktor
- Light Painting with steel wool
- Minimalist light painting: full moon on dark night

References


External links

- Article in Amateur Photographer magazine on the fundamental basics of Light Painting (http://www.amateurphotographer.co.uk/how-to/photo-techniques/539651/light-painting-masterclass-with-michael-bosanko)
- Light Graffiti Photography - Jasper Geenhuizen (http://www.lightgraffiti.nl/)
- Light Painting Photography - Comprehensive Light Painting Resource (http://lightpaintingphotography.com)
- SWISS LAPP - Light Art Photography Team (http://www.swiss-lapp.ch)
- PBS Arts - Off Book on light painting (http://vimeo.com/26634967)
- Light Art Photographer Jan Leonardo Wöllert | euromaxx (http://vimeo.com/52911250)
- Lichtfaktor - Light painting artists collective (http://www.lichtfaktor.com)
- Light Painting World Alliance - non-profit organization united all light painters in the globe (http://lpwalliance.com)
- Painting with Light - How it all began - Historical article about light painting's roots (http://lpwalliance.com/index2.php?type=publicationview&id=15)
- The Graffiti Light Project - Light Painting Exhibition and Event Team (http://graffitilight.com)
- LightArt-Photography - Light Painting and Light Art Photography since 2005, Founder Of The LAPP Technique (http://www.lightart-photography.de)
Panning (camera)

In photography, **panning** refers to the rotation in a horizontal plane of a still camera or video camera. Panning a camera results in a motion similar to that of someone shaking their head from side to side or of an aircraft performing a yaw rotation. Or to that of an opening door if the door stays facing one way.

Filmmaking and professional video cameras **pan** by turning horizontally on a vertical axis, but the effect may be enhanced by adding other techniques, such as rails to move the whole camera platform. Slow panning is also combined with zooming in or out on a single subject, leaving the subject in the same portion of the frame, to emphasize or de-emphasize the subject respectively.

In still photography, the panning technique is used to suggest fast motion, and bring out the subject from other elements in the frame. In photographic pictures it is usually noted by a foreground subject in action appearing still (i.e. a runner frozen in mid-stride) while the background is streaked and/or skewed in the apparently opposite direction of the subject's travel, similar to speed lines, and is often used in sports photography, primarily of racing.

In video display technology, **panning** refers to the horizontal scrolling of an image that is wider than the display.

For 3D modeling in computer graphics, **panning** means moving parallel to the current view plane. In other words, the camera moves perpendicular to the direction it is pointed, and this direction does not change. The term **panning** is derived from **panorama**, a word originally coined in 1787 by Robert Barker for the 18th century version of these applications, a machine that unrolled or unfolded a long horizontal painting to give the impression the scene was passing by; Barker also invented the cyclorama in which a large painting encircles an audience.
Achieving a smooth pan in photography

When photographing a moving subject, the panning technique is achieved by keeping the subject in the same position of the frame for the duration of the exposure. The length of the exposure must be long enough to allow the background to blur due to the movement of the camera as the photographer follows the subject in the viewfinder.

The exact length of exposure required will depend on the speed at which the subject is moving, the focal length of the lens and the distance from the subject and background. An F1 car speeding along a straight might allow the photographer to achieve a blurred background at 1/250th of a second, while the photographer might need to go as slow as 1/40th to achieve the same amount of blur for a picture of a running man.\(^2\)

The faster shutter speed allowed by fast moving subjects are easier to capture in a smoothly panned shot. With slower moving subjects, the risk is that the panning motion will be jerky, and it is also harder to keep the subject in the same position of the frame for the longer period of time.

To aid in capturing panned pictures, photographers use aids such as tripods and monopods, which make it easy to swing the camera along one plane, while keeping it steady in the others. A low budget option is to tie a piece of string around the lens, then to drop the other end to the floor and step on it to pull it taut. This will allow a little bit more stability and allow for smoother blur.\(^3\)

References

External links

Media related to Panning at Wikimedia Commons
Star trail

A star trail is a type of photograph that utilizes long-exposure times to capture the apparent motion of stars in the night sky due to the rotation of the Earth. A star trail photograph shows individual stars as streaks across the image, with longer exposures resulting in longer streaks. Typical exposure times for a star trail range from 15 minutes to several hours, requiring a 'bulb' setting on the camera to open the shutter for a longer period than is normal.

Star trails have been used by professional astronomers to measure the quality of observing locations for major telescopes.

Capturing star trail images

Star trail photographs are captured by placing a camera on a tripod, pointing the lens toward the sky, and allowing the shutter to stay open for a long period of time. Star trails are considered relatively easy for amateur astrophotographers to create. Photographers generally make these images by using an SLR camera with its lens focus set to infinity. A cable release allows the photographer to hold the shutter open for the desired amount of time. Typical exposure times begin at 15 minutes and can be many hours long, depending on the desired length of the star trail streaks on the image. Even though star trail pictures are created under low-light conditions, the long exposure times allow for fast films, such as ISO 200 and ISO 400, to be used. Wide-apertures, such as f/5.6 and f/4, are recommended for star trails.

Because exposure times for star trail photographs can be several hours long, camera batteries can be easily depleted. Mechanical cameras that do not require a battery to open and close the shutter have an advantage over more modern film and digital cameras which utilize battery power. On these cameras, the Bulb, or B, exposure setting is used to keep the shutter open. Another problem that digital cameras encounter is an increase in detector noise with increasing exposure time. American astronaut Don Pettit recorded star trails with a digital camera from the International Space Station in earth orbit between April and June, 2012. Pettit described his technique as follows: "My star trail images are made by taking a time exposure of about 10 to 15 minutes. However, with modern digital cameras, 30 seconds is about the longest exposure possible, due to electronic detector noise effectively snowing out the image. To achieve the longer exposures I do what many amateur astronomers do. I take multiple 30-second exposures, then 'stack' them using imaging software, thus producing the longer exposure."
Rotation of the Earth

Star trail photographs are possible because of the rotation of the Earth on its axis. The apparent motion of the stars is recorded as streaks on the film or detector.[1] For observers in the northern hemisphere, aiming the camera towards the north creates an image with concentric circular streaks centered around the north celestial pole (very close to Polaris).[2] For observers located in the southern hemisphere, this same effect is achieved by aiming the camera south. In this case, the streaks are centered on the south celestial pole. Aiming the camera towards the east or west creates straight-line streaks that are angled with respect to the horizon. The size of the angle depends on the photographer's latitude.[1]

Astronomical site testing

Star trail photographs can be used by astronomers to determine the quality of a location for telescope observations. Star trail observations of Polaris have been used to measure the quality of seeing in the atmosphere, and the vibrations in telescope mounting systems.[7] The first recorded suggestion of this technique is from E.S. Skinner's 1931 book A Manual of Celestial Photography.[8]

References

External links

Time-lapse photography

Time-lapse photography is a technique whereby the frequency at which film frames are captured (the frame rate) is much lower than that used to view the sequence. When played at normal speed, time appears to be moving faster and thus lapsing. For example, an image of a scene may be captured once every second, then played back at 30 frames per second. The result is an apparent 30-times speed increase. Time-lapse photography can be considered the opposite of high speed photography or slow motion.

Processes that would normally appear subtle to the human eye, e.g. the motion of the sun and stars in the sky, become very pronounced. Time-lapse is the extreme version of the cinematography technique of undercranking, and can be confused with stop motion animation.

History

Some classic subjects of time-lapse photography include:
- cloudscapes and celestial motion
- plants growing and flowers opening
- fruit rotting
- evolution of a construction project
- people in the city

The technique has been used to photograph crowds, traffic, and even television. The effect of photographing a subject that changes imperceptibly slowly, creates a smooth impression of motion. A subject that changes quickly is transformed into an onslaught of activity.

The first use of time-lapse photography in a feature film was in Georges Méliès' motion picture Carrefour De L'Opera (1897). Time-lapse photography of biological
Time-lapse photography was pioneered by Jean Comandon \[2\][3] in collaboration with Pathé Frères from 1909, by F. Percy Smith in 1910 and Roman Vishniac from 1915 to 1918. Time-lapse photography was further pioneered in the 1920s via a series of feature films called *Bergfilms* (Mountain films) by Arnold Fanck, including *The Holy Mountain* (1926).

From 1929 to 1931, R. R. Rife astonished journalists with early demonstrations of high magnification time-lapse cine-micrography\[4][5] but no filmmaker can be credited for popularizing time-lapse more than Dr. John Ott, whose life-work is documented in the DVD-film "Exploring the Spectrum".

Ott's initial "day-job" career was that of a banker, with time-lapse movie photography, mostly of plants, initially just a hobby. Starting in the 1930s, Ott bought and built more and more time-lapse equipment, eventually building a large greenhouse full of plants, cameras, and even self-built automated electric motion control systems for moving the cameras to follow the growth of plants as they developed. He time-lapsed his entire greenhouse of plants and cameras as they worked - a virtual symphony of time-lapse movement. His work was featured on a late 1950s episode of the request TV show, *You Asked For It*.

Ott discovered that the movement of plants could be manipulated by varying the amount of water the plants were given, and varying the color-temperature of the lights in the studio. Some colors caused the plants to flower, and other colors caused the plants to bear fruit. Ott discovered ways to change the sex of plants merely by varying the light source color-temperature.

By using these techniques, Ott time-lapse animated plants "dancing" up and down in synch to pre-recorded music tracks.

His cinematography of flowers blooming in such classic documentaries as Walt Disney's *Secrets of Life* (1956), pioneered the modern use of time-lapse on film and television. Ott wrote several books on the history of his time-lapse adventures, *My Ivory Cellar* (1958), "Health and Light" (1979), and the film documentary "Exploring the Spectrum" (DVD 2008).

A major refiner and developer of time-lapse is the Oxford Scientific Film Institute in Oxford, United Kingdom. The Institute specializes in time-lapse and slow-motion systems, and has developed camera systems that can go into (and move through) impossibly small places. Most people have seen at least some of their footage which has appeared in TV documentaries and movies for decades.

PBS's NOVA series aired a full episode on time-lapse (and slow motion) photography and systems in 1981 titled *Moving Still*. Highlights of Oxford's work are slow-motion shots of a dog shaking water off himself, with close ups of drops knocking a bee off a flower, as well as time-lapse of the decay of a dead mouse.

The first major usage of time-lapse in a feature film was *Koyaanisqatsi* (1983). The non-narrative film, directed by Godfrey Reggio, contained much time-lapse of clouds, crowds, and cities filmed by cinematographer Ron Fricke. Years later, Ron Fricke produced a solo project called "Chronos" shot on IMAX cameras, which is still frequently played on Discovery HD. Fricke used the technique extensively in the documentary *Baraka* (1992) which he photographed on Todd-AO (70 mm) film. The most recent film made entirely in time-lapse photography is Nate North's film *Silicon Valley Timelapse*, which holds the distinction of being the first feature length film shot almost entirely in 3 frame high dynamic range.

Countless other films, commercials, TV shows and presentations have included time-lapse.
For example, Peter Greenaway's film *A Zed & Two Noughts* featured a sub-plot involving time-lapse photography of decomposing animals and included a composition called "Time-lapse" written for the film by Michael Nyman. More recently, Adam Zoghlin's time-lapse cinematography was featured in the CBS television series *Early Edition*, depicting the adventures of a character that receives tomorrow's newspaper today. David Attenborough's 1995 series, *The Private Life of Plants*, also utilised the technique extensively.

**Terminology**

The frame rate of time-lapse movie photography can be varied to virtually any degree, from a rate approaching a normal frame rate (between 24 and 30 frames per second) to only one frame a day, a week, or more, depending on subject.

The term "time-lapse" can also apply to how long the shutter of the camera is open during the exposure of each frame of film (or video), and has also been applied to the use of long-shutter openings used in still photography in some older photography circles. In movies, both kinds of time-lapse can be used together, depending on the sophistication of the camera system being used. A night shot of stars moving as the Earth rotates requires both forms. A long exposure of each frame is necessary to enable the dim light of the stars to register on the film. Lapses in time between frames provide the rapid movement when the film is viewed at normal speed.

As the frame rate of time-lapse approaches normal frame rates, these "mild" forms of time-lapse are sometimes referred to simply as **fast motion** or (in video) **fast forward**. This type of borderline time-lapse resembles a VCR in a fast forward ("scan") mode. A man riding a bicycle will display legs pumping furiously while he flashes through city streets at the speed of a racing car. Longer exposure rates for each frame can also produce blurs in the man's leg movements, heightening the illusion of speed.


An animated example is the clip from the show "The Simpsons" in which Homer Simpson takes a picture of himself a day for 39 years, although it is intended to be a comedy, thus not realistic.

When used in motion pictures and on television, fast motion can serve one of several purposes. One popular usage is for comic effect. A slapstick style comic scene might be played in fast motion with accompanying music. (This form of special effect was often used in silent film comedies in the early days of the cinema; see also liquid electricity).

Another use of fast motion is to speed up slow segments of a TV program that would otherwise take up too much of the time allotted a TV show. This allows, for example, a slow scene in a house redecorating show of furniture being moved around (or replaced with other furniture) to be compressed in a smaller allotment of time while still allowing the viewer to see what took place.

The opposite of fast motion is slow motion. Cinematographers refer to fast motion as **undercranking** since it was originally achieved by cranking a handcranked camera slower than normal. **Overcranking** produces slow motion effects.
How time-lapse works

Film is often projected at 24 frame/s, meaning 24 images appear on the screen every second. Under normal circumstances, a film camera will record images at 24 frame/s. Since the projection speed and the recording speed are the same, the images onscreen appear to move at normal speed.

Even if the film camera is set to record at a slower speed, it will still be projected at 24 frame/s. Thus the image on screen will appear to move faster.

The change in speed of the onscreen image can be calculated by dividing the projection speed by the camera speed.

\[
\text{perceived speed} = \frac{\text{projection frame rate}}{\text{camera frame rate}} \times \text{actual speed}
\]

So a film recorded at 12 frames per second will appear to move twice as fast. Shooting at camera speeds between 8 and 22 frames per second usually falls into the undercranked fast motion category, with images shot at slower speeds more closely falling into the realm of time-lapse, although these distinctions of terminology have not been entirely established in all movie production circles.

The same principles apply to video and other digital photography techniques. However, until very recently, video cameras have not been capable of recording at variable frame rates.

Time-lapse can be achieved with some normal movie cameras by simply shooting individual frames manually. But greater accuracy in time-increments and consistency in exposure rates of successive frames are better achieved through a device that connects to the camera's shutter system (camera design permitting) called an intervalometer. The intervalometer regulates the motion of the camera according to a specific interval of time between frames. Today, many consumer grade digital cameras, including even some point-and-shoot cameras have hardware or freeware intervalometers available. Some intervalometers can be connected to motion control systems that move the camera on any number of axes as the time-lapse photography is achieved, creating tilts, pans, tracks, and trucking shots when the movie is played at normal frame rate. Ron Fricke is the primary developer of such systems, which can be seen in his short film *Chronos* (1985) and his feature film *Baraka* (1992, released to video in 2001).
Short and long exposure time-lapse

As mentioned above, in addition to modifying the speed of the camera, it is important to consider the relationship between the frame interval and the exposure time. This relationship controls the amount of motion blur present in each frame and is, in principle, exactly the same as adjusting the shutter angle on a movie camera. This is known as "dragging the shutter".

A film camera normally records images at twenty four frames per second. During each 1/24th of a second, the film is actually exposed to light for roughly half the time. The rest of the time, it is hidden behind the shutter. Thus exposure time for motion picture film is normally calculated to be one 48th of a second (1/48 second, often rounded to 1/50 second). Adjusting the shutter angle on a film camera (if its design allows), can add or reduce the amount of motion blur by changing the amount of time that the film frame is actually exposed to light.

In time-lapse photography, the camera records images at a specific slow interval such as one frame every thirty seconds (1/30 frame/s). The shutter will be open for some portion of that time. In short exposure time-lapse the film is exposed to light for a normal exposure time over an abnormal frame interval. For example, the camera will be set up to expose a frame for 1/50th of a second every 30 seconds. Such a setup will create the effect of an extremely tight shutter angle giving the resulting film a stop-animation or claymation quality.

In long exposure time-lapse, the exposure time will approximate the effects of a normal shutter angle. Normally, this means the exposure time should be half of the frame interval. Thus a 30-second frame interval should be accompanied by a 15-second exposure time to simulate a normal shutter. The resulting film will appear smooth.

The exposure time can be calculated based on the desired shutter angle effect and the frame interval with the equation:

\[
\text{exposure time} = \frac{\text{shutter angle}}{360^\circ} \times \text{frame interval}
\]

Long exposure time-lapse is less common because it is often difficult to properly expose film at such a long period, especially in daylight situations. A film frame that is exposed for 15 seconds will receive 750 times more light than its 1/50th of a second counterpart. (Thus it will be more than 9 stops over normal exposure.) A scientific grade neutral density filter can be used to compensate for the over-exposure.
Time-lapse photography

Time-lapse camera movement

Some of the most stunning time-lapse images are created by moving the camera during the shot. A time-lapse camera can be mounted to a moving car for example to create a notion of extreme speed.

However, to achieve the effect of a simple tracking shot, it is necessary to use motion control to move the camera. A motion control rig can be set to dolly or pan the camera at a glacially slow pace. When the image is projected it could appear that the camera is moving at a normal speed while the world around it is in time lapse. This juxtaposition can greatly heighten the time-lapse illusion.

The speed that the camera must move to create a perceived normal camera motion can be calculated by inverting the time-lapse equation:

\[
\text{actual speed} = \frac{\text{camera frame rate}}{\text{projection frame rate}} \times \text{perceived speed}
\]

Baraka was one of the first films to use this effect to its extreme. Director and cinematographer Ron Fricke designed his own motion control equipment that utilized stepper motors to pan, tilt and dolly the camera.

The short film A Year Along the Abandoned Road shows a whole year passing by in Norway’s Børfjord at 50,000 times the normal speed in just 12 minutes. The camera was moved, manually, slightly each day, and so the film gives the viewer the impression of seamlessly travelling around the fjord as the year goes along, each day compressed into a few seconds.

A panning time-lapse can be easily and inexpensively achieved by using a widely available Equatorial telescope mount with a Right ascension motor (*360 degree example using this method [6]). Two axis pans can be achieved as well, with contemporary motorized telescope mounts.

A variation of these are rigs that move the camera during exposures of each frame of film, blurring the entire image. Under controlled conditions, usually with computers carefully making the movements during and between each frame, some exciting blurred artistic and visual effects can be achieved, especially when the camera is mounted on a tracking system that enables its own movement through space.

The most classic example of this is the slit-scan opening of the stargate sequence toward the end of Stanley Kubrick's 2001: A Space Odyssey (1968), created by Douglas Trumbull.

Related techniques

• Bullet time
• Motion control photography

High-dynamic-range (HDR) time-lapse

The most recent development in time-lapse cinematography is the addition of High-dynamic-range imaging (photographic technique) to time-lapse. One of the first experiments was an 11-second series completed in un-automated form by Nicholas Phillips [7] on July 8, 2006. Modern time-lapse enthusiasts have started to follow suit as of May 2007. Ollie Larkin (work [8]) and Jay Burlage (work [9]) have both shot and processed HDR time-lapse footage in High definition, with motion control, using digital single-lens reflex (DSLR) cameras. The first example of this technique in a full length film can be seen in Silicon Valley Timelapse (2008). In 2013, it became possible to create HDR time-lapse video automatically on the iPhone using the Thalia Lapse HD/R application.[10]

One method using a DSLR involves bracketing for each frame. Three photographs are taken at separate exposure values (capturing the three in immediate succession) to produce a group of pictures for each frame representing the highlights, mid-tones, and shadows. The bracketed groups are consolidated into individual frames (see HDR). Those frames are then sequenced into video. Time Lapse is also used for travel videoclips where the viewer can experience a faster traveling speed than the normal one, for example, traveling from Los Angeles to New York in 5 minutes.
However, the number of images required to be taken is relatively high. For a 30 fps video of HDR (each frame tonemapped with 3 images), 5,400 original images (60×30×3) are required for each minute.

**Cameras that support time-lapse still image capture with a built-in intervalometer**
- Canon P&S (point and shoot) digital cameras with CHDK third party custom script installed onto the memory card.
- GoPro Cameras (HD Hero 3, HD Hero 2, HD Hero, HD Hero 960)
- Nikon J1, Nikon 1 V1, Nikon 1 J2, Nikon 1 V2, Nikon 1 J3, Nikon 1 S1
- Nikon D700,[12] Nikon D800, Nikon D800E,[14] Nikon D600
- Olympus SP-560 UZ[18]
- Panasonic Lumix DMC-GH3,[19] Panasonic Lumix DMC-LX7[20]
- Pentax Optio 555, and waterproof W series (W10, W20, W60, W90, WG-1, etc.)
- Pentax Q, Pentax Q10, Pentax K-01
- Ricoh CX, GXR, GR DIGITAL and Caplio series

**Cameras that support automatic and autonomous time-lapse video creation**
- Brinno Time Lapse Bike Camera BBC100,[28] Brinno Time Lapse Construction Camera BCC100[29]
- Pentax X-5,[31] Pentax K-01, Pentax K-30
- Nexus 4
- iPhone[10]

**Notes**
[2] http://translate.google.co.uk/translate?hl=en&sl=fr&u=http://www.pasteur.fr/infosci/archives/cdj0.html&ei=N0ktTPKaNPNjAyep4Nf8Q&sa=X&oi=translate&ct=result&resnum=1&ved=0CBkQ7gEwAA&prev=/search%3Fq%3DComandon%26hl%3Den%26sa%3DG%26prmd%3Dv
[17] Lapsing With the Nikon D800 (http://duncandavidson.com/blog/2012/06/d800_lapse_test)
References

- My Ivory Cellar John Ott. (1958)
- "Health and Light" John Ott. (1979)

External links

- HD Construction time lapse movies (http://www.vimeo.com/panterratv)
- A collection of 55 timelapse video clips from the BBC natural history archive (http://www.bbc.co.uk/nature/collections/p0085nk0)
- BBC Time lapse photography tutorial (http://timothyallen.blogs.bbc-earth.com/2009/02/24/time-lapse-photography/)
- Time Lapse using mobile devices (http://www.lapseit.com)
- Beginner Guide To Time-Lapse With an Intervalometer & DSLR (http://www.fastforwardtime.co.uk/time-lapse-guide)
- Candle timelapse video (http://www.youtube.com/watch?v=1VtDpPxwQsU)
Panoramic photography

Panoramic photography is a technique of photography, using specialized equipment or software, that captures images with elongated fields of view. It is sometimes known as wide format photography. The term has also been applied to a photograph that is cropped to a relatively wide aspect ratio. While there is no formal division between "wide-angle" and "panoramic" photography, "wide-angle" normally refers to a type of lens, but using this lens type does not necessarily make an image a panorama. An image made with an ultra wide-angle fisheye lens covering the normal film frame of 1:1.33 is not automatically considered to be a panorama. An image showing a field of view approximating, or greater than, that of the human eye — about 160° by 75° — may be termed panoramic. This generally means it has an aspect ratio of 2:1 or larger, the image being at least twice as wide as it is high. The resulting images take the form of a wide strip. Some panoramic images have aspect ratios of 4:1 and sometimes 10:1, covering fields of view of up to 360 degrees. Both the aspect ratio and coverage of field are important factors in defining a true panoramic image.

A panorama of Sydney featuring (from left) the Sydney Opera House, the central business district skyline, and the Sydney Harbour Bridge.

Photo-finishers and manufacturers of Advanced Photo System (APS) cameras use the word "panoramic" to define any print format with a wide aspect ratio, not necessarily photos that encompass a large field of view. In fact, a typical APS camera in its panoramic mode, where its zoom lens is at its shortest focal length of around 24 mm, has a field of view of only 65°, which many photographers Wikipedia:Avoid weasel words would only classify as wide-angle, not panoramic. [citation needed]

History

One of the first recorded patents for a panoramic camera was submitted by Joseph Puchberger in Austria in 1843 for a hand-cranked, 150° field of view, 8-inch focal length camera that exposed a relatively large Daguerreotype, up to 24 inches (610 mm) long. A more successful and technically superior panoramic camera was assembled the next year by Friedrich von Martens in Germany in 1844. His camera, the Megaskop, added the crucial feature of set gears which offered a relatively steady panning speed. As a result, the camera properly exposed the photographic plate, avoiding unsteady speeds that can create an unevenness in exposure, called banding. Martens was employed by Lerebours, a photographer/publisher. It is also possible that Martens camera was perfected before Puchberger patented his camera. Because of the high cost of materials and the technical difficulty of properly exposing the plates, Daguerreotype panoramas, especially those pieced together from several plates (see below) are rare. [citation needed]

An 1851 panoramic showing San Francisco from Rincon Hill by photographer Martin Behrmanx. It is believed that the panorama initially had eleven plates, but the original daguerreotypes no longer exist.
After the advent of wet-plate collodion process, photographers would take anywhere from two to a dozen of the ensuing albumen prints and piece them together to form a panoramic image (see: Segmented). This photographic process was technically easier and far less expensive than Daguerreotypes. Some of the most famous early panoramas were assembled this way by George N. Barnard, a photographer for the Union Army in the American Civil War in the 1860s. His work provided vast overviews of fortifications and terrain, much valued by engineers, generals, and artists alike. (see Photography and photographers of the American Civil War) Following the invention of flexible film in 1888, panoramic photography was revolutionised. Dozens of cameras were marketed, many with brand names heavily indicative of their time. Cameras such as the Cylindrograph, Wonder Panoramic, Pantascopic and Cyclo-Pan, are some examples of panoramic cameras.

In the 1970s and 1980s, a school of art photographers took up panoramic photography, inventing new cameras and using found and updated antique cameras to revive the format. The new panaramists included Kenneth Snelson, David Avison, Art Sinsabaugh, and Jim Alinder.¹

Panoramic cameras and methods

Short rotation

Short rotation, rotating lens and swing lens cameras have a lens that rotates around the camera's rear nodal point and use a curved film plane.¹ As the photograph is taken, the lens pivots around its nodal point while a slit exposes a vertical strip of film that is aligned with the axis of the lens. The exposure usually takes a fraction of a
second. Typically, these cameras capture a field of view between 110° to 140° and an aspect ratio of 2:1 to 4:1. The images produced occupy between 1.5 and 3 times as much space on the negative as the standard 24 mm x 36 mm 35 mm frame.

Cameras of this type include the Widelux, Noblex, and the Horizon. These have a negative size of approximately 24x58 mm. The Russian "Spaceview FT-2", originally an artillery spotting camera, produced wider negatives, 12 exposures on a 36-exposure 35 mm film.

Short rotation cameras usually offer few shutter speeds and have poor focusing ability. Most models have a fixed focus lens, set to the hyperfocal distance of the maximum aperture of the lens, often at around 10 meters (30 ft). Photographers wishing to photograph closer subjects must use a small aperture to bring the foreground into focus, limiting the camera's use in low-light situations.

Rotating lens cameras produce distortion of straight lines. This looks unusual because the image, which was captured from a sweeping, curved perspective, is being viewed flat. To view the image correctly, the viewer would have to produce a sufficiently large print and curve it identically to the curve of the film plane. This distortion can be reduced by using a swing-lens camera with a standard focal length lens. The FT-2 has a 50 mm while most other 35 mm swing lens cameras use a wide-angle lens, often 28 mm.\[citation needed\]

When objects are in fast motion during image capture, some faults can happen in single machines. In this case, some accessories can be used to prevent this kind of failure happen.

**Full rotation**

Rotating panoramic cameras, also called slit scan or scanning cameras are capable of 360° or greater degree of rotation. A clockwork or motorized mechanism rotates the camera continuously and pulls the film through the camera, so the motion of the film matches that of the image movement across the image plane. Exposure is made through a narrow slit. The central part of the image field produces a very sharp picture that is consistent across the frame.\[citation needed\]
Digital rotating line cameras image a 360° panorama line by line. The camera's linear sensor has 10,000 CCD elements. Digital cameras in this style are the Panoscan and Eyescan. Analogue cameras include the Cirkut, Hulcherama, Leme, Roundshot and Globuscope.

**Fixed lens**

*Fixed lens* cameras, also called flatback, wide view or wide field, have fixed lenses and a flat image plane. These are the most common form of panoramic camera and range from inexpensive APS cameras to sophisticated 6x17 cm and 6x24 cm medium format cameras. Panoramic cameras using sheet film are available in formats up to 10x24 inches. APS or 35 mm cameras produce cropped images in a panoramic aspect ratio using a small area of film. Advanced 35 mm or medium format fixed-lens panoramic cameras use the full height of the film and produce images with a greater image width than normal. [citation needed]

Because they expose the film in a single exposure, fixed lens cameras can be used with electronic flash, which would not work consistently with rotational panoramic cameras.

With a flat image plane, 90° is the widest field of view that can be captured in focus and without significant wide-angle distortion or vignetting. Lenses with an imaging angle approaching 120 degrees require a center filter to correct vignetting at the edges of the image. Lenses that capture angles of up to 180°, commonly known as fisheye lenses exhibit extreme geometrical distortion but typically display less brightness falloff than rectilinear lenses. [citation needed]

Examples of this type of camera are: Hasselblad X-Pan (35 mm), Linhof 612PC, Horseman SW612, Linhof Technorama 617, Tomiyama Art Panorama 617 and 624, and Fuji G617 and GX617 (Medium format (film)).

The panomorph lens provides a full hemispheric field of view with no blind spot, unlike catadioptric lenses. [citation needed]

**Segmented**

Segmented panoramas, also called *stitched* panoramas, are made by joining multiple photographs with slightly overlapping fields of view to create a panoramic image. Stitching software is used to combine multiple images. In order to correctly stitch images together without parallax error, the camera must be rotated about the center of its entrance pupil. [1][3][4] Some digital cameras can do the stitching internally, either as a standard feature or by installing a smartphone app.
Panoramic photography

Upper Falls on the Genesee River, downtown Rochester, New York. Taken with a Sony A700. 2 rows of 5 images per row, stitched as a mosaic using PTGui.

The Giza Pyramids in Cairo, Egypt

**Catadioptric cameras**

Lens and mirror based (catadioptric) cameras consist of lenses and curved mirrors that reflect a 360 degree field of view into the lens' optics. The mirror shape and lens used are specifically chosen and arranged so that the camera maintains a single viewpoint. The single viewpoint means the complete panorama is effectively imaged or viewed from a single point in space. One can simply warp the acquired image into a cylindrical or spherical panorama. Even perspective views of smaller fields of view can be accurately computed.

The biggest advantage of catadioptric systems is that because one uses mirrors to bend the light rays instead of lenses (like fish eye), the image has almost no chromatic aberrations or distortions. Because the complete panorama is imaged at once, dynamic scenes can be captured without problems. Panoramic video can be captured and has found applications in robotics and journalism. There are even inexpensive add-on catadioptric lenses for smartphones, such as the GoPano micro and Kogeto Dot.

A panoramic photograph of the Camp Nou stadium, Barcelona in January 2011
3D Panorama

Some cameras offer 3D features that can be applied when taking panoramic photographs. The technology enables the camera to take shots from different angles and combine them, creating a multidimensional effect. Some cameras use two different lenses to achieve the 3D effect, while others use one. Cameras such as Samsung NX1000,[5] and Sony Cyber-shot DSC-RX1[6] offer the 3D Panorama mode.

References

Further reading

External links
• Panoramic/360° photography techniques and styles (http://www.dmoz.org/Arts/Photography/Techniques_and_Styles/Panoramic_and_360°/) at the Open Directory Project
• Panoramic image galleries (http://www.dmoz.org/Recreation/Travel/Image_Galleries/Panoramic/) at the Open Directory Project
• A timeline of panoramic cameras 1843–1994 (http://www.panoramicphoto.com/timeline.htm)
• Stanford University CS 178 interactive Flash demo (http://graphics.stanford.edu/courses/cs178/applets/projection.html) explaining the construction of cylindrical panoramas.
• How to build a panoramic camera (http://www.funsci.com/fun3_en/panoram2/pan2_en.htm) with intricate technical details and optical specifications for constructing a swing-lens panoramic camera.
• A home-made panoramic head bracket for taking panoramic photographs. (http://www.peterloud.co.uk/nodalsamurai/nodalsamurai.html)
• IVRPA (http://ivrpa.org/) - The International VR Photography Association
Cross processing (sometimes abbreviated to **Xpro**) is the deliberate processing of photographic film in a chemical solution intended for a different type of film. The effect was discovered independently by many different photographers often by mistake in the days of C-22 and E-4. Color cross processed photographs are often characterized by unnatural colors and high contrast. The results of cross processing differ from case to case, as the results are determined by many factors such as the make and type of the film used, the amount of light exposed onto the film and the chemical used to develop the film. The effect can also be achieved with digital filter effects such as with the photo-sharing mobile application Instagram.
Cross processing usually involves one of the two following methods.

- Processing positive color reversal film in C-41 chemicals, resulting in a negative image on a colorless base.
- Processing negative color print film in E-6 chemicals, resulting in a positive image but with the orange base of a normally processed color negative.

However, cross processing can take other forms, such as negative color print film or positive color reversal film in black and white developer.

Other interesting effects can be obtained by bleaching color films processed in black and white chemistry using a hydrochloric acid dichromate mixture or using potassium triiodide ($\text{KI}_3$) solution. If these bleached films are then re-exposed to light and re-processed in their intended color chemistry, subtle, relatively low contrast, pastel effects are obtained.[1]

Cross processing effects can be simulated in digital photography by a number of techniques involving the manipulation of contrast/brightness, hue/saturation and curves in image editors such as Adobe Photoshop or GIMP. However, these digital tools lack the unpredictable nature of regular cross processed images.

References

External links

- Cross processing in Gimp tutorial (http://www.gimpforphotos.com/tutorial-intermediate/cross-processing.html)

Tilted plane focus

"Tilted plane photography" is a method of employing focus as a descriptive, narrative or symbolic artistic device. It is distinct from the more simple uses of selective focus which highlight or emphasise a single point in an image, create an atmospheric bokeh, or miniaturise an obliquely-viewed landscape. In this method the photographer is consciously using the camera to focus on several points in the image at once while de-focussing others, thus making conceptual connections between these points.

Limits to focus in imaging

Focus is relative to spatial depth. Selective focus in photography is usually associated with depth of field. A pinhole camera generates an image of infinite relative focus, from a point just outside the camera opening out to infinity. Lenses focus more selectively so that, for objects near the lens, the distance between lens and sensor or film is increased and is shortened for more distant objects, to a point beyond which all is in focus. In telephoto lenses this point may be tens or hundreds of metres from the camera. Wide-angle lenses distinguish differences in depth only up to a short distance, beyond which all is in focus.
**Depth of field**

Depth of field is an effect that permits bringing objects into focus at varying distances from the camera, and at varying depth between each other, into the field of view. A short lens, as explained above, will bring objects into focus that are relatively close to the camera, but it will also keep focus at greater distances between objects. A telephoto lens will be very shallow in its gamut of focus.

Reducing the size of the aperture of the lens deepens the focus. At a pinhole size this will increase in effect, though the closer the objects are to the camera, the shorter the distance between focussed objects.

**Plane of focus**

Because focus depends on the distance between lens and the sensor or film plane, focus in the space in front of the camera is not on a point but rather on a plane parallel to the film plane. Spherical construction of lenses, rather than the ideal parabolic construction which is rarely and expensively achieved, means that this plane is slightly concave—more so in simple single element lenses and increasingly so with lenses of lower quality construction and materials. Compound lenses are built to correct this "spherical aberration" or "curvature of field".

**Tilting the plane of focus**

Varying the distance between the lens and sensor or film plane across the field of view permits focussing on objects at varying distances from the camera. One means of achieving this is to tilt the lens and/or the sensor or film plane in relation to each other. This will mean that individual points in the picture plane will focus on different points of depth, with the effect that the plane of sharp focus will tilt.

This technique is based on the principle of Scheimpflug which, traditionally, is combined with small aperture to increase the gamut of focus beyond that achievable by depth of field alone. Usually no out-of-focus artifacts are desired in the image resulting from Scheimpflug adjustments. Here the converse is true. With the lens at full aperture, the photographer selects points in depth in the scene on which to focus and throws other points out-of-focus. This increases the contrast between the sharp and blurred areas and the selected application of focus and blur remains apparent to the viewer.

**Tilted plane focus on smaller formats**

A view camera permits full, incrementally calibrated control over this technique, though it is possible to achieve with other cameras and formats. It is possible to achieve similar effects on a 35mm camera or digital single-lens reflex camera (DSLR). The lens (preferably a long lens of around 80mm) of a manual single-lens reflex camera (SLR) is set to infinity and shutter speed is set for the correct exposure at the widest aperture. Then the lens is removed and held against the lens mount opening and tilted. It is possible to see the tilted plane effect through the viewfinder.

Despite the fact that the lens is separated from the camera body, there is little flare or fogging, and this can be avoided by placing a foam rubber 'donut' between the lens and camera body. Using a lens made for a medium-format camera will provide wider coverage, and therefore more scope for tilting the lens still further off-axis, with a capacity to focus closer and less likelihood of flare and light leaks, as the back of the lens will in most cases be larger than the lens mount.
A commercial option is the Lensbaby, although it does not permit the same degree of manipulation of the lens to off-axis positions or tilts required for the technique. A better but more expensive option is to use tilt/shift lenses (e.g. Canon 24mm TS-E).

History

Julia Margaret Cameron was a strong advocate of this use of selective focus. For example in "Prayer and Praise", produced in 1865, there is a deliberate placement of focus at more than three points: on the face and parts of the body of the foreground child; and faces of mother and father; while a second child's face is thrown radically out of focus.\(^2\)

References

Notes


[2] “Moreover, effects of photographic focus are very much at play in Prayer and Praise, and they help to mount a phenomenological proof of the truth of the enacted scene. It is in the flesh of the baby, pressed to the photograph's surface, that the range from out-of-focus to in-sharp-focus is most insistently displayed: note the hands and blurred upper line of the torso in contrast to the neck and underarm creases, the child's rounded facial features, somehow both blurred and distinct, and the punctal effect of the bit of hair. Thus the child's body serves to embody the photographic action of bringing into being, as well as the optical properties of the lens-and thereby serves simultaneously to embody the incorporeal means of the photograph and its own fleshy, somatic corporeality, as well as the oscillation between the two. The qualities of focus also serve to enhance another property of the medium: that of light, and the contrast between light and dark. Again that contrast is condensed in the corporeality/incorporeality of the child's body, and in the meeting between mother and child: her dark drapery and light hand, and his light body.”<ref name=Armscup>Armstrong, C. Cupid's Pencil of Light: Julia Margaret Cameron and the Maternalization of Photography'. In "October", Vol. 76 (Spring, 1996), pp. 114-141. The MIT Press

Citations

Bibliography

- Robin Gower (1991) Professional Photography, Australia, October, p. 15
Harris shutter

The Harris shutter is a strip device with three color filters, invented by Robert S. "Bob" Harris of Kodak, for making color photographs with the different primary color layers exposed in separate time intervals in succession.\cite{1}\cite{2} The term Harris shutter is also applied to the technique or effect.

The effect is produced by re-exposing the same frame of film through red, green and blue filters in turn, while keeping the camera steady. This will generate a rainbow of colour around any object that moves within the frame. Some good candidates for subjects include waterfalls (pictured, left), clouds blowing over a landscape or people walking across a busy town square.

Traditionally, the technique is either achieved using a camera that allows in-register multiple exposures, and changing filters on the front of the lens. Another alternative was to make a drop through filter that consisted of the three coloured gels and two opaque sections that is literally dropped through a filter holder during exposure.

With the advent of digital photography, the process has become a lot simpler — the photographer can simply take three colour photographs on location, and then use software to take the Red channel from one exposure, combine with the blue and green channels from the other two photos to good effect — this even allows for correction of movement if the camera is inadvertently moved between exposures\cite{3}. Another advantage of digital processing is that different results can be obtained by re-assigning the RGB channel of each layer.

References

External links

- Shutterbug (http://shutterbug.com/refreshercourse/lens_tips/101/index2.html)