Tiger Graphics

Tiger Graphics Little Photography School

For Kids, Beginners & Curious

Hude, October 17, 2026

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11.1 This image is available on the internet under the Pixabay Content License. Tiger Graphics thanks MasterTux for it. 88

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1 Tiger Graphics Little Photography School

For Kids, Beginners & Curious

About this page

This photography school is especially aimed at kids, beginners, and the curious who want to learn how to take photos with real cameras. However, much of the content is also relevant for smartphone photography. The photography school presents a subjective compilation of the aspects of photography that we, the photographers of Tiger Graphics, consider important for taking good photos. The guide is by no means complete. We have placed the focus on the technical aspects of photography. A few technical terms are mentioned that are not explained further, but are instead linked to Wikipedia. The operation of your camera cannot be covered here, as operation varies from manufacturer to manufacturer and camera type to camera type. Please consult your user manual for this.

The sections "Basics", "Photo Subjects", and "Image Composition" explain the most important things you need to know about "old-school" photography. For some topics, they refer to the "Technology" section, where certain aspects are explained in more detail. The "Basics" section explains the most important terms related to digital camera photography. You will need to check your own camera's manual to find out exactly how to operate it. The "Image Motifs" section explains how to capture different subjects, such as people, animals, or landscapes. In the "Composition" section, you will find many examples of what distinguishes a good image from a bad one. The "Image Errors" section explains typical mistakes that can happen while taking photos and how to fix or avoid them. A dedicated section is devoted to analog photography. It explains analog black-and-white developing and printing. Under "Experimental", you will find ideas for things you can do with photography. Some of these require additional equipment, such as special lenses or filters. A few tips on presenting images and the legal questions to consider are summarized in the "Presentation" and "Legal Issues" sections.

Further information is highlighted in blue, tips in green, and warnings in red, such as:

> **Photos on this website can be enlarged by clicking on them.**

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2 Why a Photography Guide?

You might wonder why you need this page when your smartphone or camera already takes great pictures without you having to study it. Well, sometimes photos turn out badly and you don't know why. Or you see a picture in a photo book or an advertisement and say "Wow!", but you don't really know why you like it so much. That's where knowing that you can do so much more with cameras than just pressing the shutter button comes into play. Some aspects of image composition are, of course, a matter of taste or depend on the effect you want to achieve with the picture. Much of this can, of course, be done later with software or handled by an app on your smartphone. Nevertheless, it is important to think about what you want to capture, how you want to capture it, and what the intended statement of the image should be while you are taking the photo. In the end, this is what makes all the difference.



Fig. 2.1: This photo was taken in the evening at 10:18 PM on the bird island of Runde.



Fig. 2.2: This photo was taken in the evening at 9:00 PM in my own garden.

3 Basics

3.1 Digital Camera



Fig. 3.1: Various digital cameras. The two on the left are mirrorless/system cameras, the three on the right are compact cameras.

In a digital camera, the visible light that passes through the lens is converted into electrical signals by an electronic sensor. These electrical signals are then processed inside the camera by a processor and stored on a memory card.

Digital cameras offer a wide range of settings. Beginners mostly use the Automatic mode, where the camera handles all settings automatically. This usually results in a usable picture, but rarely one with a "wow" effect.

A distinction is made between:

- Compact cameras, where the lens is permanently built-in, and
- System cameras, where you can interchange the lens.

Among system cameras, a further distinction is made between the older:

- SLR cameras (DSLRs), where the image is reflected through the lens into the viewfinder, and
- Mirrorless system cameras, which feature a display, and in some cases, an electronic viewfinder.

3.2 Sensor

The sensor of a digital camera is located inside the body. With some cameras that feature interchangeable lenses, you can see the sensor after removing the lens.

> ! Do not touch the sensor!

The light from an object (person, pet, landscape, ...) passes through the lens onto the sensor. The image on the sensor is upside down and is flipped by the processor before being saved. This is similar to our eyes, which also project upside-down images onto the retina that are only flipped right-side up inside the brain.



Fig. 3.2: View of the sensor of a digital camera.

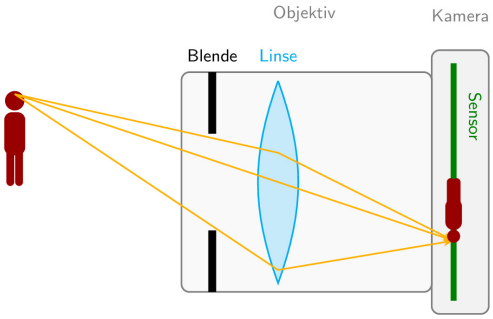


Fig. 3.3: Ray tracing path inside the camera. Nowadays, a lens consists of multiple elements.

The sensor consists of pixels, among other things. Many cameras have 6000x4000 pixels, which equals 24 million pixels, or 24 megapixels for short.

ℹ More Information

3.3 Lens

A lens consists of one or more glass elements. It ensures that an image can be captured sharply.

A distinction is made between:

- Wide-angle lenses, which provide a wide field of view, e.g., for landscape shots,
- Standard lenses, which correspond to the visual impression of the human eye, e.g., for groups of people,
- Telephoto lenses, which act like binoculars, e.g., for wildlife photos,
- Macro lenses, which act almost like a microscope, e.g., for small insects.



Fig. 3.4: Lenses from various manufacturers and systems.

❗ Lenses from different manufacturers and systems are not compatible.

ℹ More Information

3.4 Focal Length

The focal length of a lens is specified in millimeters and can be found on the front of the lens.

A distinction is made between:

- Prime lenses, which have exactly one fixed focal length, and
- Zoom lenses, where the focal length can be adjusted.

Standard lenses have focal lengths around 50mm. Wide-angle lenses have shorter focal lengths, while telephoto lenses have longer ones. There are zoom lenses that cover a very wide focal length range from wide-angle to telephoto.



Fig. 3.5: An old lens with a 50mm focal length.

There are other numbers printed on the lens behind the focal length.

ℹ More Information

3.5 Aperture

The aperture of a lens consists of blades that reduce the diameter of the opening in order to reduce the amount of light entering.



Fig. 3.6: The aperture blades, which open more or less depending on the aperture value.

A large aperture opening (small f-number) lets a lot of light through the lens and is helpful:

- When it is very dark,
- When you want to isolate a subject, for example, to make the background behind a person appear blurry.

A small aperture opening (large f-number) lets little light through the lens and is helpful:

- When it is very bright,
- When you want to render a particularly large area sharp, such as in landscape photography.

The aperture is set either by turning the aperture ring on the lens or from the camera body. In automatic mode, the aperture is adjusted automatically by the camera.



Fig. 3.7: Schematic representation of aperture openings and f-numbers.

From one stop to the next, the surface area through which light passes is halved.



Fig. 3.8: Aperture f/1.4



Fig. 3.9: Aperture f/5.6



Fig. 3.10: Aperture f/11

More Information

3.6 Shutter Speed

The shutter speed indicates how long the sensor is exposed during a shot. This is controlled via a shutter mechanism. Shutter speed is specified in seconds. A common shutter speed that can still be captured sharply handheld is 1/100 s. If you are capturing moving objects, you must choose a very short shutter speed to get a sharp image.

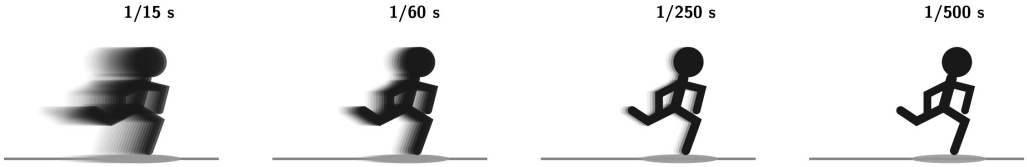


Fig. 3.11: Schematic representation of different shutter speeds and their effects.



Fig. 3.12: Toy car driving down an inclined plane, captured at 1/30 s. The motion blur is clearly visible.



Fig. 3.13: At 1/125 s, the slow-moving car is almost sharp.



Fig. 3.14: A speed of 1/250 s is sufficient to render the car sharply.

3.7 ISO

ISO stands for "International Organization for Standardization" and represents the sensitivity of the film material or the sensor in photography.
Standard films for analog cameras are available with sensitivity ratings from ISO 50 to ISO 800; on digital cameras, the ISO range extends from 100 to 12800 and beyond.

When you have loaded a film into an analog camera, you must set the ISO value on the camera so that the exposure metering works correctly.

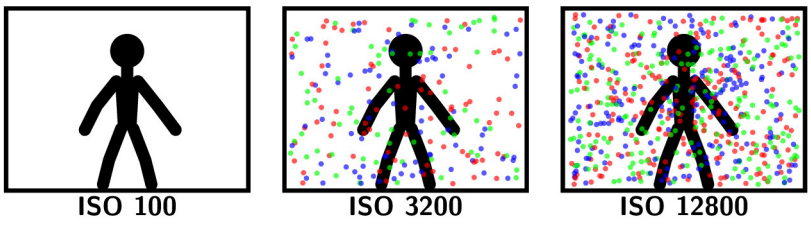


Fig. 3.15: Schematic representation of noise for different ISO values.

These images were captured using a relatively small 1-inch sensor, and the crop is heavily enlarged. With a larger sensor featuring larger pixels, the result would naturally look better. Color noise is visible at high ISO values.

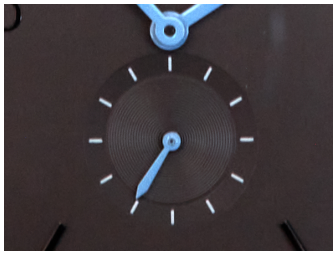


Fig. 3.16: Photo of the second hand of a wristwatch at ISO 125. The photo is almost noise-free.

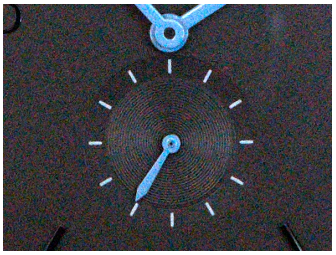


Fig. 3.17: At ISO 3200, the noise is already clearly visible.

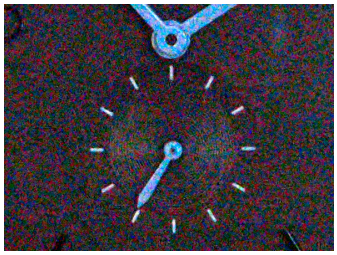


Fig. 3.18: At ISO 12800, the image becomes unusable.

ℹ More Information

3.8 Interplay of Aperture, Shutter Speed, and ISO

- A "correctly" exposed image remains correctly exposed if:
  - The shutter speed is reduced by one stop and the aperture is lowered by one stop (opened wider),
    - e.g., 1/60 s to 1/125 s and aperture f/8 to f/5.6.
  - The shutter speed is reduced by one stop and the ISO is increased by one stop,
    - e.g., 1/60 s to 1/125 s and ISO 400 to ISO 800.
  - The aperture is increased by one stop (closed down) and the ISO is increased by one stop,
    - e.g., aperture f/5.6 to f/8 and ISO 400 to ISO 800.

This allows you to control whether you want to isolate the subject (smaller f-number), render a moving subject sharply (shorter shutter speed), or keep image noise to a minimum (lower ISO).

3.9 Focusing

In automatic mode, a digital camera usually handles focusing by itself. On most cameras, the shutter button has two pressure points. If you gently press the shutter button halfway down, it focuses; pressing it all the way down captures the photo.

On most cameras, there are at least two different autofocus operating modes:

- One-Shot AF for stationary subjects, which focuses once when the shutter button is pressed halfway,
- Servo AF (Continuous AF) for moving subjects, which focuses continuously while the shutter button is pressed halfway.

And different autofocus area modes:

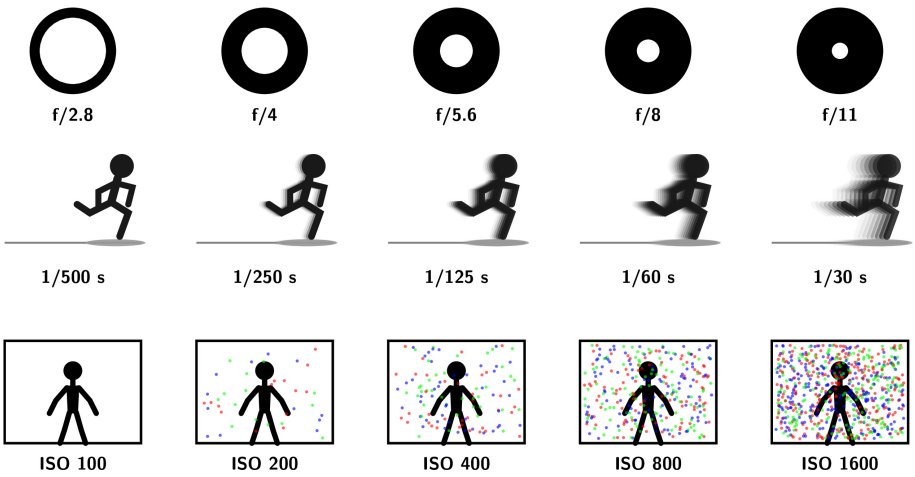


Fig. 3.19: The most important aperture values, shutter speeds, and ISO ratings. Moving one step to the right in one row and one step to the left in another keeps the exposure identical. This naturally applies to unlisted intermediate values as well.

- Single Point, to focus precisely on one point,
- Zone, to focus within a small area,
- Automatic Area Selection.

With automatic area selection, the camera detects people and faces, selects the autofocus point independently, focuses on a face or even on the eyes, and tracks them through movement. The active autofocus point virtually "sticks" to the person or their eyes. However, this does not guarantee that it will sharply capture the grandchild rather than the grandmother. It is safer to select the part of the image you want to be sharp yourself. To do this, it is best to select the autofocus mode that provides exactly one center autofocus point and choose One-Shot AF. The autofocus point is displayed in the viewfinder and on the screen; hold the camera so that the autofocus point lies on the part you want to be sharp. Usually, this is a person, or in the case of close-ups, the eye of a person or animal. If the eye is not in the center of the frame, you can move the autofocus point using buttons or a joystick on some cameras.

ℹ The display of autofocus points varies between cameras. Some lenses feature a switch to activate autofocus. The entire focus control depends heavily on the manufacturer and the specific camera model.

ℹ More Information



Fig. 3.20: Looking through the viewfinder. The small red square is the active focus point.



Fig. 3.21: In the captured image, the focus sits perfectly on the eye.



Fig. 3.22: The automatic mode focuses on the front Ottifant.



Fig. 3.23: If you select the autofocus point yourself,

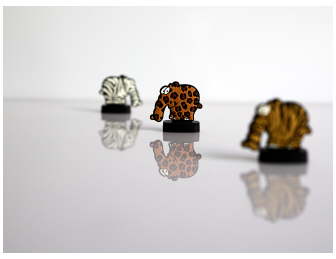


Fig. 3.24: you can focus on any of the other Ottifants instead.

3.10 Depth of Field

Depth of field describes the zone of acceptable sharpness along the axis of depth.

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The depth of field is particularly deep with:

- A small aperture (high f-number),
- A short focal length (wide-angle lens).

And particularly shallow with:

- A large aperture (low f-number),
- A long focal length (telephoto lens).



Fig. 3.25: Deep depth of field. The entire animal is sharp.



Fig. 3.26: Shallow depth of field. Only the area around the eyes is sharp.

If you want to render as much of the scenery sharp as possible in a landscape shot, it is best to focus on an object located roughly one-third as far away from you as the most distant object you want to capture. If a mountain range is 1.5 km away in a mountain landscape, you will get a sharp image at apertures from f/5.6 to f/13 if you focus on a house, a church steeple, or a tree 500 m away. Then everything from about 25 m to the mountain range will be sharp. An even better result can be achieved by utilizing the so-called hyperfocal distance.

More Information

3.11 Camera Modes

Most cameras feature additional modes alongside the automatic mode, where the camera handles everything itself. Camera modes make operating the camera easier without completely giving up control to the camera like in automatic mode.

The following modes are available on almost all system cameras:

- Auto (Automatic) – Autofocus area, shutter speed, aperture, and everything else are determined by the camera.
- P (Programmed Auto) – Shutter speed and aperture are determined by the camera.
- Tv (Shutter Priority / Half-Automatic) – You set the shutter speed, and the camera determines the aperture to ensure the image is correctly exposed. This is useful when capturing fast-moving animals or vehicles to prevent motion blur.
- Av (Aperture Priority / Half-Automatic) – You set the aperture, and the camera determines the shutter speed to ensure the image is correctly exposed. This is useful when you want to isolate a person (large aperture, small f-number) or capture a landscape (small aperture, large f-number).
- M (Manual) – Both shutter speed and aperture must be set manually.

ℹ The names of the various modes can differ depending on the manufacturer. Many cameras feature additional special scene modes and filters.

3.12 Auto Exposure Metering

In the half-automatic modes (Tv, Av), you can influence the auto-exposure system by narrowing down the area that the system uses to determine the correct exposure. The following options are available:

- Evaluative / Matrix, the entire visible frame is taken into account,
- Center-weighted, only the central portion of the frame is taken into account,
- Spot, only a small area around the active autofocus point is taken into account.



Fig. 3.27: Evaluative: the exposure was determined from the entire frame. Since the background is very bright, the animal was captured too dark.



Fig. 3.28: Spot: the exposure was measured around the eyes. The animal is now correctly exposed, though the background is very bright.

The exact areas considered in each mode can be found in your camera manual. The use of "Spot" metering should be chosen carefully, as image defects like 'blown-out highlights' and 'crushed shadows' can easily occur.

3.13 Exposure Compensation

By selecting the appropriate metering mode, you could ensure that the main subject is captured correctly while other parts of the image might end up under- or overexposed. When you capture a subject that is exceptionally bright overall, such as a snowy landscape, the image will turn out too dark in any standard exposure mode. Cameras without AI do not know that you are photographing snow. The camera assumes that the entire image features an average level of brightness—neither completely black nor completely white. If you want to shoot a snowy landscape, which is almost white, it makes sense to use manual exposure compensation. This forces the entire image to be captured brighter than the camera would make it on its own. The same applies to night shots, which are naturally darker than an average image.

This compensation is useful in the semi-automatic modes (Tv, Av):

- For subjects that are very bright overall, like a snowy landscape or the daytime sky,
- For very dark subjects, e.g., during twilight or inside a tunnel.

Most cameras are set up so that you can see the effect directly on the display or in the viewfinder and adjust the compensation accordingly.



Fig. 3.29: The shot captured with the exposure determined automatically by the camera.



Fig. 3.30: Compensation adjusted one exposure stop upward.

3.14 White Balance

White balance determines what is defined as “white” in the image. This depends heavily on the incoming light. The exact same subject looks entirely different at noon in bright sunshine than it does during sunset. Cameras can only get this approximately right automatically. That is why you can adjust the white balance manually on almost all cameras. For starters, it is usually enough to let the camera determine the white balance automatically (AWB, automatic white balance). Sometimes, an altered white balance looks more pleasing.

If you shoot in RAW format, you can alter the white balance afterward.



Fig. 3.31: Automatic White Balance. The colors look balanced and natural.



Fig. 3.32: White balance set for cloudy conditions. The colors appear warmer than in reality.



Fig. 3.33: White balance set for artificial light (tungsten). The colors appear cooler than in reality.

More Information

3.15 Camera Handling

A major advantage of cameras with viewfinders is the ability to stabilize the camera body. To do this, hold the camera with both hands up to your eye, stand with your feet slightly apart, and press your elbows firmly against the sides of your ribcage. If you then breathe in and out slowly and briefly hold your breath when pressing the shutter button, the image will remain sharp even at longer shutter speeds.



Fig. 3.34: Proper posture while photographing to stabilize the camera.

3.16 Stabilization

Many lenses and some camera bodies feature image stabilization. This compensates for the involuntary movements you make while photographing. Stabilization helps with:

- Long focal lengths (telephoto lenses),
- Long shutter speeds.



Fig. 3.35: A shutter speed of 1/8 s handheld without a stabilized 100mm lens results in a blurry image.



Fig. 3.36: A shutter speed of 1/8 s handheld is possible with a stabilized 100mm lens.

ℹ Image stabilization cannot do anything against movements that a subject makes during the exposure.

When using the camera on a tripod, image stabilization should be turned off.

3.17 Continuous Shooting (Burst Mode)

Almost all cameras feature a setting where pressing the shutter button once captures images continuously until the button is released. This is called continuous shooting. It works until the camera's internal buffer or the memory card is full. It is a useful feature when portraiting a group, allowing you to select the image later where hopefully everyone has their eyes open and isn't looking awkward. However, you should keep in mind that you will have to review and select from all these images later, which can sometimes be annoying. People used to photograph differently in the past, since a maximum of 36 exposures fit onto a roll of film and every shot cost money. Continuous shooting is highly useful in wildlife and sports photography. Nevertheless, we at Tiger Graphics rarely use continuous shooting modes.

3.18 Flashing with the Internal Flash

Most cameras offer at least two ways to work with the internal flash:

- The flash illuminates the scenery. The shutter speed is kept very short by the camera. This results in a typical flash image that is sharp.
- The flash acts only as a fill light. The shutter speed is hardly altered by the camera. In low ambient light, the exposure time remains quite long. This results in a balanced image, which, however, may be blurry.



Fig. 3.37: Continuous burst of a young blue tit.



Fig. 3.38: Sometimes all the images in a series are...



Fig. 3.39: ... funny.



Fig. 3.40: Shutter speed 1/250 s. This makes it highly likely that the subject will be sharp, but the flash effect is clearly visible.



Fig. 3.41: Shutter speed 1/10 s. Only works with a very steady hand and a stationary subject. In return, the flash provides only a tiny amount of fill light, and the image looks natural.

When taking flash photos of people or animals, do not flash directly into the eyes to avoid red eyes. Turn on the camera's internal red-eye reduction if available.

On some cameras, the flash only works when photographing with the mechanical shutter.

More Information

3.19 RAW or JPG?

If an image is perfectly captured, it doesn't matter whether you store it as a RAW or a JPG file. But what constitutes a perfectly captured image? Sometimes you want to improve or stylize the photo afterward. In such cases, the RAW format (raw data format) is better suited. It contains all the image information provided by the sensor; nothing is compressed or discarded. However, if you want to share an image quickly, JPG is the better format because it is more universal and does not need to be "developed" in software first like a RAW file. There are further advantages and disadvantages listed below:

3.19.1 Advantages of JPG

- JPG is widely supported
  - Almost all apps and programs can handle JPGs.
- JPG files are comparatively small
  - The continuous shooting rate is higher and lasts longer, meaning many images can be captured in quick succession.

3.19.2 Disadvantages of JPG

- Incorrect exposures are nearly impossible to rescue.
  - An incorrect white balance cannot be fully corrected.
  - Blown-out highlights and crushed shadows cannot be recovered.
- Lossy compression; JPGs are compressed.

3.19.3 Advantages of RAW

- Incorrect exposures can be rescued much better.
  - White balance is completely adjustable.
  - Blown-out highlights and crushed shadows can usually be saved.
- No loss of information.

3.19.4 Disadvantages of RAW

- A RAW image is a digital negative that must be "developed" using special software.
- RAW is manufacturer- or camera-specific.
- RAW files are very large:
  - A lot of storage space is required.
  - The continuous shooting rate is lower because a data block has to be written to the memory card.

ℹ Alongside RAW and JPG, other formats exist. In particular, the HEIF format is recently being used by some smartphones!

3.20 Preparation

Here are a few tips to help avoid frustration when going out on a photo tour:

- Check the functionality of the cameras.
- Check the lenses and clean them if necessary.
- Check the battery charge level inside the camera.
- Pack fully charged spare batteries.
- Pack spare memory cards and film.
- On cameras that offer the option, disable firing the shutter without a memory card. Nothing is more annoying than realizing after the session that the images were not saved.
- Think about backup options when traveling, and perform backups daily if possible.
- Don't forget water, cookies, and a warm jacket.

ℹ Some cameras feature two memory card slots and can use one of the two as a backup. However, this does not help if the camera is lost or falls into the water. Therefore, it is better to set up a backup option outside of the camera body.

3.21 Image Editing

Subsequent image editing can be performed directly via the camera's internal software on some models, or using photo software on a computer. Some camera manufacturers offer their own software. Extensive editing options are available via both free and commercial tools. If you work in RAW format, software to "develop" the raw data is absolutely mandatory.

Test or read up beforehand to verify whether the software supports the RAW format of your specific camera model.

4 Photo Subjects

In this section, the settings for the most important photo subjects are described.

4.1 People

You should only take photos of people if they agree to it. Therefore, AI-generated images serve as examples here to avoid violating personal rights and to prevent providing "training food" for AI models.



Fig. 4.1: Prompt: Generate a typical portrait of a woman in the forest.



Fig. 4.2: Prompt: Generate a full-body portrait of a man in a sports hall.



Fig. 4.3: Prompt: Generate a group photo in front of a mountain backdrop.

4.1.1 Portraits

In portrait photography, only the head and a portion of the upper body are captured.

Settings:

- Open the aperture wide (low f-number) to make the background appear blurry.
- Set the shutter speed so that the image is sharp. If the person keeps still, approx. 1/60 s; if not, preferably 1/125 s or shorter.
- Use Auto-ISO.
- If shooting in Av or Tv mode, set the metering mode to center-weighted metering.
- Focus on one eye using a single autofocus point. If the camera has eye autofocus, use it and activate continuous autofocus.
- It is better not to use a flash; instead, light the person well so that no harsh shadows are created on the face.
- If a flash is necessary, use red-eye reduction if available, or even better, use one or more off-camera flashes and set them to slow sync.

- Depending on the goal of the shot, get the person to smile. This should not look forced.
- Use the continuous shooting mode and choose the best image later.


Before ending the series, tell the person you are finished. Most of the time, this creates photos with a relaxed facial expression.

Saying the famous word "Cheese" is actually not that beneficial, as it usually causes the person to have sharper wrinkles around the corners of the mouth. It is better to have the person say "Money."


Do not flash babies directly!

4.1.2 Full-Body Shots

The same rules apply here as for portraits. Care should be taken not to cut off the feet. Shots that end below the knees look unflattering.

4.1.3 Groups

With group shots, you have to assume that someone is fidgeting or just closing their eyes. Also, not everyone in a group stands exactly in the focal plane.

Settings:

- Medium to long focal length (35 mm - 80 mm).
- Close the aperture (f/5.6 - f/8).
- Set the shutter speed shorter than 1/100 s and adjust the ISO accordingly.
- If shooting in Av or Tv mode, set the metering mode to evaluative/matrix metering.
- It is ideal to shoot outdoors under an overcast sky. In direct sunlight, the cast shadows become too harsh, so you should find a slightly shaded spot.
- Have people huddle together so that there are no gaps between them and every face is clearly visible.
- Do not cut off the feet.
- Watch out that there are no ugly objects like trash cans in the background.
- Get the people to smile.
- Use the continuous shooting mode and choose an image afterward where everyone has their eyes open.
- Take additional shots when the session is actually already over.

4.2 Animals

Photographing animals can be quite exhausting. You need to have patience and know how to operate your camera well to get those great shots you see in magazines

and on the internet. Behind all these shots lies a lot of practice and usually hundreds of failed attempts. As a beginner, you can start by photographing your own pets, dogs and cats from the neighborhood, or by visiting a zoo.



Fig. 4.4: Pet photography: Moritz with sharp eyes.



Fig. 4.5: Moritz with a sharp nose.

To stand out from the usual pictures, close-ups—images where you capture details from very close up—are great. Especially at the zoo, you can capture details using a telephoto lens. If you get very close to the fence and photograph through a gap in the mesh, you won't even see the fence. Whenever possible, photograph animals at eye level and wait until the animal looks into the camera.

Settings:

- Long focal length (telephoto lens).
- Wide open aperture to make the background blur.
- Short shutter speed; the faster the animal, the shorter the shutter speed.
- Animal eye autofocus, if available.
- Metering mode: center-weighted or evaluative/matrix.
- Auto-ISO



Fig. 4.6: Captured at eye level.



Fig. 4.7: With eye contact to the lens.



Fig. 4.8: Captured in my own garden through the window.

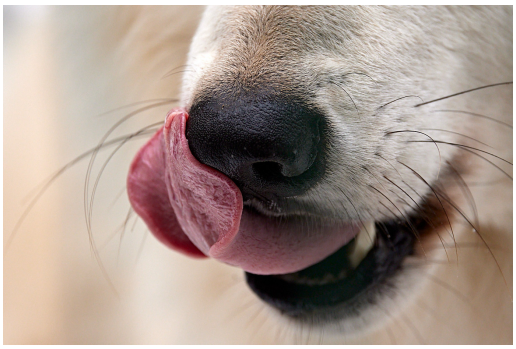


Fig. 4.9: Wolf's nose captured at the Wolf Center through the fence.



Fig. 4.10: Unusual views stand out from the mainstream.



Fig. 4.11: Here, not even 1/1600 s is enough.

! The welfare of the animals always comes first. Never disturb animals while they are raising or caring for their offspring. If possible, do not use a flash.

! Never put yourself in danger! At the zoo, do not reach through the bars and do not stick your lens through the fence.

! At the zoo, ask beforehand if photography is permitted.

Some zoos offer special opening hours for photographers.

4.3 Landscapes

In landscape photography, pay attention to the light. Shooting against the light can create flares and makes it harder for the camera to control the exposure automatically. Landscape shots become particularly impressive early in the morning shortly after sunrise or during the so-called blue hour, just before sunset. Furthermore, you should make sure that the camera is held level. Some cameras have a built-in electronic level for this purpose. Even better for landscape photography is mounting the camera on a tripod, focusing manually, and using the self-timer to prevent any camera shake.

Settings:

- A short focal length (wide-angle lens)
- Small aperture (f/8 - f/13) to render the entire scene sharp
- Low ISO (100 - 200)
- Shutter speed adjusted so that the image is well-exposed
- Metering mode: evaluative/matrix



Fig. 4.12: At 7:17 in the morning in Norway.



Fig. 4.13: Reflection.

When using a tripod, turn off the image stabilizer if available.

4.4 Nature

Nature photography ranges from the smallest blossoms to entire landscapes. Therefore, the settings heavily depend on the subject.



Fig. 4.14: Wild mushrooms

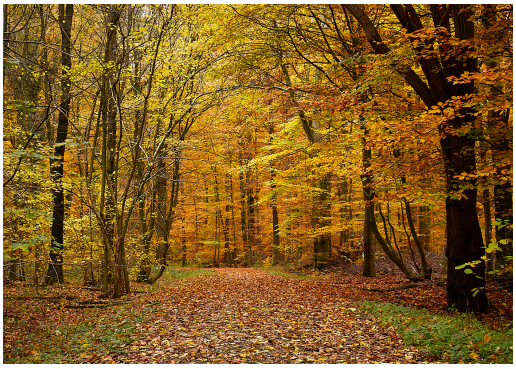


Fig. 4.15: Autumn forest

4.5 Buildings

It is best to photograph buildings from further away. If you stand too close to the building, you have to tilt the camera too much, which distorts the perspective and causes converging lines to occur. If you cannot move further away, subsequent correction via software helps. Alternatively, you can use a tilt-shift lens, which is, however, very expensive. If you photograph buildings in poor lighting conditions, a tripod is useful to keep the ISO and thus image noise low.

Settings:

- Focal length depending on the distance
- Small aperture to achieve the highest possible sharpness
- Low ISO to preserve all structures
- Adjust shutter speed accordingly
- Metering mode: evaluative/matrix

Leave some space around the actual subject when taking the photo so that nothing of the subject is lost during subsequent correction.

When using a tripod, turn off the image stabilizer if available.

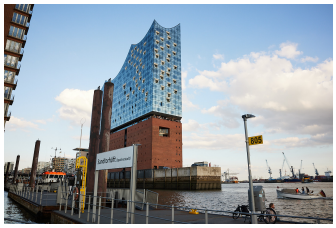


Fig. 4.16: Elbphilharmonie Hamburg with a 15 mm focal length. The converging lines are clearly visible.



Fig. 4.17: Subsequent correction. The image crop also changes in the process.



Fig. 4.18: Wasserschlösschen Hamburg. Captured with a tripod and an 6-second exposure time.

4.6 Food

In food photography, depth of field and light are particularly important. The focus should be set so that the "food" is sharply rendered and the background becomes slightly blurry. It is nice when the scenery in the background can still be guessed. Natural daylight is particularly well-suited for food photography because it reproduces colors most naturally. Care should be taken that no direct sunlight falls on the scene to avoid harsh cast shadows. If daylight is not available, daylight lamps are better suited than flashes, as you can evaluate and adjust the lighting better beforehand.

Camera settings that are well-suited:

- Medium to small aperture, depending on the focal length, subject size, and desired background blur
- Shutter speed for handheld shooting approx. 1/60 s and Auto-ISO
- If a tripod is used, use the lowest ISO and adjust the shutter speed accordingly
- Metering mode: evaluative/matrix or center-weighted



Fig. 4.19: The background makes the scene look natural.



Fig. 4.20: Daylight brings out the colors well. The shadows are not distracting here.

4.7 Vehicles

Vehicle photography ranges from toy cars to rockets with the entire spectrum of settings. As an example, only the photography of cars is treated here. Even then, the spectrum ranges from close-ups of details to stationary and moving vehicles, classic cars, race cars, all the way to shots taken from moving cars.



Fig. 4.21: Close-up of a hood at the Motor Show in Essen.



Fig. 4.22: Classic car at the Classic Days Oldenburg.

When taking shots of vehicles, always keep an eye on the lighting to bring out the paintwork as best as possible. With classic cars, black and white shots are particularly effective. The dynamics of an image can be increased by tilting the camera.

Always keep the background in mind when taking shots. People in the background are especially distracting at motor shows or classic car meets.

Settings for stationary vehicles:

- Focal length depending on the distance from the subject
- ISO as low as possible to capture the paintwork in the best possible way
- Adjust shutter speed and use a tripod if necessary
- Flash only in exceptional cases, as unpleasant reflections can occur
- Metering mode: center-weighted to evaluative/matrix

Settings for moving vehicles:

- Focal length according to the distance from the subject
- Short shutter speed, exception: panning shots
- Auto-ISO
- Metering mode: center-weighted to evaluative/matrix
- Servo autofocus, vehicle detection if available
- Flash only in exceptional cases, otherwise the image looks too static. A slight blur underlines the dynamics.



Fig. 4.23: Kiwi on the beach of Rømø.



Fig. 4.24: Shot taken from a following vehicle on ice in Sorsele, Sweden.

5 Image Composition

5.1 Image Statement

The statement of an image goes far beyond what is visible in the photo. Every picture evokes personal memories of the moment it was taken. Other viewers lack this experience; they only see the final shot. Consequently, the image can develop a completely different significance for them. A souvenir photo is easily made—you simply capture what you want to remember. However, if the photograph is intended for another purpose, you should think beforehand about what is important in the image and how to present a subject so that viewers understand the intended statement.



Fig. 5.1: Holiday feelings, Prora 2015

5.2 Image Format

The most common image formats are aspect ratios of 3:2 or 4:3, but square pictures can also achieve a great effect. Whether a photo is taken in portrait or landscape format depends on the subject. Viewing habits have changed since the rise of smartphone photography. Although we naturally perceive the world more in landscape format due to the arrangement of our eyes, portrait formats are widely used today.

Panorama

5.3 Positioning

In most pictures, it looks better if the mouse or any other subject is not positioned exactly in the center of the frame. Guidance is provided by positioning according to the golden ratio or, more simply, the rule of thirds.



Fig. 5.2: Portrait format 4:3



Fig. 5.3: Square



Fig. 5.4: Landscape format 3:2

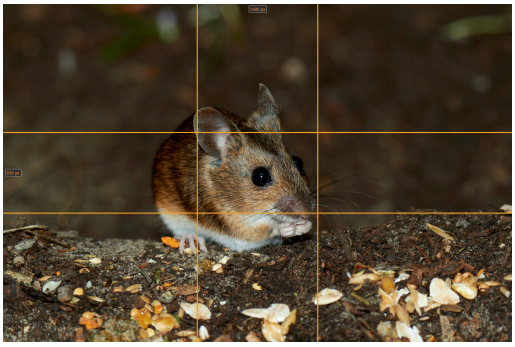


Fig. 5.5: Golden ratio: the image is divided according to the golden ratio. The mouse sits slightly offset to the left in the frame.



Fig. 5.6: Rule of thirds: the mouse does not sit in the center but roughly one-third away from the edge of the image.

5.4 Direction of View

Just as important as positioning is the direction of view. As a rule, it looks much better if the person, animal, or even the "nose" of a car faces into the frame.



Fig. 5.7: Less ideal: the mouse looks out of the frame.



Fig. 5.8: Better: the mouse looks into the surroundings within the frame.

Lenses are not as sharp at the edges, so it is better not to place the object too close to the edge and crop the image later.

5.5 Alignment

Sometimes it is not possible to capture an image perfectly straight, as it is in reality. A picture of the sea looks strange if the horizon is crooked. Sometimes, however, you might intentionally want to hold the camera tilted. It always depends on what you want to express with the image.



Fig. 5.9: A realistic picture of the sea looks strange if the horizon is crooked. The water appears to flow out of the image.



Fig. 5.10: A straight horizon looks more harmonious.



Fig. 5.11: The photo is captured correctly, but looks boring.



Fig. 5.12: With a tilted horizon, the shot appears more dynamic.



Fig. 5.13: The fence in the background makes it obvious that the image is crooked.



Fig. 5.14: Straightening the image afterward cuts off the foal's hooves.

Alignment can also be corrected later with software. When taking the photo, you must keep in mind that quite a bit of the image will be cropped out, which might still be important.

5.6 Cropping

Cropping an image achieves the same result as choosing the right framing in the first place. However, this is not always possible. Especially in bird photography, the focal length is often insufficient to render the subject large enough. In such cases, it is possible to crop the image afterward.



Fig. 5.15: The falcon was quite far away.



Fig. 5.16: Cropping afterward still works well here.

However, you should not overdo it. Otherwise, the image becomes too small overall, and you will start to see the pixels.



Fig. 5.17: There is definitely not much left to do here.



Fig. 5.18: Cropping no longer leads to a good picture. The image is too small and pixelated.

Cropping can also help get rid of image elements that you might have overlooked during the shot and that do not belong in the picture.

Furthermore, cropping can completely change the overall impact of an image. A famous example is a photograph from the Vietnam War.



Fig. 5.19: The titmouse is too small, and the birdhouse is distracting in the frame.



Fig. 5.20: Cropping conceals the fact that the titmouse was photographed at the birdhouse. The image format was additionally changed here as well.

5.7 Isolation / Subject Separation

Isolation refers to highlighting a subject against a blurry background. This is achieved with a shallow depth of field and by focusing on the subject. The background itself can appear homogeneous or still allow the surroundings to be guessed. Smartphone software developers put a lot of effort into creating a blurry background, even with lenses featuring very short focal lengths.



Fig. 5.21: The soap bubble is sharp, the background is blurry but still recognizable.



Fig. 5.22: The fly is sharp against a homogeneous background.

If you have small light sources in the background of the subject, such as a string of lights or backlighting through a forest, you can achieve a beautiful background look.

More Information



Fig. 5.23: A string of lights placed in the background provides an interesting image look.



Fig. 5.24: Natural light in the forest.

5.8 Panning Shots

A panning shot is a photograph where the camera is moved in the direction of motion along with the object during the exposure. This reduces the relative speed; the object is rendered sharply while the stationary background becomes blurry. This technique requires a lot of practice.



Fig. 5.25: Without panning: Captured with a shutter speed of 1/1250 s. The car is sharp, but the image feels static.



Fig. 5.26: Better: Captured as a panning shot with a shutter speed of 1/200 s. The image looks more dynamic.



Fig. 5.27: Panning shots require a lot of practice. Here, everything is blurry.

Turn off the image stabilizer if available. However, some lenses feature a special stabilization mode specifically for panning shots.

5.9 Black and White Photography

Black and white or monochrome photography is the oldest form of photography and remains a popular stylistic tool today. By omitting colors, attention is drawn to contrasts and brightness levels. This does not work for all subjects, but some gain artistic expressiveness. Most digital cameras feature a monochrome mode, allowing you to see the image in black and white directly in the viewfinder and on the screen, so you can evaluate the effect before taking the shot.



Fig. 5.28: The shot in color does not look as effective. The green grass distracts from the wood texture.



Fig. 5.29: In black and white, the wood texture stands out much better.



Fig. 5.30: Food photography usually only works in color.



Fig. 5.31: In black and white, the image appears flat and lacks an appealing statement.



Fig. 5.32: Sunrises and sunsets thrive on color. The color determines the image mood.



Fig. 5.33: In black and white, the picture is not bad, but the actual mood is lost. Now you notice the old contrails, which didn't stand out in the color shot at first.



Fig. 5.34: November mood in black and white.



Fig. 5.35: Anton captured at aperture f/0.85.

5.10 High-Key / Low-Key

High-Key shots are characterized by predominantly bright tones, while Low-Key shots feature predominantly dark tones. Both types of photography usually exhibit high contrast.



Fig. 5.36: High-Key shot (analog).



Fig. 5.37: Low-Key shot.

5.11 Styles

Styles or picture profiles alter a photograph to enhance or distort the image statement. The most famous is the black and white or monochrome style. Many cameras have pre-installed styles for food photography, portraits, or landscapes. Developing your own styles is more interesting.

Save in RAW format to retain full editing capabilities.

5.12 Street Photography

A special genre is street photography, which captures life in public spaces. This can be problematic because you must respect the rights of other people. Strictly speaking, you need to obtain consent from every person you photograph to use



Fig. 5.38: Original holiday photo,



Fig. 5.39: in the style of a television crime drama,



Fig. 5.40: and as if from an article opposing factory farming.

the picture. The legal situation in Germany is governed by several laws. The regulations vary from country to country, which is why you find great photos from some countries and hardly any from others. A notable street photographer was Martin Parr, a former president of the Magnum Photos agency.

The motivation for street photography for most photographers is documenting real life and the zeitgeist, often combined with a certain amount of social criticism. This, of course, conflicts directly with the necessity of obtaining prior permission for a photo.

Even though it is not permitted in Germany to publish images of people without asking, you can still create interesting shots in this genre.



Fig. 5.41: Shot of a 'Street Dog'.



Fig. 5.42: On the ferry to Norway.



Fig. 5.43: Graffiti in Bremen along the Weser.

! Every photographer should ask themselves whether a photo exposes a person and whether they would want to be photographed that way themselves.

5.13 Storytelling

An expansion of taking individual pictures is storytelling, where you try to capture an entire series of images based on a theme. Almost everyone knows this type of photography from traveling, but other topics can be considered as well.

A good preparatory exercise for storytelling is creating Mood Boards

5.14 Mood Boards

Mood boards are collections of images based on a specific overarching term or a particular mood.

Examples of mood boards can be found here.

6 Experimental

6.1 Macros

Macros refer to images where a small object is captured on the sensor as large as it actually is. It is as if you were "gluing" the subject directly onto the sensor. True macros have a magnification ratio of at least 1:1. However, ratios where the subject is slightly smaller (1:2) are also frequently called macros. Ratios larger than 1:1 are generally only achieved by special lenses (macro photo lenses).

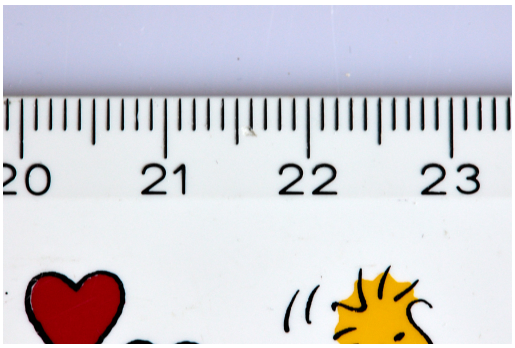


Fig. 6.1: Ruler, captured with a full-frame sensor (36mm width) and a 1:1 macro lens.

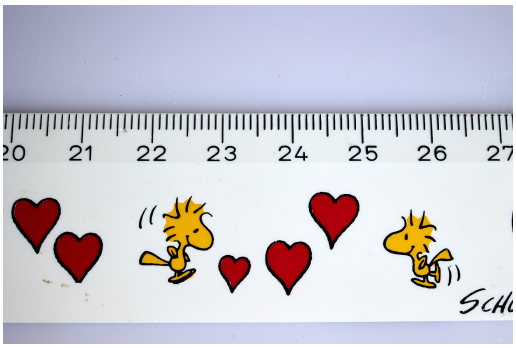


Fig. 6.2: Ruler, captured with a full-frame sensor (36mm width) and a 1:2 macro lens.

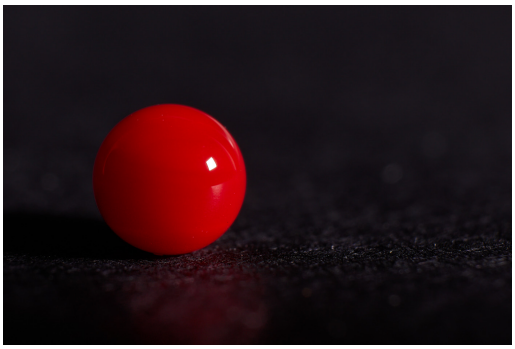


Fig. 6.3: No, not a billiard ball, but a macro shot of a pinhead.



Fig. 6.4: "Making of" the ball with a macro lens and an additional extension tube.

To capture macros, you need either:

- A compact camera with a macro function, or
- A system camera with a lens and
  - An extension tube placed between the camera and the lens, or
  - A close-up lens screwed onto the front of the lens, or
  - A reverse adapter used to mount a lens backward onto the camera, or
- A system camera with a dedicated macro lens

The most expensive option is the macro lens. This is a special lens designed to deliver sharp images at close range. However, the other options serve their purpose well too. Extension tubes in particular are quite affordable. They simply increase the distance between the sensor and the lens. This allows you to focus much closer to the subject. However, you lose the ability to focus into the distance.

One characteristic that all these options share is a shallow depth of field. The closer you get to an object, the smaller the area that can be sharply rendered. Within limits, the following can help:

- A short focal length and
- A small aperture (high f-number)



Fig. 6.5: Lemon slice in sparkling water using the macro mode of a compact camera.



Fig. 6.6: 2-Euro coin with an extension tube.



Fig. 6.7: Sewing thread.

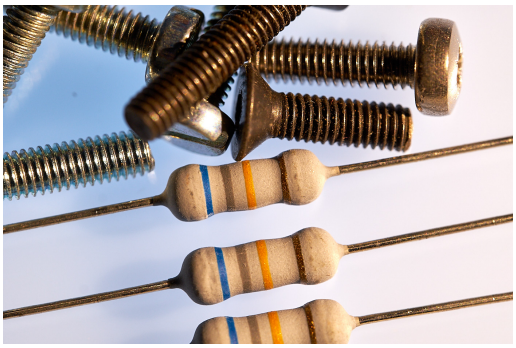


Fig. 6.8: Screws and resistors.

Some macro lenses only achieve their maximum magnification ratio with manual focusing.

6.2 Stacking

In macro photography, much like with a microscope, the depth of field—the area in which the image is sharp—is tiny. To get an entire object completely sharp, such

as a small stuffed animal or a beetle, you take many shots focused at different areas and combine the images. Such images are also called stacks. Some cameras have a built-in mode to generate these images. However, there are also various programs or apps that filter out the sharp areas from individual shots and combine them into a new image.



Fig. 6.9: First image of the series.



Fig. 6.10: Fifth image of the series.



Fig. 6.11: Tenth image of the series.



Fig. 6.12: Stack combined from 10 images.

Use a tripod.

6.3 Sunstar

A sunstar is created in a shot when you photograph directly into the sun using a small aperture (high f-number). The shape of the sunstar depends on the number and shape of the aperture blades.



Fig. 6.13: Sunstar

! Never look directly into the sun. Not even through the viewfinder! And never point a telephoto lens at the sun for a long time without a solar filter. The sensor can be destroyed afterward.

6.4 Panorama

Panoramas are images that are wider than normal shots. They are stitched together from multiple exposures. This is done either using a panorama mode, if the camera has one, or afterward with suitable software.

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If panoramas are stitched together afterward, care must be taken during shooting that the images overlap, are aligned evenly in height, and that the exposure and white balance match for all shots.

6.5 Old Lenses

Old lenses from the analog era sometimes have a very special image look. To use them, a special adapter is required in most cases. The difference in the image look is not necessarily obvious at first glance. It also depends on the subject and the light whether the difference stands out. The contrast is particularly noticeable in backlit portraits.



Fig. 6.14: Shot taken with a digital camera and an adapted Diaplan lens from an old slide projector. The Diaplan features a special bokeh with sharply defined 'bubbles'.



Fig. 6.15: Shot taken with an adapted 50mm lens at aperture f/2. The lens has a 'creamier' look than modern lenses.



Fig. 6.16: Shot taken with a modern 50mm lens at aperture f/2. The lens renders images in a more 'clinically pure' way.

6.6 Pinhole Camera

A simple pinhole camera consists of a box or can with a tiny hole in the center of one side and a ground glass screen, a sensor, or a film plate positioned on the opposite side. If you hold the side with the hole into the light, an inverted image is projected onto the screen.

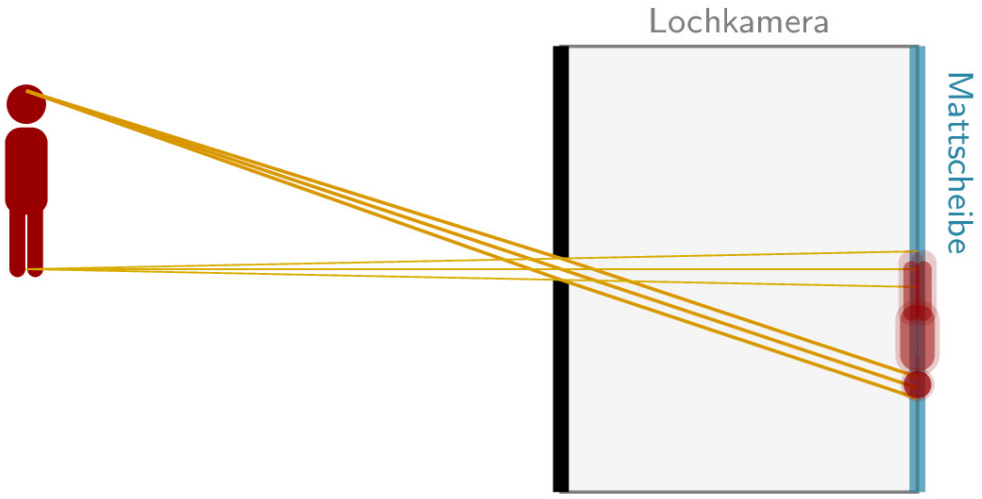


Fig. 6.17: Schematic of a pinhole camera. The light from the little man passes through the hole onto the screen, creating an inverted image.

You can easily build a pinhole camera yourself. Take a light-tight box, make a small hole in one side, and a small window on the opposite side where you paste some parchment paper. To see an image, hold the screen close to your eye and shield it additionally against light, for example with a hood.

The easiest way is to photograph the image off the screen.

If you want to record the image directly, the camera sensor or analog film must be placed instead of the screen. This is a bit more complicated, as everything — except the tiny hole — must be completely light-tight. Analog film must be placed inside the box in absolute darkness, and the hole must be sealed light-tight until the exposure is made.

There is another option when using a system camera. You drill a tiny hole right into the center of a body cap, remove the lens, and attach the cap to the camera. Then you can take photos just like with a pinhole camera. In the camera's system settings, you might need to enable shooting without a lens attached. You will have to experiment with the shutter speed. It works even better if you narrow down the drilled hole using pieces of razor blades. Ideally, it should be a tiny, perfectly circular hole.

A pinhole camera has an infinite depth of field, meaning the image is equally sharp at all distances. Unfortunately, a pinhole camera generally has a high level of



Fig. 6.18: Pinhole camera made from a whiskey tin. The screen is mounted on another tin can that slides inside the whiskey tin. This prevents too much stray light from hitting the screen from behind.



Fig. 6.19: The small hole in the bottom of the tin.



Fig. 6.20: The image on the screen.

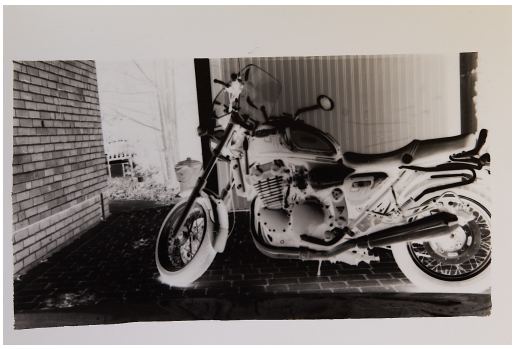


Fig. 6.21: Pinhole camera image exposed on photo paper for 20 minutes. The image appears as a negative.



Fig. 6.22: Photographed photo paper inverted and converted using photo software.

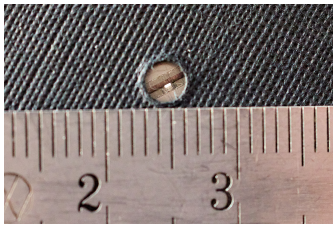


Fig. 6.23: Drilled body cap with a hole narrowed down by pieces of razor blades (approx. 0.8 mm x 0.4 mm). A circular hole would be better.



Fig. 6.24: Shot taken with the drilled body cap.



Fig. 6.25: Shot taken with the drilled body cap.

blurriness, which increases the larger the hole is.

- Large hole: Very blurry image, relatively short exposure time
- Small hole: Sharper image, long exposure time

You cannot get a truly sharp image with a pinhole camera. That is why lenses exist.

! Only drill into the body cap if you have an intact spare. If you leave the pinhole cap on the camera, the sensor can get dirty!

Info

Since 2001, there has even been a Pinhole Camera Day, where people around the world take pictures using pinhole cameras:
Worldwide Pinhole Photography Day

6.7 Infrared Photography

Infrared light (IR light for short) is light that has a longer wavelength than visible light. Some cameras can see a little bit of IR light. You can test it with a TV remote control by taking a picture of the remote while pressing a button on it. Then you will also know right away if the lens lets IR light through (and if the battery in the remote is still good). Most smartphone cameras can see more infrared than system or compact cameras. To take IR shots, an infrared filter must be screwed onto the lens, which only lets IR light through and blocks visible light. Unedited, such images will have a heavy red cast.



Fig. 6.26: Camera 'sees' the infrared LED of the remote control.



Fig. 6.27: Unedited infrared image.



Fig. 6.28: Edited infrared image.

6.8 Utraviolett Photography

Ultraviolett (UV) photography only works with special cameras that do not have a UV cut-off filter. Additionally, visible light must be blocked using filters. Unfortunately, such filters are very expensive.



Fig. 6.29: Shot taken with a special camera without internal filters and using a screw-on filter that passes almost exclusively infrared and UV. The colors were edited afterward.

6.9 Camera Trap

A camera trap automatically captures images as soon as something happens. This is typically realized using a light barrier.



Fig. 6.30: Camera trap equipped with a flash and a light barrier.



Fig. 6.31: World Cup mouse captured with a camera trap.

6.10 Astro Photography

Astro photography actually requires its own photo school guide and a lot more equipment than is normally available. However, you can still take respectable photos using a standard camera with a telephoto lens. In astro photography, there are subjects that are easy to capture, like the moon, and complicated ones, like galaxies.

Moon shots can be taken handheld even with simple telephoto lenses. Beautiful images are captured shortly before or shortly after a full moon, when the craters cast distinct shadows. With a steady hand and a stabilized lens, you can get good results using the following settings:

- Focal length of 200 mm or longer

- Turn image stabilization on or use a tripod with stabilization turned off
- Spot metering set on the moon
- Aperture f/11
- Shutter speed 1/100 s
- ISO 200

The sky must, of course, be cloudless, and the humidity must not be too high.



Fig. 6.32: Waxing moon.



Fig. 6.33: Partial lunar eclipse on July 27, 2018.

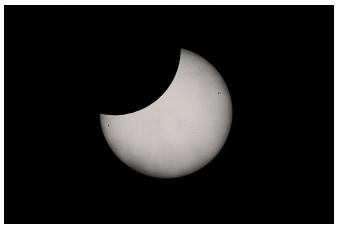


Fig. 6.34: Partial solar eclipse and sunspots on October 25, 2022, captured using a solar filter.

For solar photography during the day, a special solar filter MUST be used. Photographing without a special solar filter is only permitted shortly after sunrise or shortly before sunset when the sun is deep orange.

❗ Never look directly into the sun. Not even through the viewfinder! And never point a telephoto lens at the sun for a long time without a solar filter. The sensor can be destroyed afterward.

Capturing the Milky Way works best with a wide-angle lens.
Photographing galaxies is difficult without special additional equipment. You need a very stable tripod and a star tracker / equatorial mount that moves the camera, since the Earth continues to rotate during the exposure time.

For these types of shots, stacking is frequently applied—for example, to filter out stars from many images with different noise patterns and thus enhance the actual image information.

💡 When taking shots of the starry sky, focus manually and never rotate all the way to the end toward ∞.

This is because autofocus systems need some headroom at the ends of their ranges to adjust precisely. If you rotate all the way to the hard stop in the direction of ∞, you go past the sharp focus point for (infinitely) distant objects, and the image becomes blurry again.



Fig. 6.35: Andromeda (on the right edge of the frame), single exposure using a star tracker.



Fig. 6.36: Andromeda stacked from eight individual frames using a star tracker.

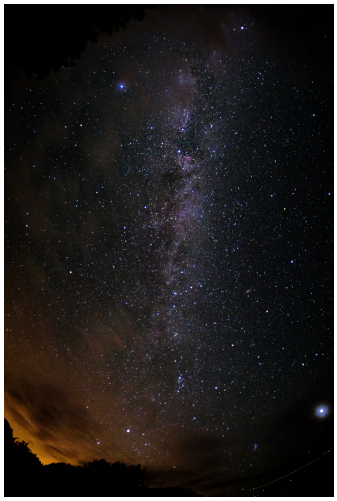


Fig. 6.37: Milky Way captured using a star tracker.

6.11 Water Drop Photography

Water drop photography is a genre that some photographers spend years mastering. The equipment required can easily cost several hundred euros in addition to the camera. However, it can also be done with basic tools, and even simply handheld.

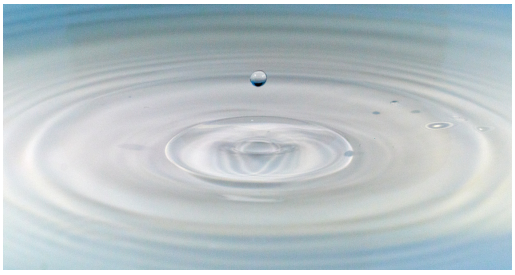


Fig. 6.38: Dripping faucet, simply captured handheld.



Fig. 6.39: Dripping faucet, simply captured handheld.

If you have one or two bright LED lights and perhaps a tripod in addition to the camera, it works even better.

First, look for a faucet under which you can place a bowl. Then, position the camera so that it frames the shot just above the bowl. Set up the lighting from both sides. If you have color filters for the LED lamps, they create beautiful effects. Then, open the faucet just a tiny bit so that it drips. It makes sense to use continuous burst shooting and select the best images later.

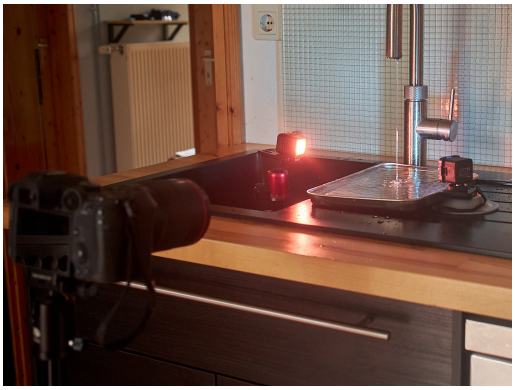


Fig. 6.40: Setup for water drop photography.

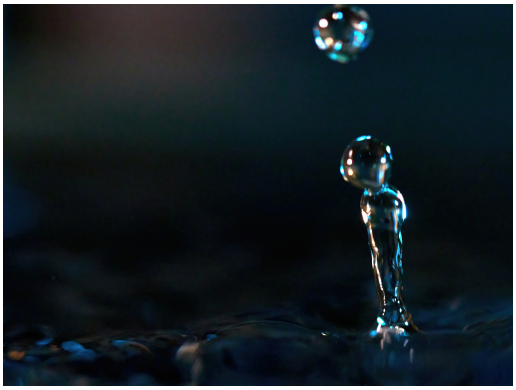


Fig. 6.41: Water drop sculptures.

! Don't forget to turn off the faucet to avoid flooding the kitchen!

6.12 Polarizing Filter

A polarizing filter filters light so that only waves traveling in a specific direction are allowed through. In photography, this is frequently used to reduce reflections. However, you can also do fun things with a polarizing filter. If you place a transparent object onto a smartphone or tablet displaying a solid white background and then photograph the object using a polarizing filter, stunning colors appear. This does not work with all transparent objects; it depends heavily on the material.

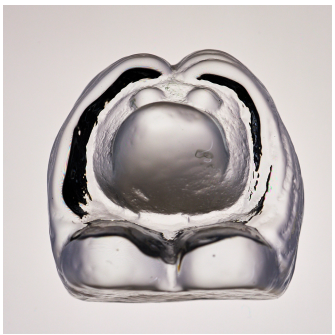


Fig. 6.42: Small glass figurine on a tablet captured without a filter,

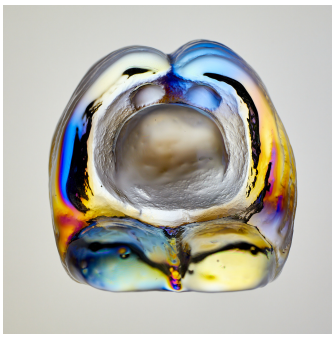


Fig. 6.43: with a polarizing filter,

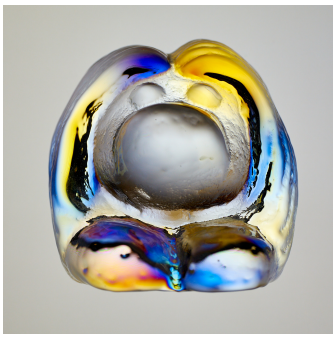


Fig. 6.44: and with a rotated filter orientation.

6.13 Playmobil

You can also have a lot of fun with toys. For the photos shown, it is helpful to work with a tripod or to rest the camera firmly somewhere. This allows you to keep the aperture and ISO low while using a longer exposure, resulting in sharp,

noise-free images. Good illumination with diffuse light or, as in the image with the tealight, using no other light source is crucial. Using the internal flash would overexpose everything.



Fig. 6.45: Firefighter at the race car. Illuminated with LED light.



Fig. 6.46: Astronaut with Mars creature. Illuminated with LED light.



Fig. 6.47: Firefighter in action. Illuminated only by the tealight.

! Never leave candles unattended!

7 Technical Matters

7.1 Amount of Light

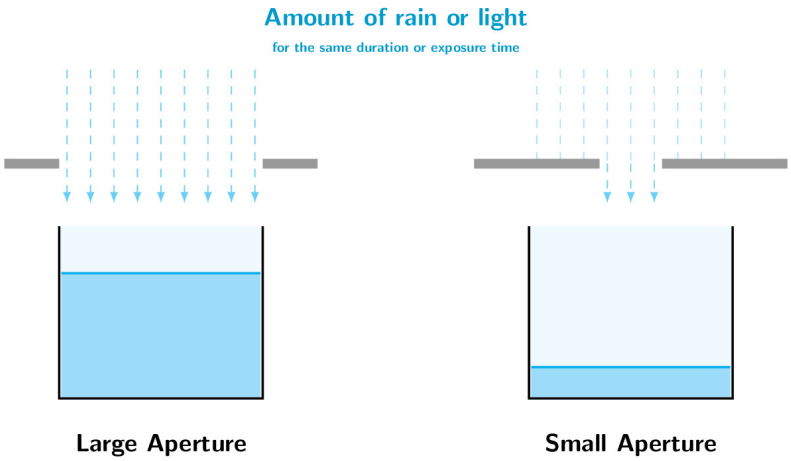


Fig. 7.1: The amount of light falling on the sensor can be imagined like rain falling into a container. For the same duration of time, less light falls on the sensor through a small aperture than through a large aperture. The image becomes darker overall. To compensate for this, you can prolong the shutter speed.

7.2 Sensor

A pixel (of the sensor) consists, among other things, of a photodiode that converts light into an electrical signal, a color filter, and a lens. Each pixel captures only one color channel. The color channels are Red, Green, and Blue (RGB). Almost all visible colors can be composed of these 3 primary colors. An image pixel with color values for red, green, and blue is compiled (partially differing by manufacturer) from neighboring pixels on the sensor (see Section 7.2.1).

7.2.1 Bayer Mask

Without the filters, the photodiodes of the pixels would only measure brightness values and generate a black and white image. Therefore, color filters are placed in front of the photodiodes, making it possible to measure red, green, and blue individually. In order to measure all colors as "correctly" as possible and thus generate an image that looks "right" to the human eye, the color filters are usually arranged in a pattern called a Bayer mask.

For saving the image pixels:

- The "red" pixels receive the values for blue and green by averaging the values of the neighboring blue and green pixels.
- The "green" pixels receive the values for red and blue by averaging the values of the neighboring red and blue pixels.

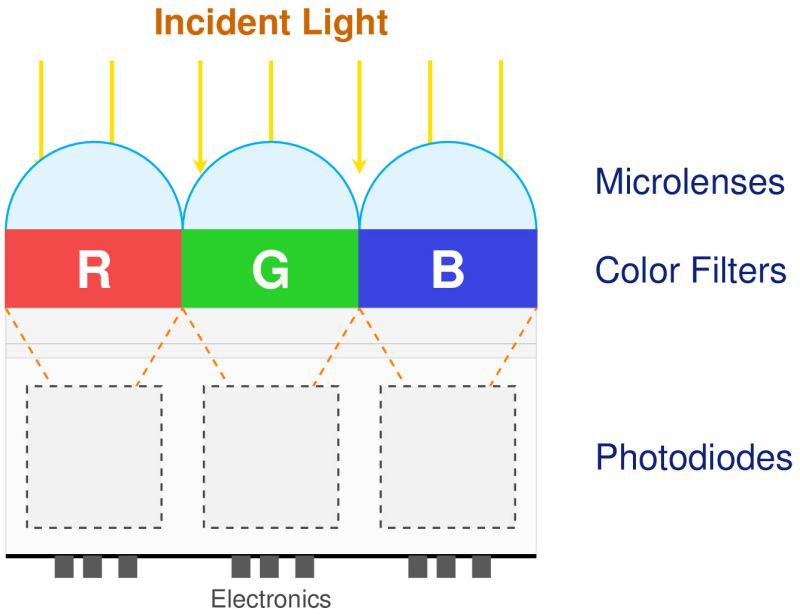


Fig. 7.2: The sensor structure (RGB group).

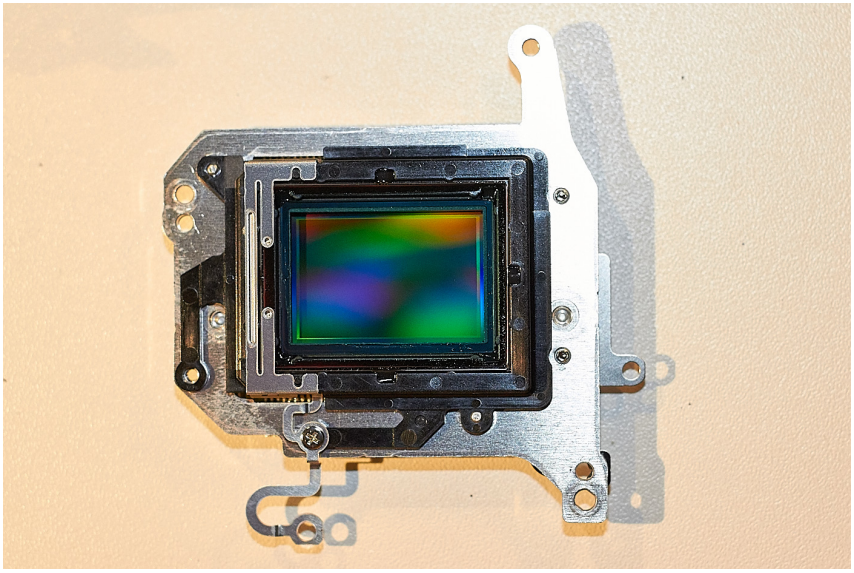


Fig. 7.3: Disassembled sensor unit of a digital camera.

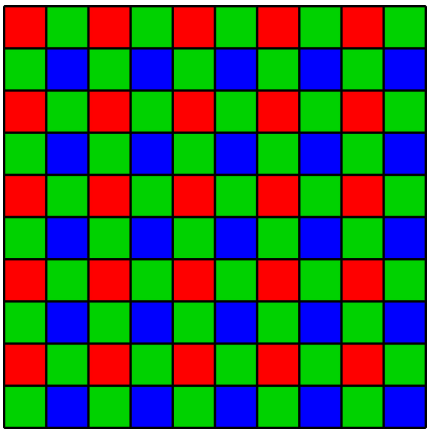


Fig. 7.4: The "color distribution" on the sensor. This pattern is called a Bayer mask.

- The "blue" pixels receive the values for red and green by averaging the values of the neighboring red and green pixels.

A less common variant is the X-Trans sensor from Fujifilm.

> **Averaging**
>
> Averaging or interpolation differs from one sensor variant to another. The formulas for this are programmed into the camera for shooting in JPG and are made available to software manufacturers for RAW processing. There are different types of interpolation.

7.2.2 Color Space

Not all colors that we can see can actually be represented by red, green, and blue. Therefore, some colors do not look "right" in images. This is also partly because cameras and monitors display colors using additive color mixing, while printers use subtractive color mixing.
The camera sensor, camera display, monitor, and printer must be coordinated with one another.

> **CIE 1931 Color Space**

7.2.3 Common Sensor Sizes

Sensor sizes range from tiny sensors in most smartphones, which are no larger than a toddler's pinky nail, to large sensors in studio cameras that are roughly the size of half a credit card.

Sensor Size	Camera Examples
1/2.3''	Nikon Coolpix P950

Sensor Size	Camera Examples
1 Inch	Canon G7x, Sony R10V
MFT	Olympus PEN
APS-C	Canon R7, Nikon Z50, Fujifilm X-T5
Full Frame	Sony α 7V, Canon R5, Nikon Z9, Leica Q3
Medium Format	Fujifilm GFX 100

Medium format is not depicted in the graphic. The APS-C formats deviate slightly from one another depending on the manufacturer. The one-inch sensor, also called the inch sensor, is smaller than 1 inch in diameter due to historical reasons. Sensors in smartphones are usually very small (approx. $1/2.3''$). The largest ones built into phones so far are the one-inch sensors.
The pixel count is independent of the sensor size. There are full-frame sensors with 20 megapixels and tiny sensors in smartphones with over 40 megapixels. The designations of the sensors vary from manufacturer to manufacturer.

7.2.4 Pixel Pitch

This specification describes the physical size of the photodiodes. A few examples:

- 1 Inch, 20 MP (e.g., Canon G7x), 2.4 μm
- APS-C, 24 MP (e.g., Canon EOS 80D), 3.7 μm
- Full Frame, 20 MP (e.g., Canon EOS 6D), 6.5 μm

7.3 ISO

ISO stands for "International Organization for Standardization" and represents the sensitivity of the film material or the sensor in photography.
For analog films, the following applies:

- Low ISO number: Very fine resolution (can be imagined as small pixels), requires a lot of light.
- High ISO number: Coarser resolution (can be imagined as larger pixels), good in low light.

For digital cameras, the following applies:

- The ISO number controls the sensitivity of the sensor by adjusting the gain amplification (similar to a volume control).
- A low ISO number generates little noise, requires a lot of light.
- A high ISO number generates more noise, good in low light.
- The larger the pixels on the sensor, the lower the noise (at the same ISO number).

Noise is created by amplifying the signal and becomes stronger when the ISO number/gain is increased.
Noise stands out more prominently in dark areas of an image than in bright areas.

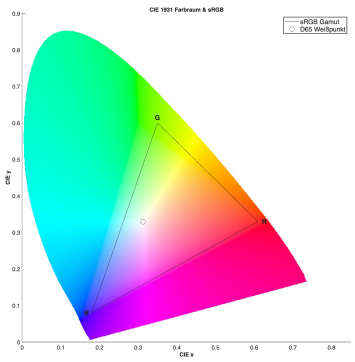


Fig. 7.5: Example of the color space of cameras (sRGB – the triangle) within the CIE 1931 color space. It is clear to see that there are far more colors than most cameras can reproduce.

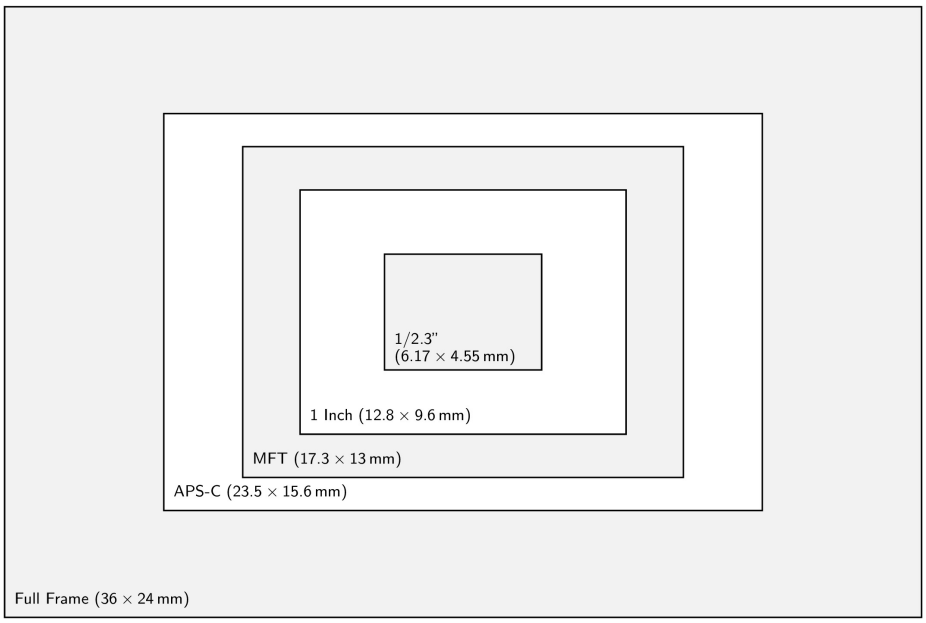


Fig. 7.6: Common sensor sizes; medium format is not shown.

Usually, larger sensors feature lower noise than smaller ones at the same pixel count. However, it also depends on the camera generation, as sensors have steadily improved over time.

7.3.1 Crop Factor

The crop factor indicates the factor by which the sensor is smaller or larger compared to full frame. More precisely: The crop factor specifies the ratio of the diagonal length of the full-frame sensor to the diagonal length of the image sensor being considered. The smaller the sensor, the larger the crop factor.

Crop factors of different sensor sizes:

Sensor Size	Crop Factor	Sensor Area (rounded)	Quota of Full Frame
1/2.3''	5.6	28 mm^2	0.03
1 Inch	2.7	123 mm^2	0.14
MFT	2	225 mm^2	0.26
APS-C	approx. 1.5	367 mm^2	0.42
Full Frame	1	864 mm^2	1

Full frame serves as a sort of baseline or reference size. It is exactly the same size as a 35mm slide or negative captured on analog 35mm film.

Small sensors capture far less light than large ones. Currently (2026), smartphones have sensors with a maximum area equivalent to 14% of a full-frame sensor. For this reason, images on smartphones are heavily corrected by software and AI, especially in low-light conditions.

7.3.1.1 Crop Factor and Field of View

7.3.1.2 Crop Factor and Focal Length

A 24mm lens does not turn into a 38mm lens on an APS-C camera. Only the captured field of view changes, as can be seen in Fig. 7.7.

However, for comparison purposes, the effective focal length is frequently specified alongside the actual focal length: The effective focal length of a 24mm lens on an APS-C camera is then 38mm.

7.4 Shutter

The shutter shields the sensor from incoming light and opens up so that the pixels are exposed for the selected duration of time.
With a focal-plane shutter, the exposure time is achieved through a slit whose width is adjusted by the camera so that, at a constant transit speed of the curtain, the designated exposure time is achieved for each individual pixel. Other variants are the diaphragm shutter and the electronic shutter.

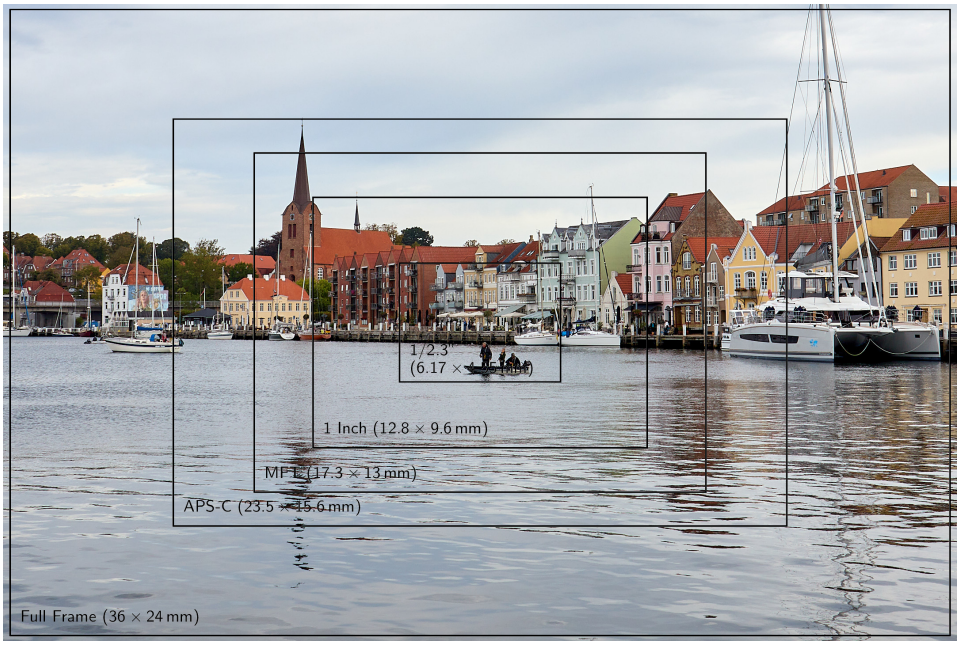


Fig. 7.7: Field of view at the same focal length.

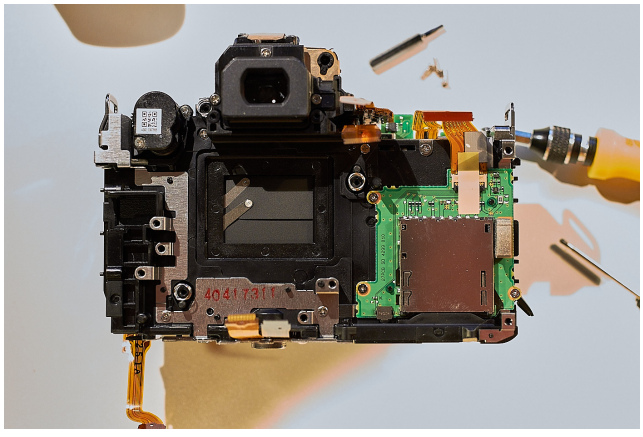


Fig. 7.8: View from behind at the focal-plane shutter after the sensor unit was removed. Two blades are visible.

7.5 Lens

Modern lenses consist of various glass elements, which can be made of different materials and are grouped into lens elements. Individual groups can be movable to allow for focusing or, in the case of zoom lenses, to change the focal length.

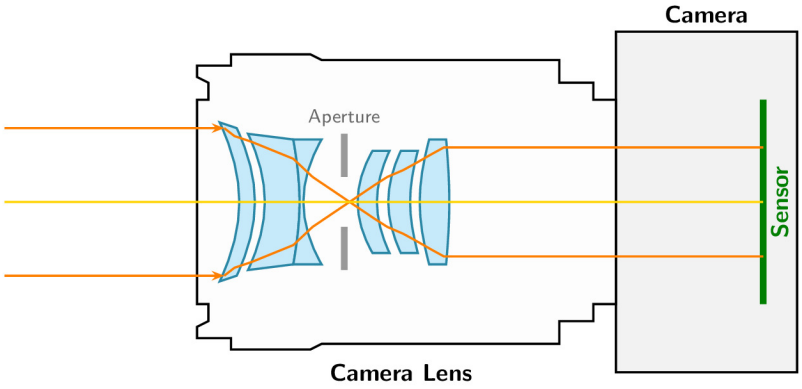


Fig. 7.9: Diagram of a modern lens and its light path (physically not quite correct, that's just AI for you ;)).

7.5.1 Lens Speed / Maximum Aperture

In addition to the focal length, another number is printed behind it: the maximum aperture or f-number. The smaller the f-number, the faster the lens speed. The f-number is the quotient of the focal length divided by the effective diameter of the lens opening.

Examples:

- Focal length 50mm, diameter 25mm: f-number f/2
- Focal length 100mm, diameter 25mm: f-number f/4

A 100mm lens with a diameter of 25mm is therefore not as fast as a 50mm lens of the same diameter.

The notation f/2 is meant to indicate that it is a fraction. On some lenses, it is therefore written as 1:2 or, for example, 50/2 on a lens with a 50mm focal length. The specified maximum aperture is also called the wide-open aperture, as it allows the maximum possible light to pass through the lens.

7.5.2 Aperture Scale / F-Stop Series

The sequence of different aperture diameters is called the f-stop series. It can be found printed on old lenses where the aperture is set manually on the lens barrel itself. On modern lenses, it is controlled electronically from the camera body.

The numerical values of the f-stop series change from stop to stop by a factor of $\sqrt{2}$.



Fig. 7.10: Aperture scale / f-stop series.

Justification

The area A of the aperture opening is calculated using the circle formula from the diameter of the aperture opening d.

$$A = \pi \cdot \left(\frac{d}{2}\right)^2$$

The diameter is therefore:

$$d = \sqrt{\frac{4}{\pi} \cdot A}$$

If twice as much light is to pass through the aperture, the area must be doubled: $A \to 2 \cdot A$.
Then the new diameter is:

$$d_{new} = \sqrt{\frac{4}{\pi} \cdot 2 \cdot A} = \sqrt{2} \cdot d$$

7.5.3 Depth of Field

For cameras that can only focus on a single distance (which applies to virtually all privately used models), depth of field describes the distance from the nearest to the most distant object that can be rendered *acceptably sharp*.
The definition of *acceptably sharp* is derived from the so-called circle of confusion. If this circle for a point-like object is just small enough to be covered by exactly one pixel, the reproduction is sharp. A smaller aperture opening results in a smaller circle of confusion.

Maximum Tolerable Circle of Confusion Diameter

How large the circle of confusion actually may be depends on many factors. See here.

Whether a large distance range is rendered *acceptably sharp* depends on:

- The optical quality of the lens,
- The pixel size of the sensor,
- The aperture opening.

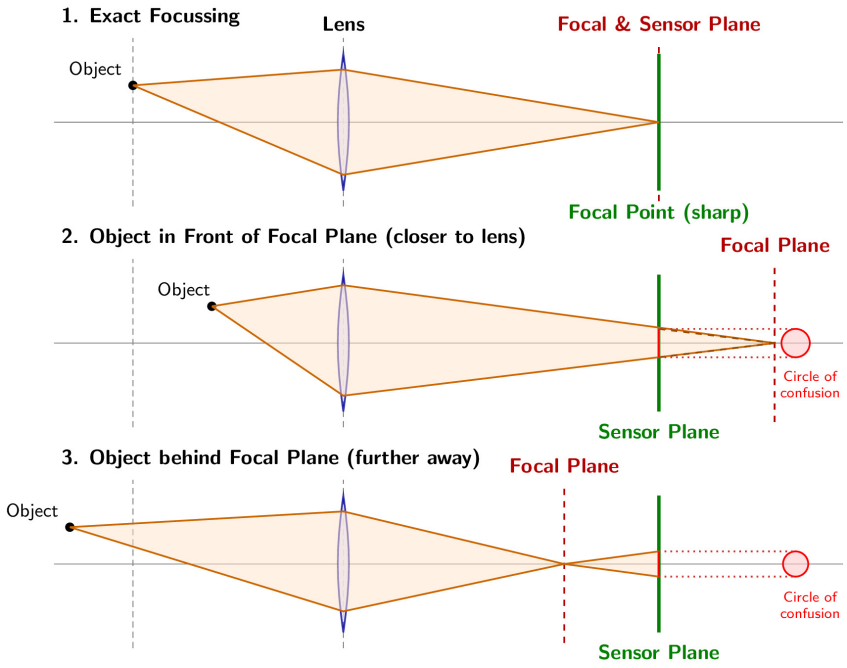


Fig. 7.11: Light path and circle of confusion at wide-open aperture.

Do not stop down the aperture too far in order to avoid diffraction.

On some lenses, the range of depth of field can be read directly off the lens barrel.

In Fig. 7.12, the focus is set to slightly more than 3 meters (scale and vertical line in orange) and the aperture stands at 8. The numbers to the left and right of the vertical line show aperture values, with which you can read the depth of field range on the distance scale again. In this example:

- Aperture f/8: approx. 2.6 m to 4.9 m
- Aperture f/16: 2 m to approx. 10 m

7.5.3.1 Hyperfocal Distance

If you want to ensure in landscape photography that the image is sharp all the way to a distant mountain ridge, you do not focus directly on the ridge itself. Instead, you look for a point located roughly one-third of the distance away, focus there using One-Shot AF, keep the shutter button pressed halfway, recompose back to your original framing, and then release the shutter. This one-third distance corresponds roughly to the hyperfocal distance.



Fig. 7.12: Depth of field scale on the focus ring: the focus is set to slightly more than 3 meters (scale and vertical line in orange) and the aperture is set to f/8. The numbers to the left and right of the vertical line show aperture values, with which you can read the depth of field range off the distance scale again.

i More Information

The hyperfocal distance is a value indicating the focus distance beyond which all objects extending to infinity are acceptably sharp.
This value is dependent on the aperture opening as well.
If you adjust the focus ring on the lens in Fig. 7.12 so that the ∞ symbol aligns with the aperture value 8, it results in a focus distance (vertical line) of 10 meters; this is the hyperfocal distance of the lens at aperture f/8.
On the depth of field scale, you can see that with this setting, everything from 5 meters (half the value of the hyperfocal distance) to infinity will be rendered sharply.
If you align the ∞ symbol with the aperture value 16, it results in a hyperfocal distance of 5 meters and a depth of field range from 2.5 meters to infinity—provided, of course, that aperture f/16 is also selected on the aperture ring for the exposure.

7.6 Bokeh

The aesthetic quality of the blur in a photograph is called bokeh. Bokeh can be easily evaluated by capturing small light sources, such as a string of lights, out of focus.

Bokehs where the out-of-focus circles ("bubbles") are perfectly circular are considered particularly beautiful. Usually, the shape of the "bubbles" changes toward the edges of the image, where they frequently appear as "cat's eyes". Bokeh affects not only points of light but generally the homogeneity of the background blur.



Fig. 7.13: String of lights captured out of focus.



Fig. 7.14: Cat's eye-like bubbles are visible around the edges.

For a calmer bokeh, you should turn off image stabilization if possible.

7.7 Focusing

In automatic mode, the camera selects the focus point on its own. This might work, but it doesn't have to. The camera always selects a high-contrast subject in the foreground to focus on.
The most reliable method to render the desired subject sharp within a scene is to select the center autofocus point and shoot using One-Shot AF. The autofocus point is displayed in the viewfinder and on the screen; hold the camera so that the most important element is visible within this autofocus point.

For moving subjects, you should utilize Servo AF. In Servo AF, the camera focuses continuously as long as the shutter button is pressed halfway, even if a cat is running toward you.



Fig. 7.15: Looking through the viewfinder. The small red square is the active point.



Fig. 7.16: In the captured image, the focus sits perfectly on the eye.

On many cameras, you can move the autofocus point directly on the screen.

Some lenses feature a physical switch to activate autofocus.

7.8 Flash

Hundreds of books have been written on the subject of flash photography. Therefore, we provide just a few notes on terminology here and refer you to further sources regarding various flash lights.

7.8.1 Internal Flash

The flashes built into some cameras are only intended to provide fill light for subjects at close range. The software inside the camera also ensures that the flash is not triggered at all if the selected shutter speed is shorter than the flash sync speed (see Section 7.8.4).
Most of the time, these flashes also generate very harsh shadows, overexposed faces, and red eyes.

7.8.2 Flashes in Mobile Devices

Most mobile devices feature a small LED light that can be used as a flash when taking pictures. In reality, however, this is not a true flash but a (rather weak) flashlight, which is only suitable for fill light at extremely close range.
Activating this "flash" for landscape shots or inside a stadium is entirely useless.

7.8.3 Hot-Shoe Flash Units (Speedlights)

Hot-shoe flash units are external flashes that are mounted onto the camera's hot shoe on compatible models. They typically feature their own power supply via batteries or rechargeable cells and are controlled via the electronic contacts inside the hot shoe.

Most camera manufacturers offer flash units tailored specifically to their camera systems, providing a wide array of control options. Such dedicated system flashes usually work on cameras from other manufacturers or older models as well, but often only with basic functions and manual settings. System flash units can mostly also be deployed for so-called off-camera flashing (Section 7.8.5).

7.8.4 Flash Sync Speed

A flash illuminates for a very brief duration; therefore, it must be triggered at a point in time when the shutter is completely open. The shortest shutter speed at which a focal-plane shutter fully exposes the film or sensor at a single moment is called the flash sync speed.

7.8.5 Off-Camera Flash

In off-camera flash photography, the flash unit is positioned at a suitable location away from the camera and is triggered wirelessly or via a cable, and sometimes controlled by the camera as well. Depending on the manufacturer and system, multiple flash units can be deployed to illuminate the scene according to the photographer's wishes. This mostly takes place in professional and studio environments. Off-camera flash photography helps avoid red eyes and allows for better shadow control.

7.9 White Balance

White balance in a digital color photograph ensures that white surfaces in the photo are actually rendered as white. Digital cameras are normally configured to perform an automatic white balance. In the settings menus, you can switch between daylight, artificial light, etc., as required. Sometimes the automatic white balance reaches its limits (shots in the snow, during sunset, or under candlelight). If you want to make sure that the white balance can be easily corrected during post-processing, you should do the following:

- Leave the camera on Automatic White Balance (AWB),
- Shoot in RAW format,
- Take test shots in the respective lighting moods using a gray card.

ℹ Sometimes you want to capture the specific ambient lighting mood, or test shots might be impossible or intrusive. In those cases, the RAW format always helps.

💡 If you changed the white balance in the camera menu for a specific situation, absolutely remember to reset it afterward.

7.9.1 Gray Card

A gray card is a small, credit-card-sized gray card. The card is matte so that it does not reflect, and it is "precisely gray".

💡 Don't forget to take the actual photo without the gray card as well.

7.10 Tonal Values

Tonal values refer to the distinct levels of brightness that can be differentiated within an image. The number depends on the sensor and the capture format (JPG or RAW).



Fig. 7.17: Shot captured with automatic white balance. The gray card is rendered with a slight blue cast.



Fig. 7.18: Correction of the white balance so that the gray card is "truly gray".



Fig. 7.19: Applying the corrected white balance values from the image featuring the gray card.

Further Information

7.10.1 Histogram

A brightness histogram is like a table of contents for an image. For each brightness value (tonal value) from black to white, it indicates how frequently it occurs in the image. Some cameras can display a live histogram on the screen. This allows you to see the distribution of brightness before taking the shot. This is useful because the camera has a limited dynamic range of tonal values. A shot is well-exposed when all tonal values are represented.



Fig. 7.20



Fig. 7.21



Fig. 7.22: Histogram for the image above. The shot contains tonal values from dark gray (left) to light gray (right); mid-tones occur most frequently.



Fig. 7.23: Histogram for the image above. The shot contains predominantly dark tonal values, with the exception of the peak where the sun hits the house wall.

If your camera can display the histogram, expose in such a way that as many tonal values as possible are represented.

Histograms are also available for individual color channels.

7.10.1.1 Expose to the Left

"Expose to the Left", short ETTL, means that the histogram of the image is shifted toward the left side. The dark tonal values are pushed together and appear almost entirely black. There are more gradations for the bright tonal values and fewer for the dark ones. This is beneficial to:

- Avoid blown-out highlights,
- Achieve shorter shutter speeds with fast-moving subjects,
- Obtain lower-noise exposures, or
- Realize a low-key shot.

You achieve "Expose to the Left" via underexposure:

- A shorter shutter speed,
- A smaller aperture, or
- A lower ISO value.



Fig. 7.24: Total lunar eclipse.

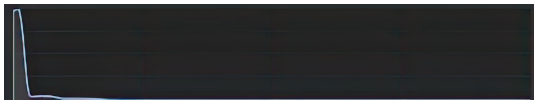


Fig. 7.25: Histogram for the image above. The shot contains almost exclusively very dark tonal values. There are many gradations within the few bright tones.

7.10.1.2 Expose to the Right

"Expose to the Right", short ETTR, means that the histogram of the image is shifted toward the right side. The bright tonal values are pushed together and appear almost entirely white. There are more gradations for the dark tonal values and fewer for the bright ones. This is beneficial to:

- Avoid crushed shadows, or
- Realize a high-key shot.

You achieve "Expose to the Right" via overexposure:

- A longer shutter speed, or
- A larger aperture.



Fig. 7.26: Helicopter against a bright sky.

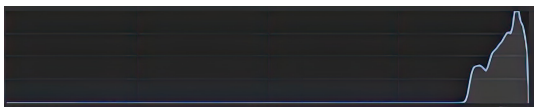


Fig. 7.27: Histogram for the image above. The shot contains almost exclusively very bright tonal values. There are many gradations within the few darker tones.

8 Analog Photography

8.1 Analog Camera

In its simplest form, an analog camera consists of a lens that focuses the incoming light so that it appears sharp inside the camera on the film plane, and a film on which the image is "saved". The film is later chemically developed (Section 8.5) so that the image becomes visible.



Fig. 8.1: The Retinette 1A, with which the Bear learned photography.

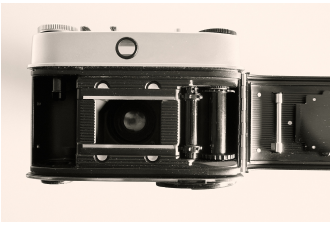


Fig. 8.2: A look inside the camera

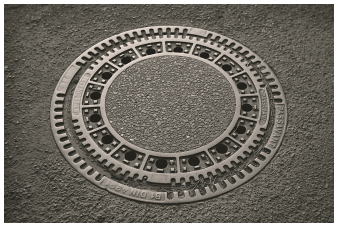


Fig. 8.3: Shot taken with the Retinette 1A using FP4+ that expired 2 years ago

8.2 Films

Until the introduction of digital cameras, there were countless films and film formats. The most famous are:

- 35 mm film, 35 mm wide, also known as Type 135
- Pocket film, 16mm, Type 110
- Roll film, medium format, 61.5 mm, Type 120

The 35 mm format was the most widespread, and its size corresponds to a modern full-frame sensor.

The most common film types are:

- Black-and-white or color negative film
- Reversal film (slide film)

All types were available in various speeds, which correspond to today's ISO values of 100, 200, and 400. Anything else was already a very expensive specialty film.

Most photographers took their films to a drugstore or a specialized shop to have them developed. This used to be expensive back then, but not as expensive as today because the production volumes were much larger. It is cheaper to develop and print them yourself if you own the necessary equipment.



Fig. 8.4: 35 mm and pocket films from the 1980s to the present day

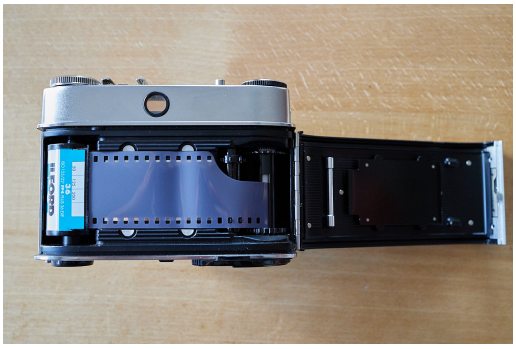


Fig. 8.5: Loading the film into the Retinette 1A.

! Films must not be exposed to light! Never pull the film out of the canister any further than necessary for loading. After loading the film, do not open the camera again until the film has been rewound back into the canister.

8.3 Aperture, Shutter Speed, and ISO

In analog photography, controlling the aperture and shutter speed works exactly the same way as on a digital camera (sections Aperture and Shutter Speed). However, the ISO value is fixed by the film and cannot be changed.

! For cameras with a light meter, the ISO value of the film must be set on the camera so that the exposure metering can determine the correct combination of aperture and shutter speed!

8.4 Focusing

A distinction is made between manual focusing by turning the focus ring on the lens and automatic focusing. Autofocus was only introduced to analog cameras in the 1980s.

With many old analog cameras, you can only estimate the distance. For orientation, there are distance markings on the focus ring and sometimes additional small pictograms. High-quality cameras have a split-image rangefinder.

Rangefinder cameras, whether analog or digital, usually have more advanced focusing aids, such as split-image rangefinders.



Fig. 8.6: The focusing aid on the Retinette 1A

8.5 Film Development

Tiger Graphics only has experience with developing and printing black-and-white negative films. Therefore, only this process is described here. The description only provides a first impression of the necessary steps.

In some drugstores, you can still drop off films for development today.

There are tons of guides for film development on the internet. Every author has made their own experiences, and accordingly, every procedure is slightly different.

Quite a bit of equipment is needed for film development. First and foremost is a darkroom—a totally dark room where even door locks and gaps must be light-tight. Alternatively, there are film changing bags that are absolutely light-tight.

8.5.1 Required Equipment

- Darkroom or film changing bag
- Exposed film
- Developing tank with a reel, onto which the film must be loaded for development
- Film developer and film fixer
- Distilled water or wetting agent or dish soap
- Containers for mixing the developer and the fixer. Warning: never mix the two together. Not even a single drop!
- Measuring cup
- Stirring rod
- Liquid thermometer
- Timer (e.g., on a smartphone)

- Bottles for storing and disposing of photo chemicals
- Pliers or opener to open the film cartridge
- Scissors to trim the corners of the film and to cut the film from the spool
- Temperature-controlled tap water
- Clips for hanging the films



Fig. 8.7: The equipment for film development



Fig. 8.8: The parts of the developing tank



Fig. 8.9: The reel

Use scissors with blunt ends to avoid injuries in the dark.

8.5.2 Preparation Steps

- Set up the equipment and completely darken the room if no film changing bag (Fig. 8.10) is used.
- Mix the developer and the fixer according to the manufacturer's instructions. It is important to pay close attention to the temperature specifications.

8.5.3 Steps That Must Be Done in the Dark

- Opening the film cartridge. If the film disappeared completely into the canister during rewinding, the canister must be opened in total darkness. To do this, the cap of the canister must be removed either with your thumb or with pliers. Then the film can be removed.
- Trimming the film corners to make threading easier (see Fig. 8.11 and 8.12).
- Loading the film onto the reel. To do this, the film must now be drawn bit by bit into the spiral reel. This works differently depending on the type of tank. It is best to watch a video from the manufacturer for this. Some reels have a small red stop brake. This must be opened before loading (see image) and pushed back into the reel after loading. Since you cannot see in the dark whether the film is sitting correctly in the reel, there is a notch where you can feel if the film was guided in properly. Correct loading is absolutely necessary, otherwise the photo chemicals cannot coat the film in all places.
- Finally, the film must be cut at its end. So always remember to bring the scissors into the changing bag.

- Inserting the center column and placing the reel into the developing tank. The column prevents the reel from wobbling inside the tank and ensures that the tank is light-tight when you pour in the chemicals.
- Close the tank tightly before bringing it out into the light.



Fig. 8.10: Working with a film changing bag

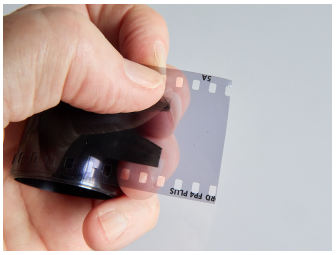


Fig. 8.11: In the dark: Untrimmed film edges

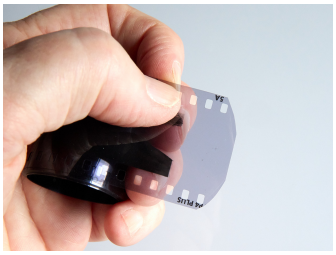


Fig. 8.12: In the dark: Trimmed film edges

Practice the entire procedure with an old, ruined film first.

Pro Tip

If you rewind the film very slowly inside the camera, you can usually hear when it slips off the spool spindle. Then turn it just a tiny bit further. This way you can prevent it from disappearing completely into the canister. You can then easily trim the edges in the light and don't have to break open the film canister in the dark, but can simply pull the film out of the canister in the dark. But be careful, do not stop rewinding too early.
Such film canisters should definitely be marked as exposed so that the film is not accidentally used/exposed a second time!



Fig. 8.13: In the dark: Inserting the film. Shown here as an example in the light using an already developed film.

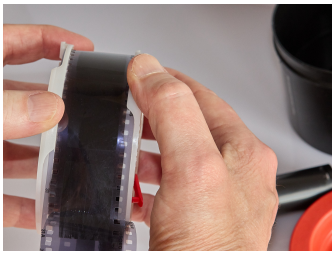


Fig. 8.14: In the dark: Winding the film.



Fig. 8.15: In the dark: Checking if the film was loaded correctly.

Special feature of some reels

Some developing tanks have a small brake so that the film cannot move out of the reel during development. This must be opened before loading the film.

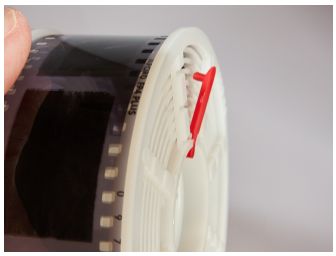


Fig. 8.16: Brake open.

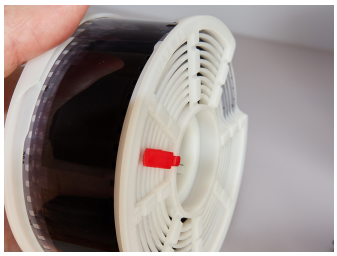


Fig. 8.17: Brake closed.

8.5.4 Film Development

The duration of development depends on the film and the photo chemicals. You need to look this up from the manufacturer or on the instruction sheet for the developer and fixer. It is crucial to strictly adhere to the temperature and time specifications. The developing tanks have a light trap, so pouring in the photo chemicals can be done in the light.

There are different ways to develop. After pouring in the developer:

- Leave the tank standing still,
- Agitate/invert the tank (this is what we do at Tiger Graphics)
- Roll the tank

If you leave the tank standing or invert it according to the instructions, you must ensure that air bubbles can escape from between the film layers. To do this, tap the tank moderately hard on the surface. After development is complete, quickly pour the developer into a suitable bottle.



Fig. 8.18: Pouring in the developer. Maintain the correct development time.



Fig. 8.19: Inverting the tank. Don't forget to put on the second cap beforehand.



Fig. 8.20: After development, pour the developer into a suitable bottle.

❗ Never pour photo chemicals down the drain!

❗ Do not use beverage bottles. Risk of accidental ingestion!

8.5.5 Washing

After development, the film is washed with tap water of the same temperature. To do this, fill the developing tank with the appropriate amount of water, move it around a bit, and pour it out again.

8.5.6 Fixing

Fixing works similarly to developing, according to the manufacturer's instructions.

❗ Do not pour used fixer into the same bottle as used developer.

❗ Take used photo chemicals, carefully labeled, to a hazardous waste disposal site!

8.5.7 Final Wash

The final wash can already be done in the light, but should also be carried out with water of the same temperature. We already take the film out of the reel for this. You open the reel by twisting the two halves in opposite directions past a small resistance. Make sure not to touch the film if possible! Lint and dust must be avoided at all costs.

💡 Prepare the hanging setup for drying before opening the tank.

8.5.8 Drying

For drying, it is best to hang the film in the shower. There are special hooks for this, but simple clothespins will also do. You should also weigh down the bottom of the film with clips so that it hangs straight. The hanging setup for a 35 mm film with 36 exposures needs to be about 2 meters high! Once the film is hanging, it is rinsed or wetted one last time. Special wetting agents are available for this. However, distilled water works too, or if your tap water is not too hard (hard water contains high amounts of calcium and magnesium) simply water with a tiny bit of dish soap (without hand care additives). We simply wet our fingers with the soapy water and carefully pull the film through our fingers from top to bottom.

Afterward, the film must remain hanging until it is completely dry. It is best to wait until the next day. Ensure that it does not catch any dust. The film can then be cut into the usual strips of 5 frames or rolled up in one piece.



Fig. 8.21: Film hung up to dry in the shower.



Fig. 8.22: The film is weighted down at the bottom so that it hangs straight.

To avoid lint on the film, wear microfiber gloves.

8.6 Processing the Negatives

8.6.1 Scanning

In order to scan 35 mm negatives with a scanner, it must be suitable for scanning negatives and should have a resolution of 9600 dpi.

More Information

Such scanners feature what is called a transparency unit. This is built into the lid of the scanner and is covered during normal operation. Please consult the scanner's manual to find out how to remove the cover.

For scanning negatives, the scanner must be set up for transparency mode. To position the negatives correctly, there are frames that securely hold the film strips on one hand and cover the area around the film strip on the other. These frames are specialty parts unique to each scanner.



Fig. 8.23: Scanner with an open lid and two film strips in the holder

The same applies to scanning: Avoid lint and dust, or carefully remove it from the negatives

Pro Tip: Scanner Software

Sometimes existing or inherited scanners are so old that their drivers no longer run on current operating systems. In almost all such cases, the scanner software VueScan, which we also use, helps and is highly recommended. The two developers (father and son) have made it their mission to keep as many scanner types as possible (now over 8,000 different models) "alive" across all operating systems.

8.6.2 Camera Scanning

Digitizing negatives by photographing them works well if you have a very homogeneous light source and a macro lens at your disposal. Alternatively, it also works with a bellows unit. The aperture should be closed down quite a bit to get sharp edges and to compensate for any flatness imperfections in the negative.



Fig. 8.24: Digitizing with an old lens and an old bellows unit



Fig. 8.25: Photographed negative



Fig. 8.26: Processed image

8.6.3 Printing (Enlarging)

In some drugstores, you can still drop off negatives for printing today.

The "supreme discipline" is printing the negatives onto photographic paper. Printing takes place in the darkroom. This is a room that, when processing black-and-white paper, may only be illuminated with a red safelight. A lot of equipment is required for this again:

- Darkroom
- Enlarger including a lens
- Timer for exact exposure control, possibly with an exposure meter
- Possibly an enlarging easel or masking frame
- Photo paper of the appropriate size (depends on the enlarger, the lens, and the desired size of the image)
- Red safelight darkroom lamp or red safelight bulb
- At least 3, better 4 photo trays (different colors) that the photo paper fits into flat
- 3 print tongs (ideally 2 different colors)
- Photo paper
- Paper developer matching the photo paper
- Fixer for fixing photo paper
- Stop bath or diluted pure vinegar (without herbs)
- Measuring cup
- Stirring rod
- Containers for mixing the photo chemicals. Warning: never let developer and fixer come into contact.
- Bottles for storing and disposing of photo chemicals
- Thermometer
- Scissors
- Black cardboard
- Possibly a magnifying loupe
- Possibly a paper squeegee

An ideal darkroom has enough space for a table with a chair for the enlarger, another surface for the trays, and a water connection. The latter is not strictly necessary, but you do need running water within reach.

There are different types of photo paper. RC (Resin-Coated) papers are suitable for beginners. These have a polyethylene base layer. This has the advantage that the base does not soak up as much liquid as fiber-based (Baryta) papers. Washing and drying the papers is faster, and the photos remain flat without any extra effort.

8.6.3.1 Setup in the Light

The enlarger is assembled according to the instructions. If available, the masking frame/easel is placed underneath. The timer is connected according to the manual.

The red safelight lamp is positioned so that you can still see the enlarger and the trays. However, it should be turn-offable from your seating position. The box with the photo paper is placed within arm's reach.

Three trays for developer, stop bath, and fixer should always be arranged in that exact order. A fourth tray with tap water will then hold the fixed image.

Developer, stop bath, and fixer are mixed according to the manufacturer's guidelines. The amount in the trays must be calculated so that a sheet of photo paper is completely submerged. The stop bath can be replaced by tap water with a splash of vinegar.

RC papers are best suited for beginners.

Film fixer is usually also suitable for paper.



Fig. 8.27: Equipment for printing.

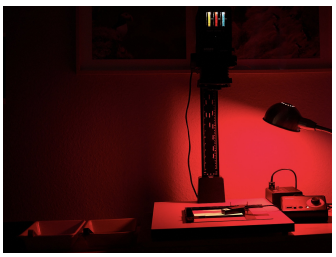


Fig. 8.28: Setup under red safelight.



Fig. 8.29: Focusing, metering, and exposing the photo paper.

8.6.3.2 Under Red Safelight

8.6.3.2.1 Exposing the Photo Paper

If you work without an exposure meter, you can do everything under the red safelight. First, the masking frame is positioned so that the negative to be exposed is projected to fill the format. It is best to sacrifice a sheet of photo paper (only take it out of the box under red safelight!) as a test sheet, so that the sharpness is actually determined on the photo paper level and not on the base board. If you don't have a masking frame, you can mark the position of the paper with adhesive tape. To see everything clearly, open the aperture on the enlarger fully. Now focus the enlarger and check if the image still fills the format. If not, readjust the height of the enlarger head and the focus until it is correct. You can double-check

the result with a magnifying loupe. Now close down the aperture by one or two f-stops so that imperfections in the flatness of the film and paper do not lead to unsharpness. If you work without a masking frame, it is better to close it down even further, as the photo paper is usually not perfectly flat. Now turn off the enlarger.

To find out the correct exposure time, you first have to estimate it. The right time depends on the negative, the set aperture on the enlarger, the photo paper, the developer, and its temperature.

Over time, you get a feeling for it. Nevertheless, it is advisable to always make a test strip beforehand. To do this, take a sheet of photo paper out of the box under red safelight and cut it into strips about 3 cm wide. Except for one strip, put all strips back into the box and close the box completely again. Then set the shortest assumed exposure time, place the test strip onto the area where the image is projected, cover about two-thirds of the test strip with black cardboard, and expose. Now pull the cardboard a bit further back so that an additional third is exposed, and expose again for the same amount of time. Finally, the cardboard is removed completely and the last third is exposed. You have to be careful that the test strip does not shift. In the end, you have a test strip where the first section was exposed three times as long as the third section. You now develop this strip (see Section 8.6.3.2.2). When the strip is finished, evaluate the result in daylight, choose the exposure time that looks correct, and set the timer to this time. Now take a full sheet of photo paper out of the box, close the box completely again, place the photo paper in the correct position, and expose it. The exposed photo paper should be placed into the developer immediately. Do not let any developer get onto your fingers.



Fig. 8.30: Test strip with 3 different exposure times



Fig. 8.31: The printed image using the middle exposure time

8.6.3.2.2 Paper Development

Agitate the photo paper in the developer by gently rocking the tray. Ensure that the entire paper is coated by the developer. The image appears after about 1 minute. The development is complete after the time specified by the manufacturer.

At the end of the development time, grab the photo paper with the tongs and place it into the stop bath. Never submerge these developer tongs into the stop bath!



Fig. 8.32: Exposed photo paper in the developer. Next to it on the left is the stop bath, and on the far left is the tray with the fixer.

8.6.3.2.3 Stop Bath

As the name suggests, the stop bath abruptly stops the development process. Furthermore, the stop bath "protects" the fixer from being contaminated with developer. The stopping process can be kept quite short (about 10 seconds). After that, grab the paper with the stop bath tongs and place it into the fixer.

8.6.3.2.4 Paper Fixing

Agitate the photo paper in the fixer by gently moving the tray. Ensure that the entire paper is coated by the fixer. Fixing is complete after the time specified by the manufacturer. Fixing can take up to half an hour and must not be shortened. Otherwise, an image can still darken even after years. Place the fixed image into a tray with water. This tray can now be carried out into the light to wash the photo.

8.6.3.3 and back in the Light

8.6.3.3.1 Washing

Washing is best done under running water that has the same temperature as the photo chemicals. To save water, you can also place the image into fresh water several times. The exact procedure depends on the paper. RC paper absorbs little liquid and requires a shorter wash than Baryta paper. If you wash the paper too briefly, stains can appear even years later. We usually rinsed RC paper carefully under running water, then let it sit in water for about fifteen minutes, and then rinsed it again. It is safer to wash the papers under continuously running water for 30 minutes. To do this, you can drill a small overflow hole into a photo tray, place

it in the sink, and let the tap run very slowly.

8.6.3.3.2 Drying

Once the image is completely washed, it is dried. RC paper can simply air dry. To get rid of excess water, the paper can be carefully wiped down with a rubber squeegee. You can also hang the image up with clothespins, as often shown in old spy movies. However, this can lead to pressure marks; so it is better to let it dry flat on an old towel.



Fig. 8.33: A 13x18 glossy photo digitized by photographing it with a smartphone. Despite special software, reflections are visible in the upper image area.

! Never open the box with the photo paper in the light!

! Only use each print tongs in its respective tray!

! The red safelight lamp must be a special lamp suitable for the darkroom. A red party light does not work and will ruin the photo paper!

! Never pour photo chemicals down the drain!

! Do not use beverage bottles. Risk of accidental ingestion!

Further Information

9 Presenting pictures

Even though nowadays most images are viewed on the smartphone, the effect is completely different when photographs are presented larger or even printed. The easiest and cheapest way is to present the images on a website. However, the effect of a printed image is quite another. Photo services do a very good job and also create pictures with frame and passepartout. Especially the effect is when you present many pictures that have a content context in the same style. This can be done on a pinboard in your own room but also in the context of an exhibition in a gallery.

At every presentation - from the birthday card for the girlfriend to the exhibition in a gallery - one should consider whether the picture or the pictures work for the viewers. You yourself experienced the entire context, the light, the smells, your own mood, the light. The viewer only sees the picture. Some pictures are great memories, but only work because you were there during the recording. Other images stand for themselves and convey their own statement.



Fig. 9.1: Matted and wood-framed photo on the wall



Fig. 9.2: "Polaroid-like pictures on felt"



Fig. 9.3: Collage of photos of an arts market

10 Printing

Printing images yourself is of course also possible. A good quality is usually only achieved if you print on photopaper. A lot of ink is needed, so that a print in DIN A4 can cost a few euros. Often misprints also occur. The most common mistakes are

- Confusion of portrait and landscape format
- Colour casts
- Cut edges

If you want to print on expensive photographic paper, it is recommended to make a test print on cheaper paper with less ink. How this works is different for each printer.

10.0.1 Color management

A challenge when printing is to get the colors exactly as on the monitor. Ultimately, this is possible for various reasons only conditionally with "home remedies".



Fig. 10.1: Test prints on different papers with different color profiles. The copper-colored car is a challenge. Also, the background rarely appears as on the monitor.

11 Legal Issues

As a photographer, you are confronted with many legal questions without always being directly aware of it.
This section compiles the most important aspects but can by no means be exhaustive. Furthermore, we at Tiger Graphics can only outline what the individual topics are about, but we cannot provide legally binding phrasing or information.



Fig. 11.1: This image is available on the internet under the Pixabay Content License. Tiger Graphics thanks MasterTux for it.

The most important aspects of photography law when taking pictures are:

- Copyright, which states that the image you capture belongs to you and you have the right to determine its use.
- The right to one's own image, which states that you may only publish or distribute photos of individuals if they have consented. This does not apply if individuals were captured incidentally, for example in a landscape shot or at a concert. It also does not apply to figures of contemporary history, such as politicians.
- Freedom of panorama, which states that you may photograph buildings and permanent works, such as monuments, from public streets and pathways, and publish those images, provided you do not use aids like ladders or drones.
- Property and house rights, which state that owners of private buildings, businesses, or museums can determine whether and with what equipment photography is permitted there. For example, a concert organizer can ban the use of (certain) cameras and enforce such a ban.

When reading these aspects, you quickly realize that there are many gray areas regarding what is allowed and what is not:

- Are you just not allowed to publish photos, or do individuals have to explicitly consent to being photographed? Is a friendly smile sufficient, or do you need written consent? Does such consent include the editing of the image and its publication?
- When is a person considered merely "incidental" and when not?
- Who qualifies as a figure of contemporary history and who does not?

To clarify all these questions, lawyers are required, and the judiciary is well occupied with disputes over precisely these points. And to make it even more complicated: different laws apply in different countries. What is permitted here in Germany might not be allowed in other countries at all. And some things that are permitted in other countries (e.g., USA or UK) are completely out of the question in the EU and Germany.

In addition, there are many legal questions regarding the use of external images, such as the image at the top of this section. If you want to display images by other photographers as part of an exhibition or on a website, you need permission to use them. This also applies to illustrations like the ones found in this photography guide. The image in this section is subject to a license that explicitly permits its use; the illustrations in this photography guide were created by Tiger Graphics using TikZ under LaTeX. But even here, legal questions arise:

- Is a graphic that you redraw 1:1 from a graphic you saw considered your own work or not?
- Am I allowed to publish my own images elsewhere if I have, for example, sold them to a publisher?

! If you are unsure whether it is okay to capture or publish a specific image, it is better to ask or, in case of doubt, refrain from doing it. There are a great many specialized lawyers who make their living by issuing warning letters for unauthorized use or publication of images!

i Further Information regarding different countries

12 About us



Fig. 12.1: Bear



Fig. 12.2: Tiger

The Bear probably stood in a darkroom for the first time at the age of 4. His first shots were taken at the age of 8 with a pocket camera. Later, he took photos with his dad's Agfa Retinette I A, and then with the smallest SLR camera in the world, the Pentax A110 – both of which still work today. The Bear learned how to take photos with a Minolta SLR camera from the school's photography club and later with his own Minolta 7000. At the age of 15, black-and-white negative films were developed and printed in the photography club and in his own darkroom in the basement.

The Tiger started out with a Praktica.

The first digital camera was the Agfa 6400, followed by the Canon Ixus. Since then, a lot of cameras have been tried and discarded. In the end, the Bear stuck with Canon and the Tiger with Fujifilm.

For more than 15 years, we have basically shot digital images in RAW and further processed them using Capture One. Every now and then, the darkroom and all the old treasures are reactivated.

We appreciate the slowness of analog photography, but nowadays we are reluctant to do without the advantages of digital technology. The result is a workflow between worlds: whenever possible, we use autofocus – but usually with a specific, manually set focus point. Our images are taken almost exclusively as single shots and are later carefully post-processed. Only in wildlife photography does the Bear use eye-detection autofocus and occasionally takes burst shots.

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