Digital Infrared Photography And Mirrorless Cameras

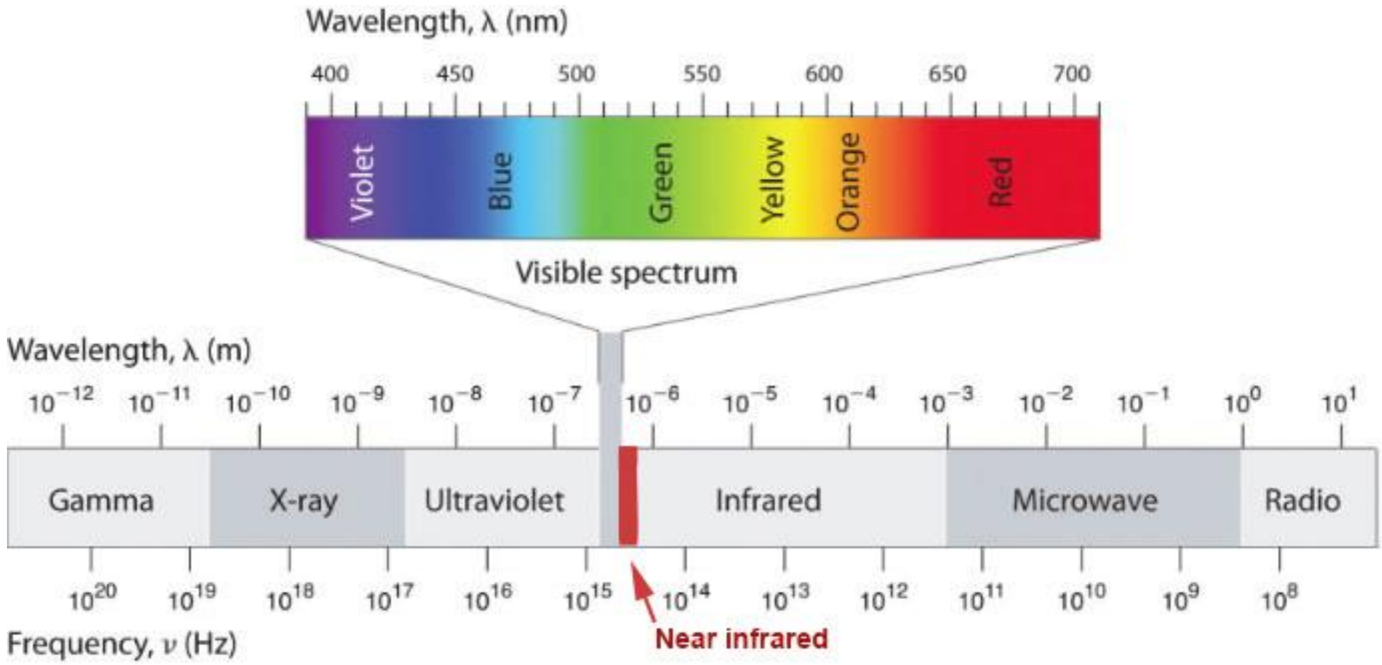
by Steve Zimic

A Primer on Infrared Light

Much of photography these days is about making images that portray subjects differently than the way we see them with our eyes. A heavily processed High Dynamic Range image is a prime example. Another is astrophotography, which allows us to see images of distant galaxies in glorious colors that the human eye could never see. Forensic photographers photograph crime scenes and artwork using infrared and ultraviolet light to reveal hidden details. All of this gives new meaning to the expression "seeing things in a different light".

Infrared photography is perhaps the easiest and most dramatic of those mentioned above. The two images below show how a normal scene is transformed into something quite unique when photographed primarily with Infrared (IR) light. Foliage becomes much brighter while the water, sky and structure become considerably darker.

So exactly what's going on that creates this unusual effect? Let's start off with the prefix 'infra' which means 'below'. The color red is at the very bottom edge of the visible spectrum of light, therefore infrared light is below or not visible, to us humans at least. Looking at the chart below, you can see that the infrared range of light is huge compared to the visible spectrum, but ordinary digital cameras can only see a small portion of that range, appropriately named 'near infrared' implying it's near the visible red light. The goal of infrared photography is to capture an image that's comprised primarily of that near infrared light. In order to do that we need to understand why it can be rather difficult to do with your current digital camera.



The image sensor in your digital camera has a special glass filter in front of it which serves several purposes. Besides protecting the image sensor, this filter has two types of coatings one of which prevents moire (anti-aliasing) and the other blocks infrared light. Both of these coatings are designed to reduce undesirable artifacts in normal color imaging. With regard to the IR blocking part of the filter, the amount of infrared light blocked varies significantly between manufacturers. As a result of this variation, some cameras are capable of wonderful infrared photography with the simple addition of an infrared pass filter on the lens, while others give poor or unusable results. Even cameras with the least amount of IR blocking, reduce a significant amount of infrared light, so putting an infrared pass filter on the camera will cause a rather intense battle between the filter on the lens and the filter in front of the sensor. As a result, the required exposure times will be rather long, forcing you to either use a tripod or shoot at an ISO of at least 1600 for hand held shots.

If you're serious about IR photography, the best advice is to dedicate a camera to shoot only in IR light by having it converted. The conversion process removes the standard filter in front of the sensor and replaces it with an IR pass filter. Since there's no longer a battle between two opposing filters, exposure times are typically 1/250 sec at F8 and ISO 100.

Infrared with a DSLR

Unconverted DSLR's

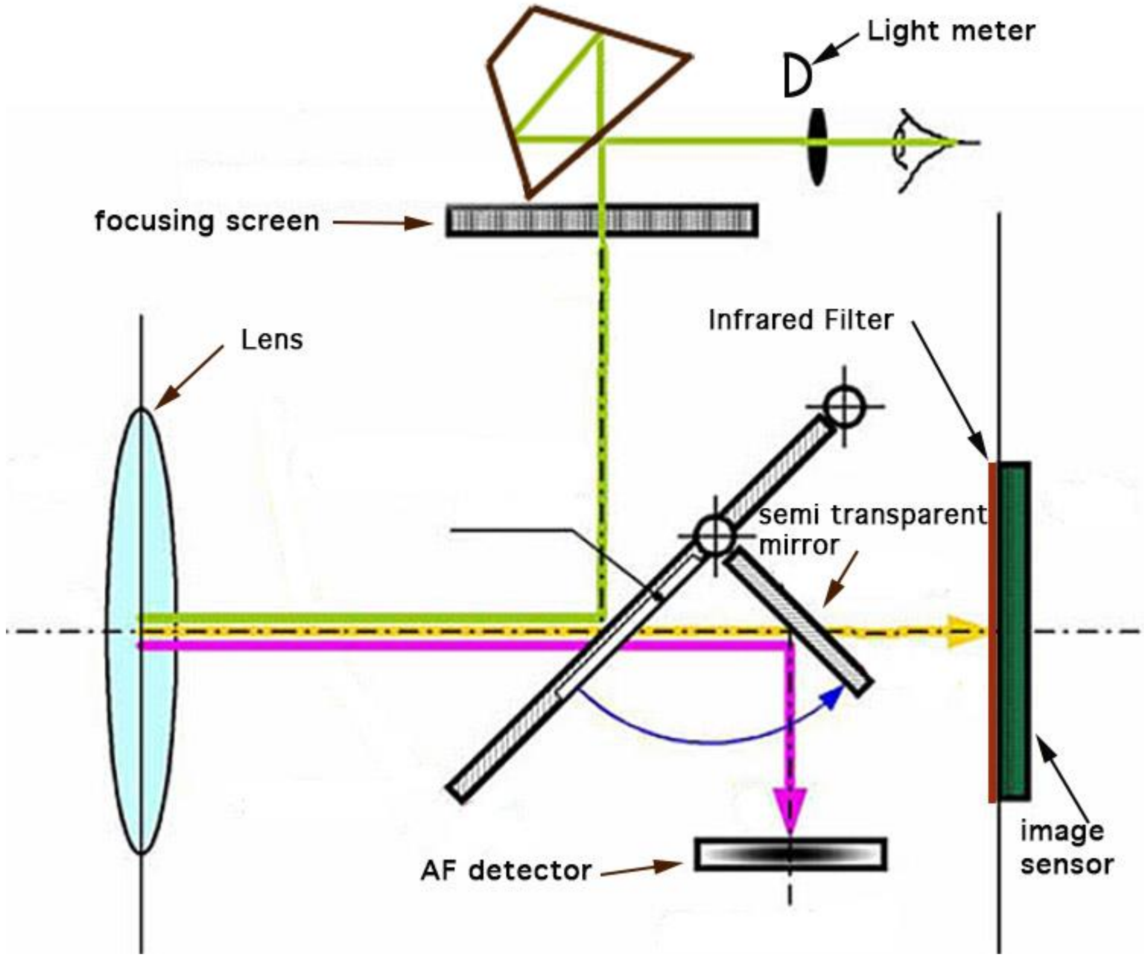
From my experience, most of the late model DSLRs from Canon and Nikon are not good choices for infrared photography unless converted to IR. There are some older models such as the Nikon D100, D70 and D40 that have relatively weak IR blocking filters and can produce fine images without being converted to IR. To determine if your current camera is IR capable, you can either buy an IR filter and try it, or simply search the web to see if anyone has had success. The main problem with using an unconverted DSLR is that once an IR filter is placed on the lens you can't see anything through the viewfinder. IR light does focus slightly different than visible light but since the focus sensor in DSLR's don't block IR light, the focusing will be fast and accurate.

IR Converted DSLR's

When shooting with an IR converted DSLR using the viewfinder, the metering is done without regard to the IR filter in front of the sensor (see diagram below). As a result the meter measures full spectrum light which often gives the wrong exposure. This problem is overcome by shooting in manual mode and checking the exposure of the resulting image(s) in review mode. If you have a camera that meters in live view, that would be the way to shoot. It would also allow you to see the image in real time displayed in infrared.

Focusing is another issue that needs consideration. Looking at the below diagram you can see that the focusing system has no idea that an IR filter is in front of the sensor. Since IR light focuses a bit different than visible light, the camera needs to be adjusted to compensate for this difference. The conversion service will need one of your lenses to calibrate the focusing. Unfortunately calibrating the camera with one lens does not guarantee that other lenses will focus properly. From personal experience with an IR converted DSLR, I can attest to this being a big problem. However an IR converted camera with live view focusing should have no problem focusing any lens. Keep in mind though, that with the exception of a few late models cameras, live view focusing can often be slow. The other problem with live view is that in bright light it can be difficult to see the LCD screen.

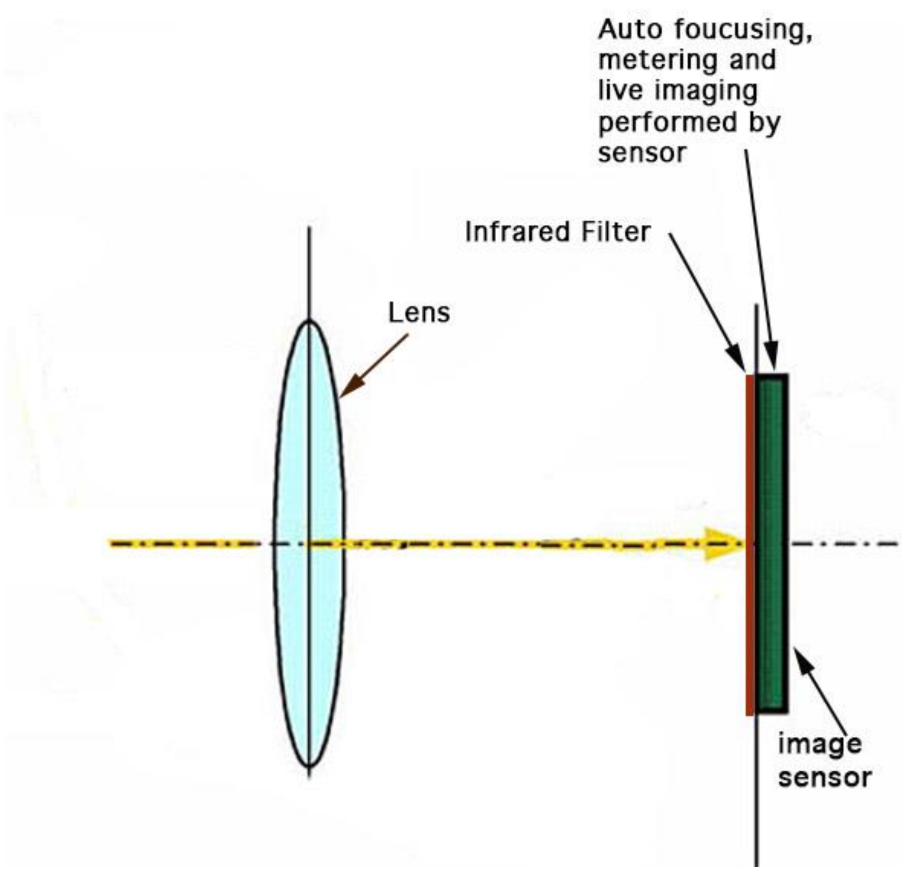
If you can live with the above issues, then a DSLR is a very good way to go. One huge advantage is that you'll probably convert a camera for which you already have an assortment of lenses.



Light meter
focusing screen
Lens
Infrared Filter
semi transparent
mirror
AF detector
image
sensor

Infrared with Mirrorless Cameras

Mirrorless cameras whether they are full frame, APSC or micro 4/3 all have the same basic design operation as shown in the diagram below. You'll immediately notice the simplicity of operation compared to the DSLR. The advantages of this system, not only for IR photography, are quite significant. For IR photography though, we can see that the infrared DSLR issues are gone. First, the focusing is always done by using the image sensor so any lens will focus correctly. Also, focusing is much more accurate, IR or not, since it's done by the image sensor where the image is recorded. Secondly, light metering is also done by the image sensor so there's no more guesswork. Perhaps the most valuable asset is that live view is always engaged whether using the LCD screen or electronic viewfinder. And since most IR photography is done in bright sunlight, having an electronic viewfinder is a hugh advantage. These advantages are true whether using an IR converted camera or a stock camera with the IR filter in front of the lens. Note that most IR conversion services will require a lens to calibrate the focus. According to Lifepixel.com (the premier IR conversion service) all micro four thirds lenses will focus perfectly with infrared light, and that has been my experience as well. They actually recommend mirco four thirds cameras as the best choice for infrared photography.



Most mirrorless cameras do seem to have relatively weak IR blocking filters from the factory, so you can actually make very nice IR images without converting the camera. However you will have significantly longer exposure times when using a screw on IR filter, i.e. 1/8sec at F4 and ISO 1600. The downside here is increased noise. Using a tripod at lower ISO settings is a

solution to the noise issue, but you may then have to contend with blur due to subject movement. One big advantage of using an unconverted camera, is that you can make two images, one IR and one in standard color and combine them in PS for some interesting effects.

Incidentally, point and shoot cameras operate the same way, although without interchangeable lenses, so they are excellent candidates for IR conversion. Ideally, choose a camera with an electronic viewfinder. The downside of course is that you're limited to the lens built into the camera.

Choosing an Infrared Filter

There are several infrared filters available, both in screw on and for having a camera converted. These filters are typically rated in nm (nanometers) which is the wavelength of light that they transmit and range from around 590nm to 850nm. A 590nm filter is a relatively weak near IR filter that will transmit a good amount of visible light, resulting in a more colorful image. The downside to this filter is that the IR light is slightly overwhelmed by the visible light so the pure infrared look is somewhat diminished. At the other end of the spectrum you have the 850nm which will yield no color at all for a pure B&W infrared. Personally, I like a filter in the 700nm range which yields some color and very strong infrared. Keep in mind that if you have a camera converted with a high color filter, you can put a stronger (850nm) filter on the lens for a more pronounced IR effect.

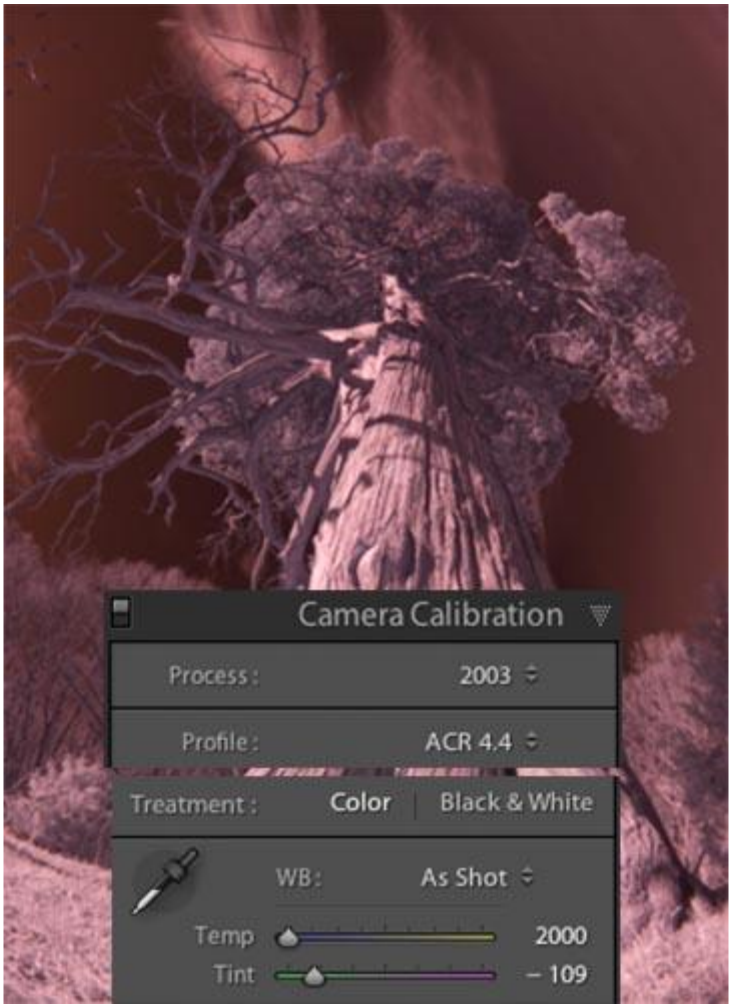
Kolarivision's website contains a wonderful chart (below) that allows you to see the difference between these filters. Kolarivision has very competitive IR conversion pricing plus they carry all of the below filters in screw in versions. Which filter you chose is strictly a matter of personal taste.

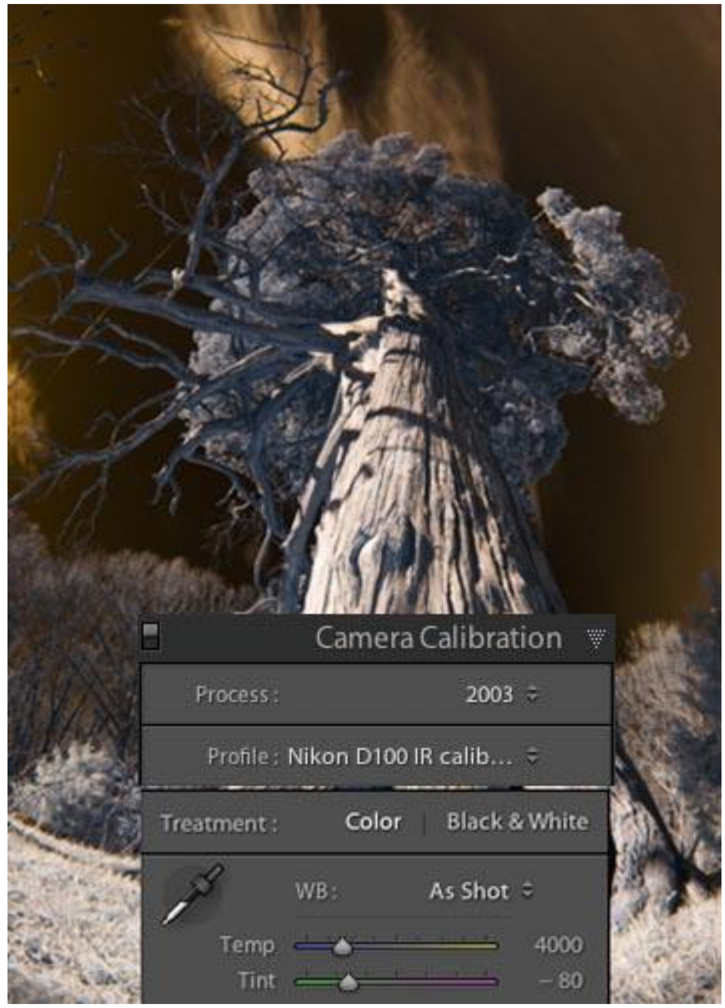
	Direct from camera (with custom WB)	Channel Swap R/B	Black & White	
590nm filter				
665nm filter				
720 nm filter				
850nm filter		N/A		

Processing Infrared Images

Shooting IR images in color requires knowing how to set a custom white balance in your camera, otherwise your image will be pure red as shown below. Setting a custom WB is not necessary if you only want pure B&W images , although you'll probably get a better result by doing so anyway. Perform the custom WB in bright sunlight using green foliage in order to render your greens neutral. If the camera can't handle that (some don't) you can use a white sheet of paper instead which is not optimal but will get you in the ballpark.
To start out you should set the camera to shoot in JPEG mode. You might also want to visit your camera's settings to increase the contrast as IR images can sometimes be a bit flat. The advantage of shooting JPEG is that what you see on your camera screen is what you'll get when you upload your images.

Of course shooting in RAW will yield better quality and more latitude for adjustments, but RAW IR images present some interesting problems when using Adobe products. The problem is that on many cameras, Adobe's camera raw (ACR) will not fully recognize the custom WB you set in the camera. You'll know you have this problem if the temperature slider in your RAW processing window is pegged to the left side with no room to move in order to remove the red cast (see image on the left below). If you must use Photoshop, a partial solution is to bring the vibrancy setting way down and increase the saturation a bit. A better solution is use software from Canon, Nikon, Olympus, DXO Optics, Bibble or Capture 1 software to process the raw images, none of which have the problem of recognizing the camera's extreme WB setting. Just save the raw files as a TIFF file and then go to Photoshop or Lightroom for the finishing touches. If you prefer pure B&W images none of this is necessary and you can convert the red image to B&W in either ACR, Photoshop or Lightroom.





You can get the WB slider back to a controlable level in ACR by creating a custom camera profile. First you'll need to convert a single IR raw file to the Adobe DNG raw format. This can be easily done via export in Lightroom or from lower left corner of the ACR window using the "save as" command. You'll also need the 'DNG Profile Editor' available free for both Mac and Windows users. Next, navigate to, and open the DNG file from the 'DNG Profile Editor' application. Click on the 'color matrices' tab and set the white balance temperature slider to –50 as a start. Save the recipe and then EXPORT the profile to the default location chosen by the 'DNG Profile Editor'. Adobe's instructions for the DNG profile editor are available as a PDF file. Go to Tutorial #4 for their recommendation using infrared cameras. You will need to restart Photshop or Lightroom for this new profile to be available. As long as the profile is in the correct location, the next time you open the camera RAW image in Photoshop or Lightroom, you will see the profile you created in the camera calibration panel's pull down window. The profile will only be available for the camera from which it was created, so don't expect it to be visible when viewing files from other cameras. The above right photo shows the Lightroom calibration panel. To access the calibration panel in ACR, click the tab which shows a small image of a camera and select it from the pull down list. You do not have to convert your images to the DNG format to use the new profile. Once the new profile is chosen you will see that the WB slider now has enough room for you to color correct the image. If and only if you're using an IR converted camera, save the settings as the default raw develop settings. That way your images will look correct upon initial

import from the camera. Alternately, or for cameras that are not converted to IR, you can save the settings as a preset so they're readily available when you shoot an IR image.

A simpler method would be export or save the image as a 16 bit TIFF file and perform a WB on that image. The resulting 16 bit file should provide similar color depth to the raw file with regard to making further adjustments. The problem with this method is that you'll double the number of files unless you delete the RAW versions.

Mirrorless Cameras beyond infrared

Advantages of Micro Four Thirds over DSLR cameras
(Taken from Wikipedia)

•Smaller and lighter

•The shorter flange focal distance means that most manual lenses can be adapted for use, though C-mount lenses have a slightly shorter flange focal distance and are trickier to adapt.

•The shorter flange focal distance may also allow for smaller, lighter and lower cost lenses. This is especially true for wide angle lenses. Compare the Olympus 4/3 7-14mm f/4 zoom (approximately $1800), with the lumix MICRO 4/3 7-14mm F/4 lens. (Approximately $800)

•Forward or back focus does not occur with contrast focus like it can when using DSLR phase focus, and likewise each lens does not have to be individually calibrated to each camera, which can be required for DSLRs to have accurate focus.

•The absence of a mirror eliminates the need for an additional precision assembly, along with its "mirror slap" noise and resultant camera vibration/movement.

•Viewfinders can be used when filming videos.

•In continuous mode (video takes or sequential shots) the smaller sensor can be cooled better to avoid the increase of image noise.

•The autofocus performance is the same for stills and videos, so the speed is much faster than conventional DSLRs in video mode.

•Because of the reduced sensor-flange distance, the sensor is easier to clean than with a DSLR, which also have delicate mirror mechanisms attached.

•The smaller sensor size may allow for smaller and lighter telephoto-lens equivalents.

•The smaller flange distance, which is 20 mm, allows for easier manufacturing of wide, fast, and telephoto lenses, as well as the option to adapt nearly any photographic and cine lens ever made.

•Smaller and lighter cameras and lenses allow discretion and portability.

•The smaller sensor size gives deeper depth-of-field for the same equivalent field of view and aperture. This can be desirable in some situations, such as landscape and macro shooting.

Advantages of the electronic viewfinder

Though many DSLRs also have "live view" functionality, these function relatively poorly compared to a Micro Four Thirds electronic viewfinder (EVF), which has the following advantages:

•Real-time preview of exposure, white balance, and tone.

•Can show a low-light scene brighter than it is.

•The viewfinder can zoom into one's preview, which a mirror-based viewfinder cannot do. This is why using manual focus through a zoomed EVF will get much a more precise result than using manual focus through a mirror.

•The viewfinder displays how the sensor will see one's potential picture, rather than an optical view, which may differ.

•The view can appear larger than some optical viewfinders, which often have a tunnel-like view.

•Not reliant on a moving mirror and shutter, which otherwise adds noise, weight, design complexity, and cost.

•No weight or size penalty for better quality of materials and design. Optical viewfinder quality varies greatly across all DSLRs.

Disadvantages of Micro Four Thirds compared with DSLRs

•The sensor is 40% smaller in area (2.0x crop factor) than APS-C (1.5x crop factor, or 1.6x for Canon-APS-C) sized sensors and 75% smaller (i.e. a quarter of the area) than a full frame sensor (1.0x crop factor) (35 mm equivalent), which can mean lower image quality when all other variables are the same. This might include poorer color transitions and more noise at equivalent ISO settings, especially in low light, when compared with the larger sensors.

•Contrast detect autofocus systems such as those used in Micro Four Thirds cameras were initially slower than the phase detect systems used in advanced DSLRs. This gap was eliminated with the Olympus OM-D E-M5 when shooting static subjects.

•The tracking of subjects moving towards or away from the camera is also difficult with contrast detection, however, this issue was eliminated in 2013 with the introduction of the Olympus OM-D E-M1's hybrid phase detection auto-focus system.

•Due to the absence of a mirror and prism mechanism, there is no ability to use a through-

the-lens optical viewfinder. A through-the-lens electronic viewfinder, an attachable not-through-the-lens optical viewfinder (similar to a rangefinder or TLR), or the universally supplied LCD screen must be used instead.

•Theoretically, changing lenses can expose the sensor to more dust in a "mirrorless" camera design, compared to DSLRs that have both a mirror and a closed shutter protecting the sensor. Mirrorless cameras have dust-removal systems which attempt to minimize the impact of this problem.

•A larger crop factor (2x multiplier versus APS-C's 1.5x) means greater depth-of-field for the same equivalent field of view and f/stop when compared with APS-C and especially full frame cameras. This can be a disadvantage when a photographer wants to blur a background, such as when shooting portraits. This problem is somewhat mitigated by the availability of relatively inexpensive, fast, high quality prime lenses, preferred also for their compact size and light weight.

•Some Micro Four Thirds cameras are smaller than DSLRs or larger body cameras, and this can result in relatively poor ergonomics. This applies especially to handling, the depth of the right-hand grip, and the size and placement of buttons and dials.

•Micro Four Thirds lenses cannot be used on 35mm equivalent and APS-C cameras due to lens vignetting.