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Camera Sensors in Forensic Photography – Does Bigger Means Better?

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ABSTRACT: If we talk about digital photography, we have to replace *photographic films* with *camera sensors*, the piece of hardware inside the camera that captures light and converts it into signals, helping us get the final product - the image. Like the first ones mentioned, digital camera sensors are devided, depending on their size, into a few categories, including, in ascending order, Micro Four Thirds sensors, APS-C sensors, full-frame sensors, and medium format sensors. Through this paper, I set out to briefly present the advantages and disadvantages of using these types of sensors in forensic photography and to provide a pertinent answer to the question: "Does bigger means better?".

KEYWORDS: forensic, photography, digital, camera, sensors, size

Introduction

As Rastislav Lukac mentioned in the preface to his paper, thanks to the hardware and software inventions of the last decades that made possible to convert analog information into digital form, digital devices have replaced their analog predecessors. Consumers of digital products have lost interest in analogue cameras and have switched to digital cameras, leading manufacturers to innovate. This is due to the many advantages that taking and developing photos using chemical and mechanical processes cannot offer to users of digital cameras (Lukac 2009, 1). This switch has taken place in all branches of photography, even in forensic photography, where execution time, accuracy and technique are three fundamental factors (Anghel 2021, 84-86).

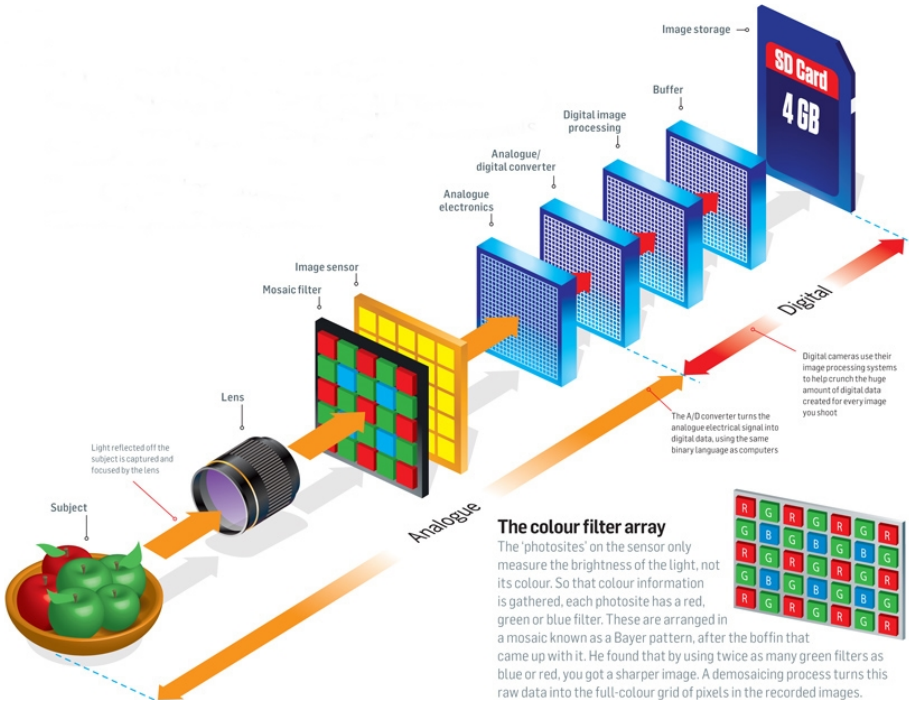


Figure 1. Converting Light Into Image
Source: www.digitalcameraworld.com

The previous figure summarizes the light-image path. The photo lens, looking like cylindrical object, made of several optical elements, called composition lenses, is attached to the camera to allow light to pass through and form an image (Bercheșan 2002, 120). Without it, the camera could not not be used. A refractive lens brings a clear image to the camera's sensor. The sensors transform the image into an electrical signal which, in turn, is transformed into a digital signal, through which the information is stored on a storage format.

Camera sensors sizes

As I mentioned before, depending on their size, camera sensors are devided into a few categories, including Micro Four Thirds sensors, APS-C sensors, full-frame sensors and medium format sensors.

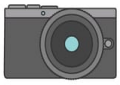
	MEDIUM FORMAT	FULL-FRAME	APS-C	MICRO 4/3	1"	1/2.55"
PICTURE						
SENSOR SIZE	53.0 X 40.20 MM	35.00 X 24.00 MM	23.6 X 15.60 MM	17.00 X 13.00 MM	12.80 X 9.60 MM	6.17 X 4.55 MM
CROP FACTOR	0.64	1	1.52	2	2.7	5.62
CAMERA						

Figure 2. Camera Sensors Sizes
Source: www.capturetheatlas.com

Medium format cameras are usually used for comercial purposes, being well-suited for portrait, studio, fashion, beauty, fine art and landscape photography. A medium format digital camera has a large sensor that is, comparing to analogue cameras, at least the size as that of 120mm size film (44x33 millimeters). Photographers who practice these types of photography use cameras with this type of sensor for the following reasons: high image quality, narrower depth of field compared to other types of sensors (smaller sensors), high resolution, which allows large images to be printed.

Full-frame cameras are the favorite of professional photographers, becoming a benchmark and being used for any branch of photography. Not as heavy and expensive as medium-format cameras and more powerful than Micro Four Thirds sensor cameras, they are the choice of anyone who wants a high level of image quality at a decent price.

Micro Four Thirds sensor cameras, although not widely used, find their applicability in the genres of photography where a wider depth of field is desired, especially landscape photography and macro photography. Portability and low price of lenses are two other benefits that potential users often consider. The last, but not the last type of sensor, the ones that can be found in smartphones, are the most used. As the years go by, the mobile phone is used for many more purposes besides phone conversations. According to online sources (Canning 2020), about 91 percent of the 1.43 trillion photos taken in 2020 were taken with a smartphone.

Advantages of a larger sensor

Firstly, as I mentioned before, larger sensors are able to produce images at a higher resolution and quality. This means that the "surface of the image" will be larger, will include more details, giving photographers the possibility to print the images or crop them in post-processing without the fear that it could compromise the quality of the final result. For example, a midrange photography, who is taken to show items of evidence and their spatial relationships, can be cropped or scaled up so that traces can be analyzed in detail.

Typical Sensor	Resolution (WxH)	Print Size & Quality		
		Excellent @ 300dpi	Good @ 200dpi	Poor @ 150dpi
3 MP	2048 x 1536	7" x 5"	10" x 8"	14" x 11"
4 MP	2464 x 1632	8" x 6"	12" x 8"	16" x 12"
6 MP	3008 x 2000	10" x 8"	15" x 10"	19" x 13 "
8 MP	3264 x 2448	12" x 8"	16" x 12"	22" x 16"
10 MP	3872 x 2592	13" x 9"	19" x 13"	26" x 17"
12 MP	4290 x 2800	15" x 10"	21" x 14"	28" x 18"
16 MP	4920 x 3264	17" x 11"	24" x 16"	32" x 22"
35mm Film (Scanned)	5380 x 3620	18" x 12"	27" x 18"	36" x 24"
36 MP	7360 x 4912	24" x 16"	36" x 24"	48" x 32"

Figure 3. Print Size Chart
Source: www.digitalphotographylive.com

Secondly, large sensors allow shooting at a wider angle, which is something to consider when shooting indoor in small spaces. Going back to *Figure 1*, we can see that each sensor has a crop factor. If we use a 35mm lens on a medium format camera, we will actually shoot at 23mm, and if we attach a 35mm lens to a camera with Micro Four Thirds sensor, we will actually shoot at 70mm. Therefore, using this information, we can conclude that in the case of long distance shooting, it is not necessary to buy, for example, an expensive 300mm lens for a full-frame camera. Instead of this, we can easily use a cheaper 200mm lens on a APS-C sensor camera (Panavision 2015, 7).

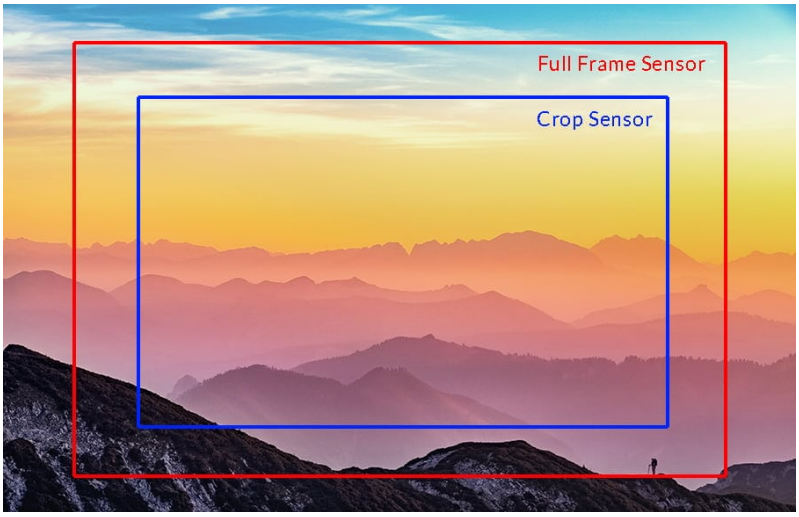


Figure 4. Crop Factor and Depending on Sensor Size
Source: www.shotkit.com

Usually, but not as a universally valid rule, larger camera sensors offer an increased dynamic range and a higher ISO performance. ISO is one of the three peaks of the exposure triangle that affects the brightness of the photo. The higher the ISO performance of the sensor, the easier it is in low light conditions, i.e., at higher ISO values. Also, a larger sensor contains larger photosites, which enhance the camera's ability to capture low-light photos compared to a smaller sensor (MasterClass 2020).

The dynamic range is the measure of the range, the difference between the lightest and the darkest tone that can be captured in an image. According to other definitions, "dynamic range describes the ratio between the brightest and darkest parts of an image, from pure black to brightest white" (Dominic). An increased dynamic range will help us in difficult light conditions, such as when the sunlight is strong and the shadows are harsh. Without a high-performance sensor in this regard and for the most accurate image exposure, we will have to resort to the technique called bracketing. This involves covering the entire dynamic range of the subject. The subject will be photographed at different exposures so that a white or black area in one photo is properly exposed in another photo.

In post-processing bracketed photos are used to create a high dynamic range photo (no. 1), also called HDR. As can be seen in the figure below, exposing the wooden box in the first photography (no. 2) almost correctly makes the building in the background not covered, due to differences in brightness. For this reason, a second photo (no. 3) was taken, in which the building is captured, but the interior space is totally underexposed. There are many situations, especially in the case of burglary, in which it is necessary to photograph a broken window from a dark room. This technique can help us to capture both the window frame and the shards, the remaining glass parts.

Figure 5. Exposure Bracketing Process
Source: www.pinterest.com

Disadvantages of a larger sensor

The first disadvantage of large sensor cameras, noticeable before the purchase moment, is the price, which is usually prohibitive. Moreover, the larger the camera sensor, the more expensive the lenses attachable to it are.

One disadvantage in use is the lack of portability, namely the size and weight of a camera with a large sensor. Such a sensor requires a larger and tougher housing, larger and heavier lenses. In certain situations, especially in dynamic scenes or in the case of undercover shooting, it would be necessary for the shooting equipment not to be noticeable, to offer mobility to the user and not to expose him. Also, in terms of speed of use, it should be noted that photos taken with such sensors take up a lot of space on the memory card. In this sense, even using high-speed transfer cards, we will not be able to shoot in a burst, and it will be necessary to purchase storage devices with a large storage space. I remind, that even in the days of analogue photography, you could shoot 36 photos with 35mm film (the equivalent of today's full-frame sensors) and 12 photos with 120mm film (the equivalent of today's medium-format sensors).

At the same time, it should be noted that larger images, which contain more information and take up more space on the storage device, require a high-performance computer for editing. Investing in such a purchase will most likely require the purchase of hardware to support post-processing of photos.

If in portrait photography, for example, users want to separate as well as possible the subject from the background, this rule does not apply in forensic photography. Each photo should contain as many details as possible that can be analyzed later, and in the case of the overall photo, the depth of field should be as wide as possible to capture both nearby and distant elements, as large apertures make the background of an image to become unrecognizable (Taylor n.d. 49). The downside is that when using cameras with large sensors, the depth of field will be shallower than if we use the same lens as a camera with a smaller sensor. The figure below is edifying. From left to right, we can see the effect of the sensor on the depth of field, using medium-format, full-frame, APS-C and Micro Four Thirds sensors.

Figure 6. Depth of Field Using Different Sensors
Source: www.picturecorrect.com

Even if in overall photography this aspect does not seem to be relevant, because the aperture can be closed in good light conditions, we must use this information because in close-up and evidence photography, where the front lens is very close to the subject, the depth of field will be narrow, and the aperture will have to be closed even to f/22. In this case, only a small amount of light will reach the surface of the sensor.

Conclusions

Going back to our question and answering this time, bigger does not mean better in every situation. If a bigger sensor means a wider angle, a higher resolution, a higher performance in low light conditions and an increased dynamic range, I can not recommend medium format sensors for shooting macro, close-up or evidence photography.

I consider that the camera should be chosen according to the type of photography practiced. I think that, in forensic photography, the most suitable sensor is the full-frame one. These are the most technologically advanced, and for several years now, manufacturers have been launching mirrorless full-frame cameras, which are much more compact and lightweight than classic D-SLRs. The range of lenses and accessories compatible with cameras with a full-frame sensor is wider than for any other sensor, and this should be taken into account.

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