Developments of the viewfinder system in digital photographic cameras

Prof. Samia Hamed Abd El-Kader ElSayed
Professor at the Department of Photography, Cinema, and TV- Faculty of Applied Arts - Helwan University and 6 October University
samia.hamed18@yahoo.com
Associ. Prof. Dr. Mohamed Galal Abd ElAziz Salama
Associate Professor at the Department of Photography, Cinema, and TV- Faculty of Arts – 6 OctoberUniversity
galal.salama@gmail.com
Assist. Prof. Dr. Mariam Mohamed Mohamed Hassan
Assistant Professor at the Department of Photography, Cinema, and TV
Faculty of Applied Arts – 6 October University
Maryamhassan.art@o6u.edu.eg

Abstract

The viewfinder systems in digital cameras witnessed multiple vision identification systems, like the digital single-lens reflex camera (DSLR), which uses optical viewfinders systems (OVFs), and was considered a scientific breakthrough until some problems appeared in various applications, like the camera size and weight, and number of frames per second. With the emergence of mirrorless cameras that use the electronic viewfinders systems (EVFs), some of these problems were solved due to the difference in the electronic viewfinders (EVFs) technology, the way the image is seen and recorded on the image sensor. However, other problems appeared like the large consumption of battery power by the electronic viewfinder (EVF) and the electronic image sensor.

The research questions

Due to arising problems in the DSLR camera technology and its optical viewfinders (OVFs), and the production of the mirrorless camera technology with their electronic viewfinders (EVFs) system, this research aims to study the different characteristics of both the optical viewfinders (OVFs) and electronic viewfinders (EVFs) to determine the extent to which the mirrorless cameras have been able to tackle some of these problems, which can be limited in this research to the following: -

- the digital viewfinder system,
- the size and weight of the camera,
- frames per second.

The research objectives

This research seeks to study the recent systems of electronic viewfinders (EVFs) and optical viewfinders (OVFs) to identify the different characteristics of each to determine the extent to which the aforementioned problems were solved, and their impact on the camera performance in general.

Research Methodology
This research adopts the descriptive-analytical method.

Key Words
Digital single-lens reflex camera (DSLR), mirrorless camera, optical viewfinders (OVFs), electronic viewfinders (EVFs).

الملخص:
مرت أنظمة تحديد الرؤية فى الكاميرات الفوتوغرافية الرقمية بأنظمة متعددة ، منها الكاميرات الرقمية العاكسة ذات العدسة الواحدة (Digital Single-Lens Reflex Cameras (DSLR والتى تعمل بنظام محددات الرؤية البصرية (OVFs (واعتبرت طفرة علمية وانتشرت انتشاراً واسعاً فى ذلك الوقت، إلى أن ظهرت بعض المشكلات أثناء التطبيقات المختلفة، مثل حجم ووزن الكاميرا وعدد اللقطات المصورة فى الثانية الواحدة. ومع ظهور الكاميرات غير المرآوية Mirrorless camerasالتى تعمل بنظام محددات الرؤية الإلكرونية(EVFs (، تم حل بعض هذه المشكلات. وذلك نتيجة اختلاف تقنية ((EVFs عن(DSLR (، وكيفية رؤية الصورة وأيضا تسجيل الصورة النهائية على مستشعر الصورة الإلكترونى. فى حين ظهرت مشكلات آخرى تتمثل فى استهلاك محدد الرؤية الإلكترونى ومستشعر الصورة الإلكترونى لطاقة البطارية بشكل كبير.

المشكلة البحثية:
بظهور بعض المشكلات فى تقنية الكاميرات (DSLR) بنظام((OVFs ، وإنتاج تقنية الكاميرات غير المرآوية بنظام) (EVFs، يسعى هذا البحث إلى دراسة الخصائص المختلفة لكل من(OVFs (، (EVFs)، لتحديد إلى أى مدى تمكنت الكاميرات غير المرآوية بنظام(EVFs) ، **في لوضع هذه المشكلات والتى يمكن حصرها فيما يلى:**
-نظام محددات الرؤية فى الكاميرات الرقمية
-حجم و وزن الكاميرا
-عدد اللقطات المصورة فى الثانية الواحدة.

الهدف من البحث:
يهدف هذا البحث إلى دراسة مستحدثات نظم محددات الرؤية (EVFs - OVFs) للوقوف على الخصائص المختلفة لكل منهما، والوصول إلى أى مدى تم معالجة المشكلات السابقة ومدى تأثيركل منهما على أداء الكاميرا بشكل عام.

منهجية البحث:
اتباع المنهج الوصفى التحليلى.

الكلمات الدالة:
-الكاميرا الرقمية ذات العدسة الأحادية العاكسة
-الكاميرا غير المرآوية
-محددات الرؤية البصرية
- محددات الرؤية الإلكترونية

Introduction
With the development of electronics and photography technology throughout the ages, digital cameras (DSLR) have replaced the decades-long, classic, film-based, single-lens reflective cameras (SLR). The DSLR cameras use a digital image sensor instead of a film to record images. The digital image sensor consists of millions of pixels, each of which is a light-sensitive element that converts the optical image into a digital image, and eventually reproduces it again to the original optical image. This made DSLR cameras a technological breakthrough for photography at the time.

However, during the various practical applications, some problems arose (e.g.in the viewfinder system, size and weight of the camera, battery life, and frames per second) requiring the production of newer technology, the mirrorless cameras, on the market in 2009. As a result, the DSLR cameras and mirrorless cameras became dependent on different operating mechanisms for obtaining the photograph. Due to the fundamental differences between both cameras - represented in the way the image can be seen across the viewfinder - there have been changes in the camera as a whole. Thus, this research addresses the differences between the optical viewfinders (OVFs) of DSLR cameras and the electronic viewfinders (EVFs) of mirrorless cameras, their respective operating mechanisms, the resulting difference of the digital viewfinder system, the size and weight of the camera, the battery life, the number of frames taken per second rate (FpS), and the and limited resolution of these problems.

1. The system of viewfinders

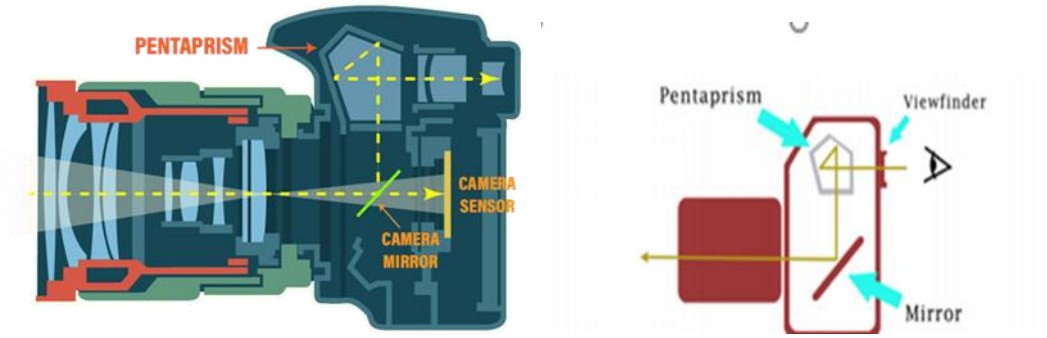
The viewfinder is the primary component of the camera and is a small display unit at the top of the DSLR or mirrorless camera through which the composition of the scene can be seen, focused on, and framed. It may not be available on all cameras, but in this case, the rear LCD screen is used to determine the image. The viewfinder is one of the most important tools to assist photographers to shoot a properly displayed image.

There are two main types of viewfinders: One is the optical viewfinders (OVFs) which use prisms and mirrors to display images, and the other is the electronic viewfinders (EVFs) that use an electronic monitor (Suzuki, 2017).

1.1 The operating mechanisms of both the OVFs and the EVFs

Most DSLR cameras operate with optical viewfinders (OVFs), while mirrorless cameras rely on electronic viewfinders (EVFs). Both cameras usually have an LCD monitor for live display. Yet, each has a different operating mechanism.

For the DSLR, which relies on the optical viewfinders (OVFs), light passes through the camera lens to hit a 45-degree slanted mirror located in front of the image sensor (creating an inverted image). Then the mirror reflects the light up to the pentaprism that reflects the image again (and therefore corrects it) and sends it to the optical viewfinder (OVF) lens that allows the image to be seen. When pressing the shutter button, the mirror rises and exposes the digital sensor that records light information in the camera memory card digitally and captures the image. Figures 1 and 2 show the operating mechanism of the DSLR camera.



FIGURES 1 AND 2: THE OPERATING MECHANISM OF THE DSLR CAMERA
Image source: Caioni (2020). Photography Equipment,
https://www.pixinfocus.com/viewfinder/

Mirrorless cameras, on the other hand, have electronic viewfinders (EVFs) where light passes through the lens directly onto the image sensor for processing. The image is then displayed directly from the sensor readout, either on the monitor at the back of the camera or in the electronic viewfinder (EVF) which is essentially a very small monitor (about half an inch) at the top back of the camera (Photography Pixel, 2021).
When shooting an image, the camera simply records what is on the sensor at that moment in time, and the image is digitally produced (Hall et al., 2021). Once the image is seen and confirmed, the sensor digitally records light information on the camera memory card (reference). Figures 3 and 4 show the operating mechanism of mirrorless cameras.

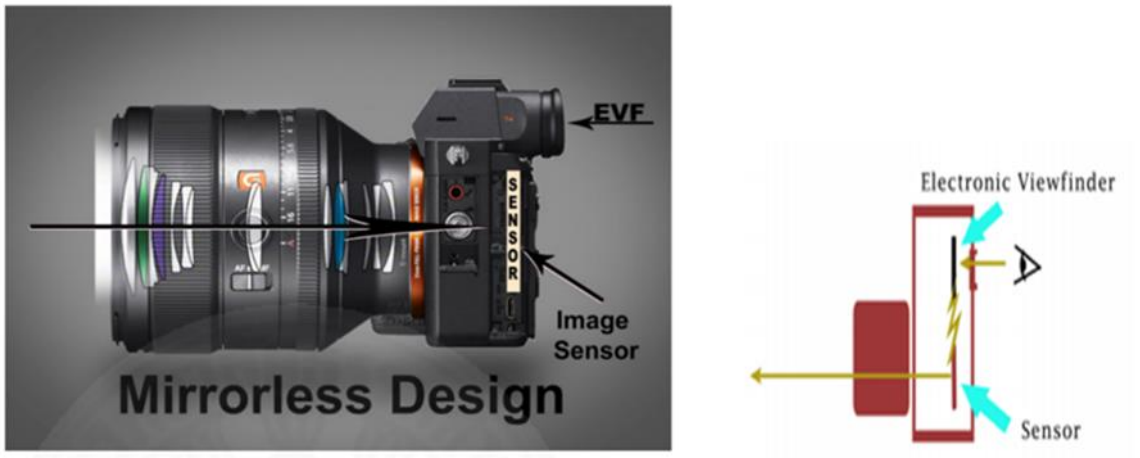


FIGURE 3 AND 4: THE OPERATING MECHANISM OF MIRRORLESS CAMERAS
Image Source: Kelion (2018). Mirrorless cameras: Photography's new decisive moment. BBC article.
Photography Pixel (2021). What is a Camera Viewfinder? (Optical VS Electronic),
https://photographypixel.com/camera-viewfinder/

The image can also be sent and displayed directly from the image sensor readouts to a viewfinder that may be a separate accessory, as with the Canon EVF-DC2 electronic viewfinder, which can be mounted on the camera installation base. Figure 5 presents the independent electronic viewfinder (Incekara et al., 2017).

FIGURE 5: THE INDEPENDENT ELECTRONIC VIEWFINDER
Image source: Gear Photo (2017). What is an EVF?
https://www.adorama.com/alc/what-is-an-evf/

Accordingly, the main difference between DSLR and mirrorless cameras is that the latter does not have a mirror or a pentaprism, depending on its performance thereby on the image sensor. Moreover, it is smaller and less weighty (Canon, 2020a).

1.2 The main similarities and differences between optical viewfinders (OVFs) and electronic viewfinders (EVFs)

Both the optical viewfinders (OVFs) and the EVFs are similar in some features and different in others, and hence, their performance differs. The similarities and differences can be noted as follows:

1.2.1 The ability of the viewfinder to work when the camera is turned off

When turning off the DSLR camera, the optical viewfinders (OVFs) work well and face no problems with the accuracy of color display or screen update rates. Whereas the electronic viewfinders (EVFs) do not work when the mirrorless camera is turned off (Ringsmuth, 2018).

1.2.2 The phenomenon of viewfinder blackout

The phenomenon of viewfinder blackout happens when the optical viewfinder (OVF) monitor becomes dark, and the image cannot be seen the moment it is captured. This occurs when pressing the shutter and the mirror flips out of the way to allow light to pass through the image sensor, which means that optical viewfinder (OVF) becomes completely dark at his moment. This effect is not noticeable when using fast shutter speeds, but appears with speeds of 1/30 seconds or slower, as this blackout period will neither make nor break the image and may cause problems when shooting fast-moving targets. In these cases, the short time when the optical viewfinder (OVF) is blank becomes enough for the object to move slightly. However, this phenomenon does not occur with electronic viewfinders (EVFs) as they do not contain mirrors (Shutter Release, 2021).

1.2.3 Previewing the field depth through the viewfinder

The optical viewfinders (OVFs) do not offer information about what the actual depth of the image's field will be. Although DSLR cameras have a preview button for the depth of the field that will close any aperture, yet if shooting images at smaller apertures, the objects will look

unrealistically dark (as the aperture will significantly reduce the amount of light going through the optical viewfinders (OVFs). This does not occur with the electronic viewfinders (EVFs) that have the ability to display the image that is already recorded on the image sensor (ibid).

1.2.4 Viewing and reviewing the images through the viewfinder

It is difficult to see and review the image taken in sunny places on the rear LCD monitor both in DSLR cameras and mirrorless cameras. Nonetheless, mirrorless cameras have the ability to view and review the image in electronic viewfinders (EVFs) which is absent in the optical viewfinders (OVFs) (Shahrul, 2021).

1.2.5 The position of the viewfinder monitor

A headache can be caused when looking at the real scene through the optical viewfinders (OVFs) for a long time, as the eye focuses then through a small lens that is adjacent to the eye on a far focal point (at the distance of the object site). While this does not happen with the electronic viewfinders (EVFs) as the eye focuses on a small monitor placed near the eye (in the position of the viewfinder) (ibid).

1.2.6 Processing the scene in low and bright light

The visual scene appears better through the optical viewfinders (OVFs) whether in low-light situations or bright lighting, as the eye-level viewfinder position makes the eye unaffected by reflections, and therefore, the image can be seen well in the bright sunlight (Hall et al., 2021). Whereas the visual scene appears through the electronic viewfinders (EVFs) in bright sunlight as a dark image compared to the real scene. Also, over and under-exposure makes the image hardly visible (Shahrul, 2021).

1.2.7 Previewing the camera settings through the viewfinder

The optical viewfinders (OVFs) display at the bottom a set of information about the camera settings such as aperture, exposure, shutter speed, ISO sensitivity speed, metering mode, indicators for showing focal points, frame guides, remaining shots, and some other data (Galdino, 2000; Hall et al., 2021). Figure 6 shows the camera settings on optical viewfinders (OVFs).

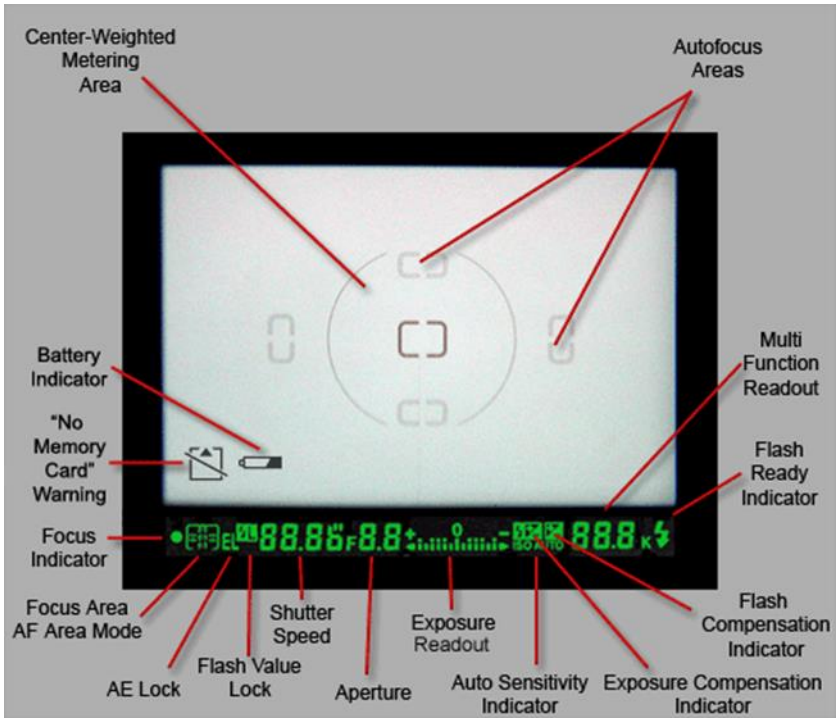


FIGURE 6: THE CAMERA SETTINGS ON OVFS
Image source: Etchells& Barnett (2005). Nikon D50/Viewfinder, https://www.imaging-resource.com/PRODS/D50/D50A7.HTM

The camera settings like the aperture, exposure, shutter speed, ISO, metering mode, and battery charge are also displayed on the electronic viewfinders (EVFs) of the mirrorless cameras or on their rear LCD monitor (Sheldon, 2018).

1.2.8 Previewing the impact of camera settings through the viewfinder

The final image of the "real" scene recorded on the image sensor is different from the preview image on optical viewfinders (OVFs). And this difference appears in the exposure, depth of field, brightness, contrast, or color tones (Ringsmuth, 2018).

While the monitor of the electronic viewfinders (EVFs) displays how the image will look precisely in terms of composition change, depth of field, and focusing in a way that matches the images that will be recorded on the image sensor (Suzuki, 2017).

Moreover, the electronic viewfinders (EVFs) have the feature of displaying information such as the histogram of the live image, which can be considered as a simulation of the digital image recorded by the camera and allows confirming that the camera is flat on the ground. In addition, by magnifying part of the image to fit the monitor, the focus can be verified, the image list can be browsed, and additional guidelines can be added such as the image network that helps frame the images. Figure 7 shows the photo grid on the electronic viewfinders (EVFs) (Ringsmuth, 2018; Sheldon, 2018).

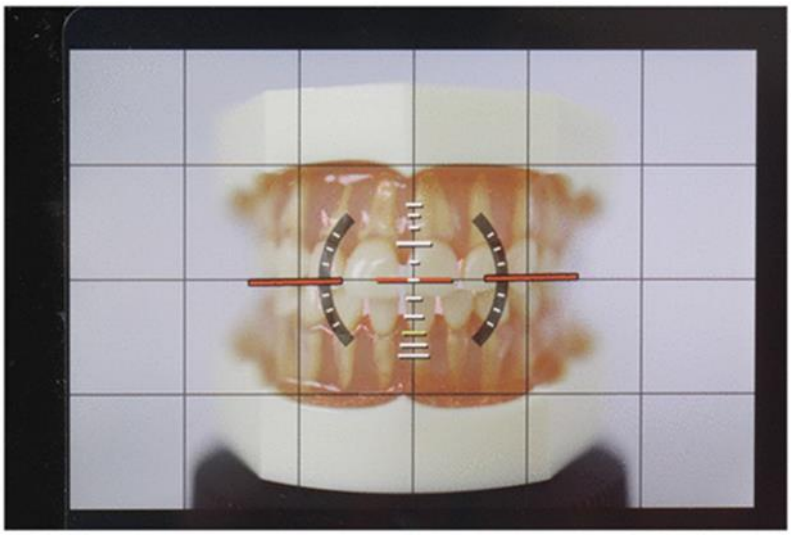


FIGURE 7: PHOTO GRID ON THE EVFS
Image source: Shahrul (2021). Mirrorless cameras in orthodontic practice. Journal of Orthodontics, 1-5, https://doi.org/10.1177/14653125211000055

1.2.9 The number and distribution of the autofocus (AF) points

The number and distribution of the AF focal points vary from camera to camera. For example, the Canon DSLR EOS 7D Mark II camera has only 65 AF points that are grouped in the middle of the frame. While in mirrorless cameras, the number of AF points in the Canon EOS RP camera is 4,779 and covers the full-frame. This is very important when trying to focus on a target on the edges of the image frame (Canon, 2021b).

1.2.10 The AF sensor of the DSLR camera

The AF sensor of the EOS DSLR camera can track a moving target and predict its location per second when pressing the shutter button. The camera will constantly focus on the target in the high-speed shooting mode. The main hypothesis behind this type of AF – called also AF Eye-Detection & Subject Tracking - is that the camera knows exactly how far the focus mechanism should be moved in the lens and in which direction to achieve focus. Figure 8 shows the AF of an EOS DSLR camera (Sengupta, 2021).

FIGURE 8: THE AF OF AN EOS DSLR CAMERA
Image source: Sengupta (2021). DSLR vs. Mirrorless Cameras in 2021 | What are the Key Differences and How to Choose Which is Best for You?
https://shirshendusengupta.com/blog/dslr-vs-mirrorless-cameras-key-differences-how-to-choose-which-is-best-for-you

1.2.11 The AF sensor of a mirrorless camera

The AF sensor of a mirrorless camera is part of the image sensor, and hence no error can occur here. Therefore, no adjustments in the AF fine or on the f/1 and f/1.2 fast lenses are required. As a result, it constantly gets the perfect focus. Nonetheless, this does not neglect the possibility of an error if the object is moving or when choosing a wrong AF sensor (Rockwell, 2018).

1.2.12 The image sensor as a tool for AF

Mirrorless cameras rely heavily on their performance on the image sensor, which acts as an AF image sensor (Canon, 2020b). And with the advances in AF to detect the phase and contrast, this has improved the performance of the camera and made it as fast and accurate as of its DSLR counterpart (Captain, 2020).

1.2.13 The hybrid AF technology

The hybrid AF technology is a combination of phase detection and contrast detection. The modern mirrorless cameras have faster and more accurate hybrid autofocus, particularly eye AF, which can identify a person's or animal's eye from a distance and follow its motion (Galdino et al., 2000; Sengupta, 2021). Figure 9 shows the eye AF of the mirrorless cameras.

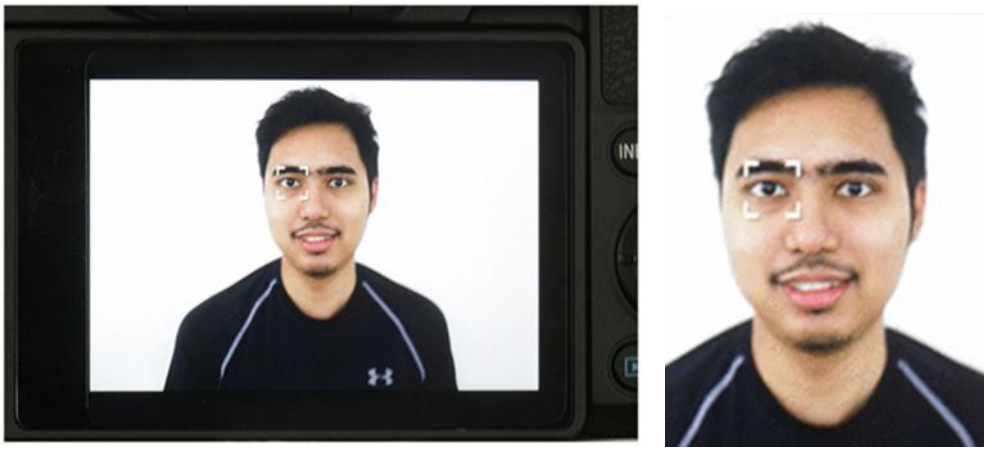


FIGURE 9: THE EYE AF OF MIRRORLESS CAMERAS
Image source: Alpha Universe (2016). Discover the power of Eye AF,
https://alphauniverse.com/stories/discover-the-power-of-eye-af/

1.2.14 The Dual Pixel CMOS AF system

The EOS DSLR cameras and Canon EOS R and EOS M Mirrorless cameras feature an advanced system known as "Dual Pixel CMOS AF", where each pixel acts as a target detection sensor, adding extra features to the camera capabilities that have reduced significantly the time needed for focusing, even in situations where the object is moving (Canon, 2020b).

1.2.15 The focus peaking

Mirrorless cameras have the focus peaking feature that highlights a particular part of the image that is in focus. This feature is valuable for obtaining a consistent and sharp focus image. Figure 10 shows the focus peaking (Shahrul, 2021).

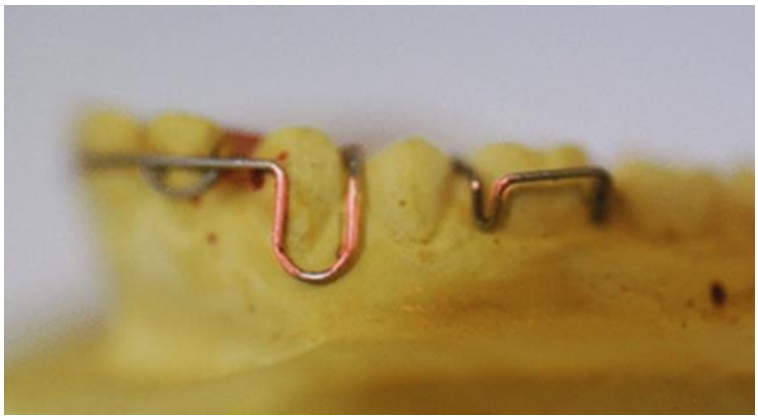


FIGURE 10: THE FOCUS PEAKING
Image source: Shahrul (2021), op. cit.

1.2.16 The sharpness and resolution of electronic viewfinders

The EVFs differ among themselves in their sharpness and resolution, depending on the number of pixels that they have. These can range from 2.36 megapixels to about 4 megapixels. The more pixels, the higher the resolution will be and the sharper the screen will look. Recently, some cameras (like the Fuji X-Pro2, and Fuji X100F) even offer hybrid viewfinders that allow switching between optical and electronic viewfinders (Shutter Release, 2021).

1.2.17 The video option

When taking a video using a DSLR camera, the camera needs to switch to a live display. The result is then very similar to the Canon EOS mirrorless camera in terms of focus and tracking. Both the modern DSLR camera model Canon EOS DSLR and the mirrorless camera model Canon EOS have a Dual Pixel CMOS AF system that is considered a huge breakthrough from previous generations.

Nevertheless, the mirrorless camera has the advantage of using the electronic viewfinders (EVFs) during video shooting in the sunshine in a better way than using an LCD monitor. Whereas it is not possible to use the optical viewfinder (OVF)of the DSLR when shooting video. In that case, an LCD monitor is used (Little, n.d).

The sound can be picked up using the built-in microphone. For better performance, an external microphone should be added (Canon, 2020b).

2. Camera size and weight

DSLR cameras operating with optical viewfinders (OVFs) usually have a relatively large size and weight because they contain a 45-degree tilted reflective mirror, a secondary autofocus mirror, pentaprism as well as other parts of the autofocus system. All these parts have a heavier weight and also need enough space to tilt the mirror and its movement during filming. As a result, the camera size becomes larger and its weight heavier than the mirrorless camera that operates with the electronic viewfinders (EVFs) that depends on an electronic image sensor, making the camera smaller and less weighty (Gear Photo, 2021).

With the production of mirrorless cameras with full-frame and medium-format image sensors in sizes suitable for the camera size and the rising need for switching lenses as well as using long focal length lenses, the size advantage started to lose importance, forcing the manufacturers thereby to produce camera-specific zoom lenses (Wueller, 2006). However, most of these lenses have almost the same weight and size as the DSLR lenses. So, when using these huge lenses with their different characteristics, the camera becomes heavier than it was and more difficult to balance due to the difference between the lightweight of the camera body and the heavy-weight lens (Zoltie, 2018). Manufacturers have recently produced new special lenses for mirrorless cameras that tend to be larger and heavier than DSLR but are designed for higher resolution to suit future cameras (Shahrul, 2021). Figure 11 shows the size of both the DSLR and mirrorless cameras

Figure11: The size of the DSLR and mirrorless cameras
Image source: Şenel (2014). Dijital SLR & Aynasız, https://senelfoto.com/2014/04/01/dslr-aynasiz/

3. Battery life

Digital cameras rely on the battery as a power source for operation. Therefore, the battery life is a key factor when the differences among the digital cameras are large and obvious. On the other hand, the battery of mirrorless cameras is weaker than its counterpart of the DSLR cameras for the following reasons:

3.1 Image processing and camera setting

In DSLR cameras it is possible to preview the image and adjust the camera setting while the camera id´s turned off and use power only when taking a shot. This extends the battery life. While in the mirrorless cameras, the camera has to be continuously on when processing the image or adjusting the camera settings (Etchells& Barnett, 2005).

3.2 The viewfinder

The DSLR camera has a longer battery life as its viewfinder works through the reflective lens and prism and hence, does not need power energy. Whereas the mirrorless cameras with their electronic viewfinders (EVFs) require a lot of battery energy, as when using the electronic viewfinders (EVFs), the camera constantly collects the electronic image sensor information and then displays them on the small screen of the viewfinder (Captain, 2020).

3.3 The camera technology

Mirrorless cameras perform more functions than DSLR cameras, and all depend on the battery energy as their operating systems require a lot of power, which leads to battery rapid depreciation and shorter life (Rockwell, 2018).

3.4 Battery size

The DSLR cameras have a relatively larger design and thus, require a bigger battery size. This may indicate that its power is bigger compared to the mirrorless cameras that have a smaller design and hence, a smaller and weaker battery (Lawton, 2021).

3.5 The average number of frames per battery charge

The number of frames per charge depends on the battery power. Usually, the DSLR cameras have an average of 800-1000 frames per charge, and professional DSLR cameras even offer 2000 and more frames per charge (Lim, 2020).

In mirrorless cameras, the battery is weaker allowing only for 300-700 frames per charge.

4. Frames per second

With the absence of mirrors in the design of the mirrorless cameras, the frame rates are not related to mechanical motion. Hence, the mirrorless cameras offer no less than 10 frames per second and may reach 30 frames per second with great sharpness and continuous autofocus between the shots. While the best DSLR camera can't keep pace with the speeds of the best mirrorless cameras. The mirrorless camera design allows for easy high-speed photography and continuous shooting as some of the camera functions are performed on the image sensor itself like the autofocus, which leads to high-speed focus. Also, a lot of models offer (4K/8K) video that processing power. For example. The best Canon EOS-1D X Mark III DSLR camera can take 16 frames per second, whereas the Panasonic Lumix G9 or the Sony Alpha A9 II mirrorless cameras can take 20 frames per second. The Sony A1 even raised the frame rate to 30 frames per second with autofocus, which is a huge and interesting achievement. In contrast, some DSLR cameras offer high frame rates (that may reach in some cases to 60 frames per second). But these rates need to use an electronic shutter and adjusting the focus from the first shot, which is not practical when shooting moving objects or using some types of artificial light. In addition, taking 60 frames per second would mean that the memory card will be filled up fast.

Mirrorless cameras excel in video shooting, as they offer high-quality video (4K/8K) and other video features that most DSLR cameras cannot keep up with them. Also, the mirrorless cameras have effective autofocus in the direct display and processing power (Hall et al., 2021).

Results

The DSLR camera is a digital camera that combines the optics with SLR camera mechanisms, yet the film is replaced with an image sensor and optical viewfinder (OVF). While the mirrorless camera lacks a mirror and relies on an electronic image sensor system and electronic viewfinder (EVF). Due to their different techniques, diverse variations were inferred from this research as follows:

First, the electronic viewfinders (EVFs) of the mirrorless cameras are characterized by the following:

1- have a bigger window,

2- enjoy increased brightness of the electronic viewfinder (EVF) monitor in low light conditions

3- show 100% of what the sensor will capture,

4- display important guides and information on the monitor like ISO, aperture, a live histogram map, and white balance settings, among others,

5- adjust the depth of field and exposure while composing the shot

6- facilitate manual focusing by magnifying a part of the frame for a clear view when the subject is in sharp focus,
7- show a true reflection of what the final image would like and allow the image to be immediately seen after being taken.
8- however, exhaust with the image sensor the battery energy faster than the DSLR cameras making battery life shorter.

As a result, the mirrorless cameras started to have the following characteristics:
1- have faster continuous shooting speeds,
2- have a smaller size and weight than its DSLR counterpart, as mirror settings are not needed,
3- have frame rates no less than 10 frames per second, and 20 or 30 frames per second in advanced models with full sharpness and continuous automatic adjustment between the shots,
4- have fast autofocus of the image as well as eye and target tracking
5- have a fast and silent electronic shutter,
6- offers video recording with 4K and Ultra HD
7- are useful when traveling due to their small size and weight
8- however, do not benefit from the small size and weight characteristic when using large lenses with certain specifications,
9- are not suitable for people with big hands due to their small parts.

Second, the optical viewfinders (OVFs) of the DSLR cameras are characterized by the following:
1- can adjusting camera settings and examine the images when the battery is turned off, while use battery power when shooting images to extend battery life,
2- enable the vision in low and high light conditions,
3- display the different camera settings like the exposure, aperture, …etc.,
4- provide real-world visions and not the image recorded on the image sensor,

As a result, the DSLR cameras started to have the following characteristics:
1- have a dynamic range and better image vision,
2- differentiate better the tones among the parts of the frame pale areas,
3- are ideal for sports photography as seeing the event instantly becomes critical for capturing the right moment,
4- however, a loud noise takes place the moment the image is taken caused by the horizontal movement on top of the DSLR camera.

Recommendations

From the previous research results, it can be inferred that each type of viewfinder has its advantages and disadvantages that affect the design and characteristics of the camera. Thus the photographer has to balance between the characteristics of the camera and the work needs to produce high-quality images.

References

Alpha Universe. "Discover the power of Eye AF", 2016, https://alphauniverse.com/stories/discover-the-power-of-eye-af/ (accessed December 8, 2020).

Caioni, S.. "Photography Equipment", 2020, https://www.pixinfocus.com/viewfinder/ (accessed July 21, 2021).

Canon. "Mirrorless vs DSLR Cameras: Which is Right for You?" 2020a, https://www.canon.co.nz/explore/mirrorless-or-dslr-cameras (accessed December 8, 2020).

Canon. "Canon EOS RP – Cameras". 2020b, https://www.canon.co.uk/cameras/eos-rp/ (accessed December 8, 2020).

Captain, S.. "DSLR vs. Mirrorless Cameras: Which is better for you?", 2020, https://www.tomsguide.com/face-off/dslr-vs-mirrorless-cameras, (accessed December 9, 2020).

Etchells, D.& Barnett, S.. "Nikon D50 - Image Resource", 2005, https://www.imaging-resource.com/PRODS/D50/D50A7.HTM (accessed July 21, 2021).

Galdino, G.M., Manson, P.N., Kolk, C.A.V.. "The Digital Darkroom, Part 2: Digital Photography Basics". *Aesthetic Surgery Journal* 20, no. 6 (2000): 1–27.

Gear Photo. "What is an EVF?", 2017, https://www.adorama.com/alc/what-is-an-evf/ (accessed July 24, 2021).

Gear Photo. "Mirrorless vs DSLRs: How Do They Compare?", 2021 https://www.adorama.com/alc/mirrorless-cameras-vs-dslr/ (accessed July 24, 2021).

Hall, P., Davies, A.,& Wilson, M.. "Mirrorless vs. DSLR Cameras: The 10 Key Differences You Need to Know", 2021, https://www.techradar.com/news/mirrorless-vs-dslr-cameras, (accessed July 23, 2021).

Incekara, A.H, Seker, D.Z, Delen, A., & Acar, A.. "Investigating the suitability of mirrorless cameras in terrestrial photogrammetric applications". In: *ISPRS Annals of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, Volume IV-4/W4, 2017, *4th International GeoAdvances Workshop*, 14–15 October 2017, Safranbolu, Karabuk, Turkey, p. 259.

Kelion, L.. "Mirrorless cameras: Photography's new decisive moment". *BBC* (26 September 2018), https://www.bbc.com/news/technology-45627055 (accessed July 20, 2021).

Lawton, R.. "DSLR vs mirrorless cameras in 2021: which type is best? We help you choose". *The Digital Camera World*, 2021, https://www.digitalcameraworld.com/features/dslr-vs-mirrorless-cameras-how-do-they-compare#section-focusing (accessed July 25, 2021).

Lim, R.. "7 Things You Need To Know About Electronic Viewfinders (EVFs)", 2020, https://photographyconcentrate.com/7-things-you-should-know-electronic-viewfinders-evfs/ (accessed July 24, 2021).

Little, J.D.. "What are the Differences Between a DSLR and a Mirrorless Camera". (n.d), https://photzy.com/what-are-the-differences-between-a-dslr-and-a-mirrorless-camera/ accessed July 26, 2021).

Photography Pixel. "What is a Camera Viewfinder? (Optical VS Electronic)", 2021, https://photographypixel.com/camera-viewfinder/ (accessed July 22, 2021).

Ringsmuth, S.. "Optical Versus Electronic Viewfinders: Which is Best for You?", 2018, https://digital-photography-school.com/optical-versus-electronic-viewfinders-best/ (accessed July 21, 2021).

Rockwell, K.. "Mirrorless vs. DSLR", 2018, https://kenrockwell.com/tech/mirrorless-vs-dslr.htm (accessed July 25, 2021).
Şenel, A.. "Dijital SLR & Aynasız", 2014, https://senelfoto.com/2014/04/01/dslr-aynasiz/ (accessed July 25, 2021).
Sengupta, S.. "DSLR vs. Mirrorless Cameras in 2021 | What are the Key Differences and How to Choose Which is Best for You?", 2021, https://shirshendusengupta.com/blog/dslr-vs-mirrorless-cameras-key-differences-how-to-choose-which-is-best-for-you (accessed July 22, 2021).
Shahrul, Al Imran. "Mirrorless cameras in orthodontic practice". *Journal of Orthodontics*, 2021: 1-5, https://doi.org/10.1177/14653125211000055 (accessed August 1, 2021).
Sheldon, W.. "Mirrorless vs DSLR Navigating the Hype", 2018, https://tinyurl.com/y6vndy4u (accessed July 25, 2021).
Shutter Release. "What Is a Viewfinder on a Camera? Everything You Need to Know", 2021, https://shutterreleaseworld.com/what-is-a-viewfinder-on-a-camera/ (accessed July 22, 2021).
Suzuki, T.. "Camera Basics #12: The Viewfinder". *Digital Camera Magazine*, 2017, https://snapshot.canon-asia.com/article/en/camera-basics-12-the-viewfinder (accessed July 26, 2021).
Wueller, D.. "Evaluating digital cameras". *Proceedings Volume 6069, Digital Photography II*, 2006, https://doi.org/10.1117/12.643727 (accessed July 22, 2021).
Zoltie, T.. "Mirrorless cameras for medical photography–time to switch?". *Journal of Visual Communication in Medicine* 41(2018): 103–108.